

VOLUME 5 OF 5

City of Waukesha Environmental Report for Water Supply Alternatives

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City of Waukesha Environmental Report for Water Supply Alternatives

Prepared for
City of Waukesha Water Utility

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Executive Summary

Executive Summary

This Environmental Report (ER) has been developed to update and provide additional information to the February 2012 Environmental Report (February 2012 ER). The City of Waukesha (the City) submitted the City of Waukesha Application for a Lake Michigan Water Supply Diversion with Return Flow in May 2010 and the ER in February 2012. An updated version of the Application will be completed in 2013 and summarized in Volume 1 of 5, Application Summary, City of Waukesha Application for a Lake Michigan Diversion with Return Flow (Application) to address changes in the proposed project and return flow management plan. This ER provides the necessary updates to the February 2012 ER in order to be consistent with the 2013 Application. This ER and the February 2012 ER are similarly organized.

The major changes included in the ER include:

1. The City of Waukesha has selected the City of Oak Creek as the Lake Michigan water supply provider. The water supply negotiations with the City of Oak Creek provided insights into a more efficient and beneficial connection point into the City of Oak Creek water distribution system. With the selection of the City of Oak Creek as the water supplier, a new water supply pipeline alignment has been added to this ER. The new Lake Michigan water supply alignment from the City of Oak Creek has been determined to meet the long-term water supply needs of the City of Waukesha. The Oak Creek alignment identified in the February 2012 ER will now be considered an additional Oak Creek alignment alternative. Refer to later sections in this document for further descriptions of the updated Oak Creek pipeline alignment for the proposed project.
2. A new return flow alignment to the Root River provides environmental benefits and is the preferred return flow alignment. It has been included to provide efficiency and reduced impacts by paralleling the new City of Oak Creek Lake Michigan Supply alignment. Because a total maximum daily load (TMDL) was started on Underwood Creek and a TMDL allocation has not yet been established for return flow, the WDNR has determined that an Underwood Creek return flow could not be approved until a TMDL allocation is available. Consequently, this alternative would not be implementable at this time and is not being pursued at this time.
3. The return flow management plan has also been modified to have continuous flow from the City of Waukesha's Wastewater Treatment Plant (WWTP).
4. The appendices to the Application have been reorganized. Several of these appendices are referenced in the February 2012 ER. These references have been updated.
5. A side-by-side comparison of the new water supply and return flow alignments to the prior alternatives has been updated in this document with a comprehensive comparison included in Appendix 6-2.
6. Clarification is provided on baseflow changes to the Fox River, Pebble Creek, Pebble Brook, and Mill Brook based upon groundwater modeling.

This Executive Summary provides a summary of changes and introduction to the project.

Overview of Waukesha Water Supply

Current Supply and Issues

The City of Waukesha currently obtains approximately 80 percent of its water supply from the deep St. Peter Sandstone Aquifer. Near and beyond the City, this aquifer is confined by a geological feature—the Maquoketa shale layer—that limits natural recharge of the aquifer. Continued use of the aquifer by the City and surrounding communities since the 19th century and the presence of the Maquoketa shale have led to the 500- to 600-foot decline in aquifer water levels (SEWRPC, 2010a).

Reduced groundwater levels in southeastern Wisconsin have in turn affected regional surface waters, which now receive about 18 percent less groundwater contribution as water migrates toward the deep aquifer (USGS, 2007). Significant water quality issues developed with declining water levels in the deep aquifer, including increased levels of salts and radium (a naturally occurring element in the deep aquifer that can cause cancer). To provide drinking water with low levels of radium, the City treats some deep aquifer water to remove radium and blends some deep aquifer water with water from the shallow Troy Bedrock aquifer. The radium concentrations have prompted the State of Wisconsin to issue a consent order to the City to bring their drinking water quality into radium compliance by June 30, 2018.

The City obtains less than approximately 20 percent of its water supply from the shallow aquifer. Increased pumping of it will stress surface water resources by reducing baseflows to local streams and wetlands (SEWRPC, 2010a).

Program to Address Issues

The City has studied water supply options for many years and has been working to address the radium contamination for over 20 years. The Southeastern Wisconsin Regional Planning Commission (SEWRPC) has also conducted a regional water supply study that examined the impacts of public water supplies on the deep and shallow aquifers as well as the use of Lake Michigan as a water supply source. On the basis of groundwater quantity and quality issues, SEWRPC recommended the long-term water supply for the City be Lake Michigan (SEWRPC, 2010a). A Lake Michigan supply is regulated under the Great Lakes-St. Lawrence River Basin Water Resources Compact (Compact) and Wisconsin State Statute § 281.346 which require return flow be sent back to the Great Lakes basin.

The City has explored water supply alternatives, including use of the deep aquifer, shallow aquifer wells, water conservation, and a Lake Michigan water supply source. Water supply and return flow alternatives were developed individually, and return flow alternatives were developed considering the Lake Michigan supply source. These individual water supply and return flow alternatives are combined to create a “system alternative”. A system alternative adds together the environmental impacts from both water supply and treated wastewater discharge to provide the sum of the impacts. An example “system alternative” for a Lake Michigan basin water supply includes connecting to the City of Oak Creek’s Lake Michigan water supply, distribution to Waukesha customers, collection of wastewater in Waukesha’s existing sewer system, wastewater treatment at the City of Waukesha treatment plant, and return flow of treated wastewater to Lake Michigan via the Root River. This ER

examines the environmental impacts associated with the water supply and return flow alternatives.

As part of the water supply planning process, the City has conducted multiple public meetings to solicit comments from City residents and the general public. Four public meetings have been held, including one meeting in a neighboring community adjacent to one of the Lake Michigan return flow alternatives (Wauwatosa, WI), where the public provided verbal and written comments regarding Waukesha's water supply alternatives. Many more public meetings have been conducted in prior years and public meetings continue to take place to update the public on long-term water supply planning activities. Public comments and issues raised have been addressed in this document. A compilation of comments received from City meetings and other public involvement processes is included in the Water Supply Service Area Plan, which is Volume 2 of the City of Waukesha Application for a Lake Michigan Diversion with Return Flow (Application).

Environmental Report Update

Reason for Preparing

This document has been developed to meet the Wisconsin Environmental Policy Act (WEPA) as required by the Wisconsin Department of Natural Resources (WDNR) and regulated under NR 150 Environmental Analysis and Review Procedures for Department Actions. The WDNR has indicated it will follow the WEPA process for evaluating the City of Waukesha water supply alternatives considered under the City's Application. This document is organized to support the WDNR's development of an Environmental Impact Statement (EIS).

The WDNR issued a formal EIS scoping request for a City of Waukesha Lake Michigan water supply on February 5, 2010. This request was issued to interested parties and resources agencies and has also been made available to the general public on the WDNR website. The WDNR has obtained input from the public through a series of public meetings held between July 26-28, 2011 in Pewaukee, Wauwatosa, and Sturtevant, Wisconsin.

Relationship to Other Documents and Programs

The WEPA process calls for interagency coordination, including federal agencies, and references developing reviews consistent with National Environmental Policy Act (NEPA) where multiple agencies are involved. This document is intended to meet the NEPA process should it be required in the future. The City is evaluating water supply alternatives to secure a sustainable, reliable water supply that is protective of public health and provides regional environmental benefits. Despite significant success with an aggressive water conservation program, the City is faced with a declining groundwater supply and worsening water quality conditions. Consequently, the City has been studying water supply alternatives. This ER evaluates the environmental impacts of the water supply alternatives.

This ER references other documents for background purposes, notably the various volumes of the Application and supporting documents.

Purpose and Need

The City needs a long-term water source that can meet water supply demands, is protective of human health and the environment, and is sustainable. The City must also obtain a water supply that meets their consent order for radium compliance by June 30, 2018. The water supply source will be used for public water supply and consider WDNR water supply planning requirements and ultimate buildout water demand.

Alternatives

Water Supply

Water supply alternatives have been studied for the City for many years. In March 2002, the Waukesha Water Utility completed a future water supply study (CH2M HILL and Ruekert/Mielke, 2002). Stakeholders in this study included representatives from the Utility, City of Waukesha, WDNR, SEWRPC, U.S. Geological Survey, Wisconsin Geological and Natural History Survey, and the University of Wisconsin-Madison. The study looked at the following 14 water supply sources and combinations of them:

- Deep (confined) aquifer near Waukesha
- Deep (unconfined) aquifer west of Waukesha
- Shallow groundwater south of Waukesha
- Shallow groundwater west of Waukesha
- Dolomite aquifer
- Fox River
- Rock River
- Lake Michigan
- Dam on the Fox or Rock River
- Waukesha quarry
- Waukesha springs
- Pewaukee Lake
- Milwaukee River
- Wastewater reuse

Other water supply sources were eliminated for various technical reasons. Combinations of alternatives have also been evaluated and screened out. The Water Supply Service Area Plan considered six water supply alternatives in detail, chosen on the basis of previous screening in the Future Water Supply Study and by SEWRPC, stakeholder feedback, and WDNR request. The benefits of an aggressive water conservation program are included in all water supply alternatives. The Application volumes and supporting documentation evaluated and compared the following alternatives in detail:

- Deep and shallow aquifers
- Shallow aquifer and Fox River alluvium
- Unconfined deep aquifer
- Multiple source water supply
- Lake Michigan and shallow aquifer
- Lake Michigan

In this document some of these alternatives were not addressed in detail because they were screened out for implementability, logistics, legal, or for other reasons. As discussed in the Water Supply Service Area Plan (Volume 2 of the Application) the *Lake Michigan and Shallow Aquifer* water supply alternative would utilize the same quantity of shallow groundwater as the *Deep and Shallow Aquifers* water supply alternative. The *Lake Michigan and Shallow Aquifer* alternative would consequently have the same shallow groundwater impacts as the *Deep and Shallow Aquifers* alternative. The *Lake Michigan and Shallow Aquifer* alternative would also have similar impacts as the *Lake Michigan* alternative because pipeline construction and the return flow impacts would still occur. Consequently, the impacts of a *Lake Michigan and Shallow Aquifer* alternative will be greater than the individual impacts of the *Deep and Shallow Aquifers* or the *Lake Michigan* alternatives. The *Lake Michigan and Shallow Aquifer* alternative will instead have a similar impact as adding the impacts of these two alternatives together. Because the *Lake Michigan and Shallow Aquifer* alternative has greater impacts, it is not evaluated further in this document.

The unconfined deep aquifer was eliminated from further evaluation in this document (see Section 2 of this document) because installing high capacity wells in the deep unconfined sandstone aquifer west of the Maquoketa shale has significant logistical, legal, and environmental resource impacts. The multiple source water supply alternatives was also eliminated from further evaluation in this document (see Section 2 of this document) because compared to the five other top ranking alternatives in the Water Supply Service Area Plan, this alternative collectively had the most significant adverse impact ratings.

The remaining water supply alternatives addressed in this document are:

- Deep and Shallow Aquifers
- Shallow Aquifer and Fox River Alluvium
- Lake Michigan supply – City of Milwaukee
- Lake Michigan supply – City of Oak Creek, two pipeline alignments
- Lake Michigan supply – City of Racine

Return Flow

The Compact and Wisconsin implementation statute requires return flow for a Lake Michigan water supply. Five alternatives were considered for return flow to Lake Michigan for a Lake Michigan water supply. The alternatives include return flow to:

- Underwood Creek, a tributary to the Menomonee River that flows to Lake Michigan
- Root River, a tributary to Lake Michigan with two pipeline alignments
- Direct to Lake Michigan near Milwaukee and Oak Creek
- Direct to Lake Michigan near Racine
- The Milwaukee Metropolitan Sewerage District (MMSD) sewer system and water reclamation facility, which would then return flow to Lake Michigan. Several sub-alternatives were considered for return flow to MMSD.

The return flow direct to Lake Michigan near Racine alternative was eliminated in Section 2 of this document because it is significantly more expensive than all other return flow alternatives (see the Return Flow Plan, Volume 4 of the Application), it has the greatest impacts because it has the longest pipeline length, and provides no additional benefit than return flow directly to Lake Michigan near Milwaukee and Oak Creek. The MMSD return

flow alternatives were eliminated because the SEWRPC regional water supply study did not recommend a MMSD alternative due to the higher cost compared to return flow directly to Lake Michigan and to a Lake Michigan tributary. Subsequent analysis confirmed the high cost of an MMSD alternative (see the Return Flow Plan - Volume 4 of the Application).

Included in all the return flow alternatives is maintaining the existing discharge location into the Fox River from the Waukesha WWTP. Return flow will be continuous, however, discharge to the Fox River will occur when flow available at the WWTP exceeds the maximum day water demand flow rate. The discharge to the Fox River and return flow would continue to meet water quality requirements.

A treated wastewater pump station and a pipeline (of varying length depending on the alternative) were included for each return flow alternative. Additional specific information regarding the various alternatives is included in this document and in the Return Flow Plan (Volume 4 of the Application).

Key Factors in Evaluating Alternatives

Exacerbating Existing Groundwater Problems

All water supply sources were reviewed for their ability to minimize depletion of the deep aquifer currently used by the City. As discussed above, historical use of the deep aquifer has resulted in significant depletion of the aquifer and water quality issues. Continued use of the aquifer could continue the depletion and water quality degradation.

Groundwater Drawdown Impacts

Groundwater drawdown in the shallow aquifer and associated impacts to surface waters and other environmental resources is considered in the water supply alternatives evaluation. Pumping groundwater from shallow aquifers changes the surface water and groundwater interaction. Previous studies have identified stream baseflow reductions will occur to surface waters, including baseflow reductions to cold water trout streams, when using more shallow groundwater for water supply. Groundwater drawdown in the shallow aquifers can also affect wetland and other aquatic resources that depend upon groundwater hydrology for maintaining wetland habitat. The City has utilized a groundwater model to simulate the groundwater drawdown expected with long-term water supply alternatives that use the shallow aquifer.

Wetlands

Operational impacts also occur to wetlands from groundwater pumping and resulting groundwater drawdown. Because a wetland is designated by the type of plants, hydrology, and soil type, groundwater drawdown in wetlands can reduce or eliminate the hydrology element required to sustain wetland conditions. The City has utilized a groundwater model to simulate the groundwater drawdown expected with water supply alternatives that use or are hydraulically connected to the shallow aquifer. The groundwater modeling results were used to determine the wetland acreage that would experience of 5 foot or greater drawdown and the wetland acreage that would experience a 1 foot or greater drawdown. Depending upon the groundwater supply alternative, groundwater pumping would reduce the groundwater level by 5 feet or more for nearly 1,000 to 2,000 wetland acres. A 1-foot or

greater groundwater drawdown would occur over more than 3,000 to 4,000 wetland acres. Use of shallow groundwater sources would have significant adverse effects on these resources.

In addition to significant adverse effects on wetlands from the drawdown of the shallow aquifer, impacts on wetlands occur from temporary construction impacts from pipeline construction and above ground structure construction required for the groundwater and Lake Michigan water supply and return flow alternatives. Construction impacts are temporary during construction and are avoided or mitigated through construction or restoration techniques. However, wetland type changes may occur during operation for some water supply and return flow pipeline alignments that cross forested or shrub/scrub wetlands. Operational impacts from above ground structures occur where access roads, treatment plants, or well house locations occur in wetlands. Before the City obtains a construction permit for the proposed project, the City will coordinate with the WDNR pursuant to the requirement of NR 103 to seek ways to reduce wetland impacts, whether temporary construction or long-term operational impacts. Such analyses will look for ways to further reduce impacts, including adjustments to pipeline routes or construction methods to further minimize impacts.

Flooding

Return flow in a Lake Michigan tributary is a very small percentage of the river flow during high flows. The flow change with return flow during the 100-year-frequency event is less than one percent in the Root River, Underwood Creek, or the Menomonee River. For the proposed return flow to the Root River, the maximum return flow rate increases Root River flows by less than 0.6 percent for the 100-year-frequency storm conservatively estimated at the discharge location and less than 0.5 percent in Racine. A change of less than one percent would cause a minor adverse impact. Flow changes to tributaries during high flow conditions were evaluated for all water supply and return flow alternatives.

Aquatic Habitat

Aquatic habitat impacts occur when flows change in surface streams. Flows change in surface streams under all alternatives considered. Groundwater pumping alternatives that affect the shallow aquifer change the surface water and groundwater interaction and decrease the surface water flow volumes. Previous studies have identified stream baseflow reductions will occur to surface waters, including baseflow reductions to the Fox River and cold water trout streams, when using more shallow groundwater for water supply. Flow changes also occur with return flow alternatives where flow is no longer discharged to the Fox River and is discharged instead to a Lake Michigan tributary or directly to Lake Michigan. Return flow to a Lake Michigan tributary can increase aquatic habitat quantity and availability by providing additional flow volume and cross-sectional flow area, especially to Underwood Creek and the Root River which have very low baseflows during some periods of the year. Each of these flow changes has been considered for water supply and Lake Michigan return flow alternatives to evaluate reductions or increases in aquatic habitat.

Vegetation and Wildlife

Groundwater drawdown in the shallow aquifer could result in habitat change in the Vernon Wildlife Area (VWA). The VWA is a 4,655-acre property in eastern Waukesha County consisting of wetlands and flowages associated with the Fox River and including a calcareous fen in the southern portion of the property. WDNR documents indicate the VWA provides significant wildlife habitat, especially for migrating and nesting waterfowl. The City has utilized a groundwater model to simulate the groundwater drawdown when the shallow aquifer is used for the long-term water supply. The groundwater modeling results were used to determine acreage of wetlands in and around the VWA that would experience of 5 foot or greater drawdown and that would experience a 1 foot or greater drawdown. Depending upon the groundwater supply alternative, groundwater pumping would reduce the groundwater level by 5 feet or more for nearly 1,000 to 2,000 wetland acres. A 1-foot or greater groundwater drawdown would occur over more than 3,000 to 4,000 wetland acres. An analysis of groundwater drawdown effects to wetlands in the VWA area has been prepared and is included as Appendix 6-4, Wetland Habitat Impact Analysis: Vernon Marsh Wildlife Area.

Vegetation and wildlife impacts are also estimated for return flow alternatives. The vegetation impacts occur from temporary construction impacts from pipeline construction required for the return flow alternatives. Construction impacts are temporary during construction and are avoided or mitigated through construction or restoration techniques. However, vegetation and wildlife changes may occur as a result of operational needs (e.g. maintenance easement) of some portions of the return flow pipeline alignments. Because these impacts are most closely associated with groundwater drawdown, aquatic habitat, and wetlands, a comparison of impacts between alternatives is included within those impact categories.

Water Quality

Water quality load to Lake Michigan changes by less than one percent. Water quality improves in a Lake Michigan tributary with return flow due to the high treatment standards at the Waukesha WWTP. However, water quality policies have influenced the decision for the preferred return flow location. Because a total maximum daily load (TMDL) was started on Underwood Creek and a TMDL allocation has not yet been established for return flow, the WDNR has determined that an Underwood Creek return flow could not be approved until a TMDL allocation is available. Consequently, this alternative would not be implementable at this time and is not being pursued at this time. Waukesha return flow will be considered in the TMDL evaluation and the TMDL will be developed to be protective of water quality. Relative impacts upon water quality are assessed consistent with the other return flow alternatives.

Construction Impacts for Pipelines

Each of the water supply and return flow alternatives involves pipeline construction for the water supply and return flow conveyance. The long, linear construction footprint of the pipeline projects will include crossings of water bodies, wetlands, public lands, and other features. The potential environmental impacts of pipeline construction have been reviewed and compared.

Comparison of Alternatives

A comparison of the environmental impacts for each of the alternatives is summarized in Table ES-1. This table does not include cultural resources or socioeconomics because none of the water supply and return flow alternatives has an adverse impact on them. All of the Lake Michigan water supply and return flow alternatives have no significant adverse impacts and have fewer impacts than groundwater alternatives. For the Lake Michigan water supply alternatives, a City of Milwaukee and Oak Creek (Alignment 1 and 2) water supply have the same impact classifications. The City of Milwaukee and Oak Creek Alignment 1 routes have much overlap but a City of Milwaukee water supply has fewer impacts because it is a shorter pipeline. The City of Oak Creek Alignment 2 has the least amount of impacts because the route follows previously disturbed transportation corridors for over 90 percent of the alignment. A City of Racine water supply differs from Milwaukee and Oak Creek only in its impacts to wetlands, which are more because it has the longest pipeline of the three Lake Michigan water supply alternatives.

Note: The Water Supply Service Area Plan Lake Michigan (City of Oak Creek) water supply alternative describes the ER Lake Michigan (City of Oak Creek) Alignment 2 alternative and the Return Flow Plan Root River to Lake Michigan return flow alternative describes the ER Root River to Lake Michigan Alignment 2 return flow alternative. The ER retains the Lake Michigan (City of Oak Creek) Alignment 1 water supply alternative and the Root River to Lake Michigan Alignment 1 return flow alternative for alternative comparison purposes.

TABLE ES-1

Water Supply and Return Flow Alternative Environmental Impact Comparison Summary

Water Supply Alternative	Groundwater Resources	Geomorphology and Sediments	Flooding	Aquatic Habitat	Water Quality	Wetlands	Soils	Land Use
Water Supply Alternatives								
Deep and Shallow Aquifers	Significant adverse impact	No adverse impact	No adverse impact	Significant adverse impact	Minor adverse impact	Significant adverse impact	Minor adverse impact	No adverse impact
Shallow Aquifer and Fox River Alluvium	Significant adverse impact	No adverse impact	No adverse impact	Significant adverse impact	No adverse impact	Significant adverse impact	Minor adverse impact	No adverse impact
Lake Michigan (City of Milwaukee)	No adverse impact	No adverse impact	No adverse impact	Minor adverse impact	No adverse impact	Minor adverse impact	No adverse impact	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 1	No adverse impact	No adverse impact	No adverse impact	Minor adverse impact	No adverse impact	Minor adverse impact	No adverse impact	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 2	No adverse impact	No adverse impact	No adverse impact	Minor adverse impact	No adverse impact	Minor adverse impact	No adverse impact	No adverse impact
Lake Michigan (City of Racine)	No adverse impact	No adverse impact	No adverse impact	Minor impact	No adverse impact	Moderate adverse impact	No adverse impact	No adverse impact
Return Flow Alternatives for Lake Michigan Water Supplies								
Underwood Creek to Lake Michigan	No adverse impact	No adverse impact	Minor adverse impact	No adverse impact	No adverse impact	Minor adverse impact	No adverse impact	No adverse impact
Root River to Lake Michigan Alignment 1	No adverse impact	No adverse impact	Minor adverse impact	No adverse impact	No adverse impact	Minor adverse impact	No adverse impact	No adverse impact
Root River to Lake Michigan Alignment 2	No adverse impact	No adverse impact	Minor adverse impact	No adverse impact	No adverse impact	Minor adverse impact	No adverse impact	No adverse impact
Direct to Lake Michigan	No adverse impact	Minor adverse impact	No adverse impact	Minor adverse impact	No adverse impact	Minor adverse impact	No adverse impact	No adverse impact

Similarly, Underwood Creek and Root River (Alignment 1 and 2) return flow alternatives have the same impact classifications. Both Underwood Creek and Root River (Alignment 1 and 2) return flow alternatives have fewer impacts than a direct to Lake Michigan return primarily because the direct to Lake Michigan return flow is the longest return flow pipeline and it includes an offshore discharge that would disturb the lake bottom. The system alternative of Root River Return Flow Alignment 2 and the Lake Michigan – City of Oak Creek Alignment 2 have minor adverse impacts similar to other Lake Michigan supply system alternatives. Of the impacts that do occur for the Lake Michigan Supply – City of Oak Creek and Root River Return Flow Alignment 2, they are minimized because much of each pipeline alignment involves a shared corridor.

A detailed comparison of all of the water supply and return flow alternatives is found in Section 6 of this document.

Selection and Description of the Proposed Project

The proposed project for the City of Waukesha water supply is to obtain a Lake Michigan water supply from the City of Oak Creek using Alignment 2 with return flow to the Root River via Alignment 2. The City of Waukesha offered to negotiate with three potential Lake Michigan water suppliers (City of Milwaukee, City of Oak Creek, and the City of Racine). The City of Waukesha was able to reach a water supply memorandum of understanding with the City of Oak Creek. Consequently, the Lake Michigan Supply – City of Oak Creek Alignment 2 was selected to have Lake Michigan as a long-term water source that can meet water supply demands, it is protective of human health and the environment, and is sustainable. It is also supportive of the City's consent order for radium compliance by June 30, 2018.

Compared to a Lake Michigan water supply, the Deep and Shallow Aquifers and the Shallow Aquifer and Fox River Alluvium alternatives would have significant adverse environmental impacts to natural resources, specifically wetlands and the Vernon Wildlife Area. The Lake Michigan water supply from the City of Oak Creek with Return Flow to the Root River via Alignment 2 has only minor adverse environmental impacts to natural resources. A Lake Michigan water source supplied through the City of Oak Creek is the preferred water supply alternative as a result. The City of Waukesha believes the Underwood Creek return flow alignment could also a viable return flow alternative once a TMDL allocation can be made.

Of the return flow alternatives, the Underwood Creek and the Root River alternatives would have minor adverse impacts in two categories, whereas the Direct to Lake Michigan alternative would have minor adverse impacts in three categories. The return flow discharge will have water quality that will meet all WDNR permit requirements and consequently all return flow alternatives will have no adverse impact on water quality. The return flow pipeline to Underwood Creek is about four miles shorter than the Root River Alignment 1 and 9 miles shorter than Root River Alignment 2. Although the Underwood Creek alignment is shorter, the Root River Alignment 2 has the least amount of impacts to environmental aquatic and terrestrial resources. Additionally, Root River Alignment 2 shares a corridor with the City of Oak Creek Supply Alignment 2 reducing the overall impact of the entire project. Because a total maximum daily load (TMDL) was started on Underwood Creek and a TMDL allocation

has not yet been established for return flow, the WDNR has determined that an Underwood Creek return flow could not be approved until a TMDL allocation is available. Consequently, this alternative would not be implementable at this time and thus is not being pursued. Waukesha return flow will be considered in the TMDL evaluation and the TMDL will be developed to be protective of water quality. Relative impacts upon water quality are assessed consistent with the other return flow alternatives. As a result, return flow to the Root River Alignment 2 is the preferred return flow alternative and is included in the proposed project.

Once the proposed project receives regional approval and progresses into detailed design, the City of Waukesha will continue to work with the regulatory agencies during final design to conduct any necessary field surveys, location refinements, mitigation planning, and to obtain required construction permits.

Cumulative Impacts

The proposed project will have no significant adverse individual or cumulative impacts on the quantity or quality of the waters and water dependent natural resources of the Great Lakes Basin. To the contrary, the proposed project is anticipated to have a net positive impact on the waters and water dependent natural resources, to the groundwater, and to inland waterways.

As a result of switching to a Lake Michigan source of water, the City of Waukesha would discontinue its use of groundwater from the deep and shallow aquifers. Pumping the deep aquifer pulls down water from the overlaying shallow aquifer to the deep aquifer. If pumping of the deep aquifer is replaced with a Lake Michigan supply, Waukesha will no longer pull water from the shallow aquifer to the deep aquifer. Discontinuing the use of groundwater would stop the cumulative adverse impacts to the groundwater and connected surface water resources (e.g. streams and wetlands). This will improve critical baseflows to surface water resources, including wetlands, streams and lakes.

Switching to a Lake Michigan water supply and discontinuing the withdrawal of groundwater from the deep aquifer would also benefit the waters of the Lake Michigan basin. Historically, water from the deep aquifer flowed towards Lake Michigan. As pumping increased, the flow of groundwater was reversed and water that otherwise would have fed Lake Michigan was drawn to the groundwater wells. Now, waters from Lake Michigan are flowing into the deep aquifer rather than recharging the lake. Switching from the groundwater supply to a Lake Michigan surface water supply would contribute to aquifer recovery and would eliminate the diversion of water from the Lake Michigan groundwater to the Mississippi River watershed.

The City will return all water from the WWTP up to the maximum day demand (MDD) water demand rate. This will return the water so that there will be no volume decrease to the Great Lakes basin and therefore no significant cumulative impact to the water dependent industries (e.g. shipping and hydropower generation) in the Great Lakes basin.

The withdrawal of water from Lake Michigan will not endanger the integrity of the Lake Michigan ecosystem; the return flow water quality will meet all WDNR requirements and the Return Flow Plan will not decrease the Lake Michigan volume. The return flow will also improve or maintain the physical and biological resources, and improve or have no adverse impact to the chemical resources of the Root River and Lake Michigan.

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Acronyms and Abbreviations

Acronyms and Abbreviations

ADD	average day demand
BLS	Bureau of Labor Statistics
BOD	biological oxygen demand
CED	Center for Economic Development
CLEAN	Contaminated Lands Environmental Action Network
COLD	cold water
CSO	combined sewer overflow
CTH	County Trunk Highway
EIS	Environmental Impact Statement
EO	Executive Order
ER	Environmental Report
ERP	environmental repair
FEMA	Federal Emergency Management Agency
INRA	Isolated Natural Resource Area
LAL	Limited aquatic life
LFF	Limited forage fish
LUST	leaky underground storage tank
MCL	maximum contaminant level
MDD	maximum day demand
mgd	million gallons per day
MMSD	Milwaukee Metropolitan Sewerage District
MW	megawatts
NEPA	National Environmental Policy Act
NRCS	Natural Resource Conservation Service
NH ₃ -N	ammonia
NRHP	National Register of Historic Places
PEM	palustrine emergent
PFO	palustrine forested
PSAAP	Public Service Archaeology & Architecture Program
PSS	palustrine scrub-shrub
RR	Remediation and Redevelopment
SEWRPC	Southeastern Wisconsin Regional Planning Commission
SSURGO	Soil Survey Geographic
TDS	total dissolved solids
the City	City of Waukesha, Wisconsin
the Compact	Great Lakes Basin Compact
the County	Waukesha County
TMDL	total maximum daily load
TP	Total phosphorus
TSS	total suspended solids
USC	U.S. Code
USCB	U.S. Census Bureau

USGS	United State Geological Survey
UV	ultraviolet
UWM	University of Wisconsin–Milwaukee
VWA	Vernon Wildlife Area
WAC	Wisconsin Administrative Code
WDNR	Wisconsin Department of Natural Resources
WEPA	Wisconsin Environmental Policy Act
WGNHS	Wisconsin Geological and Natural History Survey
WPDES	Wisconsin Pollutant Discharge Elimination System
WWFF	Warm water forage fish
WWSF	warm water sport fish
WWTP	Waukesha Wastewater Treatment Plant

Section 1
City of Waukesha Water Supply Proposed
Project Overview

SECTION 1

City of Waukesha Water Supply Proposed Project Overview

This Environmental Report (ER) has been developed to update and provide additional information to the February 2012 Environmental Report (February 2012 ER). The City of Waukesha (the City) submitted the City of Waukesha Application for a Lake Michigan Water Supply Diversion with Return Flow in May 2010 and the ER in February 2012. An updated version of the Application will be completed in 2013 and summarized in Volume 1 of 5, Application Summary, City of Waukesha Application for a Lake Michigan Diversion with Return Flow (Application) to address changes in the proposed project and return flow management plan. This ER provides the necessary updates to the February 2012 ER in order to be consistent with the 2013 Application. This ER and the February 2012 ER are similarly organized.

The major changes included in the ER include:

1. The City of Waukesha has selected the City of Oak Creek as the Lake Michigan water supply provider. The water supply negotiations with the City of Oak Creek provided insights into a more efficient and beneficial connection point into the City of Oak Creek water distribution system. With the selection of the City of Oak Creek as the water supplier, a new water supply pipeline alignment has been added to this ER. The new Lake Michigan water supply alignment from the City of Oak Creek has been determined to meet the long-term water supply needs of the City of Waukesha. The Oak Creek alignment identified in the February 2012 ER will now be considered an additional Oak Creek alignment alternative. Refer to later sections in this document for further descriptions of the updated Oak Creek pipeline alignment for the proposed project.
2. A new return flow alignment to the Root River provides environmental benefits and is the preferred return flow alignment. It has been included to provide efficiency and reduced impacts by paralleling the new City of Oak Creek Lake Michigan Supply alignment. Because a total maximum daily load (TMDL) was started on Underwood Creek and a TMDL allocation has not yet been established for return flow, the WDNR has determined that an Underwood Creek return flow could not be approved without a TMDL allocation. Consequently, this alternative would not be implementable at this time and is not being pursued at this time.
3. The return flow management plan has also been modified to have continuous flow from the City of Waukesha's Wastewater Treatment Plant (WWTP).
4. The appendices to the Application have been reorganized. Several of these appendices are referenced in the February 2012 ER. Refer to Section 1.5 for further description of the updated report organization.

5. A side-by-side comparison of the new water supply and return flow alignments to the prior alternatives has been updated in this document with a comprehensive comparison included in Appendix 6-2.
6. Clarification is provided on baseflow changes to the Fox River, Pebble Creek, Pebble Brook, and Mill Brook based upon groundwater modeling.

This ER and the February 2012 ER are similarly organized to enable correlation between the documents. Section 1.5, Report Organization, outlines the additional information within this ER.

The ER has been developed to meet the Wisconsin Environmental Policy Act (WEPA) as required by the Wisconsin Department of Natural Resources (WDNR) and regulated under NR 150 Environmental Analysis and Review Procedures for Department Actions. The WDNR has indicated they will follow the WEPA process, which includes completing an Environmental Impact Statement (EIS) for evaluating the City of Waukesha water supply alternatives considered under the City's Application. This document is organized to support the development of the EIS.

The WEPA process calls for interagency coordination, including federal agencies, and references developing reviews consistent with National Environmental Policy Act (NEPA) where multiple agencies are involved. This document is intended to meet the NEPA process should it be required in the future. The City of Waukesha has evaluated multiple water supply alternatives to secure a sustainable and reliable water supply that is protective of public health and provides regional environmental benefits. Despite significant success with an aggressive water conservation program, the City is faced with a declining groundwater supply and water quality conditions that do not meet regulatory requirements for radium and gross alpha. In addition, as described in this ER continued use of ground water supplies will impact the quality of wetlands and surface waters. The City is under a consent order to bring its water into compliance by June 30, 2018. Consequently, the City has studied various water supply alternatives to meet the City's long-term water supply needs, determining that the only reasonable alternative is a Lake Michigan water supply.

The WDNR issued a formal EIS scoping request for a City of Waukesha Lake Michigan water supply on February 5, 2010. This request has been issued to interested parties and resources agencies and has also been made available to the general public on the WDNR's website. The WDNR has obtained input from the public through a series of public meetings held between July 26-28, 2011 in Pewaukee, Wauwatosa, and Sturtevant, Wisconsin.

As part of water supply planning process, the City of Waukesha has conducted multiple public meetings to solicit comments from City of Waukesha residents and the general public. Four public meetings have been held, including one meeting in a neighboring community adjacent to one of the Lake Michigan return flow alternatives (Wauwatosa, WI), where the public provided verbal or written comment regarding Waukesha's water supply alternatives. Many more public meetings have been conducted in prior years. The information gathered from these public meetings and comments from the public have been used to identify issues of concern which have been addressed in this ER. A compilation of comments received from City meetings and other public involvement processes is included in the Water Supply Service Area Plan, Volume 2 of the Application.

A variety of water supply alternatives have been evaluated, including groundwater and surface water sources in the Mississippi River and Lake Michigan basins. The Great Lakes-St. Lawrence River Basin Water Resources Compact (Compact) and Wisconsin State Statute § 281.346 regulates Lake Michigan as a water supply diversion for the City of Waukesha and requires return flow back to the Lake Michigan basin. The Lake Michigan water supply alternatives evaluated for the City each include return flow back to the Lake Michigan basin.

This ER evaluates water supply alternatives and the environmental impacts of a City of Waukesha long-term water supply.

1.1 Existing Conditions

The development of a new water supply and return flow discharge for the City is being driven by a June 30, 2018, deadline to achieve public health protection standards for radium in drinking water. The City currently obtains approximately 80 percent of its water supply from the deep St. Peter Sandstone Aquifer. Near and beyond the City of Waukesha, this aquifer is confined by a geological feature—the Maquoketa shale layer—that limits natural recharge of the aquifer. Continued use of the aquifer by the City and surrounding communities since the 19th century and the presence of the Maquoketa shale have led to the 500- to 600-foot decline in aquifer water levels. Reduced groundwater levels in southeastern Wisconsin have in turn affected regional surface waters, which now receive about 18 percent less in groundwater contribution as water migrates toward the deep aquifer (USGS, 2007). Significant water quality issues occur with declining water levels in the deep aquifer, including increased levels of salts and radium (a naturally occurring element in the deep aquifer that can cause cancer). To provide drinking water with low levels of radium, the City treats some deep aquifer water to remove radium and blends some deep aquifer water with water from the shallow Troy Bedrock aquifer. Never-the-less, the City's water supply is not in compliance with radium water quality standards.

The City obtains approximately 20 percent of its water supply from the shallow aquifer. Increased pumping of it will stress surface water resources by reducing baseflows to local streams and wetlands (SEWRPC, 2010a). The City's existing water supply system does not meet radium water quality standards.

1.2 Purpose and Need

The City needs a long-term water source that can meet water supply demands, is protective of human health and the environment, and is sustainable. The City must also obtain a water supply that meets their consent order for radium compliance by June 30, 2018. The water supply source will be used for public water supply and consider WDNR water supply planning requirements and ultimate buildout water demand.

1.3 City of Waukesha Water Supply Proposed Project

This document is based on the City's calculated water supply need of 10.9 million gallons per day (mgd) to meet future average day water demands and a future maximum day demand of 18.5 mgd in the City's projected water supply service area, unless otherwise

noted. The water supply maximum day demand (MDD) and average day demand (ADD) values will likely be adjusted slightly from that of the analysis provided in this document to reflect the final water demand forecasts. If values are less, then the impacts documented in this document will be less but are still suitable for impact comparison purposes. Regardless, a small change in water demand will have either no significant change to impacts or a proportional change to impacts. For example, a reduced water demand and supply service area would not change the pipeline length or construction corridor, but could proportionally change stream flows and groundwater drawdown. Refer to Table 1-1 for a description of the anticipated changes to environmental impacts based on a reduced water demand.

TABLE 1-1

Anticipated Environmental Impact Change due to Possible Reduction in the Water Supply ADD and MDD

Environmental Impact Category	Groundwater Alternatives Expected Change	Lake Michigan Alternatives Expected Change
Groundwater Resources	Proportional impact due to reduced groundwater drawdown	None
Geomorphology and Sediments	None	None
Flooding	None	Proportional impact due to reduced return flow
Aquatic Habitat	Proportional impact due to changes in baseflow from groundwater drawdown	Proportional impact due to changes in baseflow from return flow
Water Quality	None	Minor proportional changes in concentration and annual load with a flow change
Wetlands	Proportional impact due to reduced groundwater drawdown	None
Soils	None	None
Land Use	None	None

The City of Waukesha water supply needs have been documented in the Water Supply Service Area Plan, Volume 2 of the Application and are slightly less than that used to complete the majority of the ER analysis (ADD of 10.1 mgd instead of 10.9 mgd).

Alternatives to the proposed Lake Michigan water supply included continued use of the deep and shallow aquifer, increased withdrawal from the shallow aquifer, local river supplies, local lake supplies, and wastewater reuse. Multiple alternatives for return flow to the Lake Michigan basin were also considered for a Lake Michigan water supply.

Alternatives that were not eliminated are compared side by side to the proposed project in Section 6, Table 6-80. This ER presents a comprehensive review of the alternatives.

The proposed project is a water supply from Lake Michigan provided by the City of Oak Creek's existing Lake Michigan water treatment plant, with return flow to Lake Michigan via the Root River. Table 1-2 summarizes the pipe size and length anticipated for the proposed project.

The February 2012 ER considered the cities of Oak Creek, Milwaukee, and Racine as potential Lake Michigan water suppliers. Recently, the City signed a letter of intent with the

TABLE 1-2
Proposed Pipeline Facilities for the Proposed Project

Alternative	Diameter (In.)	Approximate Length (miles)	Affected Counties
Proposed Project Lake Michigan Supply			
Lake Michigan (City of Oak Creek) Alignment 2	30	19.4	Milwaukee and Waukesha
Proposed Project Return Flow			
Root River to Lake Michigan Alignment 2	30	20.2	Milwaukee and Waukesha

Note: The final pipeline diameter may be 30 or 36 inches depending upon final detailed design considerations. For either diameter pipe, the construction width for environmental impacts is the same width due to construction staging requirements.

City of Oak Creek to supply water. Documentation of these communications is included in the Water Supply Service Area Plan (Volume 2 of the Application). Another return flow alignment to the Root River was added to include potential benefits of a return flow alignment parallel to the new City of Oak Creek Lake Michigan water supply alignment.

The February 2012 ER included a water supply alternative from Lake Michigan (City of Oak Creek) and a return flow alternative from the Root River to Lake Michigan. However, the new proposed project consists of different alignments for both the supply and return flow. Within the ER, these prior alternatives will be called Lake Michigan (City of Oak Creek) Alignment 1 and Root River to Lake Michigan Return Flow Alignment 1, while the proposed project will be called Lake Michigan (City of Oak Creek) Alignment 2 and Root River to Lake Michigan Return Flow Alignment 2. Please note any reference to Lake Michigan (City of Oak Creek) or Root River to Lake Michigan within the February 2012 ER refers to Alignment 1 and not the proposed project.

Note: The Water Supply Service Area Plan Lake Michigan (City of Oak Creek) water supply alternative describes the ER Lake Michigan (City of Oak Creek) Alignment 2 alternative and the Return Flow Plan Root River to Lake Michigan return flow alternative describes the ER Root River to Lake Michigan Alignment 2 return flow alternative. The ER retains the Lake Michigan (City of Oak Creek) Alignment 1 water supply alternative and the Root River to Lake Michigan Alignment 1 return flow alternative for alternative comparison purposes.

A major factor in the determination of the new alignments was the construction corridor the proposed project's supply and return flow routes share. The Lake Michigan (City of Oak Creek) Alignment 2 and Root River to Lake Michigan Return Flow Alignment 2 are parallel for approximately 15 of the 20 mile alignments all of which are in street right-of-way. This shared construction corridor and location within previously disturbed street rights-of-way will reduce the amount of environmental impacts and provide cost efficiencies.

After reviewing the May 2010 Application, the WDNR asked for additional information, specifically regarding return flow to the Root River. The proposed project return flow was changed from Underwood Creek to the Root River due to several reasons. Firstly, uncertainty surrounding the ongoing Underwood Creek and Menomonee River total maximum daily load (TMDL) under development for phosphorus, total suspended solids,

and bacteria could potentially delay the timeline of the project and ability to meet the consent order for radium compliance in June 2018.

Secondly, return flow will provide an environmental benefit to the Root River and Root River watershed that will be beneficial to Great Lakes fisheries. Unlike Underwood Creek, the Root River has a more natural channel and the discharge location to the confluence with Lake Michigan is longer. A greater length provides more opportunity for habitat enhancements from increased baseflow. The Root River has had documented low flow and flow augmentation proposed since 1966 (SEWRPC, 1966, p. 188). Increased flow will benefit the aquatic habitat, particularly the fisheries, of the river. Additionally, the WDNR's Steelhead Facility, which harvests fish eggs from Lake Michigan trout and salmon, is located in the City of Racine will benefit from an increase in Root River baseflow (see the Return Flow Management Plan – Volume 4 of the Application). The WDNR has previously considered flow augmentation for the Steelhead Facility to increase egg harvesting success because there are times when fish are prevented from reaching the facility due to low flows in the Root River.

1.4 Return Flow Management Plan

The return flow management plan has been updated since the February 2012 ER in order to have continuous return flow. The WWTP will provide continuous return flow to the Root River up to the future water supply maximum day demand flow rate. The maximum return flow rate will equal the maximum day water supply demand. Water at the WWTP in excess of this amount will continue to be discharged into the Fox River and meet permit limits. The Return Flow Plan analysis shows that no less than 100 percent of the water volume will be returned to the Great Lakes basin. The Return Flow Plan (Volume 4 of the Application) provides greater detail on the return flow management plan. This updated return flow management plan results in potentially small increases in peak flow in the river and thus changes the flooding impact of all Lake Michigan tributary return flow alternatives from no adverse impact to minor adverse impact. Refer to Section 6.4.2.2 and Table 6-17 for further explanation.

1.5 Report Organization

The 2013 Application has simplified the organizational structure with several volumes of the application and several attachments. Table 1-3 lists the changes affecting the February 2012 ER.

1.6 Project Location

The project is located in southeastern Wisconsin as shown in Figure 1-1. The Lake Michigan (City of Oak Creek) Alignment 2 water supply route and return flow through the Root River to Lake Michigan Alignment 2 evaluated are shown in Figure 1-2. Additional details of the proposed project are described in Section 3.

TABLE 1-3
Updated Application Volumes and Appendices Reference Table

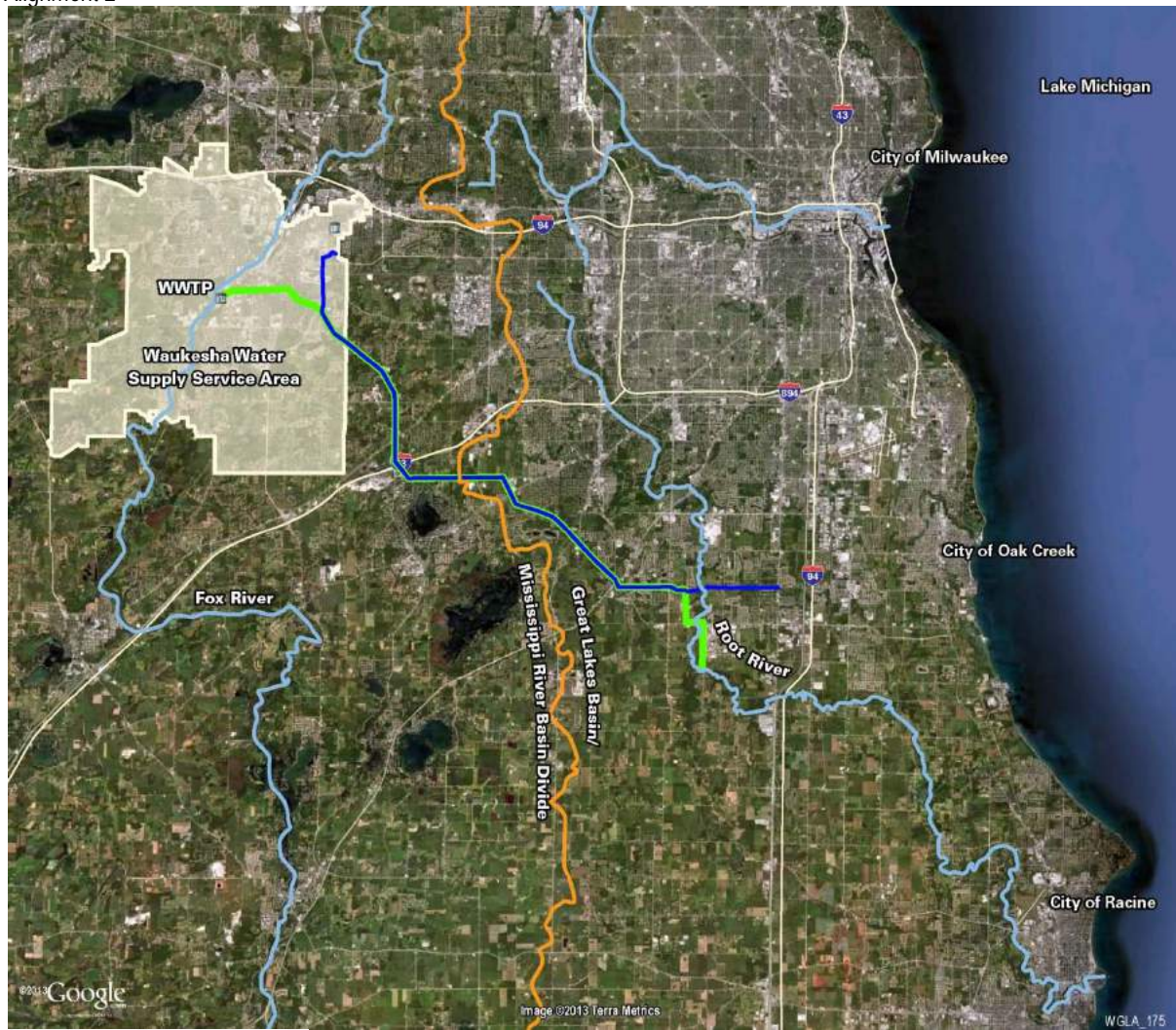
New Numbering	Old Appendix Letter	Document Name	Comment
—	A	Final Draft Technical Memorandum: Summary of Water Requirements	Attached to Volume 2—Water Supply Service Area Plan
Application Volume 2	B	Water Supply Service Area Plan for the City of Waukesha	Retained and Relettered
Application Volume 5	C	City of Waukesha Water Supply: Environmental Report	Retained and Relettered
—	D	City of Waukesha Water Supply Cost Estimates Update	Attached to Volume 2—Water Supply Service Area Plan for the City of Waukesha
—	E	Facility Plan Amendment - City of Waukesha Wastewater Treatment Plant Improvements for Returning Water Withdrawn from Lake Michigan	Attached to Volume 4—Return Flow Plan
—	F	Return Flow Alternatives Summary for a City of Waukesha Lake Michigan Water Supply	Attached to Volume 4—Return Flow Plan
—	G	Technical Memorandum: Underwood Creek Effluent Return Evaluation, July 23, 2009	Attached to Volume 4—Return Flow Plan
—	H	Return Flow Effects on Habitat and Fisheries in Underwood Creek, Menomonee River, and Fox River	Attached to Volume 4—Return Flow Plan
—	I	Water Quality Model of Proposed Discharge to Underwood Creek	Attached to Volume 4—Return Flow Plan
—	J	Fox River and Underwood Creek Flow Rates with Return Flow in Years 2005 and 2008	Attached to Volume 4—Return Flow Plan
—	K	Diurnal Return Flow Effects on Underwood Creek Flow Rates	Attached to Volume 4—Return Flow Plan
—	L	Return Flow Effects on Underwood Creek and Fox River Flashiness Index	Attached to Volume 4—Return Flow Plan
Application Volume 3	—	Water Conservation Plan	New Volume
Application Volume 4	—	Return Flow Plan	New Volume

FIGURE 1-1
General Location Map



FIGURE 1-2

Proposed Project Lake Michigan Supply City of Oak Creek Alignment 2 with Return Flow Root River to Lake Michigan via Alignment 2



Legend

- Water Supply Alignment
- Return Flow Alignment

1.7 Document Layout

This ER maintains the same document layout as the February 2012 ER. The document includes eight major sections in addition to the Executive Summary, consistent with the outline that the WDNR provided for the EIS. A brief summary of the sections include:

- Section 1 (this section) provides a summary of the project need, location and the proposed project and an updated description of the proposed project.
- Section 2 includes the addition of the two new alignments that make up the proposed project, Lake Michigan (City of Oak Creek) Alignment 2 and Root River to Lake Michigan Alignment 2 return flow. No other changes to any other alternatives have been made since the completion of the February 2012 ER. This section also summarizes all of the water supply sources and their alternatives that have been studied since the City began their water supply planning more than 10 years ago. The section identifies water supply and return flow alternatives which were eliminated and have no further analysis as well as those that have detailed analysis later in this document.
- Section 3 is a summary of the updated proposed project, including the water supply pipelines and water treatment, and the wastewater treatment of return flow to the Lake Michigan basin.
- Section 4 documents the authorities and approvals required for the proposed project, from local, state, federal, and tribal entities. Minimal changes have been made to this section.
- Section 5 documents the affected environment and environmental effects of the updated proposed project, including the physical and biological environment, aquatic resources, terrestrial resources, and socioeconomics.
- Section 6 includes a side by side comparison table of the potential environmental impacts due to the proposed project and updates to the environmental impacts of each alternative based on any new information. Section 6 describes in detail the environment and environmental effects for all of the alternatives. Baseflow changes from groundwater alternative pumping are clarified based upon discussions with the WDNR.

This section documents the alternatives to the proposed project together, including details of their water supply and return flow infrastructure and treatment. This section includes the same analyses as Section 5, and includes the same information as Section 5 for the proposed project. Information from Section 5 is largely repeated in Section 6 to provide a side-by-side comparison of the system alternatives that survived screening and that were evaluated in detail in this ER.

- Section 7 documents the updated proposed projects' environmental significance as it relates to short and long term effects, scarce resources, reversibility of effects, cumulative effects, risk, precedence and public controversy.
- Section 8 includes an updated list of references and works cited.

Many sections include multiple attachments with data tables and additional analyses to support the documentation in each section. Table 1-4 lists which sections of the February

2012 ER are updated with this ER. This ER also summarizes and includes reference to several Application volume documents and other reports related to the Application that provide necessary supporting backup analyses.

TABLE 1-4
Report Section Description Between this ER and the February 2012 ER

Report Section	Description
Section 1	Update provides additional and updated information.
Section 2	Update provides additional and updated information.
Section 3	Update provides additional and updated information.
Section 4	No significant changes
Section 5	Replaces February 2012 ER Section 5
Section 6	Replaces February 2012 ER Section 6
Section 7	Replaces February 2012 ER Section 7
Section 8	Replaces February 2012 ER Section 8
Appendix 3-1	Update Appendix 3-1 replaces February 2012 ER Attachment 3-1
Appendix 5-1	Replaces February 2012 ER Attachment 5-1
Appendix 5-2	No change from February 2012 ER Attachment 5-2
Appendix 5-3	Replaces February 2012 ER Attachment 5-3
Appendix 6-1	Replaces February 2012 ER Attachment 6-1
Appendix 6-2	Replaces February 2012 ER Attachment 6-2
Appendix 6-5	Update Appendix 6-5 provides additional information about the proposed project.
Appendix 6-6	Update Appendix 6-6 provides additional information about the proposed project.
Appendix 6-7	No change from February 2012 ER Attachment 6-7
Appendix 6-8	No change from February 2012 ER Attachment 6-8

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Section 2
System Alternatives

SECTION 2

System Alternatives

The evaluation of water supply alternatives that led to the proposed project introduced in Section 1 considered water supplies in the Mississippi River basin and the Lake Michigan basin. In the case of the Lake Michigan basin water supply alternatives, the City of Waukesha is required to comply with the Compact and Wisconsin implementation statute requirements by returning the flow to the Lake Michigan basin. The water supply sources outside of the Lake Michigan basin would have wastewater treatment and discharge to the Mississippi basin at the existing City of Waukesha Wastewater Treatment Plant (WWTP). For water supply alternatives in the Lake Michigan basin, return flow alternatives to satisfy the Compact requirements were developed.

Water supply and return flow alternatives were developed individually, while return flow alternatives were developed considering the Lake Michigan supply source. These individual water supply and return flow alternatives are combined to create a “system alternative”. A system alternative combines the impacts from both water supply and treated wastewater discharge to provide the sum of the impacts with respect to the environment. An example “system alternative” for a Mississippi River basin water supply includes using deep and shallow aquifers for the water supply with wastewater treatment at the existing WWTP. An example “system alternative” for a Lake Michigan basin water supply includes connecting to the City of Oak Creek’s Lake Michigan water supply with wastewater treatment at the City of Waukesha WWTP and return flow of treated wastewater to Lake Michigan via the Root River.

The water supply sources and system alternatives in the Mississippi River and Lake Michigan basins are described below.

2.1 Background Information on Water Sources Considered in Prior Studies

Extensive studies have investigated various water supply alternatives for the City of Waukesha (CH2M HILL and Ruekert & Mielke, 2002, SEWRPC, 2010a, Cherkauer, 2009, CH2M HILL, 2010). In March 2002, the Waukesha Water Utility completed a future water supply study. Stakeholders in this study included representatives from the Utility, City of Waukesha, Wisconsin Department of Natural Resources (WDNR), Southeastern Wisconsin Regional Planning Commission (SEWRPC), U.S. Geological Survey (USGS), Wisconsin Geological and Natural History Survey, and the University of Wisconsin–Madison. The study looked at the following 14 water supply sources and combinations of them:

- Deep (confined) aquifer near Waukesha
- Deep (unconfined) aquifer west of Waukesha
- Shallow groundwater south of Waukesha (including riverbank inducement through Fox River alluvium)

- Shallow groundwater west of Waukesha
- Dolomite aquifer
- Fox River
- Rock River
- Lake Michigan
- Dam on the Fox or Rock River
- Waukesha quarry
- Waukesha springs
- Pewaukee Lake
- Milwaukee River
- Wastewater reuse

The SEWRPC is the official regional planning agency for the seven-county Southeastern Wisconsin Region, including Waukesha County. SEWRPC is charged by law with making and adopting a comprehensive plan for the physical development of the region. In December 2010, SEWRPC released a final report titled, A Regional Water Supply Plan for Southeastern Wisconsin (SEWRPC, 2010a). This plan is an extensive evaluation of water supply alternatives for the seven-county area, including the City of Waukesha, to the year 2035. Similar to the Future Water Supply Study, the SEWRPC study screened alternative water supplies and ultimately identified similar water supply alternatives. Extensive groundwater and surface water modeling was conducted in the evaluation of these alternatives. The water supply alternatives evaluated for the region included the following:

- Lake Michigan
- Shallow aquifers
- Deep aquifer
- Shallow aquifers and artificial recharge using rainwater and wastewater treatment plant effluent
- Deep aquifer and artificial recharge using treated Lake Michigan water
- Combinations of these alternatives

During the development of the City's Application, additional analysis was completed for the Unconfined Deep Aquifer, the Silurian Dolomite Aquifer, and combinations of source water supplies beyond that evaluated in the 2002 Future Water Supply Study and SEWRPC study. These evaluations are documented in the Water Supply Service Area Plan (Volume 2 of the Application).

2.2 System Alternatives Considered

Each of the water supply alternatives is further discussed below where it is also combined with its wastewater discharge location to create a “system alternative.” The system alternatives are evaluated below based on their water supply source watershed - Lake Michigan basin or Mississippi River basin.

2.2.1 Lake Michigan Basin System Alternatives

Within the Lake Michigan basin, surface water and groundwater sources were considered.

2.2.1.1 Surface Water Alternatives in the Lake Michigan Basin

Water Supply Alternatives

Milwaukee River

The Milwaukee River is tributary to Lake Michigan in Milwaukee, Wisconsin. The river flows through highly urbanized areas of the City and much of its lower watershed is fully developed with industrial, commercial, and residential land uses. The river was considered as part of the 2002 Future Water Supply Study as one of the 14 potential sources of water, but it was eliminated during initial screening due to public health and water quality concerns of using an urban river as a public water supply, it had limited volume during low-flow periods, and it subsequently would have been more costly than other surface water sources that have better water quality. Because this alternative was screened out during the Future Water Supply Study, a return flow alternative was not developed for a Milwaukee River water supply and this alternative is not considered further in this document.

Lake Michigan

A Lake Michigan supply was the other surface water alternative considered in the Lake Michigan basin. Water quality in Lake Michigan is very good and the City of Milwaukee, City of Oak Creek, and City of Racine all have existing drinking water treatment plants that could be used to supply water to the City of Waukesha with a connection to their existing distribution systems. Between the City of Waukesha and the Cities of Milwaukee, Oak Creek and Racine, there are wetlands, streams, and other natural resources which could be impacted by construction of supply or return flow pipelines. The proposed alignment for the pipeline avoids these resources as much as practicable, the majority of impacts are temporary construction impacts because the pipeline corridor will be restored after construction, and they follow previously disturbed routes through existing development, transportation corridors, and utility corridors. Since the completion of the February 2012 ER, the City of Oak Creek has been chosen as the proposed water supplier from the three suppliers. An updated alignment for the City of Oak Creek, called Lake Michigan Supply (City of Oak Creek) Alignment 2, is the proposed project.

Return Flow Alternatives

The Compact and Wisconsin implementation statute requires return flow for a Lake Michigan water supply. Five alternatives were considered for return flow to Lake Michigan for a Lake Michigan water supply. The alternatives include return flow to:

- Underwood Creek, a tributary to the Menomonee River that flows to Lake Michigan

- Root River, a tributary to Lake Michigan, two pipeline alignment alternatives
- Direct to Lake Michigan near Milwaukee and Oak Creek
- Direct to Lake Michigan near Racine
- The Milwaukee Metropolitan Sewerage District (MMSD) sewer system and water reclamation facility, which would then return flow to Lake Michigan. Several subalternatives were considered for return flow to MMSD.

Similarly to the Lake Michigan (City of Oak Creek) alternative, the Root River return flow alternative consists of two separate alignment alternatives. Root River Return Flow Alignment 1, as well as the other proposed return flow alternatives, are described in detail within Sections 2 and 6. Root River Return Flow Alignment 2 is a new alignment first described within this document and is the preferred return flow location.

Note: The Water Supply Service Area Plan Lake Michigan (City of Oak Creek) water supply alternative describes the ER Lake Michigan (City of Oak Creek) Alignment 2 alternative and the Return Flow Plan Root River to Lake Michigan return flow alternative describes the ER Root River to Lake Michigan Alignment 2 return flow alternative. The ER retains the Lake Michigan (City of Oak Creek) Alignment 1 water supply alternative and the Root River to Lake Michigan Alignment 1 return flow alternative for alternative comparison purposes.

Underwood Creek Return Flow

Underwood Creek is an urban stream with portions of the creek flowing through parts of Greenfield, Brookfield, Elm Grove, and Wauwatosa before its confluence with the Menomonee River in Wauwatosa. Return flow to Underwood Creek is expected to occur in Waukesha County, near the crossing of Underwood Creek and Bluemound Road. At that location, Underwood Creek is a concrete lined channel that flows about 2.6 river miles to its confluence with the Menomonee River in Wauwatosa before flowing another 10 river miles to Lake Michigan in the City of Milwaukee. Most of Underwood Creek downstream of the return flow location is concrete lined, but a 2,400-foot-long segment of lining was removed and rehabilitated with natural channel design features (MMSD, 2008a). The rehabilitated creek provides improved habitat because the bottom substrate is coarse grained sediments (gravel and cobbles); it provides various habitat features such as riffles, runs, pools, and glides; it meanders and includes other habitat features like rock boulders; the vegetation will overhang the channel once it is mature; and the creek is reconnected with its floodplain.

A screening level layout was developed for the return flow pipeline. It begins at the City of Waukesha WWTP, and proceeds north and east through a City park and along an alley and minor streets for about 1.3 miles. The pipeline continues east for another 1.3 miles following an abandoned railroad corridor planned for a future recreational trail, where it joins with an utility corridor and bike trail and runs for another 7 miles. The pipeline continues north 1.9 miles along a street and bike path until it ends near the confluence of the north and south branch of Underwood Creek, near Bluemound Road. A return flow to Underwood Creek is retained for additional analysis in Section 6 of this document.

Root River Return Flow

The Root River is very similar to Underwood Creek. The Root River flows through parts of Milwaukee and Racine counties, and into Lake Michigan in Racine, Wisconsin. The river has

more natural channel (e.g., natural bottom substrate and vegetated river banks) than does Underwood Creek, and it has a mixture of land uses between its headwaters and Lake Michigan. The headwaters of the Root River are heavily urbanized, the middle reaches are primarily agriculture and lower density development, and the lower parts of the watershed near Lake Michigan are heavily urbanized.

The conceptual pipeline Alignment 1 for return flow to the Root River is the same as the pipeline for Underwood Creek for about the first 9.6 miles. Where the Underwood Creek pipeline heads north toward Underwood Creek, the Root River pipeline would continue southeast for 6 miles toward the Root River following streets, a parkway, and a bike trail. This return flow alternative is discussed in more detail in Section 6, but it is not the preferred return flow alternative for a Lake Michigan supply.

Root River return flow Alignment 2 is the preferred return flow alternative for a Lake Michigan supply from the City of Oak Creek. The Lake Michigan (City of Oak Creek) Alignment 2 runs parallel to this alignment for approximately 14.8 miles. This return flow alignment is discussed in more detail in Section 3 and 5 of this ER.

Return flow direct to Lake Michigan near Milwaukee and Oak Creek

Return flow direct to Lake Michigan near Milwaukee and Oak Creek includes a pipeline from the City of Waukesha WWTP to Lake Michigan. The conceptual pipeline alignment is the same as that for Underwood Creek and Root River Alignment 1 for about the first 9.6 miles. Where the two pipelines diverge, the Lake Michigan alignment continues east about 11.2 miles parallel to a railroad corridor. As the alignment nears Lake Michigan, it continues east about 1.2 miles along a city street where it intersects with the lake. The alignment extends into Lake Michigan about 0.5 miles to provide an offshore outfall. The alignment is the same as that developed by SEWRPC, except the last segment of pipe is a few city blocks to the north. The city street used for the last segment is larger and the shoreline at Lake Michigan has been previously disturbed but is undeveloped compared to the SEWRPC alignment. This alignment appears to have slightly less constructability challenges and is shorter in distance than the alignment developed by SEWRPC.

Similar to the Underwood Creek and Root River return flow alignments, this alignment follows corridors that are previously disturbed and avoids environmental resources such as wetlands, stream crossings, and other similar land uses as much as possible. Some areas of the alignment will have temporary (short-term) impacts to these resources because of construction activities associated with building the pipeline. This alternative will impact the Lake Michigan bottom where the outfall is constructed within Lake Michigan for an offshore discharge.

As discussed in detail in the Return Flow Plan (Volume 4 of the Application) and in Section 6 of this document, for discharges to Underwood Creek or Root River, the return flow is able to provide a resource benefit by providing additional flow in the creek and river during periods when little or no flow is naturally present. The return flow to these Lake Michigan tributaries could provide habitat benefits by no longer having the streams occasionally dry up. In contrast, return flow directly to Lake Michigan would have no environmental benefit because the return flow would be conveyed in a pipe, instead of through a surface water where the additional flow could benefit the water dependent natural resources.

Consequently, return flow directly to Lake Michigan is not a preferred alternative but is

evaluated further in Section 6 of this document to carry forward an alternative that includes a return flow piped directly to Lake Michigan.

Return flow direct to Lake Michigan near Racine

Return flow direct to Lake Michigan near Racine includes a pipeline from the City of Waukesha WWTP to Lake Michigan near Racine. This return flow alternative was originally developed as a return flow alternative for a Lake Michigan water supply from the City of Racine. Sharing a corridor between the water supply and return flow alignments will minimize cost, construction, and environmental impacts for this alternative. The same as the other return flow pipeline alignments, this corridor follows previously disturbed lands that include agriculture, utility corridors, roads and recreational paths. The first 4.4 miles of the pipeline from the City of Waukesha WWTP follows the same alignment as the Underwood Creek, Root River Alignment 1, and Direct to Lake Michigan near Milwaukee and Oak Creek return flow alternatives. The middle portion of the alignment (about 28 miles) shares the corridor with the Racine water supply alignment. The eastern 4 miles of the shared corridor is where the water supply and return flow alignments diverge, where the proposed water supply continues south to connect with the Racine distribution system and the return flow alignment continues east towards Lake Michigan. The return flow alignment for these 4 miles was chosen because it allowed the discharge location to be near the City of Racine (within about 6.5 miles of the water treatment plant) and the alignment was able to follow an existing utility corridor and previously disturbed open space at the Lake Michigan shoreline.

The environmental impacts associated with the direct to Lake Michigan near Racine return flow alignment will be similar to those for the Racine water supply alignment due to shared corridors for most of the alignment. The same as the other return flow alignments, this alignment follows corridors that are previously disturbed and avoids environmental resources such as wetlands, stream crossings, and other similar land uses as much as possible. Some areas of the alignment will have temporary (short-term) impacts to these resources because of construction activities associated with building the pipeline similar to those impacts with other return flow alignments. The same as the return flow direct to Lake Michigan near Milwaukee and Oak Creek, this alternative will impact the lake bottom where the outfall is constructed within Lake Michigan for an offshore discharge.

The same as return flow directly to Lake Michigan near Milwaukee and Oak Creek, this alternative would not provide an environmental benefit by augmenting flow in a Lake Michigan tributary because it includes a pipeline directly to the Lake. This alternative is also significantly more expensive than all other return flow alternatives (see the Return Flow Plan, Volume 4 of the Application), it has the greatest impacts because it has the longest pipeline length, and provides no additional benefit than return flow directly to Lake Michigan near Milwaukee and Oak Creek. This alternative was developed to evaluate a return flow pipeline as close as practicable to Racine, in the event that a Racine water supply was obtained and it was required that a return flow pipeline be constructed directly to Lake Michigan. However, as discussed in the Return Flow Plan, (Volume 4 of the Application), a return flow pipeline directly to Lake Michigan is not expected to be necessary if water is returned to a Lake Michigan tributary and a water supply agreement with the City of Racine was not developed in favor of a Lake Michigan water supply agreement with the City of

Oak Creek. Consequently, this return flow alternative is not evaluated further in this document.

Return Flow through the Milwaukee Metropolitan Sewerage District

Return Flow through the Milwaukee Metropolitan Sewerage District (MMSD) would include a sewer connection between the City of Waukesha and MMSD. The MMSD operates regional sewage collection and water reclamation systems for most communities within the Lake Michigan Basin in the Milwaukee metropolitan area. Under this return flow alternative, the City of Waukesha sanitary sewer system would collect flow from its sanitary sewer service area and convey return flow to MMSD for treatment and discharge to Lake Michigan. There are two sub-alternatives for return flow to MMSD:

- Sub-alternative 1: Sanitary sewer flow treated at the City of Waukesha WWTP with return flow to MMSD
- Sub-alternative 2: Sanitary sewer flow conveyed to MMSD without treatment at the Waukesha WWTP

Several variations of sub-alternative 2 were considered as documented in the Return Flow Plan (Volume 4 of the Application). For either option, a pipeline alignment would be selected to provide return flow while minimizing impacts to environmental resources and other land uses. The City would continue to operate a WWTP, for sub-alternative 1.

For either sub-alternative, improvements to the MMSD collection system and treatment plants are likely required. The MMSD system is capacity-limited during wet weather, so any flow returned to MMSD would likely require additional conveyance and treatment capacity equivalent to the return flow or storage to temporarily hold the water until treatment capacity is available.

As with returning flow directly to Lake Michigan, returning flow to MMSD does not allow the return flow to be used as a resource because the flow would not be in a Lake Michigan tributary. For sub-alternative 1 with treatment of return flow at the City of Waukesha WWTP and MMSD, the return flow would be inefficiently using resources by providing double-treatment with no significant improvement in return flow water quality.

The SEWRPC regional water supply study included the MMSD return flow alternative in its evaluation of return flow alternatives, but the MMSD alternative was not recommended because the cost exceeded that of return flow directly to Lake Michigan and to a Lake Michigan tributary. The MMSD alternative evaluation in the Return Flow Plan (Volume 4 of the Application) confirms the high-cost of the MMSD alternative. Consequently, utilizing MMSD infrastructure for conveyance and treatment is not evaluated further for these reasons, and for those discussed above.

2.2.1.2 Groundwater Alternatives in Lake Michigan Basin

During the Future Water Supply Study, a wellfield near the Lake Michigan shoreline was initially considered for detailed evaluation because research had shown that there may be permeable sand and gravel and dolomite units that extend under Lake Michigan and connect Lake Michigan to the shallow aquifers in eastern Ozaukee County (Cherkaurer et al., 1990). Under these conditions, it would be possible to construct a wellfield along the Lake Michigan shoreline and induce recharge from the lake. The wellfield would require at

least 15 to 20 miles of pipeline through multiple communities that are nearly built-out and where land is either not available or very unlikely to be dedicated to a municipal wellfield. In addition, the ability to obtain adequate water quantity and quality was not proven. For these reasons, groundwater in the Lake Michigan basin was eliminated from detailed evaluation. Because this alternative was screened out during the Future Water Supply Study, a return flow alternative was not developed and this alternative is not evaluated further in this document.

2.2.1.3 Summary of Lake Michigan Basin System Alternatives

The Lake Michigan basin water supply and return flow alternatives that passed initial screening are shown in Table 2-1. These alternatives are evaluated in detail in this document.

The individual water supply and return flow alternatives that passed initial screening are combined into system alternatives for further evaluation in this document.

Each of the water supply alternatives is combined with each of the return flow alternatives to formulate ten system alternatives. Table 2-2 is a summary of the ten Lake Michigan basin system alternatives that are retained for further evaluation in Section 6 of this document.

TABLE 2-1
Lake Michigan Basin Water Supply and
Return Flow Alternatives Evaluated in Detail

Water Supply Alternatives
Lake Michigan (City of Milwaukee)
Lake Michigan (City of Oak Creek) Alignment 1
Lake Michigan (City of Oak Creek) Alignment 2
Lake Michigan (City of Racine)
Return Flow Alternatives (for Lake Michigan Water Supplies)
Underwood Creek to Lake Michigan
Root River to Lake Michigan Alignment 1
Root River to Lake Michigan Alignment 2
Direct to Lake Michigan near Milwaukee and Oak Creek (hereafter referred to as <i>Direct to Lake Michigan</i> in Sections 5 and 6)

TABLE 2-2
Lake Michigan Basin System Alternatives

Lake Michigan Basin Water Supply	Return Flow Alternative			
	Underwood Creek to Lake Michigan	Root River to Lake Michigan Alignment 1	Root River to Lake Michigan Alignment 2	Direct to Lake
Lake Michigan (City of Milwaukee)	X	X		X
Lake Michigan (City of Oak Creek) Alignment 1	X	X		X
Lake Michigan (City of Oak Creek) Alignment 2			X	
Lake Michigan (City of Racine)	X	X		X

2.2.2 Mississippi River Basin System Alternatives

Within the Mississippi River basin, surface water and groundwater sources were considered.

2.2.2.1 Surface Water Alternatives in Mississippi River Basin

Fox River

The Fox River was included as an alternative as part of the Future Water Supply Study. The Fox River flows from the northeast to the southwest through the heart of the City of Waukesha. The watershed is developing with growth in the City of Waukesha, the City and Village of Pewaukee, the Village of Sussex, and portions of the City of Brookfield and Village of Menomonee Falls. Wastewater treatment plants that discharge to the Fox River are located in the Village of Sussex and in the Cities of Brookfield and Waukesha. Sussex and Brookfield are upstream of Waukesha.

The water quality in the Fox River was determined to be of suitable quality as a water supply with adequate treatment. The Fox River is designated as a recreational water, where if it were to be a source of drinking water, its designation would change. This could result in stricter wastewater treatment plant effluent limitations and significant compliance costs for any wastewater plant discharging into these waters.

As part of the Future Water Supply Study, flow records for the Fox River were obtained for a period extending 20 years. The Fox River has significant seasonal variations in flow where summer dry weather flow drops well below seasonal averages. Review of historical data indicates that adequate dry weather flow, including an allowance for baseflow, would have been available for only 4 of the past 20 years. A supplemental reservoir such as a dam along the river, a large lake, quarry, or aquifer storage would be required to bridge the dry weather period. Providing a dam on the Fox River was evaluated in the 1970 Fox River Watershed Plan as a method of bridging the summer dry periods by impounding wet weather flows. The concept was not carried forward in the 1979 Regional Water Quality Management Plan, as it would have required significant areas of land purchase and would have posed significant regulatory and environmental challenges not likely to be resolved. A Fox River water supply intake would be located downstream of the City of Brookfield and Village of Sussex wastewater treatment plants, and possibly downstream of the City of Waukesha's wastewater treatment plant. Water treatment technologies exist to treat wastewater for drinking water use, however utilizing the Fox River downstream of at least two wastewater treatment plants would not likely be publically acceptable and may not be permitted by the WDNR (wastewater reuse is discussed further in an alternative below). Consequently, this alternative was eliminated from further evaluation as a reliable source of water in the Future Water Supply Study, and therefore it is not evaluated further in this document.

Rock River

The Rock River was included as an alternative as part of the Future Water Supply Study. The Rock River is located west of the City of Waukesha where the closest segment is in Jefferson County about 19 miles northwest of the center of the City of Waukesha. The Rock River watershed is about 7 times the area of the Fox River watershed and is characterized by small rural communities with associated wastewater treatment facilities. Land use is predominantly rural and natural areas including the Horicon Marsh.

The water quality in the Rock River is generally better than the Fox River because it is a less developed watershed. The Rock River was also determined to be of suitable quality as a water supply with adequate treatment. The same as the Fox River, the Rock River is designated as a recreational water, where if it were to be a source of drinking water, its designation would change. This could result in stricter wastewater treatment plant effluent limitations and significant compliance costs for any wastewater plant discharging into these waters.

Flow records for the Rock River were obtained for a period extending 20 years. The Rock River also has significant seasonal flow variations where summer dry weather flows drop well below seasonal averages. Review of historical data indicates that adequate dry weather flow, including an allowance for baseflow, would have been available for 16 of the past 20 years. A supplemental reservoir such as a dam along the river, a large lake, quarry, or aquifer storage would be required to bridge the dry weather period. Constructing a dam would have required significant areas of land purchase and would have posed significant regulatory and environmental challenges. Consequently, this alternative was eliminated from further evaluation as a reliable source of water in the Future Water Supply Study, and therefore it is not evaluated further in this document.

Quarries

Quarries were considered during the Future Water Supply Study and the Water Supply Service Area Plan (Volume 4 in the Application) as a potential surface water source and as a storage reservoir for diverted surface water from the Fox River. Four quarries are near the City of Waukesha, but none of them are within the City's boundaries. Two active stone quarries are located north of the City of Waukesha. These quarries are adjacent to the Fox River in the town of Pewaukee. There are also two quarries located in the town of Lisbon. Each of these quarries is active and none are planned for as a drinking water supply. There are no quarries in Wisconsin currently used for drinking water supply.

Quarry water would be obtained through an intake structure in each quarry and conveyed to a treatment plant prior to distribution throughout the City. The Pewaukee quarries pumped about 1 to 3 million gallons per day (mgd) and the Lisbon quarries pumped about 3 to 6 mgd for dewatering purposes based on 2002 to 2010 data from the WDNR. Average day sustainable water supply was assumed to be 2.5 mgd, and about 5 mgd during maximum day demands. Less water would be available from all quarries during a drought since some of the water comes from rainfall and the rest depends on groundwater storage and recharge which is also affected by drought. The quarries alone cannot provide adequate supply for future water demands.

Using an open surface water quarry for water storage and supply increases the potential for contamination from surface water runoff or groundwater. Quarry operations use fuels and solvents that can contaminate groundwater. There are 127 potential contamination sources near the quarries that pose a risk to public health (see the Water Supply Service Area Plan, Volume 2 of the Application) where contamination in groundwater could be carried into the quarry. Urban runoff (stormwater) also could carry contaminants into quarries. Although contaminated water can be treated, the contaminants must be known ahead of time so that the proper treatment technology can be built into the treatment plant to protect public health. If other contaminants that cannot be removed by conventional surface water treatment were discovered, additional treatment would be required. Depending on the

contaminant, this could significantly increase capital and operating costs. A WDNR approval for using a quarry as a public water supply would be required and may not be approved because of the public health concern. To develop this water supply source, the permitting process would be extensive because there are no other drinking water quarry supplies in the state.

Supplementing quarry water with water directly from the Fox River may increase the quantity of water available, but the environmental, public health, and regulatory concerns increase. Diverting surface water into direct contact with groundwater will have regulatory impacts and storing water in a quarry would cause stagnation and adverse water quality impacts such as algae growth, lack of oxygen and release of undesirable compounds such as iron, manganese and hydrogen sulfide that can cause “rotten egg” odors in the water. This would increase treatment requirements and reduce public health protection.

For these reasons utilizing quarries as a single water supply source or as part of a multiple source alternative was eliminated from further evaluation in this document.

Pewaukee Lake

Pewaukee Lake was considered during the Future Water Supply Study. It is located about 5 miles north of the center of the City of Waukesha. It has a surface area of approximately 2,500 acres and it contains about 12 billion gallons of water. The lake watershed is about 18,000 acres, or 28 square miles and the lake includes about 14 miles of shore land that is mostly high-value residential development. The lake is the source water for the Pewaukee River, which flows southeast to the Fox River upstream of the City of Waukesha. The source water for the lake is precipitation to the lake, runoff from the lake watershed, or infiltration/exfiltration to the shallow sand and gravel aquifer. The water surface in the sand and gravel aquifer is reflected by the lake water surface.

Like the river water sources, Pewaukee Lake is also most vulnerable during the dry summer months. It must continue to provide baseflow to the Pewaukee River and maintain its level to accommodate the high demand for summer recreational activities. One week of City of Waukesha demand is equal to about 1 inch of lake level. Dry periods can last up to 2 months, resulting in a significant potential draw down. Some replenishment from the sand and gravel aquifer is expected to offset the draw down, but significant impacts on Pewaukee River flows and lake levels during dry weather periods are likely.

The same as the Rock River and Fox River, Pewaukee Lake is a recreational water that if changed to a water supply source, its designation would change.

For these reasons utilizing Pewaukee Lake as a single source or as part of a multiple source alternative was eliminated from further evaluation in this document.

2.2.2.2 Groundwater Alternatives in Mississippi River Basin

Shallow Sand and Gravel Aquifer

The shallow aquifer includes sand and gravel beds in unconsolidated glacial deposits. This water supply source was evaluated in the Future Water Supply Study and by SEWRPC. The extent of this aquifer is generally sporadic in the eastern half of Waukesha County, but it produces a significant portion of the water supply for several communities and many private wells surrounding the City of Waukesha. Several areas near the city have the

potential to produce adequate quantities of water from this aquifer to meet the water demand projections of the City of Waukesha. However, most areas are outside of the City's boundaries.

The sand and gravel aquifer offers some advantages, including faster local recharge, low radionuclide content, and lower costs compared to some other groundwater sources. In spite of the advantages, development of the aquifer has been limited by the distribution of the permeable sand and gravel deposits. In most of southeastern Wisconsin, sand and gravel deposits are absent or too thin to support high-capacity wells. However, several geologic features contain channel deposits of permeable sand and gravel that can support wells producing over 1,000 gallons per minute (gpm). These geologic features include bedrock valleys, outwash deposits, and end moraine deposits. As these features cover a limited area of southeastern Wisconsin, sand and gravel aquifer wells must be sited in these specific areas to produce significant volumes of water.

In the areas where many of the sand and gravel deposits exist near the City of Waukesha, there are also many environmental resources including wetlands, the Vernon Marsh Wildlife Area, cold water trout streams and other connected surface waters like the Fox River, Pebble Brook, Pebble Creek and Mill Brook. Given the permeable nature of the sand and gravel aquifer and its shallow location, there is direct hydraulic connectivity between environmental resources and the ground water. Pumping the shallow sand and gravel aquifer can lower the groundwater levels and result in direct impacts to the surface environmental resources. The effects could include alteration of the vegetation community, flow regimes in the wetlands and streams, and the overall ecological function of the resource.

This water supply alternative is not carried forward as a single source, but is combined with other groundwater alternatives described below. Combinations of groundwater sources are evaluated in detail in Section 6 of this document.

Deep Sandstone Aquifer

The deep sandstone aquifer is a major source of groundwater for municipal supplies in southeastern Wisconsin. It was evaluated in the Future Water Supply Study and by SEWRPC. About 95 percent of the municipal water in Waukesha County comes from wells in the deep sandstone aquifer. Most of the City of Waukesha wells produce water from the deep sandstone aquifer. About 50 communities and 200 industries in southeastern Wisconsin rely on the deep sandstone aquifer for at least part of their water supply.

The sandstone aquifer is comprised of three major sandstone units, separated by lower permeability shale and dolomite units that act as confining layers. In the eastern portion of Waukesha County at the City of Waukesha, the Maquoketa shale is a relatively impervious confining unit that separates the shallow aquifer from the deep sandstone aquifer. Very little water seeps through the shale into the sandstone aquifer. Since the shale is present over most of eastern Waukesha County, the sandstone aquifer is confined and isolated from direct recharge in the area of heaviest demand and in the City of Waukesha. The sandstone aquifer in Waukesha County receives almost all of its recharge from the western portion of the county, where the Maquoketa shale is absent and surface water can infiltrate through the shallow glacial deposits into the deeper sandstone aquifer.

The deep sandstone aquifer currently used as a water supply for the City of Waukesha extends east from Waukesha under Lake Michigan. A report by the United State Geological Survey (USGS) estimated 30 percent of the 33 mgd of water pumped by the deep aquifer wells in southeastern Wisconsin originate from inside the Lake Michigan Basin (USGS, 2006). Groundwater flow into Lake Michigan is a significant component of overall flow. Direct and indirect groundwater inflow contributes 33.8 percent of Lake Michigan water (USGS, 2000).

Two areas of the deep sandstone aquifer that were evaluated as part of the Future Water Supply Study, SEWRPC, and subsequent analysis during the Lake Michigan Application process, included the confined aquifer near the City of Waukesha and the unconfined aquifer near the western boundary of Waukesha County.

Deep Confined Sandstone Aquifer

Pumping from the sandstone aquifer has created a large cone of depression centered on eastern Waukesha County. The original groundwater gradient was from west to east but the cone of depression has reversed the regional groundwater gradient in Ozaukee and Milwaukee Counties. This condition has probably existed for about 50 years and is causing water to migrate westward from under Lake Michigan to the pumping center in eastern Waukesha County. Several water quality parameters have changed in the aquifer over the last 10 to 20 years. Most sandstone wells in Waukesha County exceed the maximum contaminant limit (MCL) for radium and gross alpha. Gross alpha levels have risen significantly in most sandstone aquifer wells in Waukesha County. Typically, gross alpha levels have more than doubled over the last 20 years. Many wells contain low levels of arsenic, and in a few wells, arsenic has been detected at levels above the MCL. Total dissolved solids (TDS) levels have increased in many of the deepest wells in the county. Some wells have experienced rising TDS levels that have more than doubled in 10 years and have produced brackish water. The historical water quality trend complicates efforts to comply with the radionuclide MCLs.

The rise in TDS levels in the aquifer appears to be related to the upward migration of water from deeper portions of the aquifer. This condition is caused by extreme vertical gradient created by the regional cone of depression. The rise in gross alpha levels may be due to related processes or to other geochemical changes in the aquifer caused by the significant decrease in groundwater level.

The groundwater flow path has reversed direction from its predevelopment condition due to heavy pumping of the deep confined sandstone aquifer, and although there is the Maquoketa shale confining unit, wells in the deep confined sandstone aquifer have significant impacts on environmental resources like wetlands and streams. The USGS and WGNHS indicate that 70 percent of water pumped from the deep aquifer would have gone to inland surface waters. The remaining 30 percent originates from inside the Lake Michigan Basin and 4 percent of that is contributed by Lake Michigan (Feinstein and USGS, 2006).

The deep confined sandstone aquifer does not have capacity, nor sufficient water quality, to support the future regulatory and water supply needs for the City of Waukesha in a cost effective manner. Utilizing this water source as a single source of water for the City of Waukesha was therefore eliminated from evaluation by the Future Water Supply Study and SEWRPC. However, the deep confined sandstone aquifer is carried forward in combination

with the shallow sand and gravel aquifer. Although the deep aquifer has water quality and quantity impairments, it is carried forward in combination with the shallow sand and gravel aquifer because the deep aquifer wells are within the City of Waukesha's city limits and the existing wells could have additional treatment added to supplement a new source for peak demands. Because the Future Water Supply Study showed the Fox River alluvium has similar water supply benefits but greater costs than the shallow sand and gravel aquifer, the deep confined sandstone aquifer is evaluated in detail in combination with the shallow sand and gravel aquifer. This alternative is discussed in detail in the Water Supply Service Area Plan, Volume 2 of the Application.

Deep/Western Unconfined Sandstone Aquifer

In western Waukesha County, about 10 miles west of the City of Waukesha, the Maquoketa shale confining layer ends and the deep sandstone aquifer is unconfined and overlain with a shallow sand and gravel aquifer. Without the confining layer, the deep sandstone aquifer is more easily recharged from shallow aquifers and groundwater levels are higher. The higher groundwater levels result in shallower wells that have better water quality than the deep sandstone aquifer that is confined by the shale under the City of Waukesha. However, the water quality in the unconfined deep sandstone aquifer is still impacted by radium and gross alpha (although the levels are currently below primary drinking water regulations) and the environmental impacts to shallow aquifers, surface waters and wetlands is significant because of the hydraulic connectivity between these and the unconfined deep aquifer.

Pumping from the unconfined deep sandstone aquifer was modeled using the SEWRPC regional groundwater model at flows between 2 mgd and 15 mgd. Modeling results indicated drawdowns in the sandstone aquifer between 46 feet (2 mgd) to 240 ft (15 mgd) near the wells. This corresponded to drawdowns in the shallow aquifer (above the sandstone) of 0.28 foot (2 mgd) to 1.6 feet (15 mgd). The shallow aquifer drawdown impacts surface water sources such as rivers, streams, and lakes. It is estimated that with average day demands of 10 mgd, groundwater pumping will impact 480 acres of wetlands and over 100 acres of surface waters within the 1 foot drawdown contour line (see the Water Supply Service Area Plan in Volume 2 of the Application). At maximum day demands the drawdown would be much greater.

Water extracted from the unconfined deep aquifer intercepts natural recharge of the deep confined sandstone aquifer near Waukesha. Removing this water will not eliminate adverse environmental impacts from drawdown in the deep confined aquifer discussed above and still adversely affects the amount of groundwater recharging the Lake Michigan basin.

One of the most significant impacts of this water supply alternative is its implementability. This alternative would require siting and constructing up to 13 wells (12 wells for 10.1 mgd ADD), interconnecting piping, a pump station, a long transmission pipe to Waukesha, and a treatment plant for removal of iron and manganese and disinfection. Waukesha would need to operate and maintain a remote wellfield and pump station, and a large water treatment plant would be required. Treatment for radium would not likely be initially required because the levels of radium in existing wells is below drinking water standards, but needing radium treatment in the future is possible because existing wells in the unconfined deep aquifer have radium. Each well, pump station and treatment plant would likely require land acquisition, where approximately 14 municipalities, counties, and utility

companies are anticipated to require coordination to construct the water supply facilities. Land purchase and easement requirements for the unconfined deep sandstone aquifer supply may be more difficult to implement than, for example, those of the shallow aquifer near the City of Waukesha because of the greater distance from the City of Waukesha.

Pumping water from this deep unconfined sandstone aquifer would create a large area of groundwater drawdown. Over 150 private wells are within the one foot groundwater drawdown contour line area, and over 10 high capacity or public drinking water wells are within the 10 foot groundwater drawdown contour line area. In addition, the wellfields in this area are in the Rock River watershed whereas the wastewater discharge from the City of Waukesha would be in the Fox River watershed. Cost estimates of this alternative assumed the water would not have to be returned to the Rock River watershed.

Installing high capacity wells in the deep unconfined sandstone aquifer west of the Maquoketa shale has significant logistical, legal, and environmental resource impacts. Consequently, this alternative is not evaluated further in this document. Additional detail of this alternative is included in the Water Supply Service Area Plan (Volume 2 in the Application).

Silurian Dolomite Aquifer

The regional bedrock, the Silurian dolomite, lies below the surficial glacial deposits and sand and gravel aquifer, and serves as an aquifer (commonly called the dolomite aquifer) for much of eastern Wisconsin. This water supply source was considered during the Future Water Supply Study, SEWRPC, and in the Water Supply Service Area Plan (Volume 2 of the Application). The dolomite itself is relatively dense and incapable of storing or transmitting significant quantities of water. The dolomite aquifer usually produces small quantities of water that are sufficient for private homes only. However, numerous zones of fractured rock exist within the dolomite, which can produce several hundred gpm from the void spaces created by the fractures and related solution cavities. It is only where the dolomite aquifer is fractured that it may produce enough water for municipal needs. The fractures tend to concentrate in regional fracture zones. The fracture zones are nearly vertical and are typically miles long, but only a few tens of feet wide. The dolomite aquifer has become an important water source for municipal wells for much of eastern Wisconsin, especially for the Cities of New Berlin and Brookfield, the Towns of Brookfield and Pewaukee, and the Villages of Germantown and Menomonee Falls (now on standby). The dolomite aquifer is only available in limited areas around the eastern, northern, and southern sides of Waukesha.

Groundwater can rapidly flow through the fractures, both horizontally and vertically, without significant filtration. As a result, contamination from the sand and gravel aquifer can be transported for thousands of feet without much attenuation⁹. Locating potential wells away from these contamination sources and screening the sites for suitable thickness and permeability of overlying unconsolidated material is critical. In the neighboring City of Brookfield, siting wells in the dolomite aquifer away from contamination sources with adequate production rates has nearly exhausted new well locations.

Because wells in the dolomite aquifer rely on rock fractures and overlain sand and gravel aquifers for their capacity, effects on wetlands and streams are possible. Three of the possible four well locations were adjacent to Mill Brook and Pebble Creek, and adjacent to the Vernon Marsh Wildlife Area. Groundwater drawdown in these areas could impact the hydraulic regimes in these resources, change vegetation communities, and negatively impact the ecologic function.

For these reasons, the Silurian dolomite alternative was eliminated from further evaluation in this document.

Fox River Alluvium (Riverbank Inducement)

Locating a wellfield in the permeable alluvial river sands immediately adjacent to a river can intercept the groundwater that would normally discharge to the river. If the wellfield is pumped higher than the natural groundwater flux toward the river, water will be taken initially from storage in the alluvial sand aquifer and ultimately be replenished by recharge from the river as induced by the pumpage. Utilizing the Fox River alluvium as a water supply alternative was evaluated in the Future Water Supply Study and the Water Supply Service Area Plan (Volume 2 of the Application).

The fundamental principles of this method involve using the permeable sand and gravel deposits adjacent to and under many rivers as a storage vessel to store water during high river stage flow for use by the wellfield. This method has the advantages of storing large volumes of water without a surface reservoir, and evening out the changes in water quality that occur in the river water.

These types of wellfields are usually called alluvial wellfields, although they are also called river bank filtration or riverbank inducement systems. The volume and timing of the recharge is a function of several factors, including the groundwater flux toward the river, the permeability and extent of the alluvial deposits, the permeability of the river bed, the volume of pumpage from the wellfield, and the proximity of the wells to the river. Alluvial wellfields often consist of a line of shallow wells drilled adjacent to a river that are screened in river alluvium at depth of about 50 to 100 feet. Often, these wells are drilled in the flood plain and have casings that extend above the flood level. In some areas, horizontal collector wells are used to obtain water from under the river bed itself.

In the Waukesha area, there are at least two potential areas for developing an alluvial wellfield. The two areas are the shallow sand and gravel deposits immediately south of the City of Waukesha and the potential shallow alluvial deposits along the Fox River. The Fox River alluvium was evaluated during the Future Water Supply Study. Additional groundwater modeling completed by the University of Wisconsin-Milwaukee (UWM) and the U.S. Geologic Survey (Feinstein/ USGS, 2011, Feinstein et al., 2011, and UWM, 2011). A follow-up USGS report proposed 27 wells estimated to produce 9 mgd that would stretch across a 10-mile reach of the Fox River both upstream and downstream of the City of Waukesha (USGS, 2012). This report indicates that the water source would provide less than 55 percent of the MDD necessary to meet service area requirements. This supports not having the Fox River alluvium as a stand alone water supply alternative.

By its nature, this alternative draws groundwater directly from surface water features. Although the groundwater wells would be primarily directed at drawing Fox River water,

the wellfield would also impact other surface waters such as Pebble Creek, Pebble Brook and Mill Brook. The wellfields are also in and adjacent to the Vernon Marsh Wildlife Area and thousands of acres of wetlands. Consequently, this alternative could have significant impacts to the hydrologic regimes of these environmental resources where the wetlands and streams could have significant changes to vegetation and ecosystem communities.

This alternative was eliminated from further consideration as a single water source for the City of Waukesha. However, in combination with the shallow aquifer, using the Fox River alluvium as a water supply alternative is evaluated in more detail in Section 6 of this document.

Waukesha Springs

The City of Waukesha was once famous for its natural springs that were thought to have healing properties. These springs were fed by the confined water of the shallow sand and gravel aquifer. Many of these springs still exist, but deliver only small quantities of water relative to the current and future demand of the City of Waukesha. Therefore, the use of these historic springs as a source of water for the city was eliminated during the Future Water Supply Study.

2.2.2.3 Mississippi River Basin Multiple Source Alternative

In the Water Supply Service Area Plan (Volume 2 of the Application), a multiple source alternative was evaluated based on available water resources in the area. The six water supplies in this multiple source alternative include:

- Existing deep confined sandstone aquifer wells in the City of Waukesha
- Existing shallow sand and gravel aquifer wells (that are outside the City of Waukesha limits to the south)
- New wells in the Fox River alluvium (riverbank inducement wells that are outside the City of Waukesha limits to the south)
- Quarries north of the City of Waukesha
- New wells in the unconfined deep sandstone aquifer west of the City of Waukesha
- New wells in the Silurian dolomite aquifer (that are outside the City of Waukesha limits to the Southeast)

Similar to the individual alternatives that make-up this multi source alternative, the environmental impacts, long-term sustainability, public health, and implementability of this alternative had significant adverse impacts. Compared to the five other top ranking alternatives in the Water Supply Service Area Plan, this alternative collectively had the most significant adverse impact ratings. This alternative was also significantly more costly than the five other top ranking alternatives. Consequently, this alternative was eliminated from detailed analysis in this document.

2.2.2.4 Summary of Mississippi River Basin System Alternatives

The Mississippi River basin system alternatives that are retained for further evaluation in Section 6 of this document include:

- Deep confined sandstone aquifer combined with shallow sand and gravel aquifer (Deep and Shallow Aquifers)
- Shallow sand and gravel aquifer combined with Fox River alluvium (Shallow Aquifer and Fox River Alluvium)

2.2.2.5 Other Alternatives

The Future Water Supply Study evaluated using aquifer storage and recovery (ASR) and wastewater reuse as “water supply” alternatives. Although ASR and wastewater reuse are not water supply alternatives per se, they are methods to reduce peak water demand and can be used as part of a water management strategy.

Aquifer Storage and Recovery

Aquifer Storage and Recovery involves injecting treated municipal drinking water into the aquifer during times of less water use and pumping this water out when demand is high, typically during the summer. ASR was first used in the United States at Wildwood, New Jersey in 1968 as a method to help the area water utility meet summer peak demands, which could be as much as five times the average day demand. ASR allows a utility to take excess capacity, available during low demand periods, and store it in aquifers through wells where it may be later recovered to meet seasonal peak demands. The treated water that is stored underground typically does not require treatment upon recovery and still meets all drinking water standards. Chlorine is typically added to maintain distribution system disinfectant residual when the water is recovered for use.

The cities of Oak Creek and Green Bay sought approval to use ASR wells from the WDNR to address water shortages during peak demand periods. In Green Bay ASR was developed but produced water with significant concentrations of arsenic that mobilized from the aquifer. Similarly, pilot testing of ASR in Oak Creek found increasing concentrations of manganese and iron, and concentrations of mobilized substances eventually exceeded state groundwater quality standards. In 2011 the Oak Creek utility discontinued ASR operations and, instead, expanded its surface water treatment capability (Wisconsin Groundwater Coordinating Council, 2011).

ASR could be used with any of the water supply alternatives, but because of the operational problems experienced in Oak Creek and Green Bay, ASR is not included with the water supply alternatives. It is therefore not evaluated further in this document. Even if ASR is utilized in the future if these operational challenges are overcome, the analysis of other water supply alternatives included in this report will not be impacted because their effects on environmental resources is evaluated based on average day demands during average time periods, whereas ASR affects peak demands during summer months.

Wastewater Reuse

Treated wastewater can be used for potable water supply either directly or indirectly. Direct potable reuse of wastewater involves treating wastewater plant effluent to drinking water quality. Although technically feasible, this method of wastewater reuse is uncommon because of the multiple treatment barriers required, the higher health risks posed, the high costs involved, and the public perceptions of safety. Several communities have demonstrated direct potable reuse, and tests have indicated that the water meets drinking

water standards. However, very few have successfully implemented direct potable reuse for public consumption, even in areas of limited water.

Indirect potable reuse involves discharging treated wastewater to a receiving water body, then using that receiving water body as a source of drinking water supply. Indirect potable reuse can be either planned or unplanned. Much of the Great Lakes Basin practices unplanned indirect potable reuse because wastewater treatment plants discharge into the Great Lakes, which is a source of drinking water. The federal government enlisted the National Research Council to develop reuse guidelines (NRC, 1998, 2012). The recent 2012 guidelines are more supportive of reuse than the 1998 guidelines because of advances in technology and treatment plant design, but there are no regulations for potable reuse practices. Since there are other sources of higher quality water for the City of Waukesha, wastewater reuse is not considered further in this document as a source of potable water.

Treated wastewater can also be considered for non-potable reuse. Golf courses and industries that require large volumes of non-potable water are candidates for non-potable reuse. The wastewater would require further treatment, and separate pumps and pipes would be required to deliver the water to potential customers. Non-potable reuse is used to supplement water demands, but is only part of the water supply equation. Non-potable reuse is most commonly practiced in arid regions with limited water supplies. In Waukesha, there would be limited and seasonal demand for non-potable water, and it would be costly to implement because the infrastructure for a separate non-potable water distribution system does not exist. Consequently, non-potable reuse is not evaluated further in this document.

2.2.2.6 Combined Lake Michigan and Mississippi River Basin System Alternatives

Three alternatives were identified that included water sources from both the Lake Michigan and Mississippi River basins. Two alternatives from SEWRPC included artificial recharge of groundwater and one alternative from the Water Supply Service Area Plan (Volume 2 of the Application) included combining Mississippi River basin groundwater with Lake Michigan surface water.

Artificial Recharge

Some of the SEWRPC groundwater alternatives (Shallow aquifer and artificial recharge using rainwater and wastewater treatment plant effluent; and deep aquifer and artificial recharge using treated Lake Michigan water) assume that the shallow aquifer will be artificially recharged with rainwater infiltration facilities, or that treated wastewater effluent will be artificially recharged into the shallow aquifer. By artificially increasing the amount of water infiltrating into the shallow aquifer, surface water baseflow reduction from groundwater pumping can be decreased. However, SEWRPC noted several issues and concerns:

- WDNR regulations do not allow using treated wastewater effluent to recharge a potable drinking water aquifer. A high level of treatment would be required for this to be considered. Capital and operating costs would be very high. SEWRPC estimates capital costs of advanced wastewater treatment alone would be \$12.6 million for 1 mgd (SEWRPC, 2010a). Transmission mains from the Waukesha wastewater plant to recharge areas would add another \$4 million.

- Large land areas are required for artificial recharge, with significant costs and public concerns. An important issue is who owns and controls the use on these lands. SEWRPC estimated more than 100 acres would be needed for Waukesha to implement artificial recharge, even if it relies on the deep aquifer for more than half of its water supply (SEWRPC, 2010a).
- Water which is artificially recharged is more vulnerable to contamination, which might increase the cost of treatment and risk to public health.
- The long-term feasibility of artificial recharge is unknown. Long-term soil permeability for effective recharge might be compromised where plugging of the aquifer would reduce effectiveness over time. Restoration or decommissioning of facilities would add to costs.
- Rainfall recharge will be subject to drought constraints.

Because of the issues above, artificial groundwater recharge was eliminated from consideration by SEWRPC and is subsequently eliminated from further evaluation in this document.

Lake Michigan and Shallow Aquifer

The Water Supply Service Area Plan (Volume 2 of the Application) included a combined alternative that evaluated utilizing a Lake Michigan water supply with shallow aquifer groundwater in the Mississippi River basin. About 40 percent of the City's required water demand would be obtained from a Lake Michigan water supplier with the remaining 60 percent supplied by the shallow aquifer.

This alternative would include impacts from both the shallow aquifer wellfield development and the construction of the Lake Michigan water supply and return flow pipelines. Similar to the Lake Michigan water supply alternatives, the impacts of the Lake Michigan supply pipelines would include temporary construction related impacts, while the shallow groundwater wellfields would have permanent and significant adverse impacts to wetlands and streams such as the Vernon Marsh Wildlife Area, Pebble Creek, Pebble Brook and Mill Brook. The impacts for this combination alternative would be similar to the groundwater drawdown impacts of the Deep and Shallow Aquifers alternative since the shallow aquifer pumping rate is similar between the two alternatives; and the impacts from constructing a Lake Michigan water supply and return flow pipeline. Consequently, the impacts will be more than either of the sources considered independently.

This alternative has significant implementability challenges because it includes obtaining a Lake Michigan water supply and a shallow groundwater wellfield that are both outside of City of Waukesha's boundary. Utilizing two different water sources (Lake Michigan surface water and shallow groundwater) adds significant operational and maintenance complexity when blending a surface water source with a groundwater source. In addition, this alternative is significantly more costly than other alternatives that have less implementability and environmental impacts.

Because of these reasons, this alternative is not evaluated further in this document.

2.2.3 Water Conservation Alternatives

Water conservation has been implemented by the City of Waukesha for many years. Since the adoption of the 2006 Conservation Plan, the City has successfully advanced various water conservation measures through public information and education, regulations, collaborative partnerships, and incentive programs. Water use in the City has been reduced, in part, because of the measures. Reduced water use is illustrated by the following aggregate metrics:

- Between the base year of 2005 and 2010, total water pumped from wells was reduced 14.0 percent (Waukesha Water Utility, 1999–2010).
- Between 2005 and 2010, peak season pumping (May 1 to October 1) was reduced 19.4 percent w(Waukesha Water Utility, 2005–2010).
- Since 2005, declining water use reduced the number of days water demand exceeded 10 mgd from 28 to zero. The City has an operational goal to pump 10 mgd or less, to help meet its radium compliance order and stipulation (City of Waukesha Water Utility, 2010). Since 2006, the City has achieved this goal, except during the 2012 drought when demands increased.
- Residential customers who have replaced a toilet in conjunction with the City’s rebate program are estimated to be saving an average of over 15,000 gallons per year (City of Waukesha Water Utility, 2010).
- By regulation, the City annually submits detailed information on the performance and costs of its conservation program to the Public Service Commission (PSC).

Water savings from conservation is an important component of the City’s long-range water supply plan. Because water saved from using water efficiently is a source of water supply, one of the City’s water conservation goals includes reducing average day demand by 0.5 mgd by year 2030 and by 1.0 mgd by 2050. The water savings represent 5 and 10 percent water savings in average day demand, respectively, of projected baseline (no conservation related) water demands between 2010 and 2050.

Objectives for the planning process used in the development of the updated 2012 Water Conservation Plan (Volume 3 of the Application) included:

- Developing planning analysis and implementation time lines in a manner consistent with NR 852 and the SEWRPC 2035 Regional Water Supply Plan
- Leveraging lessons learned from implementation of existing City conservation and efficiency measures
- Incorporating stakeholder and customer input in the evaluation of conservation and efficiency measures

The water conservation measures implemented by the City apply to its customers, whether they are located within city limits or not. Under current water service rules regulated by the Wisconsin PSC, all customers are subject to the City’s conservation measures, including the water rate schedule, outdoor water use restrictions, and financial incentives to install water-saving toilets. If water service is extended to areas outside the City, customers will be

required to adhere to the City's conservation program as established in the service rules as well as in future service contracts. The City will provide water conservation public education to new customers and make available information, services and incentives to help its customers use water wisely.

Water conservation is a central part of the City's water supply, were water conservation is integral for any future water supply alternative. Although titled as "alternatives", all of the water conservation measures in the Conservation Plan are, or will be, implemented equally for any future water supply alternative. The City cannot meet future water demand through water conservation alone.

2.2.4 No Action Alternative

The City of Waukesha currently obtains water from multiple wells within the deep and shallow aquifers. The "no action" alternative would include the continued use of these aquifers. The No Action alternative, by definition, would continue to use the aquifers without modification. Because the deep and shallow aquifer wells do not have sufficient

capacity to meet future demands and because the deep aquifer wells exceed radium water quality requirements, the No Action alternative will not provide for the City's long-term water quantity and quality needs. However, the No Action alternative is carried forward in Section 6 of this document to support an EIS process under NEPA.

2.2.5 Summary of Remaining System Alternatives

Water supply alternatives remaining considering both groundwater and Lake

Michigan alternatives are shown together with the return flow alternatives in Table 2-3. The system alternatives combining a Lake Michigan water supply with a return flow alternative are shown in Table 2-4. These system alternatives are evaluated in detail in Section 6. Appendix 6-2 displays a side by side comparison of the environmental effects of the ten system alternatives.

TABLE 2-3
Water Supply and Return Flow Alternatives

Water Supply Alternative

Deep and Shallow Aquifers

Shallow Aquifer and Fox River Alluvium

Lake Michigan (City of Milwaukee)

Lake Michigan (City of Oak Creek) Alignment 1

Lake Michigan (City of Oak Creek) Alignment 2

Lake Michigan (City of Racine)

Return Flow Alternatives (for Lake Michigan Water Supplies)

Underwood Creek to Lake Michigan

Root River to Lake Michigan Alignment 1

Root River to Lake Michigan Alignment 2

Direct to Lake Michigan near Milwaukee and Oak Creek (hereafter referred to as *Direct to Lake Michigan Return Flow* in Sections 5 and 6)

TABLE 2-4
Water Supply and Return Flow System Alternatives

Water Supply Alternative	Lake Michigan Return Flow Alternative
Mississippi River Basin System Alternatives	
Deep and Shallow Aquifers	None – Continued Discharge to Fox River
Shallow Aquifer and Fox River Alluvium	None – Continued Discharge to Fox River
Lake Michigan System Alternatives	
Lake Michigan (City of Milwaukee)	Underwood Creek to Lake Michigan
Lake Michigan (City of Milwaukee)	Root River to Lake Michigan Alignment 1
Lake Michigan (City of Milwaukee)	Direct to Lake Michigan
Lake Michigan (City of Oak Creek) Alignment 1	Underwood Creek to Lake Michigan
Lake Michigan (City of Oak Creek) Alignment 1	Root River to Lake Michigan Alignment 1
Lake Michigan (City of Oak Creek) Alignment 1	Direct to Lake Michigan
Lake Michigan (City of Oak Creek) Alignment 2	Root River to Lake Michigan Alignment 2
Lake Michigan (City of Racine)	Underwood Creek to Lake Michigan
Lake Michigan (City of Racine)	Root River to Lake Michigan Alignment 1
Lake Michigan (City of Racine)	Direct to Lake Michigan

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Section 3
Proposed Project

SECTION 3

Proposed Project

The proposed project for the City of Waukesha's future water supply is a Lake Michigan water supply provided by the City of Oak Creek with return flow to the Root River. A Lake Michigan water supply would be obtained from the City of Oak Creek via Alignment 2. The proposed project includes return flow to the Root River through Alignment 2.

The City of Waukesha water supply needs have been documented in the Water Supply Service Area Plan, Volume 2 of the Application and are slightly less than that used to complete the majority of the ER analysis (ADD of 10.1 mgd instead of 10.9 mgd). The average day demand projection may be adjusted lower depending upon the final water demand projections, however the environmental impacts are conservatively estimated based upon the 10.9 mgd. The City of Waukesha water supply needs have been documented in the Water Supply Service Area Plan (Volume 2 of the Application) and are summarized below.

The February 2012 Environmental Report (ER) identified a different proposed project. This ER considers the previously proposed project within the February 2012 ER an alternative to the proposed project. The following section includes information on the proposed project, the City of Oak Creek Supply Alignment 2 and the Root River to Lake Michigan return flow Alignment 2. Appendix 3-1 displays aerial and topographic maps of the proposed project. A detailed evaluation of the environmental effects is included in Section 5 of this document. A side by side comparison of environmental effects of the proposed project and alternatives to the proposed project is included in Table 6-80 and Section 6 of this document.

Note: The Water Supply Service Area Plan Lake Michigan (City of Oak Creek) water supply alternative describes the ER Lake Michigan (City of Oak Creek) Alignment 2 alternative and the Return Flow Plan Root River to Lake Michigan return flow alternative describes the ER Root River to Lake Michigan Alignment 2 return flow alternative. The ER retains the Lake Michigan (City of Oak Creek) Alignment 1 water supply alternative and the Root River to Lake Michigan Alignment 1 return flow alternative for alternative comparison purposes.

3.1 Water Supply

The water supply will be obtained from Lake Michigan. The City of Oak Creek is a municipal water utility operating adjacent to Lake Michigan that has facilities in place to withdraw water from Lake Michigan and treat it to drinking water quality standards. The City of Oak Creek has signed a letter of intent with the City of Waukesha indicating the City of Oak Creek's willingness to provide water from its existing Lake Michigan supply and associated water treatment facilities (see the Water Supply Service Area Plan, Volume 2 in the Application). New facilities in the form of a booster pump station and pipeline are needed to supply water to the City of Waukesha.

Once the City of Waukesha receives the water, the water will be used as Waukesha's primary municipal water supply. After receiving a Lake Michigan water supply, the City of Waukesha's groundwater water supply wells will no longer be used, although the wells

may be maintained as an emergency backup should the primary Lake Michigan supply temporarily become unavailable.

3.1.1 Lake Michigan Intake

The City of Oak Creek has an existing intake from Lake Michigan with adequate capacity to accommodate the increased volume to supply the City of Waukesha. No changes would occur to any of the existing intakes under the proposed project. The raw water from the Lake Michigan intake at each supplier is pumped to the municipal drinking water treatment plant for treatment to drinking water standards.

3.1.2 Water Supply Treatment

The existing treatment plant capacity in the City of Oak Creek would be used to supply drinking water to the City of Waukesha. Once the Lake Michigan raw water reaches the treatment plant, it is treated to meet drinking water standards. The City of Oak Creek has available treatment capacity to serve the City of Waukesha's existing water supply needs.

3.1.3 Supply Pipeline

The infrastructure needed to convey the drinking water from the City of Oak Creek to the City of Waukesha consists of a booster pump station and a pipeline. The water supply pipeline would connect to the City of Oak Creek existing distribution system and would convey the water to the City of Waukesha's existing Hillcrest drinking water reservoir for distribution throughout the City of Waukesha. A booster pump station will be required at the point of connection to the existing distribution system. A summary of the water supply pipeline is included in Table 3-1.

TABLE 3-1
Proposed Project Pipeline Facilities

Alternative	Diameter (inches)	Length (miles)	Counties
Lake Michigan Supply			
Lake Michigan (City of Oak Creek) Alignment 2	30	19.4	Milwaukee and Waukesha

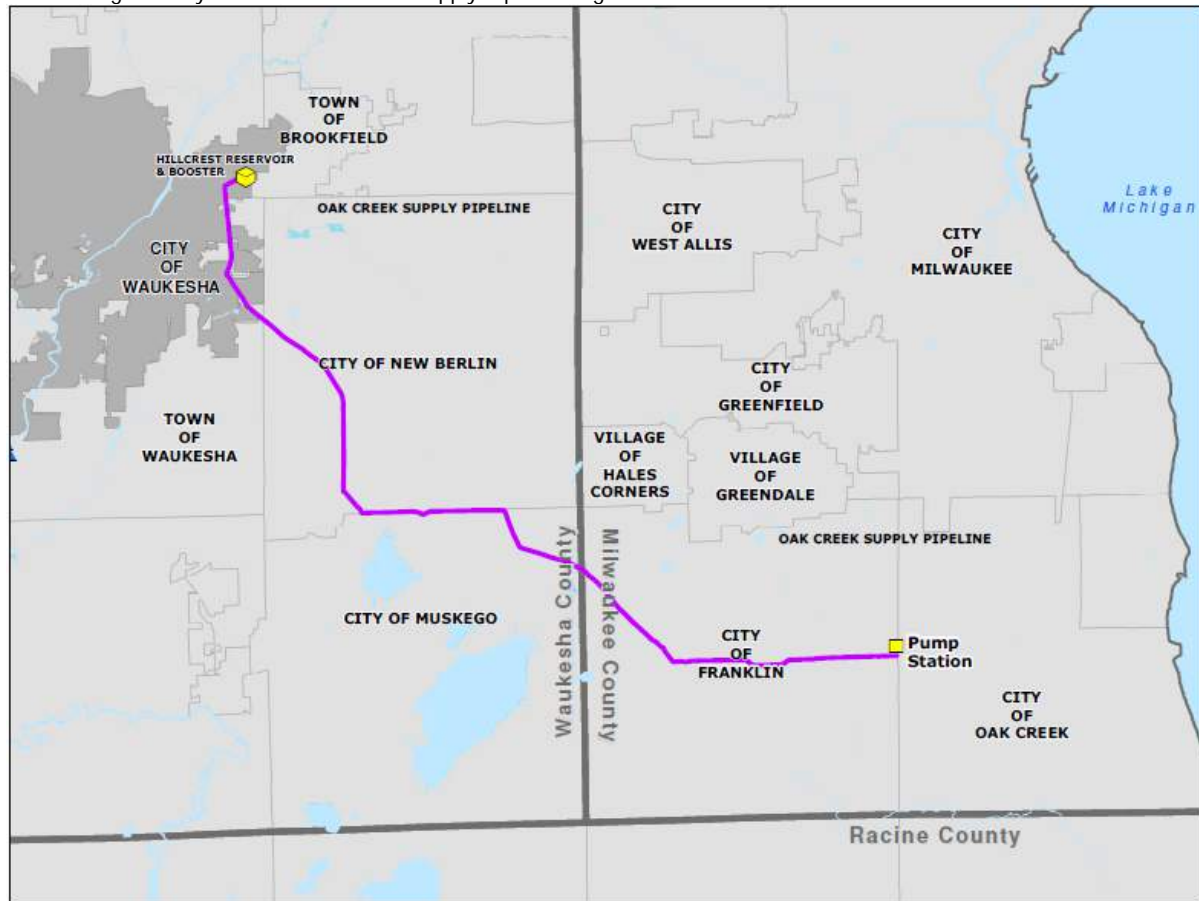
Note: The final pipeline diameter may be 30 or 36 inches depending upon final detailed design considerations. For either diameter pipe, the construction width for environmental impacts is the same width due to construction staging requirements.

The proposed project includes a connection to the City of Oak Creek's distribution system at the intersection of South 27th Street and West Puetz Road. A pump station would be constructed at the connection to the City of Oak Creek's distribution system.

From this connection, a 30-inch pipeline would head northwest through the City of Franklin, City of Muskego, City of New Berlin, Town of Waukesha and City of Waukesha. The 19-mile-long pipeline follows transportation corridors and right-of-ways to minimize environmental impacts. The supply would connect at the Hillcrest reservoir in the City of Waukesha.

Figure 3-1 and Appendix 3-1 show the pipeline alignment for the proposed project.

FIGURE 3-1
 Lake Michigan—City of Oak Creek Water Supply Pipeline Alignment 2 Alternative



3.1.4 Water Distribution and Use

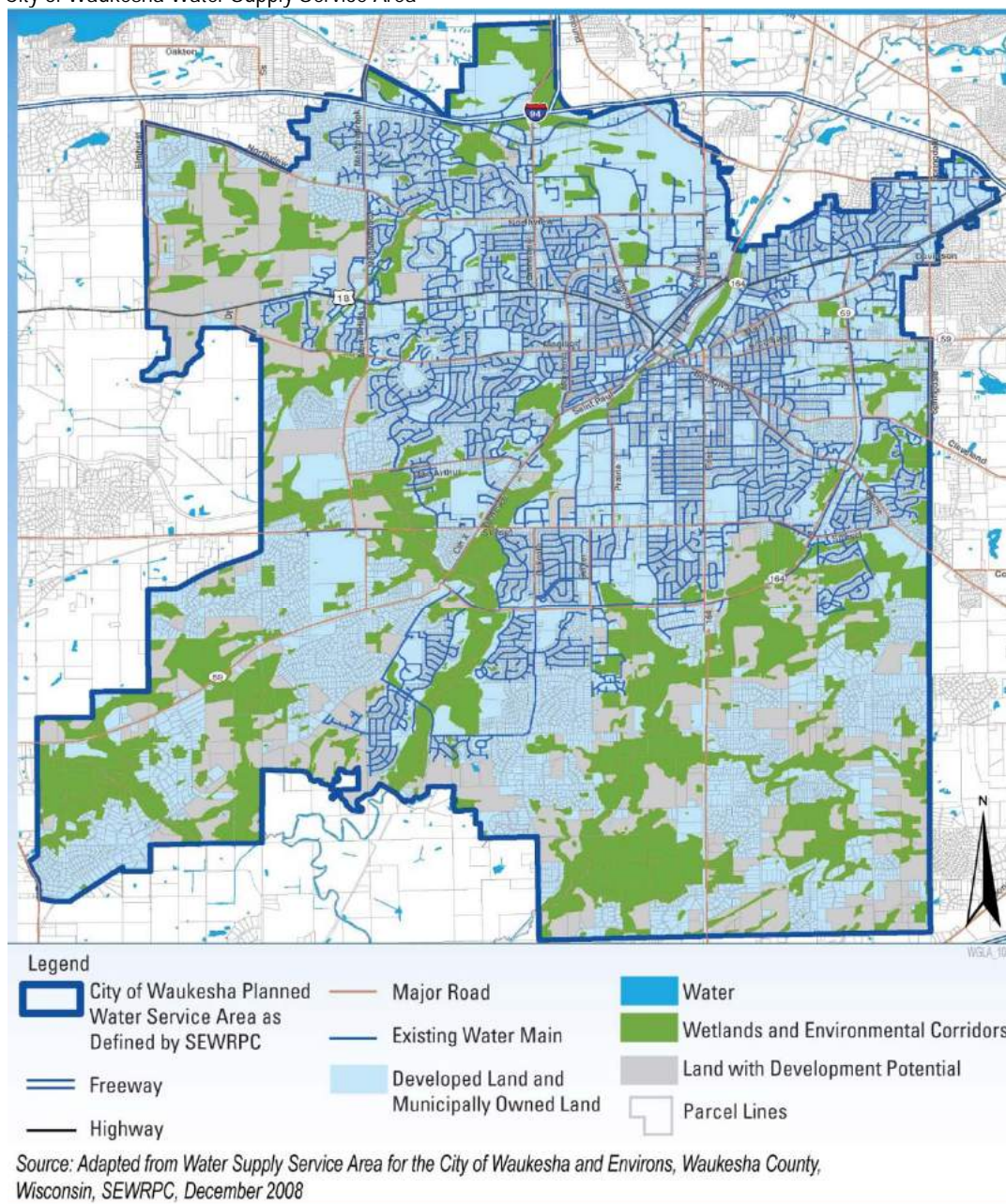
3.1.4.1 Water Demand Forecasts

Water demand forecasts for the City of Waukesha water supply service area were developed on the basis of the delineated water supply service area, population projections for the service area, historical water use by customer class, and the expansion of the City's water conservation program.

3.1.4.2 Water Supply Service Area

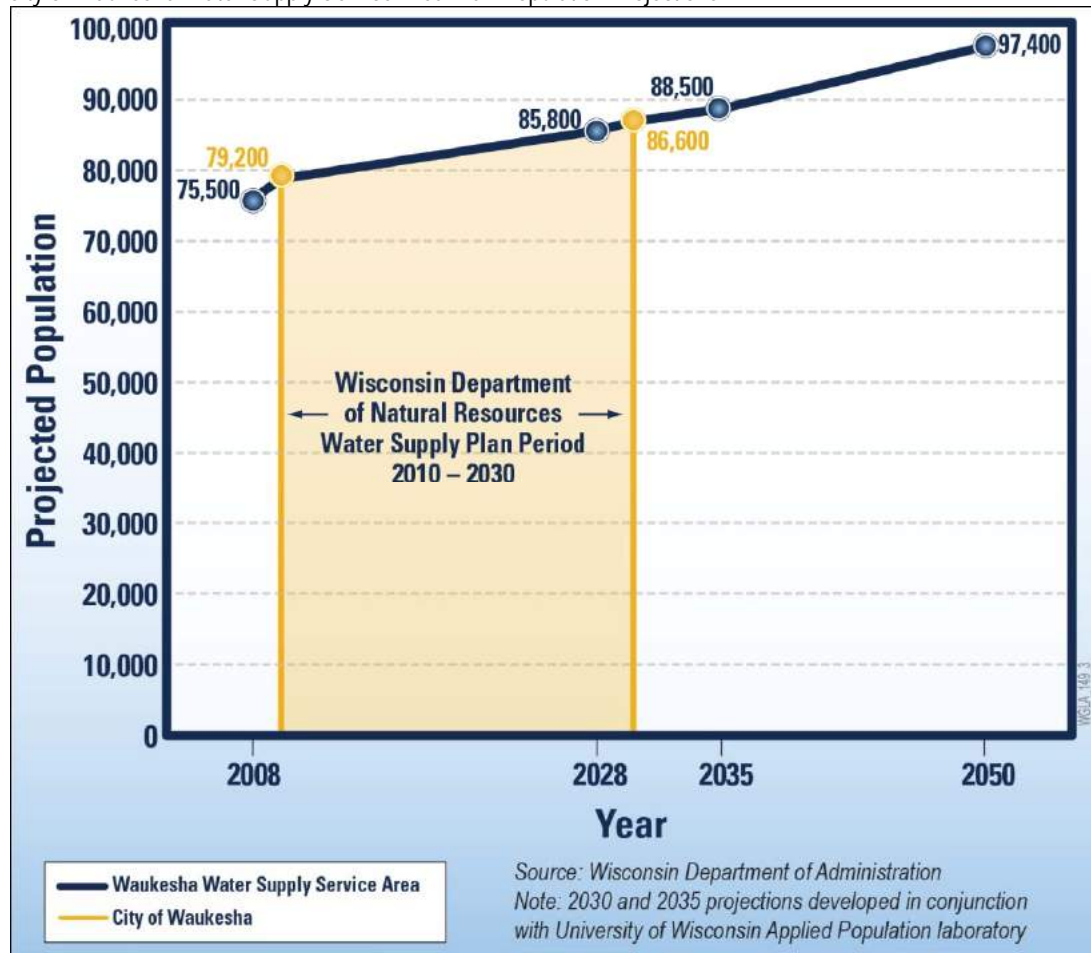
The City of Waukesha presently provides water service to the City and limited properties that are located outside the city limits. For long-range water supply planning, SEWRPC delineated the City of Waukesha water supply service area that includes nearby parts of neighboring communities. The water supply service area includes 3.7 percent of the City of Pewaukee, 9 percent of the Town of Delafield, 14.9 percent of the Town of Genesee, and 83.6 percent of the Town of Waukesha. One reason the areas are candidates for future municipal water service is because of past private well contamination by pathogens, pollution, and naturally occurring elements in the groundwater. If there is a need and a request for public water service, the City's municipal water system may be expanded to serve the areas that are currently served by private wells and septic systems. To the extent practical, the water supply service area is consistent with the City's delineated sewer service area.

FIGURE 3-2
City of Waukesha Water Supply Service Area



The City of Waukesha water supply service area is shown in Figure 3-2. It represents the full development land use envisioned in the Waukesha County Comprehensive Plan. Full development, or buildout, condition is projected to occur sometime around 2050, based on historical state population trends. SEWRPC prepared population projections for the water supply service area including 85,800 people in 2028, 88,500 people in 2035, and an ultimate buildout population of 97,400 people (Figure 3-3). The projections are based on municipal estimates from the State of Wisconsin Department of Administration and multiple planning factors, including but not limited to land use, household size, demographic trends, and community development plans. Additional details of the water supply service area are included in the Water Supply Service Area Plan (Volume 2 of the Application).

FIGURE 3-3
City of Waukesha Water Supply Service Area Plan Population Projections



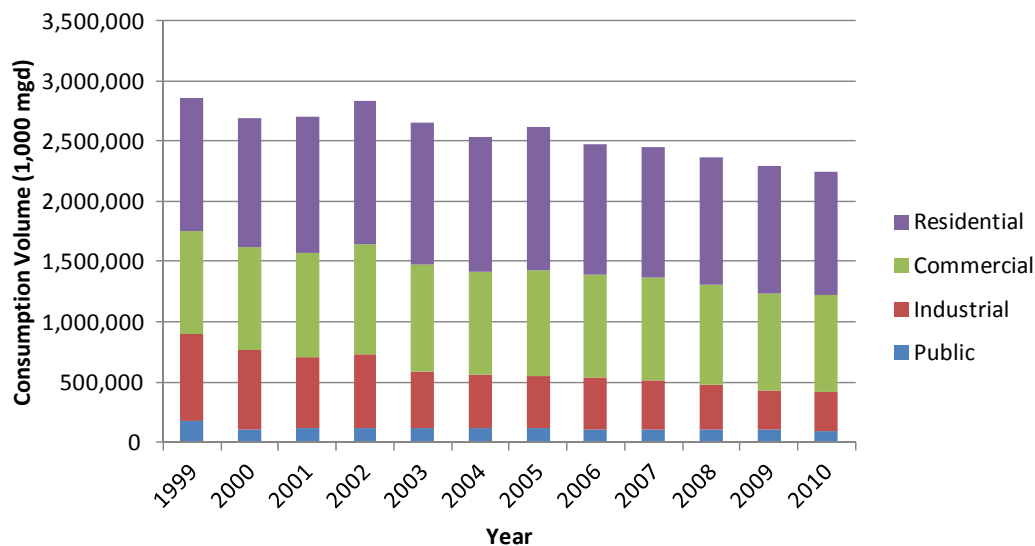
3.1.4.3 Water Conservation Applied Across the Water Service Area

The water conservation measures implemented by the City apply to all of its customers, whether they are located within city limits or not. Under current water service rules regulated by the Wisconsin Public Service Commission (PSC), all customers are subject to the City's conservation measures, including the water rate schedule, outdoor water use restrictions, and financial incentives to install water-saving toilets. If water service is extended to areas outside the City, customers will be required to adhere to the City's conservation program as established in the service rules as well as in future service contracts. The City will provide water conservation public education to new customers and make available information, services and incentives to help its customers use water wisely.

3.1.4.4 Historical Water Use

Figure 3-4 and Table 3-2 summarize water use by customer class and historical water consumption for the period 1999 to 2010. Residential customers, including multi-family residential customers, consistently represent the City's largest customer class. The City's residential population increased about 12 percent between 1999 and 2010. Since 1999, water use by single-family residential customers has decreased by 8.6 percent. Over this same period, total water pumping decreased 19.4 percent.

FIGURE 3-4
Annual Water Use Trend by Customer Class: Waukesha Water Utility



Since adoption of the 2006 Water Conservation and Protection Plan additional focus was provided on water use efficiency. This is evidenced by the greater than 14 percent reduction in total pumping from wells between 2005 and 2010. Some water use reduction may be attributed to weak economic conditions and seasonal rainfall over the same period; however, some of the water saved can be attributed to water conservation education, regulation, and incentives. Additional details of historical water use and conservation are included in the Water Supply Service Area Plan (Volume 2 of the Application).

3.1.4.5 Variations in Customer Demand.

Water demand varies and is typically influenced by several factors including precipitation, temperature, economic conditions, personal income, and community conservation goals. While reductions in water use in wet and cool years or increases in water use associated with higher personal income may be observed, correlating how the factors affect one another is not a straightforward process. Quantification and disaggregation of the effect of variables such as weather (especially temperature and rainfall), economic conditions, and public awareness on water use require extensive data collection and analysis. Results of the City's review of available water use-related data indicating trends that provide insights into long-range water demand forecasts are described below.

3.1.4.5.1 Seasonal Variation in Water Demand.

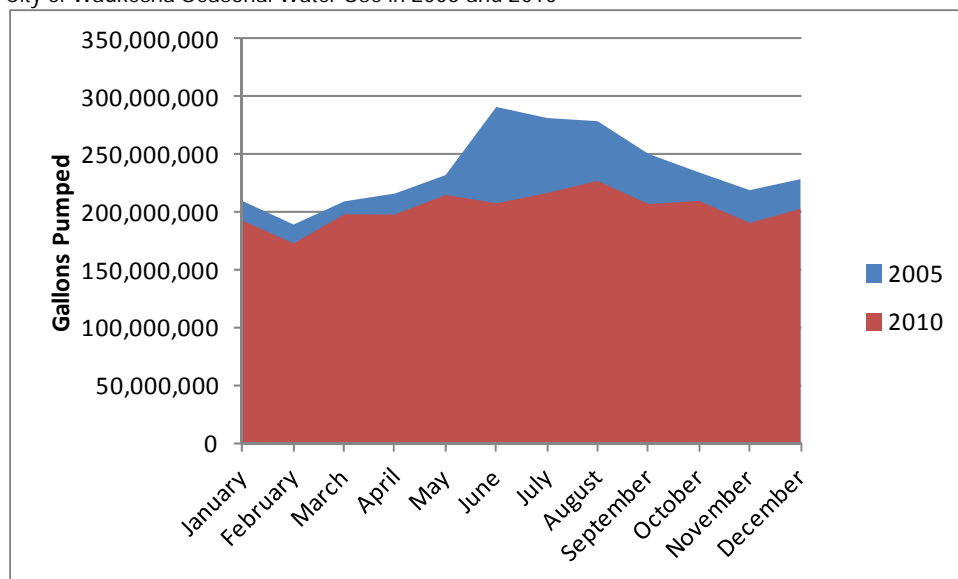
Seasonal water use patterns provide helpful information regarding water use in the City's water service area. Figure 3-5 presents monthly water use in 2005 (before the 2006 Water Conservation and Protection Plan) and in 2010. In 2006, the City adopted a municipal ordinance restricting lawn and landscape irrigation to no more than 2 days per week between May 1 and October 1. Since Waukesha's water conservation ordinance has been in effect, seasonal peak water demands have declined significantly. While the City must plan for a peak pumping season from May through September, its water demand forecasts for the future assume the City will continue to restrict peak season outdoor water use.

TABLE 3-2
City of Waukesha Historical Annual Water Consumption

Year	Residential	Commercial	Industrial	Public	Total Water Sales	Total Pumpage	Water Used but not Sold	Unaccounted for Water	Unaccounted for Water, %
2010	1,016,670	801,974	326,289	93,491	2,238,164	2,437,964	47,113	152,687	6
2009	1,054,288	806,736	325,667	99,619	2,286,310	2,479,895	27,930	165,655	7
2008	1,056,650	827,543	382,413	99,646	2,366,252	2,530,964	37,879	126,833	4
2007	1,086,542	846,566	404,079	110,532	2,447,719	2,618,682	3,791	167,172	6
2006	1,077,127	858,062	424,603	109,846	2,469,638	2,620,450	14,676	136,136	5
2005	1,193,851	874,418	428,518	120,126	2,616,913	2,831,510	5,054	209,543	7
2004	1,117,325	854,624	435,004	121,601	2,528,554	2,698,980	6,169	164,257	6
2003	1,176,115	895,850	461,885	120,071	2,653,921	2,795,859	3,228	138,710	5
2002	1,185,745	914,138	612,856	119,173	2,831,912	2,953,216	21,540	99,764	3
2001	1,128,475	874,030	586,552	114,492	2,703,549	2,821,969	37,909	80,511	3
2000	1,067,184	848,664	660,364	108,873	2,685,085	2,836,141	19,057	131,630	5
1999	1,112,499	847,914	722,097	177,408	2,859,918	3,028,414	n/a	168,496	6

Note: Consumption volume values are given in 1,000 gallons.

FIGURE 3-5
City of Waukesha Seasonal Water Use in 2005 and 2010



Source: City of Waukesha Annual Report to the Wisconsin Public Service Commission, 2010

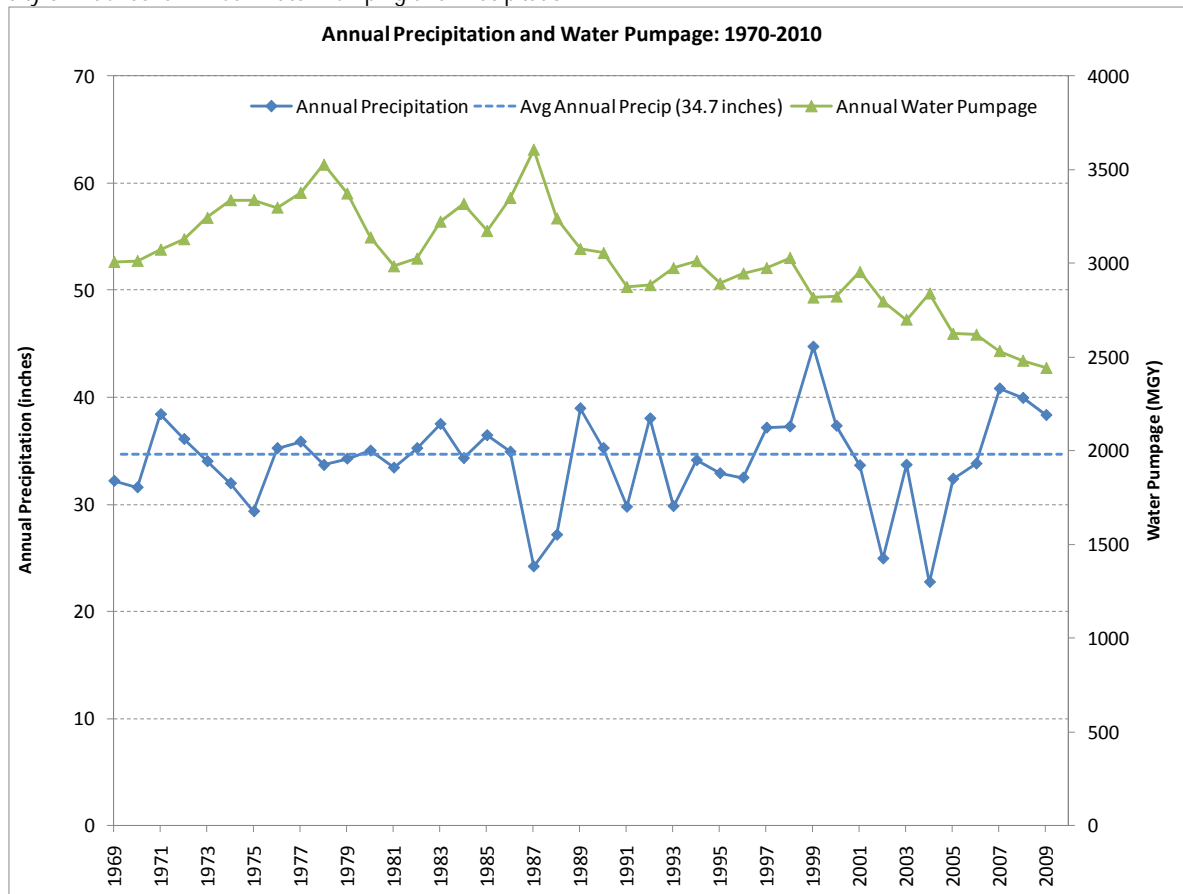
3.1.4.5.2 Water Demand Variation with Precipitation.

Local climate conditions (such as temperature and wind) and precipitation events (duration, number, and intensity of rainfall and snow) vary widely throughout the year and from year-to-year. To some extent, their effect on water use can be observed. In Waukesha, for example, some years that experienced high precipitation correlate with reduced demands, such as 2008 through 2010, as shown in Figure 3-6, while in other years they do not.

To look for high-level water use trends, the City reviewed the annual water pumpage and precipitation data over the past 40 years, summarized in Figure 3-6. The data indicate a declining trend in the volume of water pumped to meet City demand. This trend may be attributed to many factors, including new water conserving appliances required by code since the mid-1990s, the City's water conservation measures, and the recent economic downturn. The data also illustrate that water demand in the City increases in years of below-average rainfall.

Even though the City receives an average of 34.7 inches of precipitation annually and has implemented a conservation program, it must plan for periods of abnormally dry to moderate drought conditions or high temperatures when water demands may increase or supplies may be constrained. Sound engineering practice requires planning for potential droughts to ensure adequate water supply availability to meet essential water needs, such as those for residential sanitation, firefighting, economic stability, system maintenance, and other similar requirements.

FIGURE 3-6
City of Waukesha Annual Water Pumping and Precipitation



3.1.4.5.3 Water Demand Variation due to Economic Conditions.

During the economic downturn of the last several years, water use in the City has declined. In fact, water use, both in terms of volume and water use intensity, is at historically low levels. During a weak economy, discretionary water use typically declines, and customers make changes in their behavior, processes, appliances, and equipment to use water more efficiently. In recent years, the City's commercial and industrial customers have implemented water use efficiency measures to reduce or maintain the cost of providing their services and products. With respect to long-term planning, the City considers the impacts of economic cycles transitory. That is, when economic conditions improve during the future planning period, the forces that restrain growth and water use will be removed and water demand will return to higher levels and gradually increase with future growth. Thus, in such a future planning horizon, growth in the commercial and industrial water use sectors is expected to occur at a faster rate than for the residential sector.

3.1.4.5.4 Diurnal Variation in Customer Demand.

Table 3-3 summarizes historical variation in average day and maximum day demand over the past 10 years, with the ratio of the annual maximum day to average day water pumpage ranging from a low of 1.29 to 1.66.

TABLE 3-3
City of Waukesha Maximum and Average Daily Flow, 1999–2010

Year	Average Day Pumpage (mgd)	Maximum Day Pumpage (mgd)	Maximum Pumpage Date	Ratio of Maximum to Average Day
2010	6.69	8.65	08/28	1.29
2009	6.79	9.35	08/04	1.38
2008	6.91	9.93	08/19	1.43
2007	7.17	9.79	07/24	1.36
2006	7.18	10.23	07/18	1.42
2005	7.76	12.87	06/23	1.66
2004	7.39	10.48	09/13	1.42
2003	7.66	11.67	08.22	1.52
2002	8.09	12.78	07/17	1.58
2001	7.73	12.53	07/09	1.62
2000	7.72	10.15	06/27	1.31
1999	8.30	11.59	07/07	1.40

Source: City of Waukesha operating data.

Based on analysis of the City's pumpage data, including review of recent water conservation impacts upon water demand, the maximum day to average day pumping factor used for water system facility design is 1.66. The analysis of this system performance metric is included in an attachment to the Water Supply Service Area Plan, Volume 2 of the Application. An attachment to the Water Supply Service Area Plan indicates the appropriate average to peak day ratio used for long-term planning and design (1.66) reflects that value with a 98 percent confidence level (that is, probability) in recent years that the actual peak day pumping will be of equal or lesser value. Although average to peak ratio appears to be trending downward since 2005, it is unknown how much of the decrease is due to reliable long-term water use efficiency and how much is due to rainfall, the economy, and other factors.

3.1.5 Water Demand Forecasts

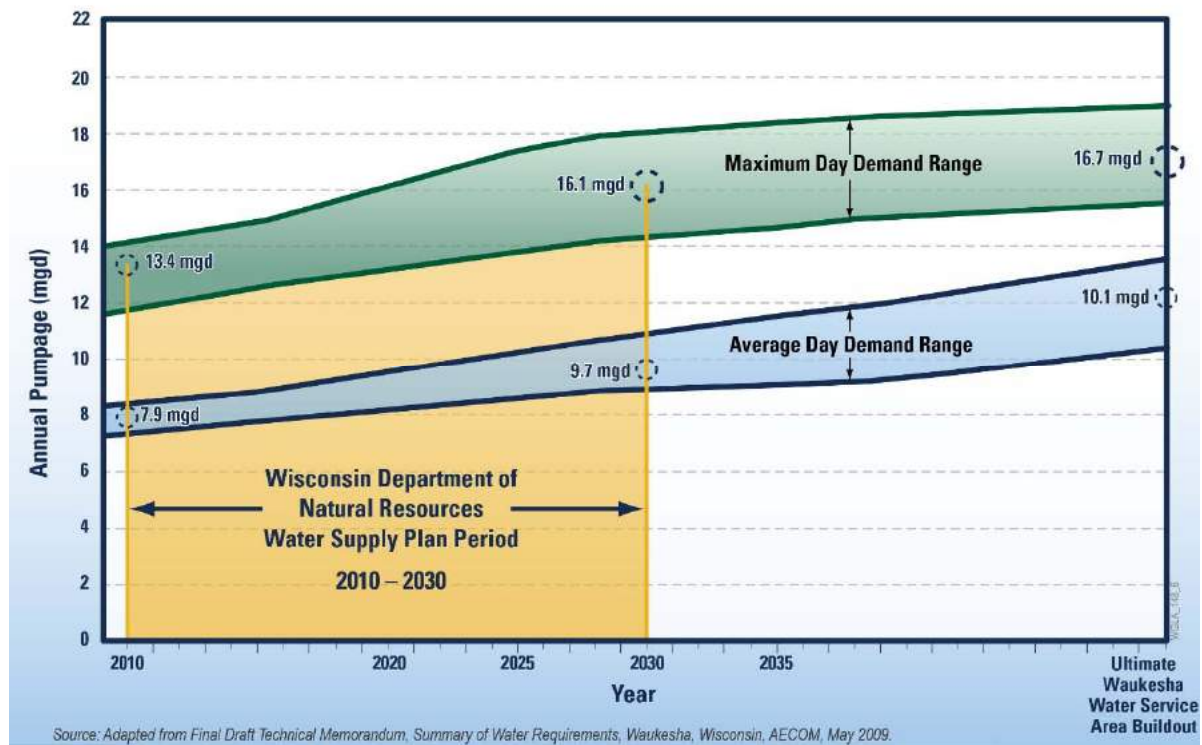
As part of its 2006 water system master plan, the City prepared water demand forecasts. These were updated in 2013 to reflect updated water service area population projections and City water use after implementation of conservation measures. The Water Demand Projections memorandum attachment to the Water Supply Service Area Plan (Volume 2 of the Application) contains the analysis of future water demands used during the planning process. Figure 3-7 shows the average day and maximum day water demand projections.

Note: The environmental impacts determined in this section are conservative and are based on conservative potential water demand values. Analysis of the environmental impacts in this ER has occurred with an MDD of 18.5 mgd and an ADD of 10.9 mgd as documented in the February 2012 ER unless otherwise noted. The water demand forecasts have changed slightly since the February 2012 ER as shown in Figure 3-7 (10.1 mgd ADD compared to 10.9 mgd ADD). Water demands may vary depending upon the final water demand forecasts.

The official water request is as documented in the Application Summary (Volume 1 of 5). If values are less, then the impacts documented in this document will be conservative for impact comparison purposes. Regardless, a small change in water demand will have either no significant change to impacts or a proportional change to impacts. See Table 1-1 for a description of how impacts change with a change in water demand.

FIGURE 3-7

City of Waukesha Water Supply Service Area Water Demand Forecasts



The future water demand forecasts are based on the following major assumptions:

- The City's water conservation program is maintained and expanded to meet long-term conservation goals and customer needs.
- The water conservation measures will continue to be implemented, monitored, and adopted as needed to cost-effectively meet the City's 10 percent water savings goal of 0.5 mgd by 2030 and 1 mgd at ultimate buildout. The water conservation plan has been included in the ADD and MDD projections.
- The target 10 percent savings of 1 mgd average day flow by 2050 complies with *A Regional Water Supply Plan for Southeastern Wisconsin* (SEWRPC, 2010a), which evaluated several levels of water conservation ranging from 4 to 10 percent reductions of average daily demand.
- The ranges of future water forecasts shown in Figure 3-7 were determined by applying water use intensity factors, water savings from conservation, and some contingency to address uncertainty associated in long-term water supply planning for the project population. The uncertainties considered include drought, changes in customer class

(particularly the number and type of commercial and industrial users), and prevailing economic conditions.

3.2 Return Flow

The Compact and Wisconsin State Statutes § 281.346 require return flow for the Lake Michigan water supply equal to the volume of the withdrawal, less an allowance for consumptive use. In compliance with the statute, the City of Waukesha evaluated several return flow management plan alternatives and recommends a return flow management plan that would return all the water from the WWTP up to the MDD water demand rate (see the Return Flow Plan in Volume 4 of the Application for details of the return flow management plan). The Return Flow Plan analysis shows that no less than 100 percent of the water volume will be returned to the Great Lakes basin. The return flow will be from treated wastewater from the City's wastewater treatment plant (WWTP).

The proposed project includes return flow to the Root River, a tributary to Lake Michigan (see Figure 3-8). The return flow pipeline would convey treated wastewater from the City of Waukesha's WWTP to the Root River in Milwaukee County (Franklin, Wisconsin). The City's existing WWTP would provide treatment and a new return flow pump station would be constructed to pump the return flow to the Root River.

Discharge to the Fox River would continue for volumes at the WWTP greater than the future MDD withdrawn from the Lake Michigan basin. The WWTP generally receives more wastewater than drinking water supplied to its customers due to inflow and infiltration of stormwater and groundwater into the sewer system. Therefore, the City's Fox River outfall would be utilized to minimize out of basin water sent to Lake Michigan consistent with the management plan outlined in the Return Flow Plan (Volume 4 of the Application). A new pipeline is not needed for a discharge to the Fox River.

3.2.1 Wastewater Treatment

The City of Waukesha's WWTP is an activated sludge treatment facility with tertiary dual media filtration (sand and anthracite) and ultraviolet (UV) light disinfection. The plant consistently produces high quality effluent that has very low BOD (biochemical oxygen demand), TSS (total suspended solids), $\text{NH}_3\text{-N}$ (ammonia) and TP (total phosphorus) that meets all of its permit requirements. The City of Waukesha's WWTP currently discharges to the Fox River, which is in the Mississippi River watershed. The proposed project would require a new pump station, return flow pipeline, and outfall for the return flow to the Root River, a tributary to Lake Michigan.

The City has recently completed a Wastewater Treatment Facility Plan that identified improvements and WWTP expansion projects for the next 20 years (Strand, 2011). Included in that plan were provisions for UV disinfection and reaeration improvements. An amendment to that facility plan (see the Return Flow Plan - Volume 4 of the Application) was developed that identified improvements required for a return flow to the Root River. Most notably is a return flow pump station that would be located at the City's WWTP to return treated wastewater.

3.2.2 Return Flow Pipeline

A screening level layout was developed for the return flow pipeline (Figure 3-8 and Appendix 3-1). The alignment begins at the City of Waukesha WWTP and proceeds southeast through the Cities of New Berlin, Muskego and Franklin. The pipeline mainly follows major roads listed in Table 3-4. The pipeline follows previously disturbed transportation corridors to minimize environmental impacts. In total, the pipeline consists of about 20.2 miles of 30-inch pipe. Table 3-5 summarizes the return flow pipeline.

TABLE 3-4
Roads Parallel to Root River Return Flow Alignment 2

Direction	Length (miles)	Road	City
NE	0.4	Offroad	Waukesha
E	1.6	College Avenue	Waukesha
SE	6	Racine Avenue	Waukesha/New Berlin
SE	0.5	Minor Roads	New Berlin
E	2.7	W. College Avenue	New Berlin/Muskego
SE	2	Tess Corners Drive	Muskego
SE	2.5	W. Martins Road	Franklin
E	1.9	W. Puetz Road	Franklin
S	0.9	S. 68th Street	Franklin
E	0.5	W. Ryan Road	Franklin
S	1.2	S. 60th Street	Franklin

TABLE 3-5
Proposed Project Pipeline Facilities

Alternative	Diameter (inches)	Length (miles)	Counties
Return Flow for Lake Michigan Supply			
Root River to Lake Michigan Alignment 2	30	20.2	Milwaukee and Waukesha

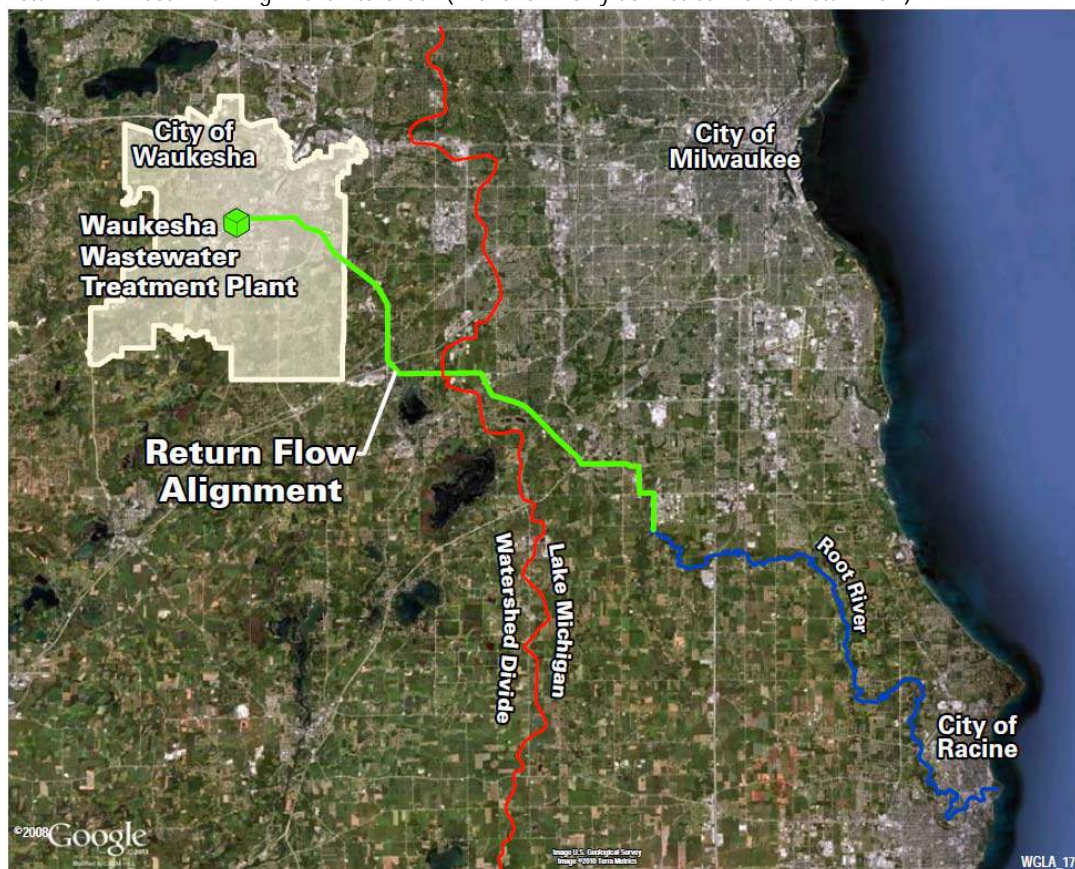
Note: The final pipeline diameter may be 30 or 36 inches depending upon final design considerations. Either diameter pipe will have essentially the same construction width impacts due to construction staging requirements.

3.2.3 Effluent Discharge

The Wisconsin Pollutant Discharge Elimination System (WPDES) permit for the City of Waukesha WWTP is effective through December 31, 2012 or remains in effect until a new permit is issued. The WPDES permit is included in the Return Flow Plan (Volume 4 of the Application). The WWTP is an activated sludge treatment facility with tertiary dual media filtration (sand and anthracite) and ultraviolet light disinfection. The plant consistently produces high quality effluent that has very low BOD (biochemical oxygen demand), TSS (total suspended solids), NH₃-N (ammonia) and TP (total phosphorus). The WWTP meets all of its permit requirements and is committed to doing so when a new permit is issued.

FIGURE 3-8

Return Flow Root River Alignment 2 to Creek (river shown only downstream of the return flow)



The WPDES permit currently allows discharge to the Fox River. Discharge to the Fox River has ranged from an annual average daily flow of 8.7 mgd in 2005 to 11.4 mgd in 2008 and 2009. The City of Waukesha Wastewater Treatment Plant Facility Plan¹ has forecast future average annual flow rates of 11.7 mgd.² The Return Flow Plan (Volume 4 of the Application) will switch discharge from the Fox River to the Root River. In general, the return flow management plan provides return flow up to the maximum day water demand if sufficient water is available at the WWTP. The portion of water at the WWTP in excess of this amount will continue to be discharged into the Fox River.

The City is anticipating lower effluent limits for TP. The WDNR has provided the City with draft limits, and the City has completed their WWTP facility planning assuming a new effluent limit equals 0.075 mg/L (compared to the current limit of 1.0 mg/L and recent average annual historical performance of 0.16 mg/L). The new limit is equal to the water quality criteria for the Fox River and the Root River at the discharge locations (NR 102).

In the WPDES permit for continued discharge to the Fox River, the Waukesha WWTP has a chloride variance that includes a mandatory source reduction program with an interim discharge limit.³ A significant source of chloride in the Waukesha WWTP is residential

¹ Strand, 2011. page 4-6. Addendum No. 1, October 5, 2012.

² Strand, 2011, page 4-2.

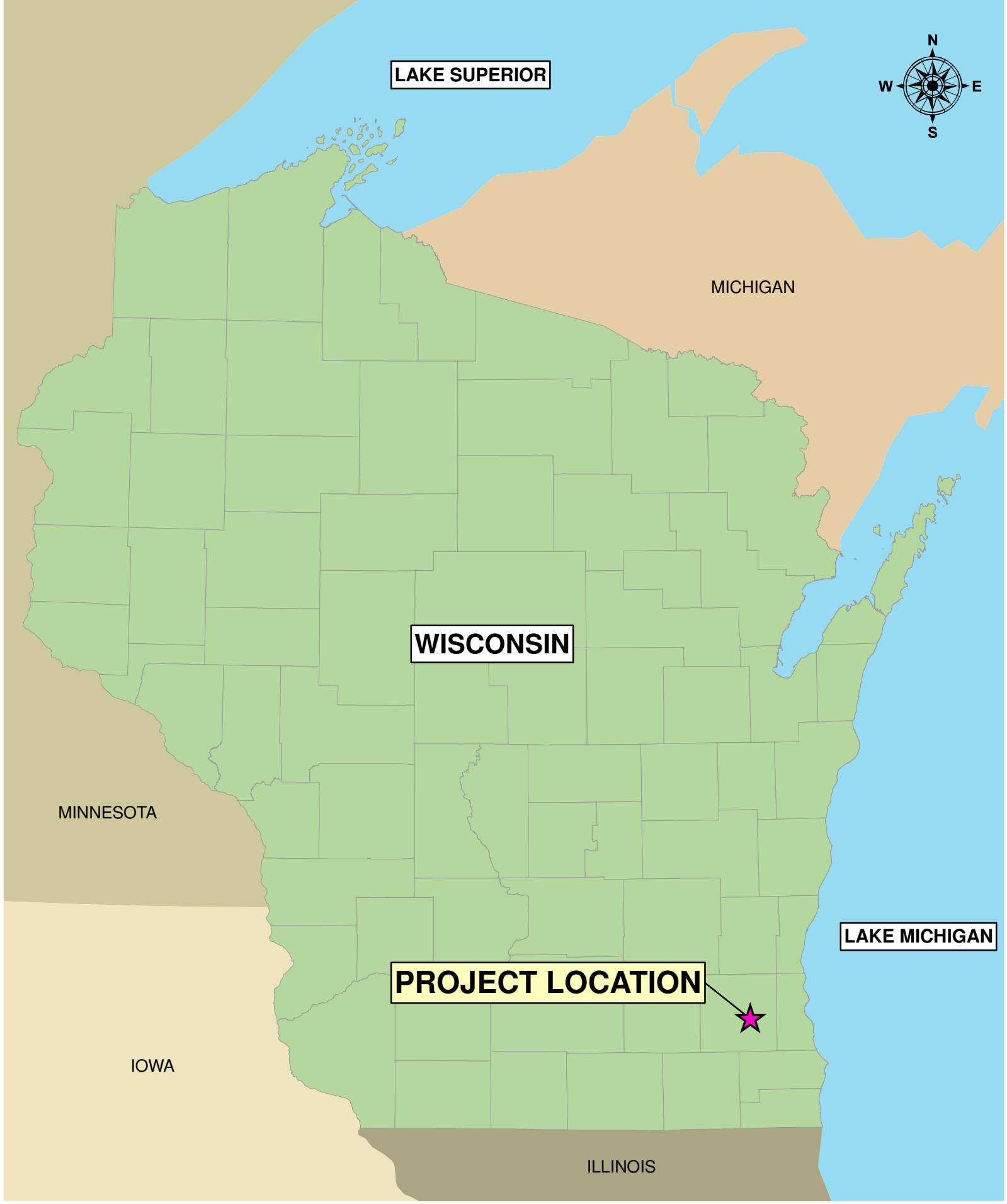
³ Draft WPDES Permit No. WI-0029971-08-0, April 2013

water softening. The need to continue to have a chloride variance varies significantly depending upon the water source, treatment, and discharge location (for example: continued groundwater source with discharge to the Fox River or Lake Michigan source with return flow to the Lake Michigan basin). Water softening no longer would be needed with a Lake Michigan water supply source. Consequently, a reduction in chloride concentration in return flow over time is expected. The City has evaluated chloride concentrations in return flow with a switch to Lake Michigan water and has developed a chloride compliance plan. The chloride reduction plan identifies chloride reduction elements to meet the chloride water quality standards with return flow (see the Return Flow Plan – Volume 4 of the Application).

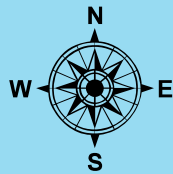
The WDNR has adopted new thermal rules (NR 102 and 106) for the protection and propagation of aquatic life that applies to WPDES permit holders discharging to surface waters. In preparation for this new rule, the City has been collecting effluent temperature data for over a year. The City has evaluated approaches to meet WDNR thermal discharge requirements following the rules and applicable guidance regardless of a discharge location (see the Return Flow Plan – Volume 4 of the Application).

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Appendix 3-1
Groundwater Drawdown Maps



LAKE SUPERIOR



MICHIGAN

WISCONSIN

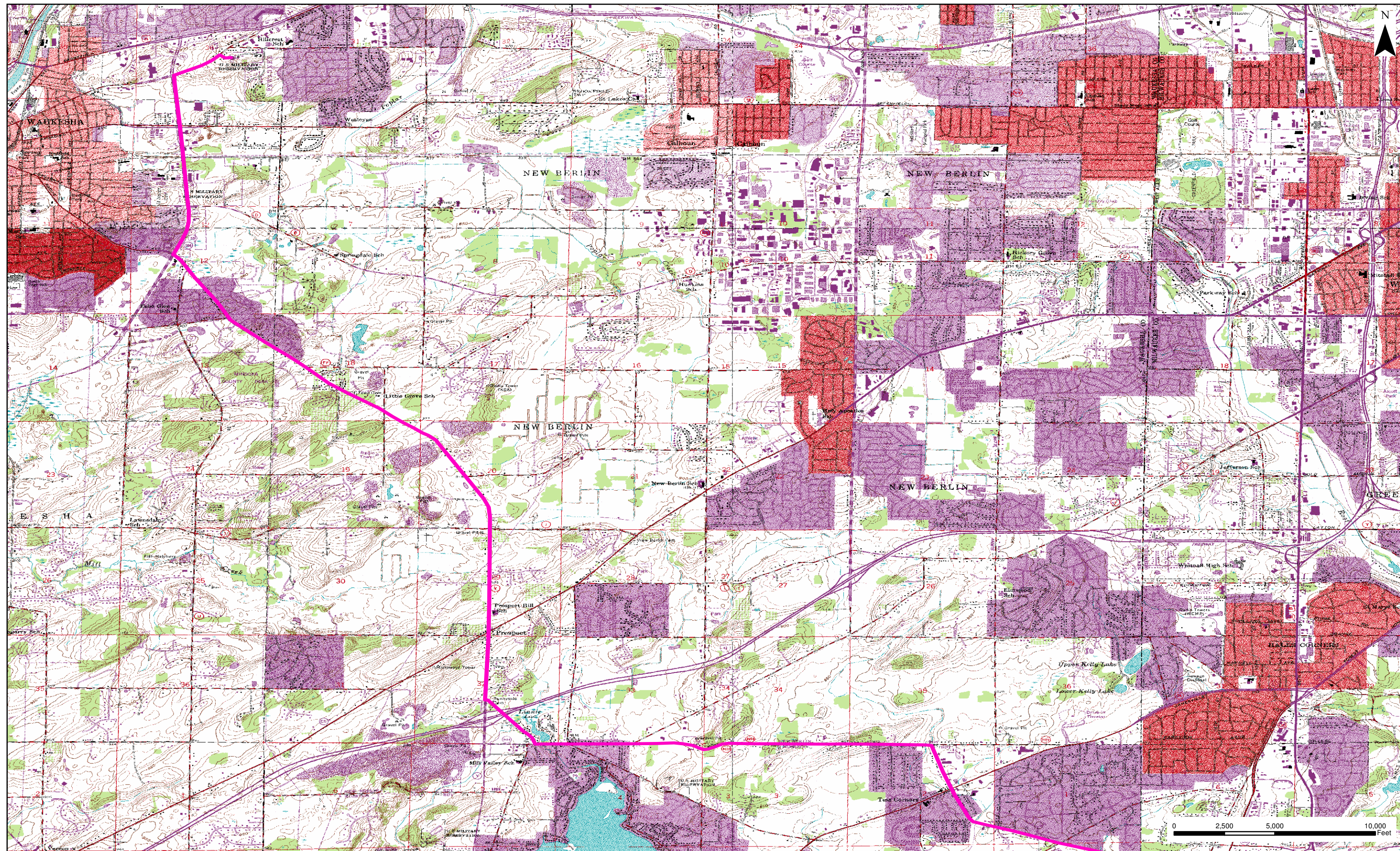
MINNESOTA

IOWA

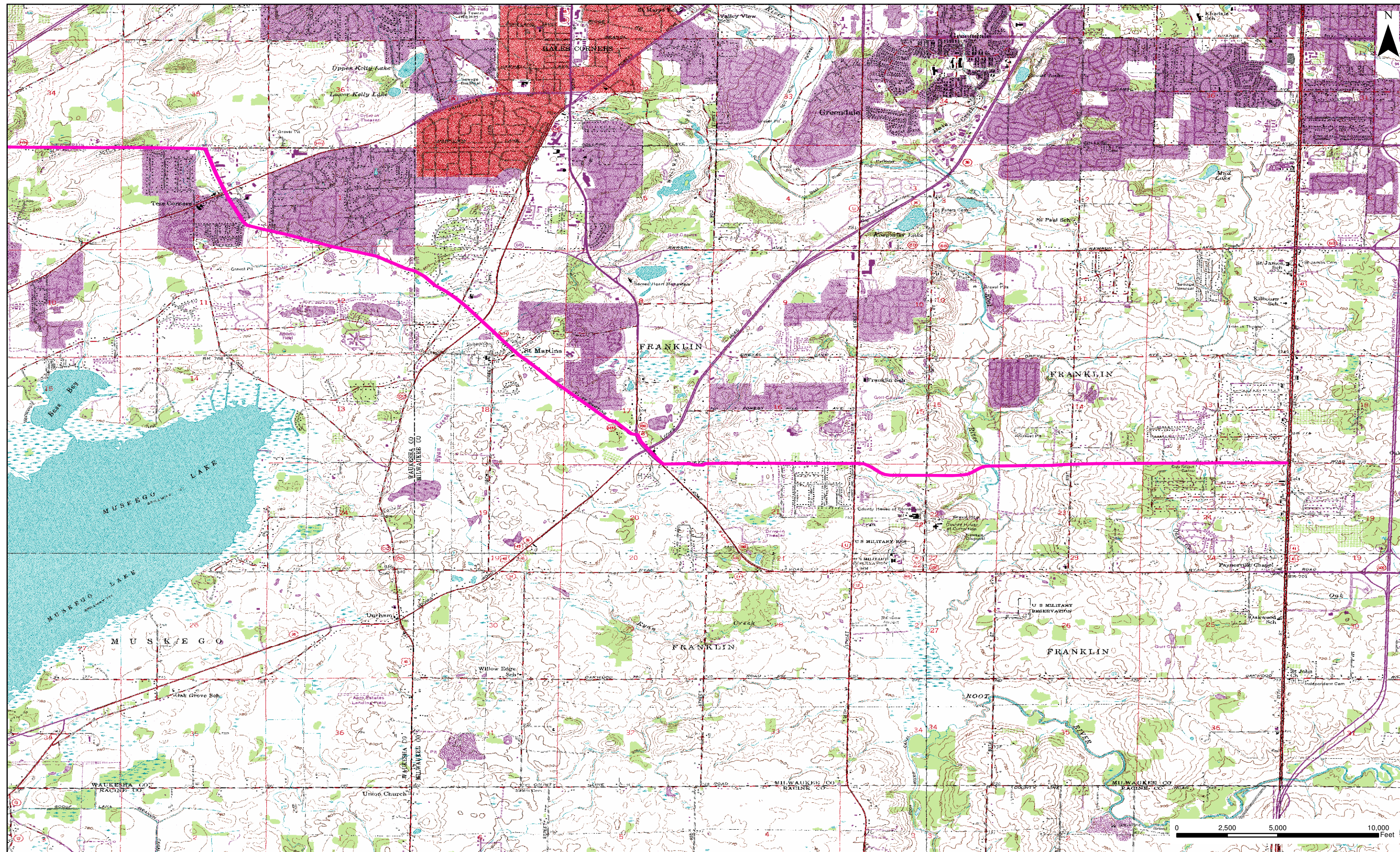
ILLINOIS

LAKE MICHIGAN

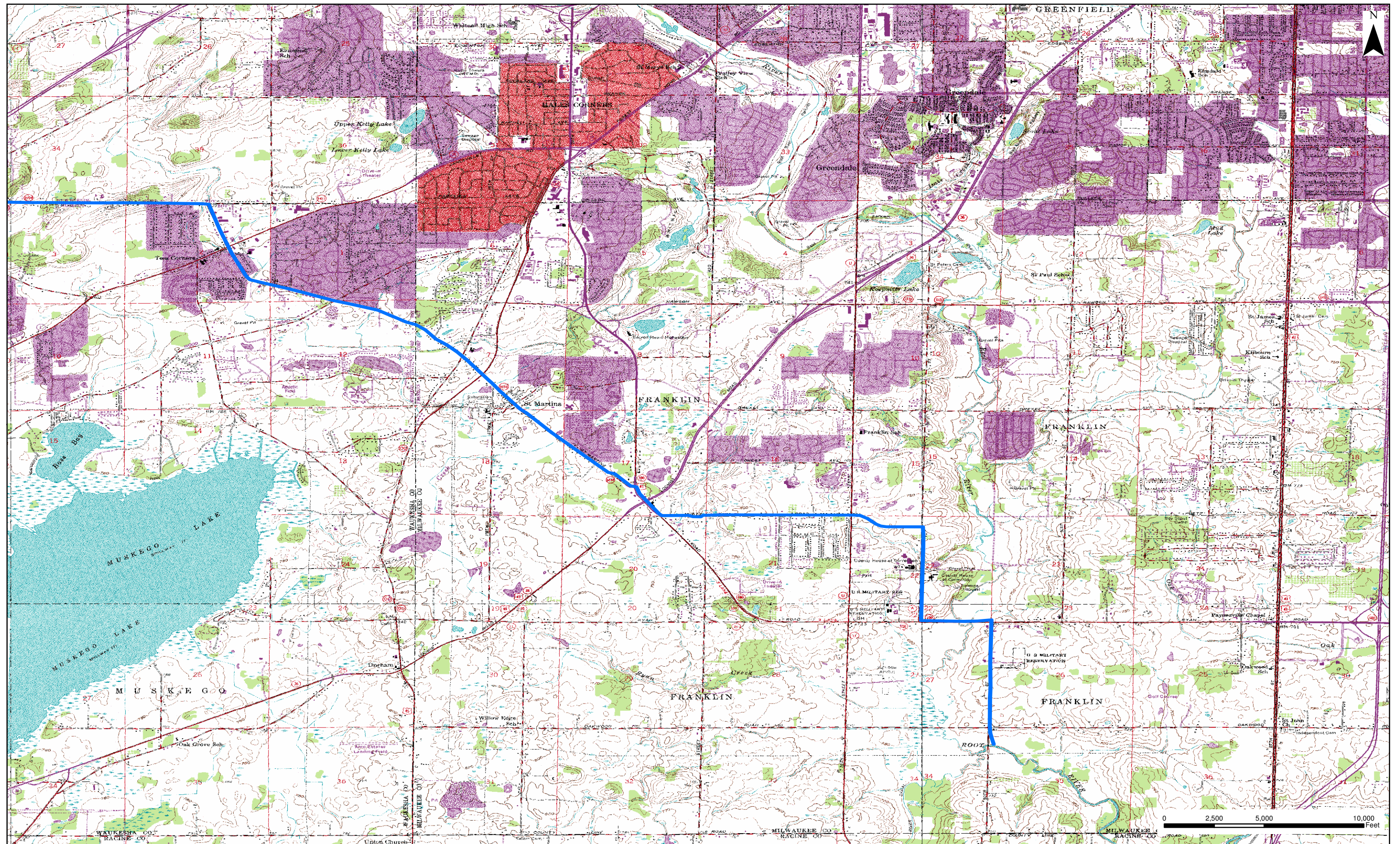
PROJECT LOCATION



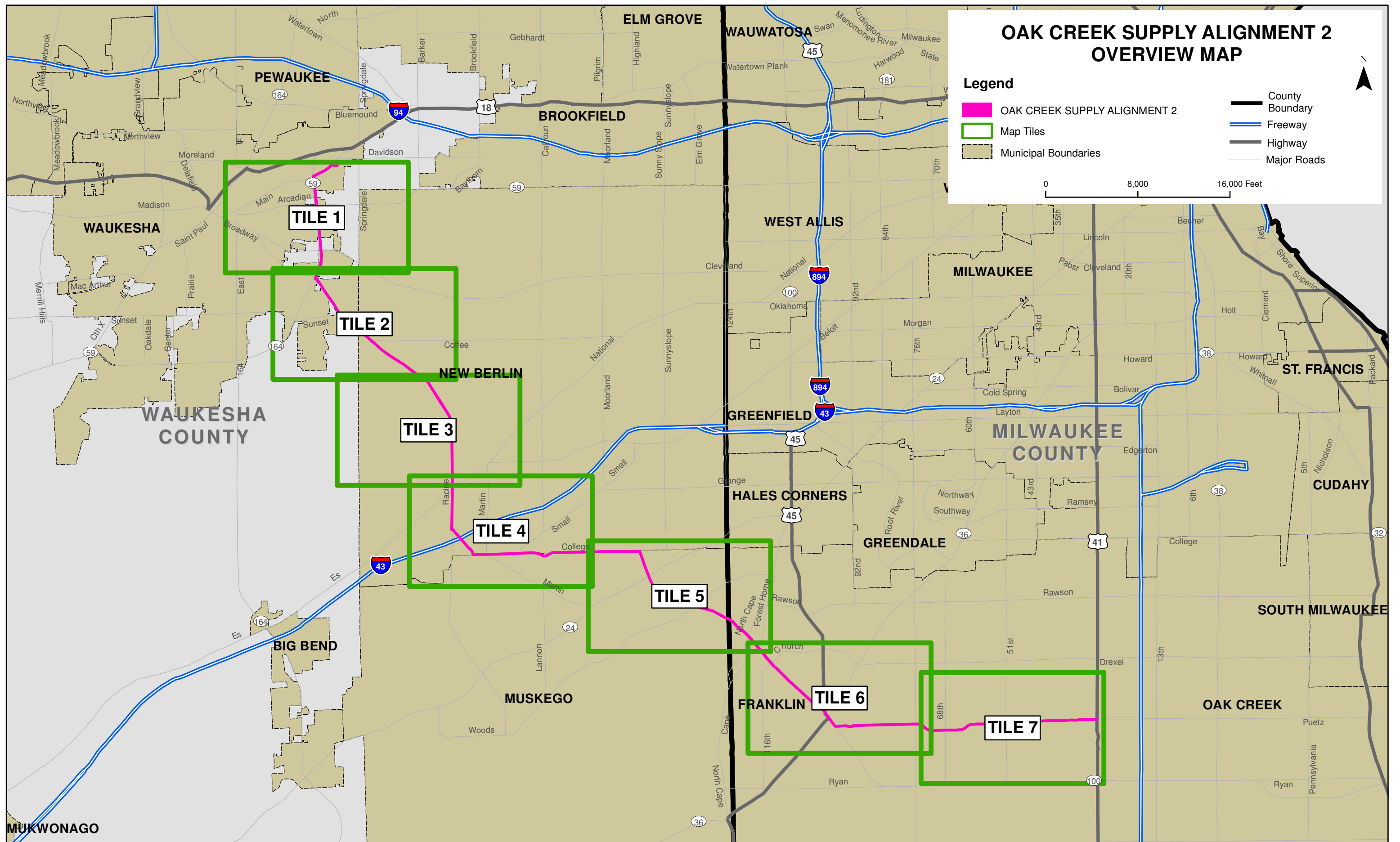
OAK CREEK SUPPLY ALIGNMENT 2 - TILE 1

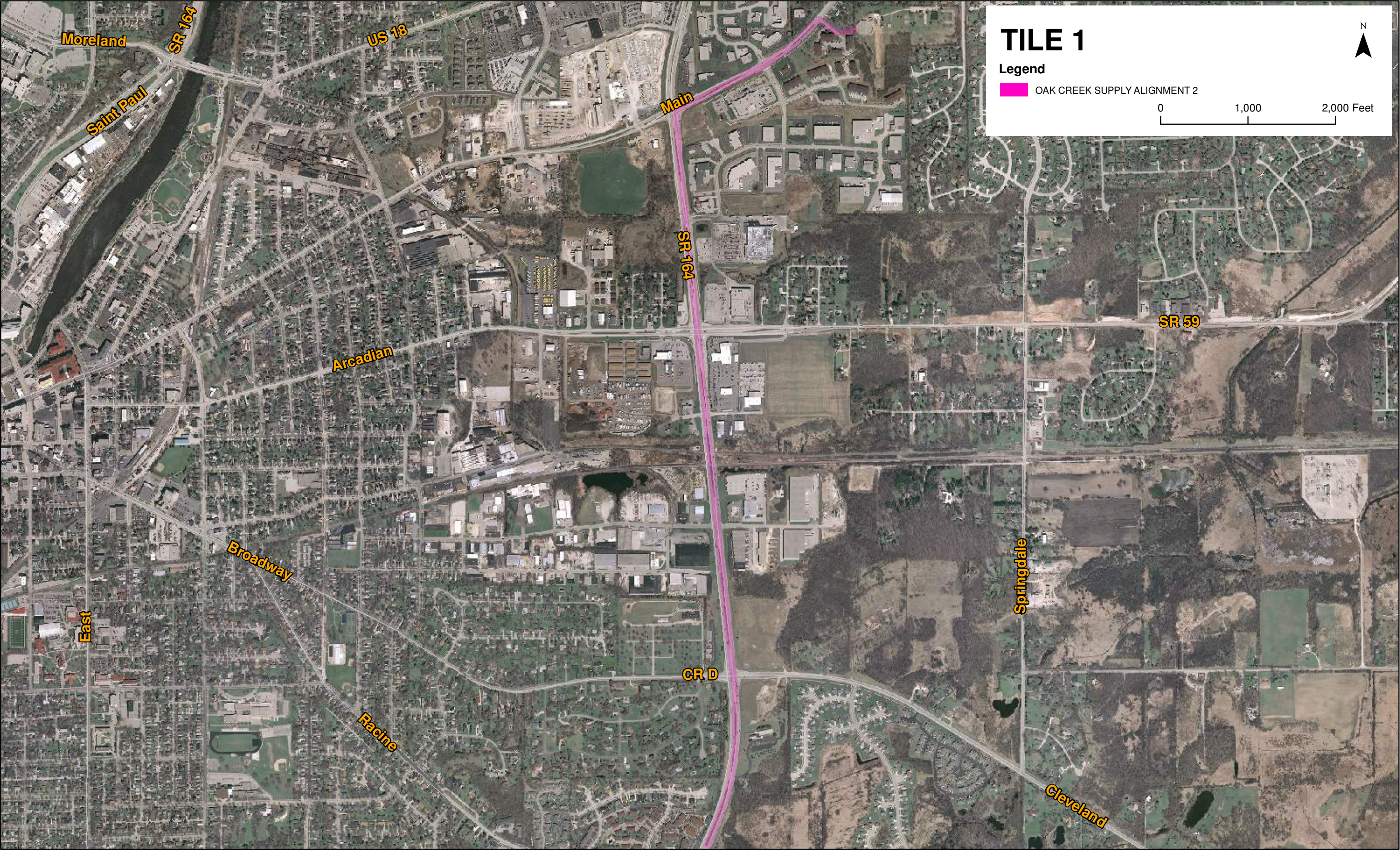


OAK CREEK SUPPLY ALIGNMENT 2 - TILE 2



ROOT RIVER RETURN FLOW ALIGNMENT 2 - TILE 2





TILE 1

Legend

OAK CREEK SUPPLY ALIGNMENT 2

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Feet

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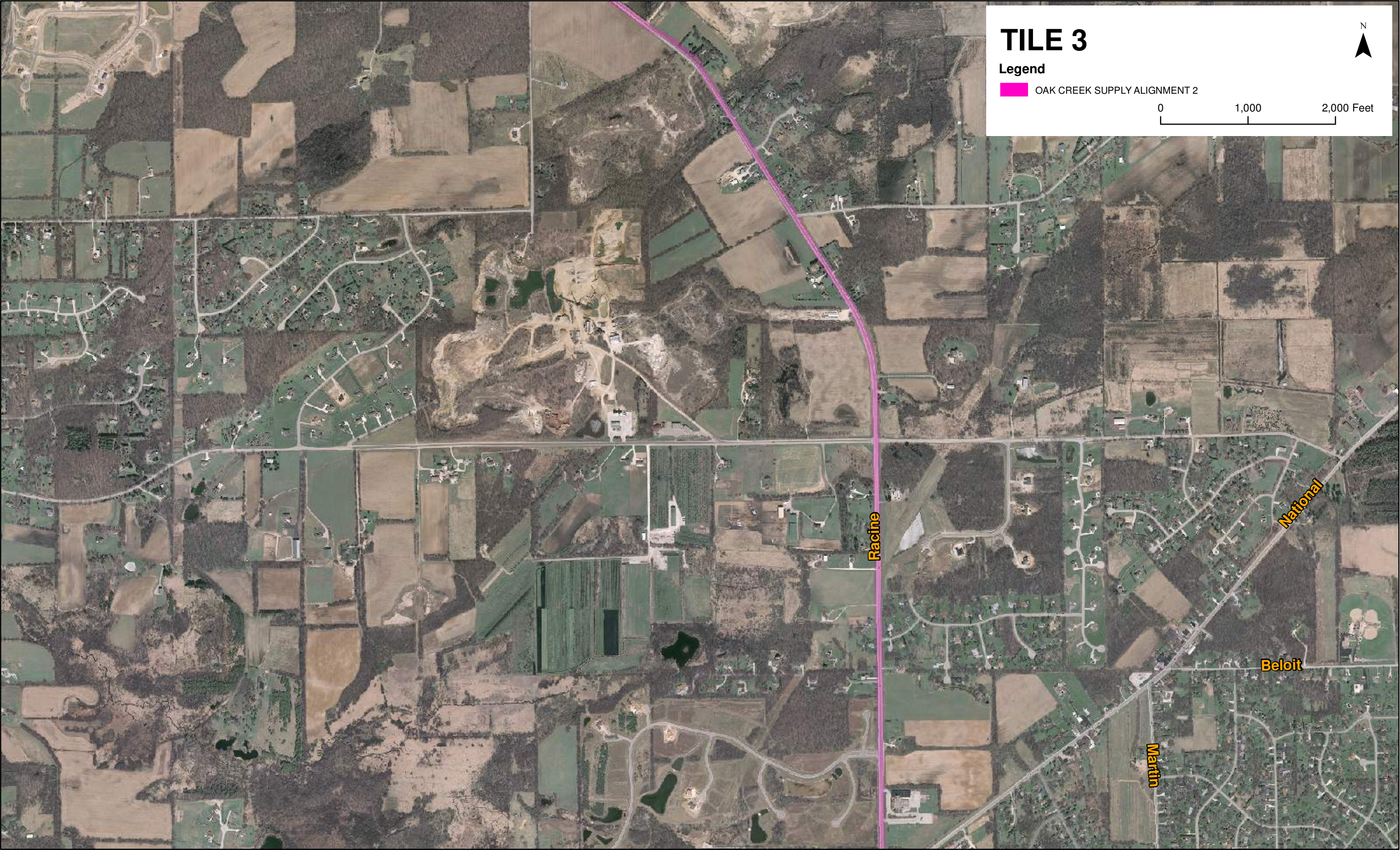
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 OAK CREEK SUPPLY ALIGNMENT 2

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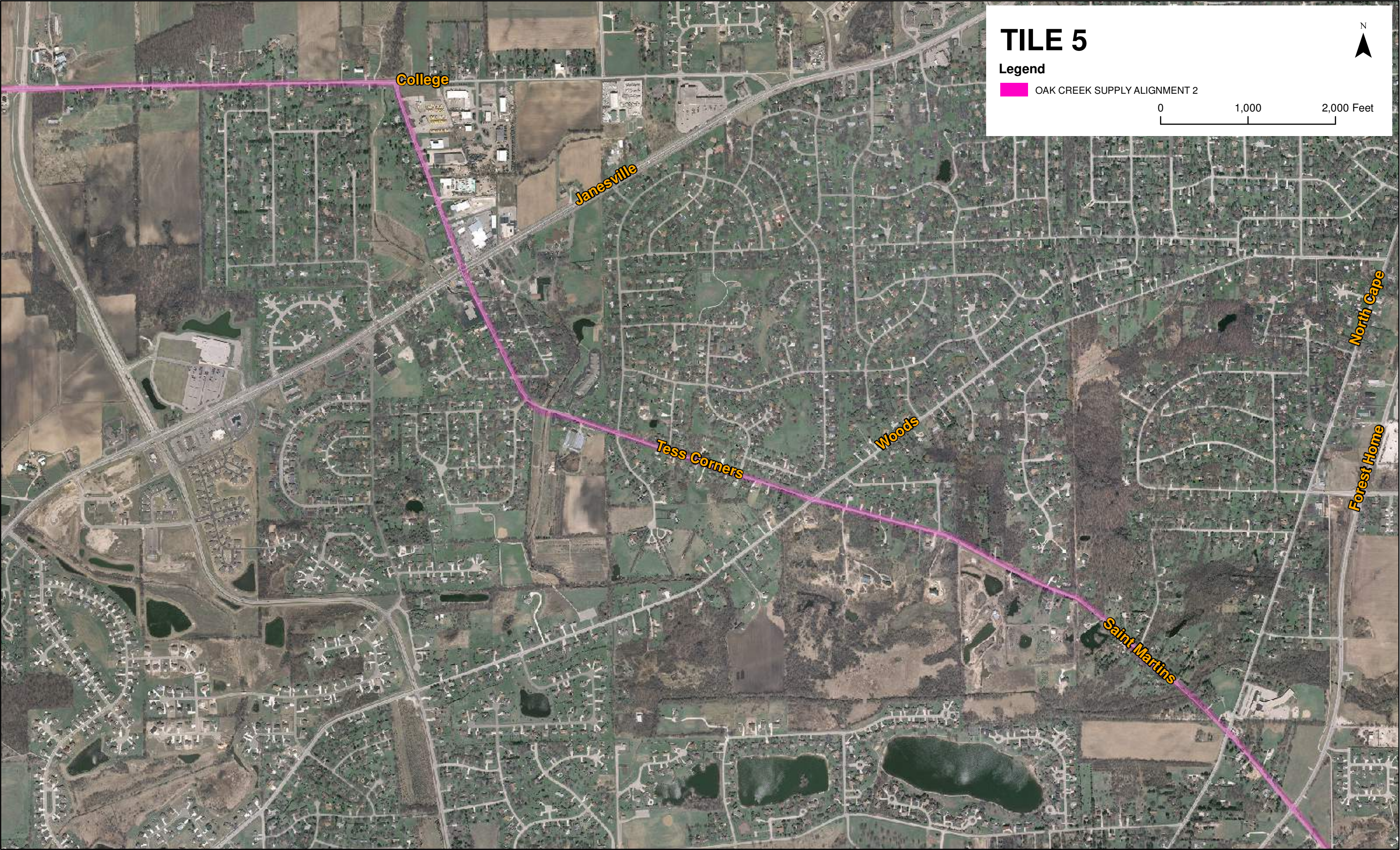
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OAK CREEK SUPPLY ALIGNMENT 2

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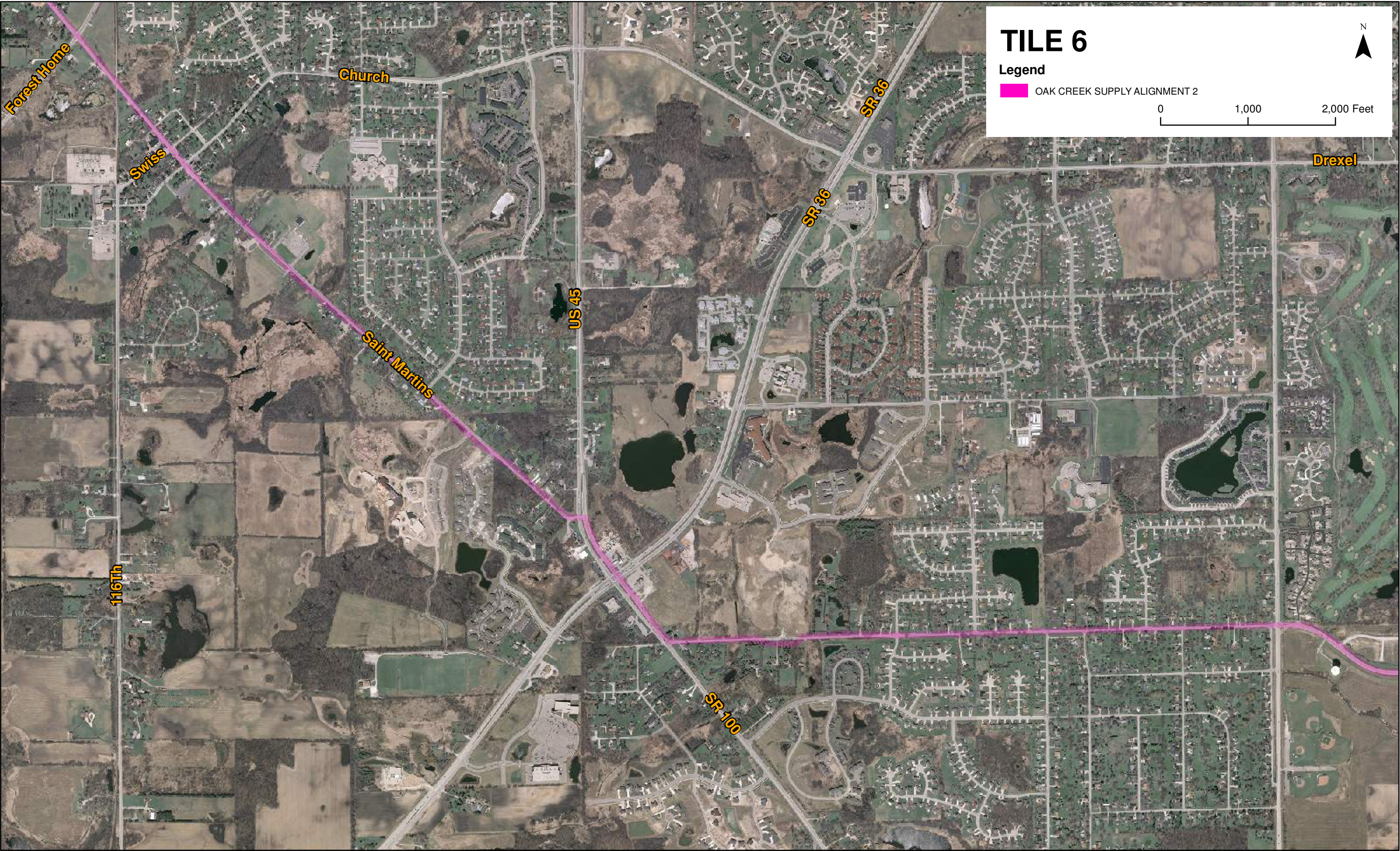
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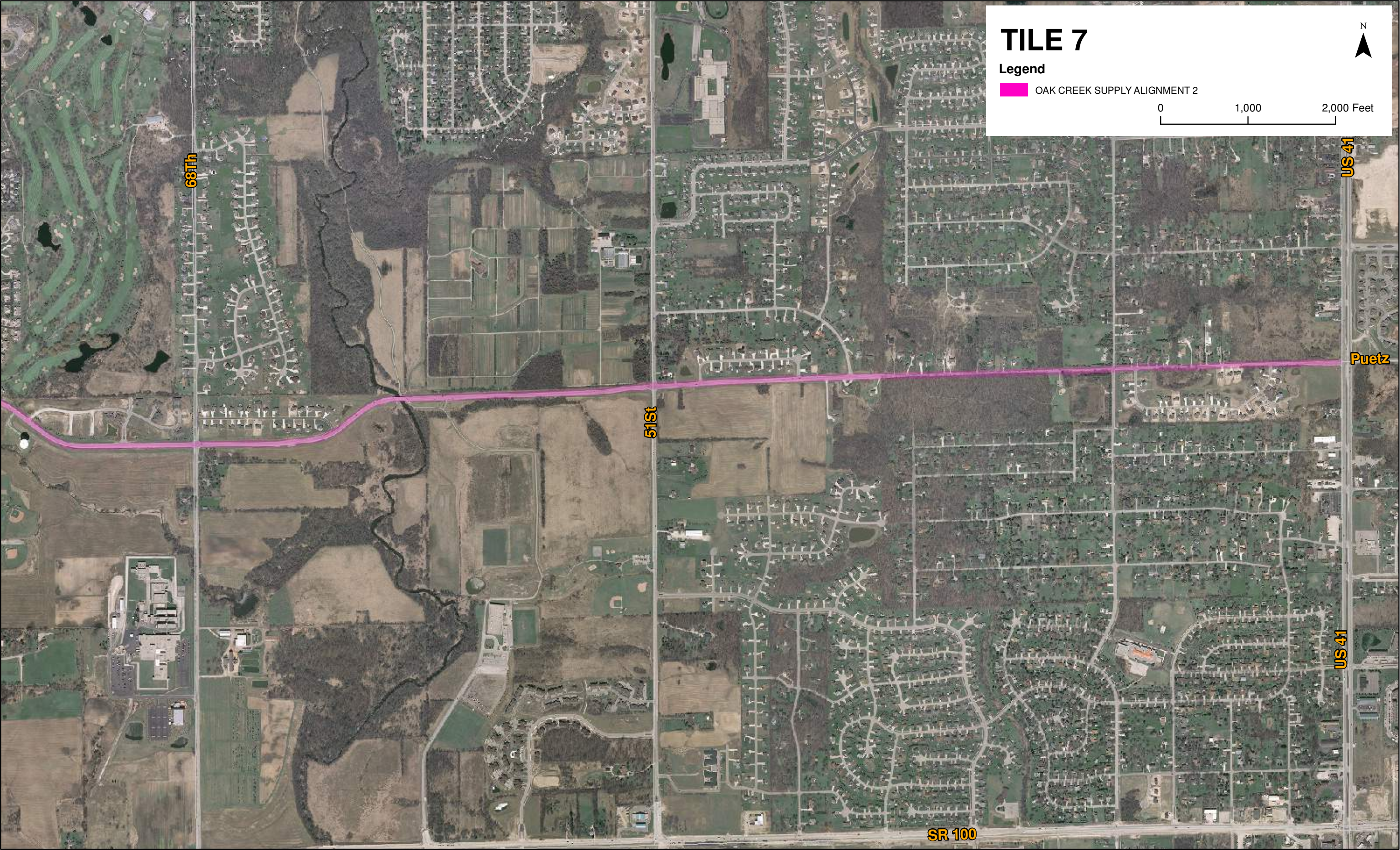
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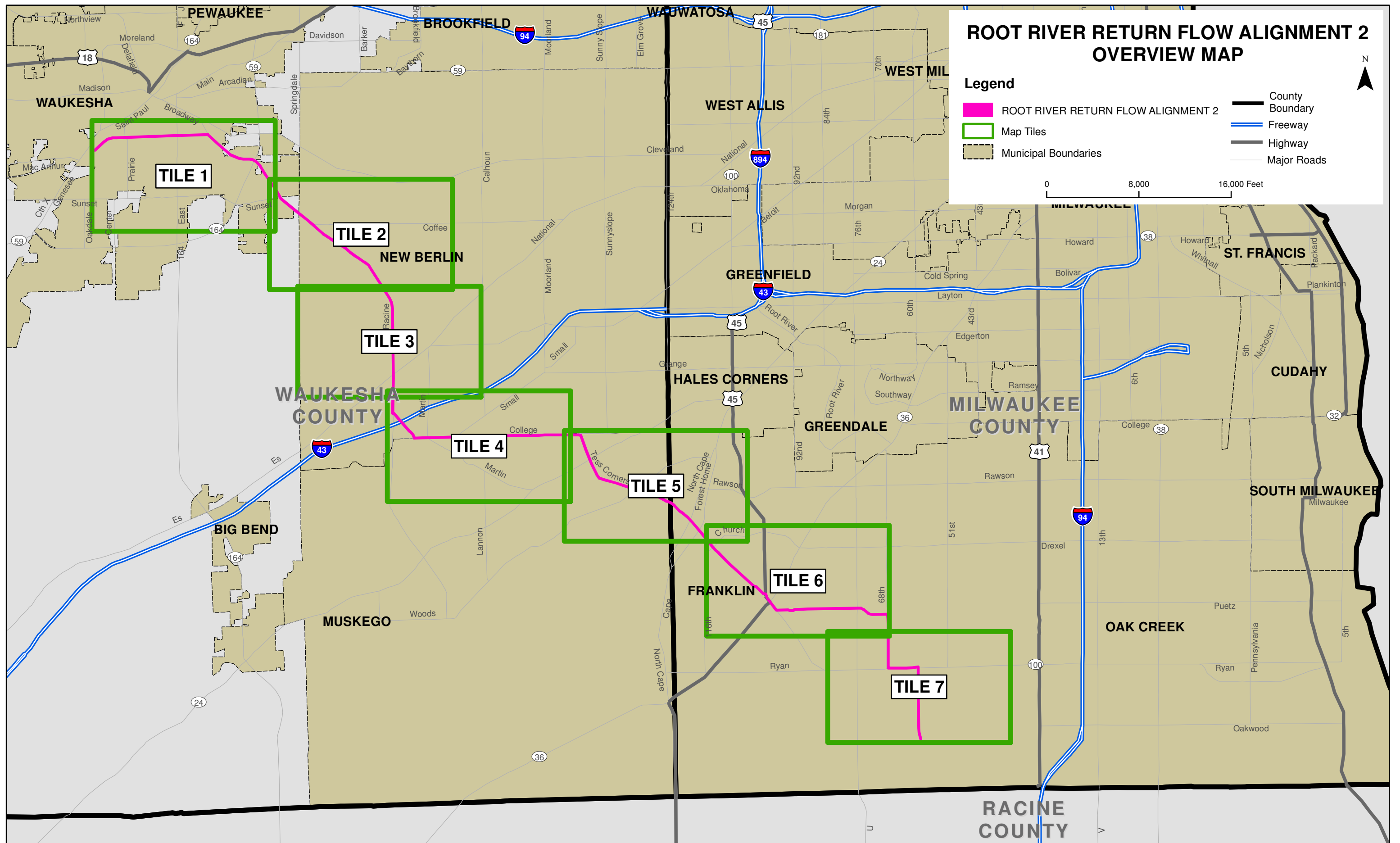
 OAK CREEK SUPPLY ALIGNMENT 2

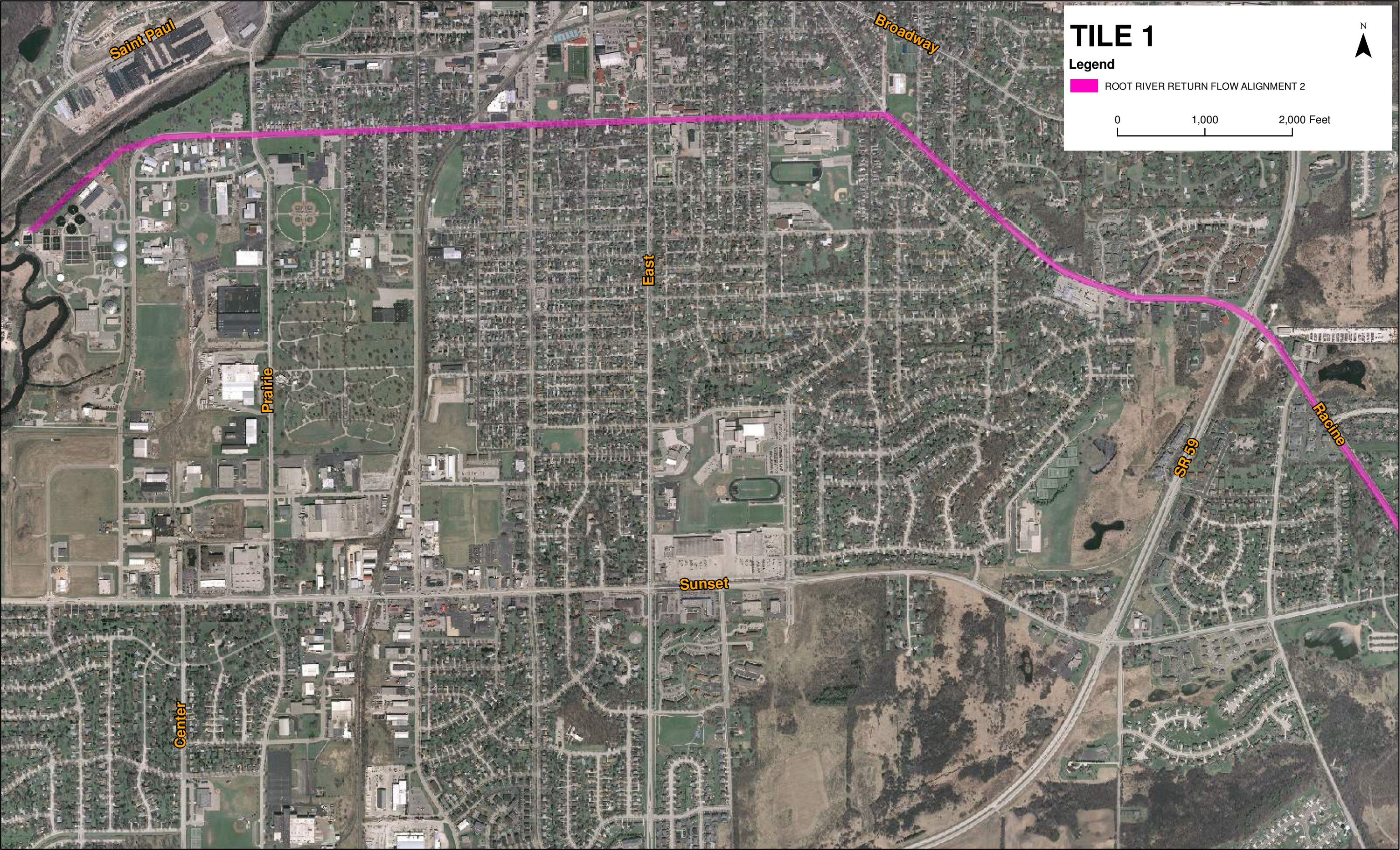
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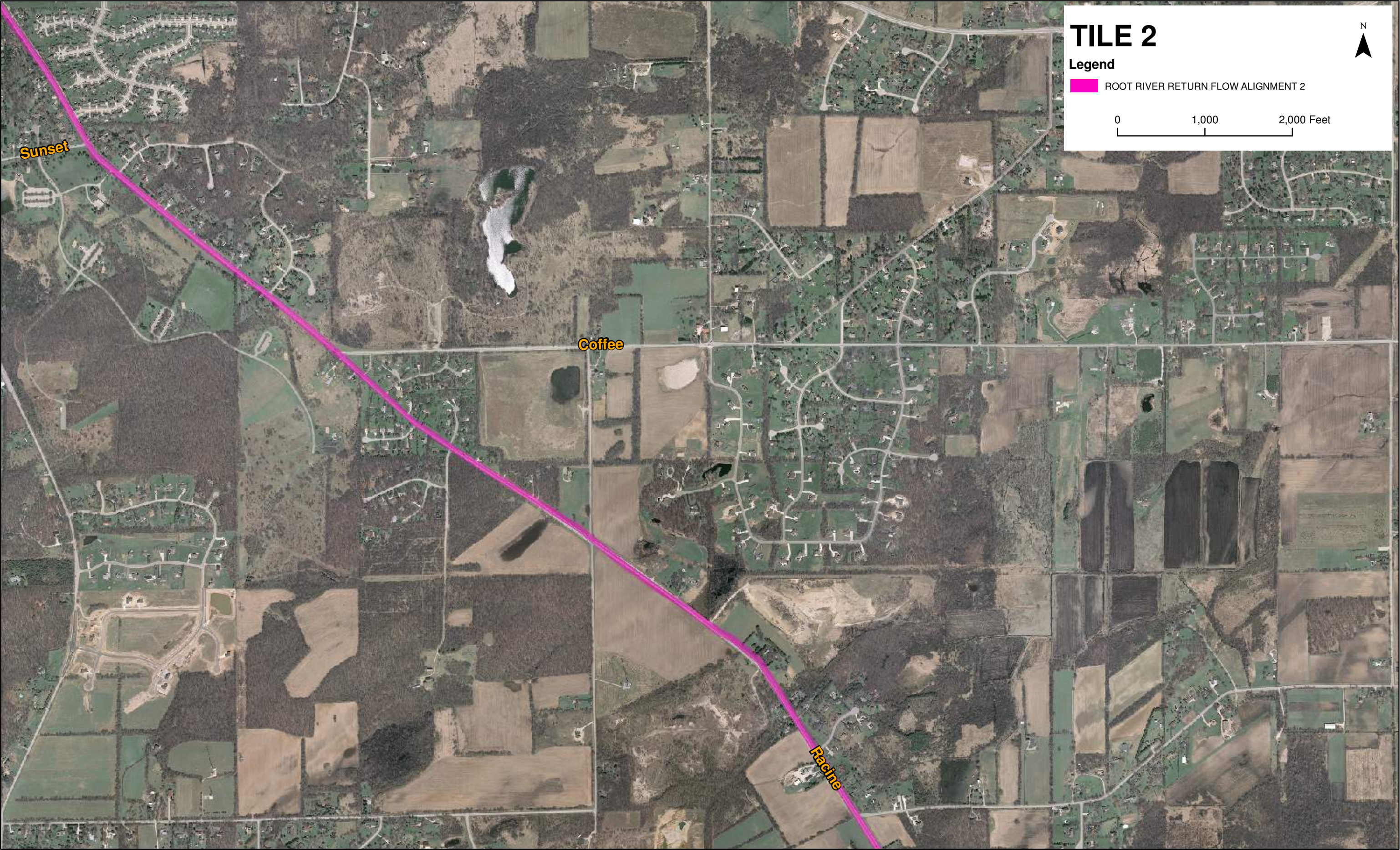


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ROOT RIVER RETURN FLOW ALIGNMENT 2

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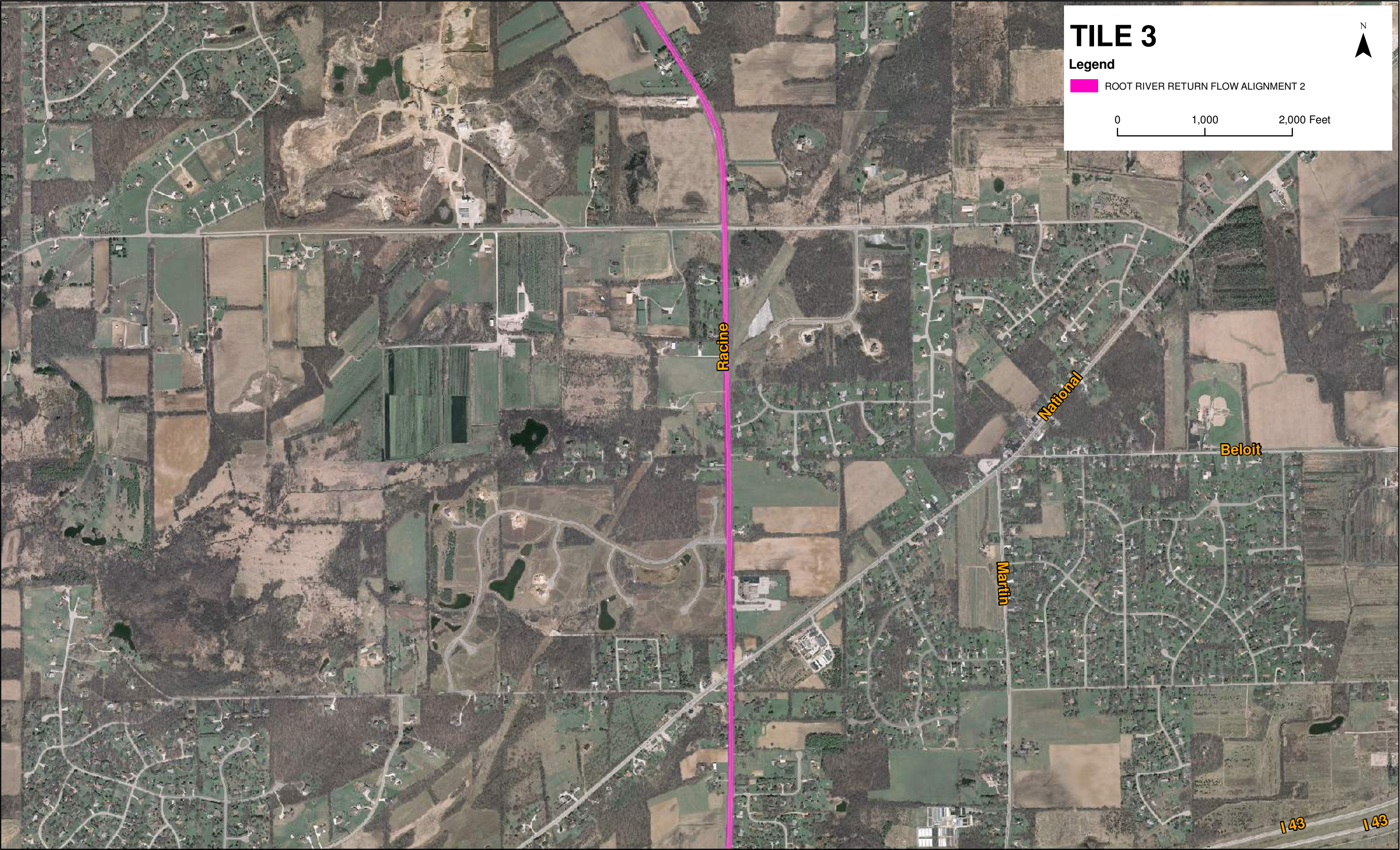
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ROOT RIVER RETURN FLOW ALIGNMENT 2

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TILE 3

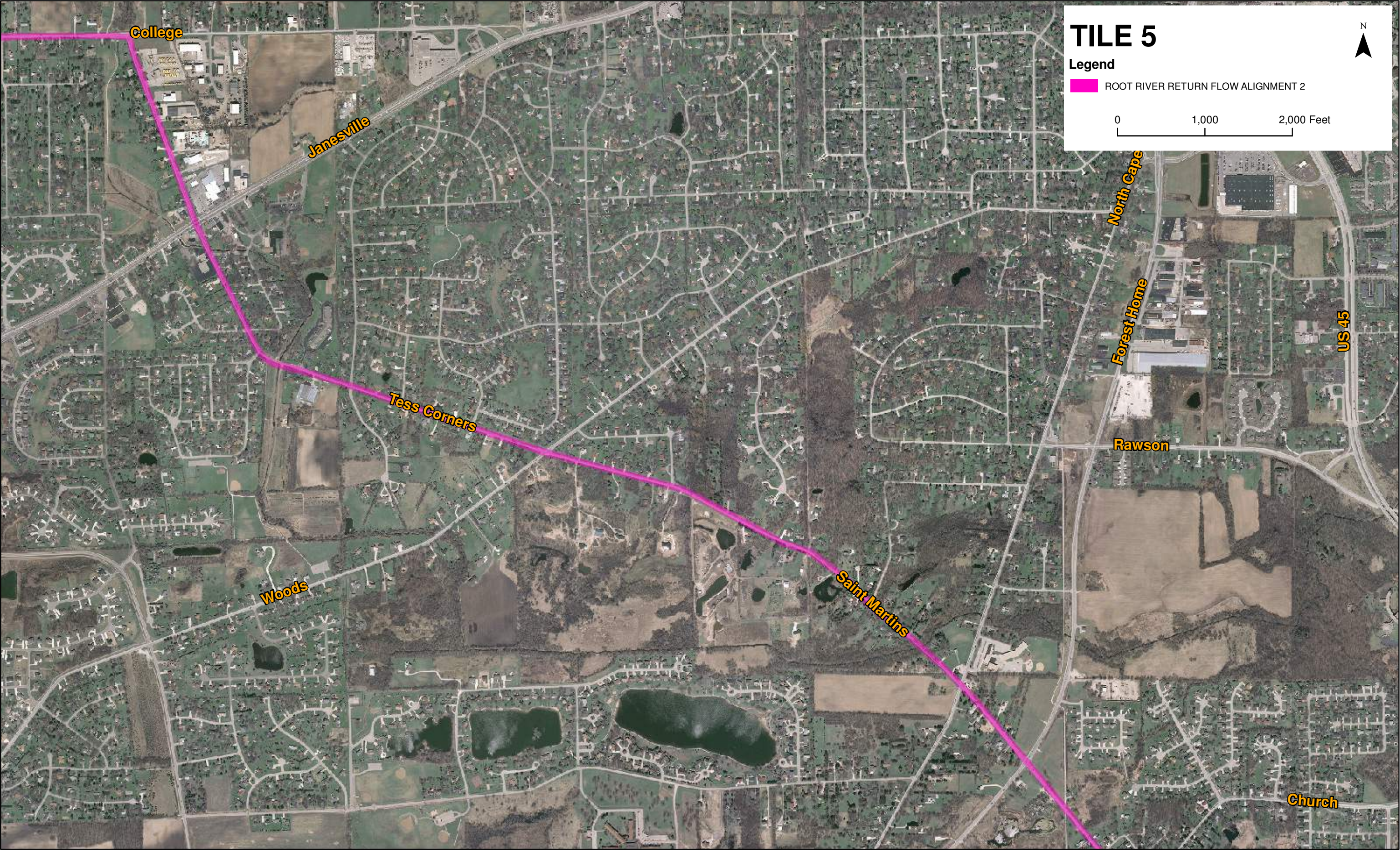
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ROOT RIVER RETURN FLOW ALIGNMENT 2

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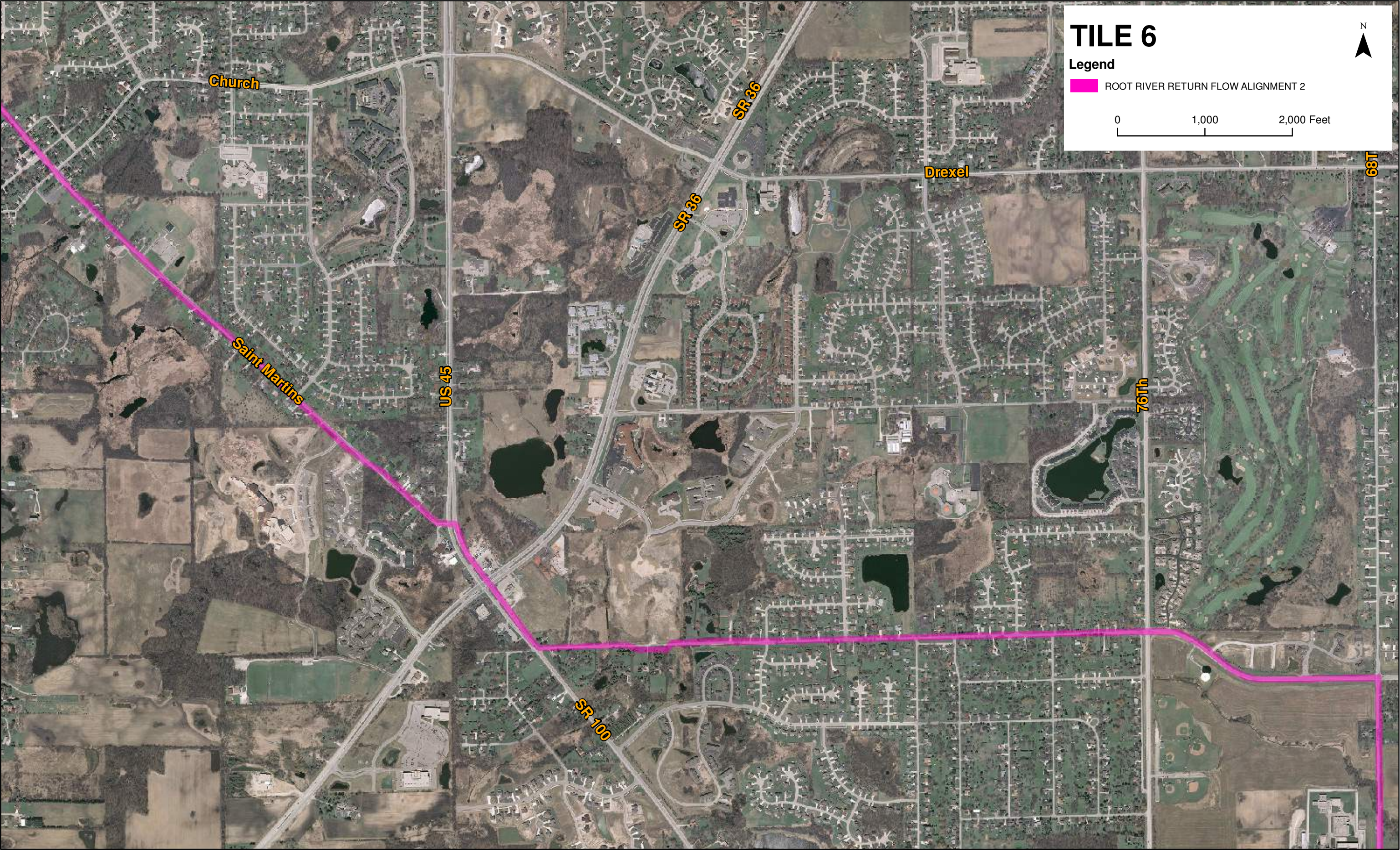
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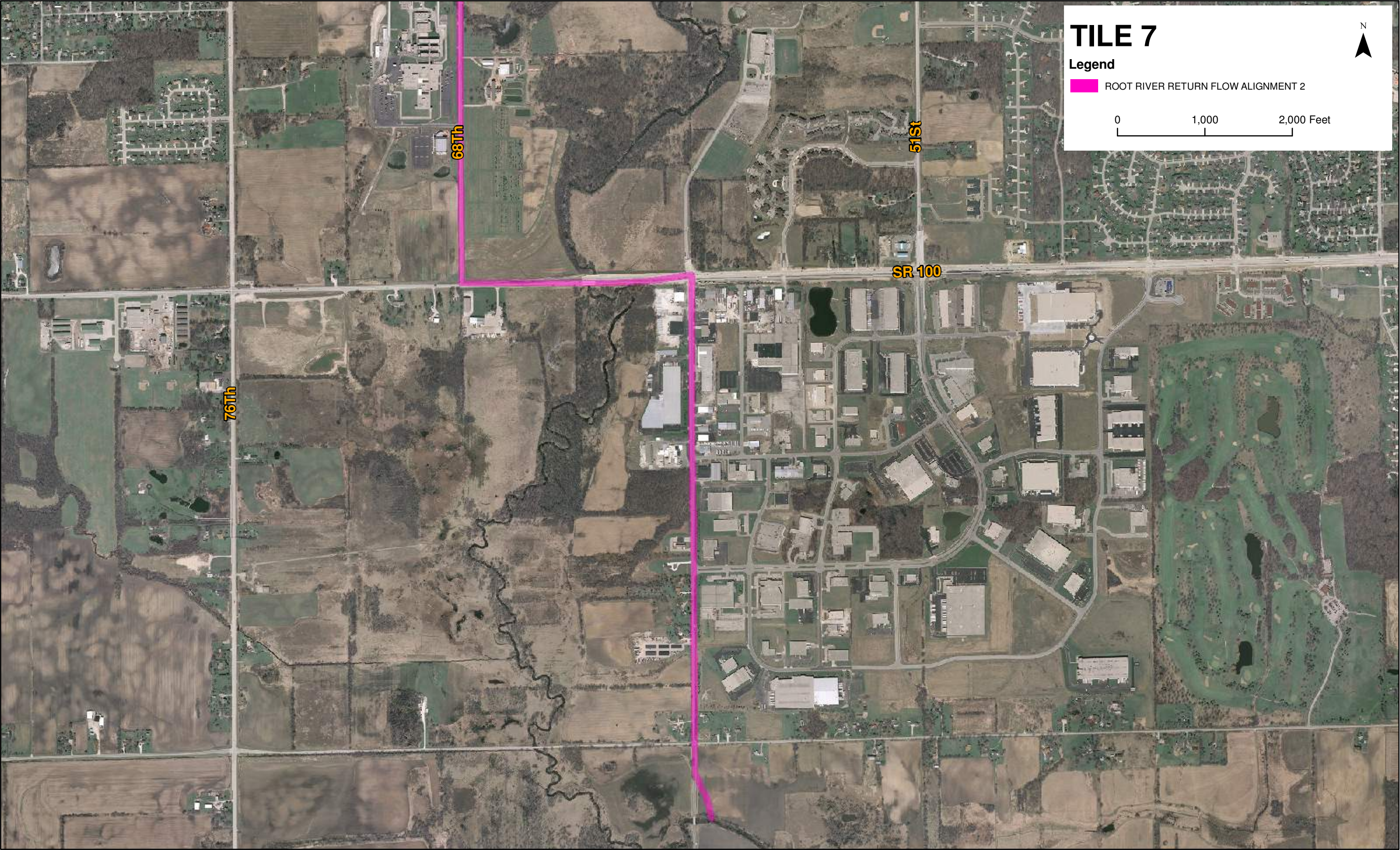
Legend

ROOT RIVER RETURN FLOW ALIGNMENT 2

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TILE 7

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ROOT RIVER RETURN FLOW ALIGNMENT 2

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Section 4

Authorities and Approvals

SECTION 4

Authorities and Approvals

The agencies expected to be applicable to review the project before construction are listed below. Table 4-1 lists the applicable permits, reviews, and clearances. To date, consultations with federal, state, and local regulatory officials and government agencies regarding clearances and data consultations for this Project have been limited to preliminary or screening-level discussions. In-depth coordination regarding project specific permits, approval, and conditions will be completed once regional approval for Lake Michigan water has been obtained.

4.1 WDNR

The Wisconsin Department of Natural Resources (WDNR) is the lead state agency on the project. Details regarding the applicable WDNR permits are listed in Table 4-1 under State Permit Approvals.

4.2 Great Lakes Compact

Implementing a Lake Michigan water supply alternative would require review and approval under the Great Lakes–St. Lawrence River Basin Water Resources Compact, under Article 4, Water Management and Regulation. This approval is listed in Table 4-1.

4.3 Other Wisconsin

Other Wisconsin state approval authorities include the Wisconsin State Historic Preservation Office and the Wisconsin Department of Agriculture, Trade, and Consumer Protection and are listed in Table 4-1 under State.

4.4 Federal

Federal agency approvals include the U.S. Fish and Wildlife Service, Green Bay Endangered Species Field Office and the U.S. Army Corps of Engineers St. Paul District listed in Table 4-1 under Federal.

4.5 Local

Local county agency and municipal approvals include individual county agencies and permits, which are listed on Table 4-1 under County.

4.6 Tribal

Coordination with the various tribes (if applicable) will be coordinated as part of the Federal and State regulatory review.

TABLE 4-1
Permits, Licenses, Approvals, and Certificates Required for Construction, Operation, and Maintenance

Permit/Approval (Statute/Reg.)	Administering Agency	Status
State		
Chapter 30 Stream Crossings Navigable Waters (Applications on County Basis; WI NR 199, 102, 103, 155, 117)	WDNR, Bureau of Fisheries Management and Habitat Protection	Proceeding subsequent to governors' approval
WPDES Stormwater Discharge Permit (WI NR 216)	WDNR, Bureau of Watershed Management	Proceeding subsequent to governors' approval
Hydrostatic Test Discharge General Permit (WI Chapter 283, 216)	WDNR, Bureau of Watershed Management	Proceeding subsequent to governors' approval
Pit/Trench Dewatering General Permit (WI Chapter 283, 216)	WDNR, Bureau of Watershed Management	Proceeding subsequent to governors' approval
Section 401 Water Quality Certification—Joint Application with COE Outside Navigable Waters (Applications on County Basis; see Stream Crossings in Section 2)	WDNR, Bureau of Fisheries Management and Habitat Protection	Proceeding subsequent to governors' approval
WDNR—Wastewater Facilities Plan Review (WI NR 110)	WDNR	Submitted with the Application
WDNR—Wisconsin Floodplain Management Program (WI NR 116)	WDNR	Proceeding subsequent to governors' approval
WDNR—Environmental Report (Statewide; WI NR 150)	WDNR, Bureau of Integrated Science Services	2013
Natural Heritage Inventory (Wisconsin Endangered Species Law—WI Stats. S. 29.415)	WDNR, Bureau of Endangered Resources	Initiated January 12, 2010
Incidental Take Permit (WI Stats. 29.604)	WDNR, Bureau of Endangered Resources	Proceeding subsequent to governors' approval
WDNR—Water Quality Anti-Degradation (WI NR 207)	WDNR	Proceeding subsequent to governors' approval
WDNR—WPDES Permit for Effluent Standards and Limitations (WI NR 217 and WI SS 283)	WDNR	Draft provided; additional review occurring with governors' approval
WDNR—Water Service Area Plan (WI NR 281)	WDNR	Submitted with the Application
Wastewater systems construction plan review	WDNR	Conducted at design completion and prior to construction
Water systems construction plan review	WDNR	Conducted at design completion and prior to construction
Great Lakes Compact		
The Great Lakes—St. Lawrence River Basin Water Resources Compact (Article 4, Water Management and Regulation).	The Great Lakes—St. Lawrence River Basin Water Resources Council (Compact Council)	Pending approval by WDNR and forwarding to the regional body for review.

TABLE 4-1
Permits, Licenses, Approvals, and Certificates Required for Construction, Operation, and Maintenance

Permit/Approval (Statute/Reg.)	Administering Agency	Status
Wisconsin Other		
Cultural Resources Review (36 CFR Part 800; WI Chapter 285)	Wisconsin State Historic Preservation Office	Proceeding subsequent to governors' approval
Agricultural Impact Statement (WI Statute 32.035)	Wisconsin Department of Agriculture, Trade, and Consumer Protection	Proceeding subsequent to governors' approval
Control of Particulate Emission, Specific geographic areas for additional particulate emission control (WI NR 415.035)	Wisconsin Department of Agriculture, Trade, and Consumer Protection	Proceeding subsequent to governors' approval
Federal		
Endangered Species Section 7 Consultation (Endangered Species Act—16 U.S.C.1531 et. seq.)	U.S. Fish and Wildlife Service, Green Bay ES Field Office	Initiated January 13, 2010
Section 404 Dredge and Fill Permit (Clean Water Act—33 U.S.C. 1344)	U.S. Army Corps of Engineers, St. Paul District	Proceeding subsequent to governors' approval
Section 10 Navigable Waters (Rivers and Harbors Act of 1899—33 U.S.C. 403)	U.S. Army Corps of Engineers, St. Paul District	Proceeding subsequent to governors' approval
County		
Shoreland-Wetland Zoning Permit and Conditional Use Application	Varies by county	Proceeding subsequent to governors' approval
Erosion and Sedimentation Control Permit	Varies by county/municipality	Proceeding subsequent to governors' approval
Tribal		
Coordination with the various tribes (if applicable) will be coordinated as part of the Federal and State regulatory review for permits listed above.	Varies	Proceeding subsequent to governors' approval

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Section 5

**Proposed Project: Affected Environment and
Environmental Effects**

SECTION 5

Proposed Project: Affected Environment and Environmental Effects

This section describes the impacts of the proposed project. A side by side comparison of the proposed project to other alternatives is provided in Table 6-80 of this ER. The proposed City of Waukesha water supply project is a Lake Michigan water supply with return flow to the Root River. The City of Oak Creek was determined as the Lake Michigan water supply provider after contract negotiations with the Cities of Milwaukee, Oak Creek, and Racine. The unsuccessful suppliers are alternatives to the proposed project; they will not be implemented. The proposed project includes return flow to the Root River.

The 2012 Environmental Report (ER) identified a different proposed project. This ER considers the previously proposed project as an alternative to the proposed project. This section provides an updated evaluation of the impacts of the proposed project.

Note: The Water Supply Service Area Plan Lake Michigan (City of Oak Creek) water supply alternative describes the ER Lake Michigan (City of Oak Creek) Alignment 2 alternative and the Return Flow Plan Root River to Lake Michigan return flow alternative describes the ER Root River to Lake Michigan Alignment 2 return flow alternative. The ER retains the Lake Michigan (City of Oak Creek) Alignment 1 water supply alternative and the Root River to Lake Michigan Alignment 1 return flow alternative for alternative comparison purposes.

The impact of the proposed project on the physical and biological environment falls into three main categories:

- Aquatic resource impacts
- Terrestrial resource impacts
- Air quality

The environmental impacts of the proposed project are compared side by side for each resource category documented in this section. A summary table of overall resource impacts is included at the end of this section. The resource impacts were developed for individual water supply and return flow components.

Resource impacts for the proposed project system alternative, where a Lake Michigan water supply alternative is combined with a return flow to the Lake Michigan basin, are estimated by adding the water supply impact with the return flow impact to obtain an overall system alternative impact. This approach conservatively estimates the proposed project system impacts because portions of the water supply and return flow pipeline corridors are shared which leads to double counting some resource impacts, such as impacts to wetlands. Proposed project system impacts are summarized in Appendix 5-1.

Note: The environmental impacts determined in this section are conservative and are based on conservative potential water demand values. Analysis of the environmental impacts in this ER has occurred with an MDD of 18.5 mgd and an ADD of 10.9 mgd as documented in

the February 2012 ER unless otherwise noted. The water demand forecasts have changed slightly since the February 2012 ER (10.1 mgd ADD compared to 10.9 mgd ADD). Water demands may vary depending upon the final water demand forecasts. The official water request is as documented in the Application Summary (Volume 1 of 5). If values are less, then the impacts documented in this document will be conservative for impact comparison purposes. Regardless, a small change in water demand will have either no significant change to impacts or a proportional change to impacts. See Table 1-1 for a description of how impacts change with a change in water demand.

5.1 Aquatic Resources

Aquatic resources have been further subdivided into: Lake Michigan, inland waterways, wetlands, and groundwater. Each of these resources is discussed sequentially.

5.1.1 Lake Michigan

Lake Michigan will be affected by the proposed project.

5.1.1.1 Physical Description

5.1.1.1.1 Affected Environment

Lake Michigan is bordered by four states and is connected through the other Great Lakes to the eight Great Lakes states and two Canadian provinces. Lake Michigan is the second largest of the Great Lakes and is the only Great Lake entirely within the borders of the U.S. (WDNR, 03/2010a). Lake Michigan is 307 miles long, up to 118 miles wide, and up to 925 feet deep. Lake Michigan has a surface area of 22,300 square miles, an average depth of 279 feet, and a volume of 1,180 cubic miles (1,300,000,000,000 gallons), and a retention time of 99 years (USEPA and Environment Canada, 2012).

In recent years, nuisance algae (genus *Cladophora*) growth has been observed along the Lake Michigan shoreline. The algae grow underwater attached to rocks, are dislodged by waves, and then washed up on shore. The decaying algae create nuisance odors. Similar algae growths were observed in the mid-1950s and again during the 1960s and 1970s, before this most recent occurrence. The cause of this latest resurgence in algae growth is uncertain, but it may be due in part to changes in water clarity and phosphorous availability brought on by the prevalence of invasive zebra and quagga mussels (WDNR, 03/2010b).

The Milwaukee Harbor estuary is designated a Great Lakes Area of Concern because of the presence of legacy contaminants and other impairments. The harbor suffers from urban stresses similar to those experienced in other highly urban areas at the other 42 areas of concern throughout the Great Lakes. Priorities for the Milwaukee Area of Concern include remediation of contaminated sediments in tributaries and nearshore waters of Lake Michigan, prevention of eutrophication, non-point-source pollution control, improvement of beach water quality, enhancement of fish and wildlife populations, and habitat restoration (USEPA, 03/2010). Even though the Milwaukee Harbor estuary has these stresses, the fishery is reported to contain a high abundance and diversity of species because the fishery is connected to the rest of Lake Michigan and the parts of the Milwaukee, Menomonee, and Kinnickinnic Rivers that achieve full fish and aquatic life standards (SEWRPC, 12/2007, p. 205).

5.1.1.1.2 Environmental Effects

A Lake Michigan water supply and return flow, regardless of supply and return flow locations, will not affect the physical features of Lake Michigan, except for small changes as described below in Lake Michigan Geomorphology and Sediment. Lake Michigan size, volume, and floodplain will not be altered because a Lake Michigan water supply will provide return flow back to the Lake Michigan basin consistent with the Compact. The Return Flow Plan (Volume 4 of the Application) has been designed to meet the Compact requirements with a maximum return flow rate equivalent to the maximum withdrawal rate that also minimizes out of basin water in return flow. Consequently, no significant adverse impacts are expected to Lake Michigan's size, volume, or floodplain.

5.1.1.2 Water Quality

5.1.1.2.1 Affected Environment

SEWRPC and the Milwaukee Metropolitan Sewerage District (MMSD) have been measuring water quality in the Greater Milwaukee area since the 1960s (SEWRPC, 12/2007, p. 149). Notable water quality improvements have been documented since the MMSD's deep tunnel system came online in 1994 to reduce the number of combined sewer overflows (CSOs). Water quality trends at sampling stations in the Milwaukee outer harbor and nearshore Lake Michigan areas over this historical monitoring period have indicated (SEWRPC, 12/2007, p. 155):

- Fecal coliform concentration has trended down.
- Biological oxygen demand has trended down.
- Dissolved oxygen concentration has trended down or stayed the same and generally meets standards.
- Total suspended solids concentration trends varied with some stations increasing and others staying the same.
- Total phosphorus concentration has trended down in the outer harbor and up in the nearshore area. Since 1986, average annual concentrations have been less than 0.1 mg/L, except for 1 year. The recently developed phosphorous standard for the near shore and open waters of Lake Michigan is 0.007 mg/L (NR 102.06(5)(b)), however, an interim effluent limit for discharge to Lake Michigan was set at 0.6 mg/L (NR 217.13(4)) for all dischargers.

Table 5-1 summarizes the water quality data.

Annual pollutant loadings to Lake Michigan from the Greater Milwaukee watersheds are documented in SEWRPC's *A Regional Water Quality Management Plan Update for the Greater Milwaukee Watersheds* (2007). Average annual loadings for select parameters are as follows:

- Fecal coliform: 83,435 trillion cells
- Total phosphorus: 767,230 pounds
- Total suspended solids: 184,435,700 pounds

TABLE 5-1
Average Water Quality Data at Select Locations in Lake Michigan near the Greater Milwaukee Watersheds

Dissolved oxygen	9.6 to 11.5 mg/L
Phosphorus	0.062 to 0.087 mg/L
Fecal coliform summer season geometric mean	603 to 770 per 100/mL
Total suspended solids	10.3 to 19.4 mg/L

Additional detail on these and other water quality parameters is found in SEWRPC's *A Regional Water Quality Management Plan Update for the Greater Milwaukee Watersheds* (2007).

5.1.1.2.2 Environmental Effects

Water quality environmental effects will occur during both construction as well as during operation and maintenance. Potential impacts to aquatic resources generally associated with construction can be both direct and indirect. They will depend primarily upon the physical characteristics of Lake Michigan and time of year.

The primary temporary construction impacts to surface waters can be associated with elevated loads of suspended sediment resulting from trenching activities and with erosion of cleared banks and rights-of-way from pipeline construction. Impact severity is a function of sediment load, particle size, and duration of construction activities. Since the construction near Lake Michigan will require appropriate environmental permits and the construction contractor will be required to use BMPs designed to reduce the impact on turbidity and erosion, construction impacts will be minimized.

Without mitigation by implementing BMPs, temporary construction impacts can also elevate suspended sediment levels that increase turbidity and consequently reduce primary photosynthetic production, flocculate plankton, decrease visibility and food availability, and produce effects that are aesthetically displeasing (USFWS, 1982). However, Long (1975) concluded that most fish avoid turbid water and can survive for several days in waters where construction in a stream has caused turbidity. Since the construction impacts will be temporary and river crossings will use BMPs designed to reduce the impact, turbidity and erosion created by construction will be minimal.

Example construction best management practices are described in, Section 5, Appendix 5-2, "Example Wetland and Waterway Pipeline Construction Crossing Impact Minimization Techniques."

Operational and maintenance effects on water quality could include changes in storm water runoff quality from new above ground construction and changes in water quality from discharge to Lake Michigan or to a Lake Michigan tributary.

The WDNR commonly provides allowances for permitted discharges in the form of interim limits, variances, or other allowances when background levels are higher than water quality standards, when the water quality constituent cannot be removed by municipal WWTP best available technology permitted in Wisconsin, or water quality standards can be met after mixing or other processes in the receiving water. Water quality parameters may be addressed by similar regulatory approaches for allowances under current or future regulations.

For example, the Waukesha WWTP currently discharging to the Fox River has an allowance for chloride discharge in the form of an interim limit governed by NR 106.83(2)(b). In the WPDES permit for continued discharge to the Fox River, the Waukesha WWTP has a chloride variance that includes a mandatory source reduction program with an interim discharge limit (WDNR, 2013d). A significant source of chloride in the Waukesha WWTP is residential water softening. The need to continue to have a chloride variance varies significantly depending upon the water source, treatment, and discharge location (for example: continued deep aquifer groundwater source with discharge to the Fox River or a Lake Michigan source with return flow to the Lake Michigan basin), as described below.

The City has been implementing a Mercury Pollutant Minimization Program that began in 2007. Since then, the mercury concentration in the WWTP effluent has further improved to

levels that will meet Fox River discharge or Lake Michigan basin return flow draft requirements. The City will continue the mercury source reduction program and based upon established performance either Fox River discharge or Lake Michigan return flow will meet requirements for the mercury water quality limits.

The permit for continued discharge to the Fox River provides a phosphorous compliance schedule because the limits are very low and will require significant capital investment in the WWTP. The phosphorus standard for the Fox River and the Root River is the same (0.075 mg/L) and the existing phosphorus concentration in these streams is often higher than the standard (see above tables for phosphorus background data in each stream). Consequently, in the recently completed Facility Plan (Strand, 201), the WWTP evaluated potentially having to meet a phosphorus discharge limit equal to the water quality standard (0.075 mg/L). This would improve phosphorus water quality for a discharge in any of these streams.

The WDNR has adopted new thermal rules (NR 102 and 106) for the protection and propagation of aquatic life that applies to WPDES permit holders discharging to surface waters. In preparation for this new rule, the City has been collecting effluent temperature data for over a year. The City has evaluated approaches to meet WDNR thermal discharge requirements following the rules and applicable guidance regardless of a discharge location (see the Return Flow Plan – Volume 4 of the Application).

Potential operational changes to Lake Michigan water quality are described below and are used as the primary comparison of relative impacts.

Lake Michigan Water Supply (City of Oak Creek) Alignment 2

A Lake Michigan supply, regardless of the water source includes new aboveground impacts limited to only a new pump station less than a quarter acre in size located far from Lake Michigan. Consequently, operational stormwater quality impacts to Lake Michigan will be insignificant. All Lake Michigan supply options will include return flow water quality impacts, which are described below.

Root River to Lake Michigan Return Flow Alignment 2

All water returned to the Lake Michigan watershed will meet WDNR water quality permit requirements. A summary of proposed discharge limits from the WDNR and a comparison to historical Waukesha WWTP performance are detailed in the Return Flow Plan (Volume 4 of the Application). For phosphorus, both the Fox River and the Root River have the same water quality standard of 0.075 mg/L, which will require WWTP improvements already planned. A comparison of historical WWTP discharge quality to other Lake Michigan tributary dischargers is shown in Table 5-18 in the Inland Waterways section below.

Water softening no longer would be needed with a Lake Michigan water supply source. Consequently, a reduction in chloride concentration in return flow over time is expected. The City has evaluated chloride concentrations in return flow with a switch to Lake Michigan water and has developed a chloride compliance plan. The chloride reduction plan identifies chloride reduction elements to meet the chloride water quality standards with return flow (see the Return Flow Plan – Volume 4 of the Application).

Return flow will switch discharge from the Fox River to the Lake Michigan watershed. The return flow management plan is discussed in Volume 4 of the Application. In general, the return flow management plan provides return flow up to the maximum day water demand

if sufficient water is available at the WWTP. The portion of water at the WWTP in excess of this amount will continue to be discharged into the Fox River and meet permit limits as discussed in the Return Flow Plan. The Return Flow Plan analysis shows that no less than 100 percent of the water volume will be returned to the Great Lakes basin.

Flow from return flow ultimately ends up in Lake Michigan. Water quality information was reviewed for overall water quality parameter loadings from the greater Milwaukee watersheds tributary to Lake Michigan. SEWRPC compiled total annual water quality parameter loadings for all the greater Milwaukee watersheds (SEWRPC, 12/2007, Tables 54-56). The contribution of the City of Waukesha return flow loadings was calculated using the information from the water quality modeling documented in the Return Flow Plan (Volume 4 of the Application) using Root River water quality modeling information for comparison to Lake Michigan loadings from SEWRPC. The Root River analysis indicated the following:

- Fecal coliform contribution in the return flow under very conservative, worst-case conditions is only 0.18 percent of all fecal coliform loading from the greater Milwaukee watersheds.
- Total suspended solids contribution in the return flow under very conservative, worst-case conditions is only 0.19 percent of all total suspended solids loading from the greater Milwaukee watersheds.
- Phosphorus contribution in the return flow is only 0.35 percent of all phosphorus loading under very conservative worst-case conditions. Both Underwood Creek and the Root River now have a phosphorus water quality standard of 0.075 mg/L. The interim limit for direct discharge to Lake Michigan is 0.6 mg/L.

5.1.1.2.3 Environmental Effects Comparison: Lake Michigan Water Quality

Level of relative impact (no adverse impact, minor adverse impact, etc.) in water quality was developed to compare impacts. Impacts were compared based upon Table 5-2.

TABLE 5-2
Environmental Impact Category Description: Water Quality

Category	Water Quality	Stream Water Quality Numeric Standards Compliance ^a	Increase in Average Annual Loading to Lake Michigan Near Milwaukee ^a
No adverse impact	Improves or remains approximately the same; Temporary construction impacts	River meets water quality standards or discharge is better than or equal to water quality standards	Contributes a de minimis change (<1%)
Minor adverse impact	Remains approximately the same	Discharge requires existing variance to water quality standards	Contributes a minor change (>1%, but <10%)
Moderate adverse impact	Moderate lowering of in-stream water quality	Discharge requires new variance to water quality standards	Contributes a moderate change (>10%, but <25%)
Significant adverse impact	Substantial lowering of in-stream water quality	New exceedences to water quality standards	Contributes a substantial change (>25%)

^aBased upon expected water quality from historical wastewater treatment performance and draft permit limits where existing water quality exceedences occur, the receiving water quality will improve or stay the same with the discharge.

For water quality in Lake Michigan only, a discussion of relative impact is included below. Section 5.1.2.3 contains a comparison for water quality for inland waterways. Table 5-3 compares the water quality impact on Lake Michigan.

TABLE 5-3

Proposed Project Environmental Impact Comparison Summary:
Lake Michigan Water Quality

Proposed Project	Water Quality
Water Supply	
Lake Michigan (City of Oak Creek) Alignment 2	No adverse impact
Return Flow for Lake Michigan Water Supply	
Root River to Lake Michigan Alignment 2	No adverse impact

Lake Michigan Water Supply (City Oak Creek) Alignment 2

The Lake Michigan water supply would not change water quality in Lake Michigan or adversely affect other surface water resources. Use of Lake Michigan water would eliminate the need for water softening, which would be necessary under the Deep and Shallow Aquifers groundwater supply alternative. Over time, the use of water softener salts would cease and chloride discharged from the WWTP to the environment would reduce. The Lake Michigan water supply consequently would produce no adverse impact on water quality.

Root River to Lake Michigan Alignment 2 Return Flow

Water quality loading to Lake Michigan from the watersheds around greater Milwaukee was reviewed and found to be only 0.18 percent of all fecal coliform loading and only 0.19 percent of all total suspended solids loading under conservative, worst-case conditions. Phosphorus loading was found to be only 0.35 percent of all phosphorous loading under worst-case conditions. Consequently, the water quality impacts to Lake Michigan would be expected to have no adverse impacts.

5.1.1.3 Geomorphology and Sediments

5.1.1.3.1 Affected Environment

The geomorphology of surface waters is assessed based on the impact to the surface water geomorphic stability, change in erosion potential, or change in vertical or lateral stability. The geology of Lake Michigan was developed during the Pleistocene Epoch as continental glaciers repeatedly advanced across the Great Lakes region and Lake Michigan. The repeated advancement and glacial retreat deepened and enlarged the basins of the Great Lakes (USEPA and Environment Canada, 2012). Near Milwaukee, the near-shore geomorphology is varied. Example lakebed substrates include: rock, cobble and sand, sand, and clay outcrops (WPSC, 2003).

Groundwater flow into Lake Michigan is a significant component of overall flow. Direct and indirect groundwater inflow contributes 33.8 percent of Lake Michigan water (USGS, 2000).

The deep aquifer currently used as a water supply for the City of Waukesha extends east from Waukesha under Lake Michigan. A report by the United State Geological Survey (USGS) estimated 30 percent of the 33 mgd of water pumped by the deep aquifer wells in southeastern Wisconsin originate from inside the Lake Michigan Basin (USGS, 2006).

5.1.1.3.2 Environmental Effects

Lake Michigan Water Supply and Return Flow

Flow within Lake Michigan will not be affected by a Lake Michigan water supply or return flow, because the City of Waukesha's return flow management plan goal will provide continuous return of the water at the WWTP (see the Return Flow Plan in Volume 4 of the Application). In general, the return flow management plan provides return flow up to the maximum day water demand if sufficient water is available at the WWTP. The portion of water at the WWTP in excess of this amount will continue to be discharged into the Fox River and meet permit limits. The Return Flow Plan analysis shows that no less than 100 percent of the water volume will be returned to the Great Lakes basin. The geomorphology and sediment of Lake Michigan will not be adversely affected by a Lake Michigan water supply because, the supply will use the treatment plant intakes in the lake, and no construction is expected to occur within the lake for a water supply.

For the Root River Alignment 2 return flow, the geomorphology of these streams has been shown to be stable, as documented in Section 5.1.2.4. The geomorphology and sediment of Lake Michigan will not be affected by the Root River Alignment 2 alternative.

5.1.1.3.3 Environmental Effects Comparison: Lake Michigan Geomorphology and Sediments

Level of relative impact (no adverse impact, minor adverse impact, etc.) in geomorphology and sediment quality was developed to compare impacts. Impacts were compared based upon Table 5-4. For geomorphology and sediment impacts in Lake Michigan only, the relative impact is discussed below. The comparison for geomorphology and sediments for inland waterways is included in Section 5.1.2.4. Table 5-5 summarizes the Lake Michigan geomorphology and sediment impact.

Lake Michigan Water Supply (City of Oak Creek) Alignment 2

A Lake Michigan water supply prevents the need for baseflow reduction to inland waterways from groundwater pumping. The changes in geomorphology are dependent upon only the return flow location. Thus, a Lake Michigan water supply would have no adverse impacts on geomorphology.

TABLE 5-4
Environmental Impact Category Description: Geomorphology and Sediments

Category	Channel Stability with Return Flow	Substrate Change to Lake Michigan
No adverse impact	Channel is stable for flows up to 2-year return where channel is currently stable.	No substrate change.
Minor adverse impact	Channel has some instability for flows up to 2-year return where channel is currently stable.	Fewer than 10 acres.
Moderate adverse impact	Channel has frequent instability for flows up to 2-year return where channel is currently stable.	Greater than 10 acres, but less than 20 acres.
Significant adverse impact	Channel is unstable at most flows where the channel is currently stable.	Greater than 20 acres.

TABLE 5-5
Proposed Project Environmental Impact Comparison Summary: Geomorphology and Sediments

Proposed Project	Geomorphology and Sediments
Water Supply	
Lake Michigan (City of Oak Creek) Alignment 2	No adverse impact
Return Flow for Lake Michigan Water Supply	
Root River to Lake Michigan Alignment 2	No adverse impact

Root River to Lake Michigan Return Flow Alignment 2

A recent sediment transport study of the Root River concluded that the river stability is relatively insensitive to changes in flows, because of the erosion resistance of the channel boundary materials, the relatively flat channel gradient, and the presence of a functional floodplain. There are no direct impacts upon Lake Michigan with this alternative. Return flow to the Root River consequently would have no adverse impact on the geomorphology of Lake Michigan.

5.1.1.4 Flora and Fauna

5.1.1.4.1 Affected Environment

Wildlife species require adequate food, water, cover, and living space for the survival of individuals and to maintain population viability. Aquatic resources affected by the proposed project consist generally of streams and wetlands but also include Lake Michigan. Aquatic areas can provide habitat to a diverse wildlife population, and some common species (beaver, muskrat, and herons) depend on aquatic habitats for food and shelter. Others (e.g., raccoon) are less restricted but prefer to be close to water. Amphibians and many reptiles favor aquatic habitats; representative species include bullfrog and northern water snake. The Lake Michigan shoreline is an essential ecological area for migratory birds.

Lake Michigan is primarily cold water and relatively infertile. Historically, the fish fauna consisted mostly of lake trout, whitefish, and sculpins. Over the last century, the fisheries of Lake Michigan have experienced dramatic alterations because of fishery exploitation, overharvesting, and nutrient loading changes stimulating algae or plant growth (typically tolerant species). Invasive, or exotic, species, such as the sea lamprey, have caused a significant decline in the population of native species, such as lake herring. The biota is dominated by such introduced or invasive species as the Pacific salmon and trout, alewife, rainbow smelt, ruffe, white perch, goby, zebra mussel (*Dreissena polymorpha*), quagga mussel (*Dreissena bugensis*), and exotic zooplankton (WDNR, 12/2011a).

The main source of pollution in Lake Michigan is human activity such as habitat alteration, which has affected water quality within the lake. The habitats in Lake Michigan have been altered by increased shoreline degradation, as most of the coastline and wetlands along it have been permanently affected. The loss of natural shoreline habitat has allowed increased urban and agricultural runoff into the lake, the alteration of watershed hydrology, the increase of the water temperature, and led to a reduction of open space (US Coast Guard and USEPA, 2008). Increased algae (genus *Cladophora*) growth has been observed along the shoreline in the last few years. The cause of the latest resurgence in algae growth is not known with certainty, but it could be from changes in water clarity and phosphorous availability resulting from the increased dominance of invasive zebra and quagga mussels (WDNR, 03/2010b).

The Milwaukee Harbor estuary within Lake Michigan is designated a Great Lakes Area of Concern because of legacy contaminants present and other impairments. The harbor suffers from urban stresses similar to those experienced in other highly urban areas at the other 42 areas of concern throughout the Great Lakes. Even though the Milwaukee Harbor estuary has these stresses, the fishery is reported to contain a high abundance and diversity of species, because the fishery is connected to the rest of Lake Michigan and to parts of the Milwaukee,

Menomonee, and Kinnickinnic Rivers that achieve full fish and aquatic life standards (SEWRPC, 12/2007, p. 205).

The near-shore areas along Lake Michigan are within the southern Lake Michigan coastal ecological landscape and are characteristic mainly of glacial lake influence, along with ridge and swale topography, clay bluffs, and lake plains. Ground moraine inland from the lakeshore is the dominant landform, with soils generally consisting of silt-loam surface overlying loamy and clayey tills. Most of the near-shore areas along the lake are dominated by agriculture and urban development. Very few forested areas exist, but the remaining stands are dominated by maple and beech trees and also contain oak, hickory, and lowland hardwood species. There are also areas of wet-mesic and wet prairie, but they are limited and occur only in small preserves because of the landscape being heavily disturbed and fragmented. Because of fragmentation and significant disturbance, non-native plants are abundant in those areas.

The USFWS and the WDNR were contacted to determine where federal- or state-listed species occur along the project corridor in Lake Michigan. The species identified by these agencies as potentially occurring within the project corridors are summarized for the proposed project in Section 5.1.3 on Wetlands and all other alternatives in Section 6.4.3 on Wetlands, since most of the potential impacts involve federal- or state-listed species associated with wetlands. A summary discussion of listed species potential habitat impacts for the proposed project is included in Section 5.1.3.2, Flora and Fauna.

A literature review of historical information on biological components of Lake Michigan indicates the following represent typical biological components in the project area.

Benthic Invertebrates

A survey of the Great Lakes in 1998 identified 20 taxa of benthic macroinvertebrates in Lake Michigan with an average of about 7 taxa per sampling site (Barbiero et al., 2000). The amphipod *Diporeia* (formerly *Pontoporeia*), tubificid oligochaetes, and sphaeriid snails dominate the Lake Michigan benthic macroinvertebrate community. However, in near-shore areas, oligochaetes are the dominant taxonomic group. The density of benthic macroinvertebrates typically ranges from 1,500 to 6,500 organisms per square meter. Surveys performed in 2002 near the Great Lakes Water Institute with headquarters in Milwaukee revealed that oligochaetes and chironomidae are present, as are freshwater sponges, *Ectoprocta*, mayflies, leeches, isopods, and amphipods. Dreissenid mussel infestations (zebra and quagga) were confirmed on most suitable habitat (USGS, 2011).

Over the past several decades, the southern basin of Lake Michigan has been invaded by the zebra (*Dreissena polymorpha*) and quagga (*Dreissena bugensis*) mussels and has undergone major shifts in nutrient loading.

Reductions in nutrient loadings have reduced the overall productivity of the lake and produced a decline in the density of benthic macroinvertebrate fauna, particularly oligochaetes and snails, observed between 1980 and 1987 (Nalepa et al., 1998). The year 1988 marked the beginning of colonization of southern Lake Michigan by the zebra mussel and the beginning of a decline in the abundance of *Diporeia*. Filter feeding by zebra mussels in near-shore waters was thought to have decreased the amount of food available to the amphipod (Nalepa et al., 1998).

Plants

Macrophytes

The outfall for return flow discharge to the Root River is not in Lake Michigan. Consequently, there will be no direct impact to Lake Michigan aquatic vegetation with the proposed project.

Algae

Free-floating or planktonic algae are present in Lake Michigan, dominated by the diatoms (represented by *Synedra*, *Fragilaria*, *Tabellaria*, *Asterionella*, *Melosira*, *Cyclotella* and *Rhizosolenia*), among others. Concentrations of free-floating algae fluctuate during the year, subject to the availability of sunlight, water temperatures, and in the cases of diatoms, bioavailability of silicon (WPSC, 2003).

Algae typically found attached to substrate are also present in Lake Michigan. These include *Cladophora*, *Ulothrix*, *Tetraspora*, *Stigeoclonium*, and red algae *Asterocytis*.

Fish

Fish species occurring in near-shore waters of Lake Michigan are shown in Table 5-6 (WPSC, 2003).

5.1.1.4.2 Environmental Effects

Impacts to Lake Michigan aquatic flora and fauna pertain to overall potential aquatic habitat impacts in Lake Michigan. There are no direct impacts to Lake Michigan with a Lake Michigan water supply because infrastructure is already in place or with return flow to Root River via Alignment 2. Discussion of how the project will protect against the spread of invasive species is included in Section 5.1.2.5.

Evaluation of Potential Impacts to Invertebrates, Plants, and Fish

Given the discharge water quality requirements for return flow to Lake Michigan, no significant permanent impacts to the common invertebrates, plants, and fish in the lake are expected. The WDNR informed the City of Waukesha that the City will have to meet future water quality effluent standards at least as stringent as those imposed on discharge to the Fox River (WDNR, 2011a). Given that future WPDES discharge requirements (likely no less stringent than those currently in place) will be designed to protect receiving waters, water quality is not expected to have a significant permanent pollutant loading or other effects upon invertebrates, plants, or fish in Lake Michigan. Based upon revised effluent limits proposed by the WDNR (2011a), these annual estimates are conservative (see an attachment to the Return Flow Plan - Volume 4 of the Application - for additional information). The City of Waukesha will work with the WDNR and regulatory community to avoid, minimize, and mitigate potential temporary and permanent impacts.

An evaluation of Lake Michigan wildlife, endangered resources, and natural communities impacts has been included as part of a comprehensive evaluation for all affected environments in Wetlands (Section 5.1.3), because most of the sensitive natural communities and endangered resources identified are associated with wetlands. A summary of listed species habitat impacts for the proposed project is included in Section 5.1.3.2, Flora and Fauna.

TABLE 5-6
Fish Species in Near-Shore Waters of Lake Michigan

Common Name	Scientific Name	Common Name	Scientific Name
Alewife	<i>Alosa pseudoharengus</i>	Round whitefish	<i>Prosopium cylindraceum</i>
Bowfin	<i>Amia calva</i>	Bloater	<i>Coregonus hoyi</i>
Brook trout	<i>Salvelinus fontinalis</i>	Rainbow smelt	<i>Osmerus mordax</i>
Brown trout	<i>Salmo trutta</i>	Gizzard shad	<i>Dorosoma cepedianum</i>
Common carp	<i>Cyprinus carpio</i>	Lake chub	<i>Couesius plumbeus</i>
Freshwater drum	<i>Aplodinotus grunniens</i>	Emerald shiner	<i>Notropis atherinoides</i>
Lake sturgeon	<i>Acipenser fulvescens</i>	Spottail shiner	<i>Notropis hudsonius</i>
Longnose sucker	<i>Catostomus catostomus</i>	Longnose dace	<i>Rhinichthys cataractae</i>
Muskellunge	<i>Esox masquinongy</i>	Bluntnose minnow	<i>Pimephales notatus</i>
Northern pike	<i>Esox lucius</i>	Sand shiner	<i>Notropis stramineus</i>
Pumpkinseed	<i>Lepomis gibbosus</i>	Fathead minnow	<i>Pimephales promelas</i>
Rainbow trout	<i>Oncorhynchus mykiss</i>	Burbot	<i>Lota lota</i>
Rock bass	<i>Ambloplites rupestris</i>	Slimy sculpin	<i>Cottus cognatus</i>
Smallmouth bass	<i>Micropterus dolomieu</i>	Largemouth bass	<i>Micropterus salmoides</i>
White bass	<i>Morone chrysops</i>	Walleye	<i>Stizostedion vitreum</i>
White sucker	<i>Catostomus commersoni</i>	Johnny darter	<i>Etheostoma nigrum</i>
Yellow perch	<i>Perca flavescens</i>	Trout-perch	<i>Percopsis omiscomaycus</i>
Lake trout	<i>Salvelinus namaycush</i>	Three spine stickleback	<i>Gasterosteus aculeatus</i>
Chinook salmon	<i>Oncorhynchus tshawytscha</i>	Nine spine stickleback	<i>Pungitius pungitius</i>
Coho salmon	<i>Oncorhynchus kisutch</i>	Brook stickleback	<i>Culaea inconstans</i>
Lake whitefish	<i>Coregonus clupeaformis</i>	Round goby	<i>Neogobius melanpostomus</i>

Environmental Effects Comparison: Lake Michigan Flora and Fauna

Level of relative impact in aquatic habitat was developed to compare impacts. Impacts were compared based upon Table 5-7 and summarized in Table 5-8. The comparison for aquatic habitat for inland waterways and wetlands is included in Section 5.1.2 (Inland Waterways) and Section 5.1.3 (Wetlands).

Impacts to aquatic habitat resulting from the operations (i.e., post-construction) of a Lake Michigan water supply and return flow are described below.

Lake Michigan Water Supply (City of Oak Creek) Alignment 2

Lake Michigan water supply from the City of Oak Creek would have negligible effect on the lake's aquatic habitat. No new infrastructure is needed in Lake Michigan to provide water to Waukesha, so no construction impacts to aquatic habitat in the lake will occur. In addition, the Return Flow Plan returns the water to Lake Michigan while minimizing out of basin water (see Volume 4 of the Application). Consequently, no change is expected in Lake Michigan habitat due to any volume change.

TABLE 5-7
Environmental Impact Category Description: Aquatic Habitat

Category	Habitat Creation	Baseflow Reduction in Warm Water Streams	Baseflow Reduction in Cold Water Streams	Substrate Change to Lake Michigan
No adverse impact	Temporary impacts from construction; Neutral or improved habitat creation and frequency of availability from operation	No baseflow reduction	No baseflow reduction	No measureable change
Minor adverse impact	Minor habitat loss	Up to 25%	Up to 15%	Fewer than 10 acres
Moderate adverse impact	Moderate habitat loss	Greater than 25%, but less than 50%	Greater than 15%, but less than 25%	Greater than 10 acres, but less than 20 acres
Significant adverse impact	Significant habitat loss	50% or more	25% or more	Greater than 20 acres

Root River to Lake Michigan Alignment 2 Return Flow

A geomorphology study of the Root River concluded that the river stability is relatively insensitive to changes in flows because of the erosion resistance of the channel boundary materials, the relatively flat channel gradient, and the presence of a functional floodplain (MMSD, 09/2007, p. 1). Because the Root River is stable with return flow, there would be no significant increases in sediment flowing to Lake Michigan. Thus, there would be no adverse impacts to Lake Michigan aquatic habitat with return flow to the Root River.

TABLE 5-8

Proposed Project Environmental Impact Comparison Summary: Lake Michigan Aquatic Habitat

Proposed Project	Aquatic Habitat
Water Supply	
Lake Michigan (City of Oak Creek) Alignment 2	No adverse impact
Return Flow for Lake Michigan Water Supply	
Root River to Lake Michigan Alignment 2	No adverse impact

5.1.2 Inland Waterways

Inland waterways are differentiated from Lake Michigan for the purposes of the affected environment analysis. Inland waterways are affected by the proposed project through pipeline crossings and discharge of return flow. The types of information included within each of these affected environments vary because the effects water supply and return flow have on these surface waters also vary. Consequently, detailed information on water quality and aquatic habitat is provided for surface waters potentially receiving the return flow while such information is not provided for surface waters where new discharge does not occur. Streams crossed by pipelines will only experience pipeline construction related impacts, which are described below and is applicable to all inland waterways affected by the project.

According to the Wisconsin Administrative Code (WAC), Chapter NR 102 Water Quality Standards for Wisconsin Surface Waters, Wisconsin categorizes surface waters per five fishery “use” subcategories (WDNR, 2010d). Stream use is determined by fish species or

other aquatic organisms capable of being supported by a natural stream system. The designation of an appropriate use class is based on the ability of a stream to supply habitat and water quality requirements for a class of organisms:

- Cold water communities (COLD) – capable of supporting cold water sport fish
- Warm water sport fish communities (WWSF) – capable of supporting warm water sport fish
- Warm water forage fish communities (WWFF) – capable of supporting an abundant, diverse community of warm water forage fish
- Limited forage fish communities (LFF) – capable of supporting limited tolerant or very tolerant forage or rough fish, or tolerant macroinvertebrates
- Limited aquatic life (LAL) – capable of supporting very tolerant macroinvertebrates or no aquatic life

Wisconsin NR Code 104 classifies all LFF and LAL water bodies as “variance” waters. Streams without a known designation by default are classified warm water sport fisheries and are considered WWSF or WWFF waters (WDNR, 2010e).

An Outstanding Resource Water is “a lake or stream having excellent water quality, high recreational and aesthetic value, high-quality fishing and is free from point source or nonpoint source pollution.” An Exceptional Resource Waters is “a stream exhibiting the same high quality resource values as outstanding waters, but may be impacted by point source pollution or have the potential for future discharge from a small sewer community.”

According to Wisconsin NR Code 102.10 and 102.11, none of the inland waters affected by the project (Root River and Fox River) are Outstanding or Exceptional Resource Waters. Genesee Creek in Waukesha County west of Vernon Marsh is an Exceptional Resource Water upstream of State Highway 59, but that area is outside the influence of the project.

5.1.2.1 Location, Existing Designations/Classifications

5.1.2.1.1 Affected Environment

Inland waterways that receive effluent are described below. The inland waters discussed are Fox River and Root River.

Tables 5-9 through 5-11 list surface waters that are crossed with a water supply or return flow pipeline and receive only temporary construction impacts. A water bodies and stream GIS dataset were used to determine the number and acreage of surface water crossings. All water bodies and all streams ranked as major that intersect the estimated 75-foot-wide construction corridor for impact evaluation purposes are included in Tables 5-9 through 5-11. Based on an investigation of minor ranked streams using the WDNR’s Surface Water Data Viewer, the majority of streams ranked as minor crossed within the alternatives proposed construction corridor are considered unnamed ditches or canals and therefore were not included in the impact analysis.

TABLE 5-9
Water Body Crossings

Pipeline Route	Water Body/ Stream No.	Water Body Name	Water Body Type	Approximate Crossing Width (ft)	Crossing Area (acres)	Fisheries Classification ^a
Lake Michigan Water Supply						
Lake Michigan (City of Oak Creek) Alignment 2	3732	Unnamed	Intermittent/ephemeral	14.3	0.02	Unknown
	3932	North Branch Root River	Perennial	49.7	0.09	WWSF
	5109	Unnamed	Intermittent/ephemeral	18.9	0.04	Unknown
Return for a Lake Michigan Water Supply						
Root River to Lake Michigan Alignment 2	3732	Unnamed	Intermittent/ephemeral	14.3	0.02	Unknown
	4264	North Branch Root River	Perennial	38.7	0.07	WWSF
	4325	North Branch Root River	Perennial	6.6	0.17	WWSF
	5109	Unnamed	Intermittent/ephemeral	18.9	0.04	Unknown

^a (WDNR, 2002d)

TABLE 5-10

Summary of Acres of Water Body Crossings

Name	Lake Michigan–Oak Creek Supply Alignment 2	Root River to Lake Michigan Return Flow Alignment 2
North Branch Root River	0.09	0.24
Unnamed	0.06	0.06
Grand Total	0.15	0.30

The following inland waterways are not affected by the proposed project. However, they are affected by alternatives to the proposed project, the impacts of which are discussed in Section 6.

- Pebble Brook
- Pebble Creek
- Mill Brook
- Underwood Creek and Menomonee River

TABLE 5-11

Number of Water Body Crossings

Water Supply	
Lake Michigan (City of Oak Creek) Alignment 2	3
Return Flow for Lake Michigan Water Supply	
Root River to Lake Michigan Alignment 2	4

Fox River

The Fox River will be affected by the project. It is classified for WDNR fish and aquatic life standards and is a WWSF community. The Fox River currently receives the flow from the Waukesha Wastewater Treatment Plant (WWTP) discharge. A change in discharge location will affect the Fox River.

Just downstream of the City of Waukesha are several perennial Fox River tributaries—Genesee Creek, Mill Brook, Pebble Creek, and Pebble Brook—all listed as supporting cold water communities. The potential sources of impairments in the watershed are non-point-source discharges, contaminated sediments, and discharges from municipal separate storm sewer systems (WDNR, 2012a).

Root River

Root River would be affected only by the Lake Michigan water supply alternatives for return flow to the Root River and by Lake Michigan water supply or return flow pipeline alignments that cross the Root River. Table 5-9 lists one North Branch Root River crossing for the Lake Michigan (City of Oak Creek) Supply Alignment 2 and two North Branch Root River crossings for the Root River to Lake Michigan Return Flow Alignment 2. At each of these crossings of the Root River, the Root River flows through a culvert under the road.

Return flow would be discharged to the Root River in the City of Franklin near the crossing of South 60th Street and the Root River. The Root River flows through parts of Milwaukee and Racine counties and into Lake Michigan at the City of Racine. The river has more natural bottom substrate and vegetated river banks than does Underwood Creek, and it has a mixture of land uses between its headwaters and Lake Michigan. The headwaters of the Root River are heavily urbanized, the middle reaches are primarily agriculture and lower density development, and the lower parts of the watershed near Lake Michigan are heavily urbanized. The Root River is classified for WDNR fish and aquatic life standards and is a WWSF community (WDNR, 2002b).

Other Surface Waters

Other surface waters within the affected environment are those that are crossed with a water supply or return flow pipeline and receive only temporary construction impacts. These surface waters are listed in Tables 5-9 through 5-11. All of the surface waters listed in Tables 5-9 through 5-11 cross the proposed project alignments in areas where the stream flows through a culvert underneath roads. Since the proposed project alignment follows previously disturbed transportation corridors, minimal temporary construction impacts are expected.

5.1.2.1.2 Environmental Effects

There are no changes to the designations or classifications of inland waterways with the proposed project. Impacts to stream crossings will be temporary during construction, the impacts of which are discussed below. Streams crossed only by a pipeline are not evaluated further as a result.

5.1.2.2 Size, Flows, and Floodplain

5.1.2.2.1 Affected Environment

Fox River

The Fox River receives the WWTP discharge and drains 151 square miles at the southern end of the City of Waukesha. The upper Fox River, flowing through the City of Waukesha, is a perennial stream (WDNR, 2002a). At the USGS Fox River stream gage 05543830 in the City of Waukesha, average annual stream flow is 110 cfs (71 mgd) over the period of record, 1963 to 2009 (USGS, 04/2010a). The WDNR designates Fox River a WWSF with the following uses: fish and aquatic life, recreation, public health and welfare, and fish consumption.

Root River

The Root River flows through parts of Milwaukee and Racine counties, and into Lake Michigan at Racine. The river has more natural channel (e.g., natural bottom substrate and vegetated river banks) than does Underwood Creek, and it has a mixture of land uses between its headwaters and Lake Michigan. The headwaters of the Root River are heavily urbanized, the middle reaches are primarily agriculture and lower density development, and the lower parts of the watershed near Lake Michigan are heavily urbanized.

WDNR (2002b) classifies the Root River a WWSF community for fish and aquatic life standards.

At USGS Root River stream gage 04087220 near the City of Franklin, about 2 miles upstream of the return flow location, the average annual stream flow is 45.6 cfs (29.5 mgd) over the period of record 1964 to 2011 (USGS, 02/2012a).

At USGS Root River stream gage 04087240 in the City of Racine, approximately 20 miles downstream of the return flow location, the average annual stream flow is 157.8 cfs (102.0 mgd) over the period of record 1964 to 2012 (USGS, 02/2012b).

5.1.2.2.2 Environmental Effects

There is no long-term change to inland waterways size, although pipeline stream crossings will cause temporary aquatic habitat impacts. Lake Michigan water supply and return flow pipelines cross surface waters. Tables 5-9 through 5-11 list the extents of the perennial and

intermittent surface water crossings. Refer to the maps found in Appendix 3-1 of Section 3 for maps associated with the proposed project. All crossings would have temporary impacts during construction. Once construction is complete, the surface water crossing will be restored. Operational and maintenance impacts are expected to be negligible.

Temporary construction impacts on in-stream and shoreline vegetative cover may include alteration or temporary loss at pipeline water crossings. Submergent and emergent vegetation, in-stream logs and rocks, and undercut banks provide cover for fish and other aquatic biota. Fish that live in these areas may be displaced during construction, this habitat alteration will be insignificant because of the small area affected at each crossing location and because the streambanks will be restored to promote regrowth of riparian vegetation. During design, the City of Waukesha will work with the resource agencies to determine the appropriate construction techniques for each crossing to minimize and mitigate temporary impacts. Techniques that could be used are discussed in Appendix 5-2, Example Wetland and Waterway Pipeline Construction Crossing Impact Minimization Techniques. Impacts to aquatic habitat resulting from post-construction operation are described below.

There are two kinds of operational flow changes to inland waterways: baseflow changes and flooding changes. Baseflow changes can affect aquatic habitat by changing the water depth and wetted surface area available to aquatic species, and also water temperature. For example, if flow decreases in cold water streams in the summer, the water temperature increases. The potential effect of the proposed project on baseflow is evaluated for each inland waterway.

Flooding is a concern in urbanized communities, especially in southeastern Wisconsin where extensive flood mitigation projects have been constructed and more are planned. Floodplain impacts of a Lake Michigan water supply and return flow were evaluated based on their impact on flooding along affected surface water resources. Each major water resource analyzed is discussed below. The proposed project would have no significant baseflow or flooding changes to any other inland waterways not described below.

Fox River

Baseflow Changes

Impacts to aquatic habitat in the Fox River are discussed below. As noted, the average annual stream flow is 110 cfs (71 mgd) over the period of record.

Lake Michigan Water Supply (City of Oak Creek) Alignment 2

A Lake Michigan water supply would have an effect on the aquatic habitat in the Fox River. As discussed in the Return Flow Plan (Volume 4 of the Application), a Lake Michigan supply would return flow from the City of Waukesha WWTP to the Lake Michigan basin. A Lake Michigan supply also would affect the Fox River, regardless of the return flow location.

A Lake Michigan supply and cessation of shallow groundwater pumping would improve the subsurface flow to the Fox River, and allow the baseflow to be restored at least partially to conditions similar to pre-well conditions, because the groundwater would contribute more baseflow to the river. This would improve the baseflow under current shallow groundwater pumping conditions and have the greatest benefit in the future when water demand is projected to be greater.

A Lake Michigan supply will require a shifting of the WWTP discharge from the Fox River to the Lake Michigan basin, but a return flow will not eliminate discharge to the Fox River. The City of Waukesha's return flow management plan goal will provide continuous return of the water at the WWTP (see the Return Flow Plan in Volume 4 of the Application). In general, the return flow management plan provides return flow up to the maximum day water demand if sufficient water is available at the WWTP. The portion of water at the WWTP in excess of this amount will continue to be discharged into the Fox River and meet permit limits. The Return Flow Plan analysis shows that no less than 100 percent of the water volume will be returned to the Great Lakes basin.

Because the WWTP flow to the Fox River will be reduced with a Lake Michigan supply, less water will be available in the river, reducing the amount of aquatic habitat. However, removal of the WWTP flow from the Fox River does not cause drawdown in smaller Fox River tributary streams that are sensitive to changes in baseflow from groundwater pumping. The Compact requires that the minimum return flow be at least the water withdrawn less an allowance for consumptive use. The Compact also requires that the return flow minimize out-of-basin water sent into the Great Lakes basin. These two requirements established minimum and maximum return flow rates to provide the water balance between the withdrawal and return, as described in the return flow management plan. As a result, WWTP flow will still occur at times to the Fox River with any Lake Michigan water supply.

A study by the USGS and University of Wisconsin Milwaukee reports that wastewater flows from Sussex, Brookfield, and Waukesha contribute 40 percent of the total Fox River flow during annual low flows (Cherkauer et al., 2010). The City of Waukesha's average annual WWTP flow is about 10 mgd, or 50 percent of the WWTP flow from the 3 communities. Using this percentage, the City of Waukesha WWTP contributes about 25 percent of the Fox River flow during annual low flow conditions. Thus, during low flow periods, Fox River annual low flow would be reduced by roughly 25 percent. Lower flows change the amount of aquatic habitat available, however as described in the Return Flow Plan (Volume 4 to the Application), water depth change is expected to be approximately 2 inches or less. Consequently, significant habitat change is not expected. The reduction in flow, and thus in aquatic habitat, would have an impact. The baseflow change of the Fox River flow at the Vernon Wildlife Area was estimated at 23 percent.¹ Consequently, a minor adverse impact designation is given for impacts to the river during annual low flow conditions.

Root River to Lake Michigan Return Flow Alignment 2

Because a Lake Michigan supply would also include return flow, any impacts to the Fox River are assigned to the Lake Michigan water supply. Impacts with return flow are described in the following subsections.

Flooding Changes

Lake Michigan Water Supply (City of Oak Creek) Alignment 2

A Lake Michigan water supply would not affect flooding on the Fox River, because Lake Michigan is in a different watershed.

¹ Fox River baseflow was estimated from groundwater modeling (RJN Environmental Services, 2013) and adjusted to represent the Q80 Fox River flow (Fox River Q80 flow at USGS Gauge 05543830 at the City of Waukesha + Waukesha WWTP average flow + Q80 flow in downstream tributaries).

Root River to Lake Michigan Return Flow Alignment 2

Return flow would not affect flooding on the Fox River. As discussed in the return flow management plan in Volume 4 of the Application, return flow will only occur in the Fox River once return flow exceeds the maximum return flow rate and only for the portion of flow that exceeds the maximum return flow rate. The maximum return flow rate is expected to occur infrequently. Therefore, a Lake Michigan water supply with the return flow would not adversely change flooding on the Fox River.

Two small aboveground pump stations are associated with the proposed project: one for water from a Lake Michigan water supplier, and one at the Waukesha WWTP for return flow. The stations would be located and designed so there would no damage from a 100-year return period flood.

Root River**Baseflow Changes*****Lake Michigan Water Supply (City of Oak Creek) Alignment 2***

Change in flow would be documented under return flow, since there is no change in surface water flow based solely upon a Lake Michigan supply.

Root River to Lake Michigan Return Flow Alignment 2

At USGS Root River stream gage 04087220 near the City of Franklin, about 2 miles upstream of the return flow location, the average annual stream flow is 45.6 cfs (29.5 mgd) over the period of record 1964 to 2011 (USGS, 02/2012a).

At USGS Root River stream gage 04087240 in the City of Racine, approximately 20 miles downstream of the return flow location, the average annual stream flow is 157.8 cfs (102.0 mgd) over the period of record 1964 to 2012 (USGS, 02/2012b).

The Return Flow Plan (Volume 4 of the Application) contains additional information on the Root River flow and geomorphic conditions. In summary, return flow to the Root River will increase the flow in the river downstream of the return flow location. The average annual flow from the Waukesha WWTP is 18.1 cfs (11.7 mgd). The maximum return flow rate will be 28.6 cfs (18.5 mgd).

During low-flow periods, the return flow would constitute 80 to 90 percent of the river flow (USGS, 02/2012a). Flow in the Root River sometimes is very low, and the functional habitat in the river is limited by the river flow. Augmentation of the return flow would eliminate the very low-flow periods and provide more aquatic habitat.

A sediment transport study of the Root River concluded that the river stability is insensitive to changes in flow because of the erosion resistance of the channel boundary materials, the relatively flat channel gradient, and the presence of a functional floodplain (MMSD, 09/2007, p. 1). For these reasons, return flow will have no significant adverse impact on the baseflow or geomorphic conditions in the river. Instead, it will benefit Root River flow during low-flow periods because the return flow will provide additional baseflow in the river.

Flooding Changes***Lake Michigan Water Supply (City of Oak Creek) Alignment 2***

Change in flow would be documented under return flow, since there is no change in surface water flow based solely upon a Lake Michigan supply. No Lake Michigan water supply

would affect flooding in inland waterways because the water intake in all cases would be in Lake Michigan.

Root River to Lake Michigan Return Flow Alignment 2

Root River flow rates at the discharge location for the 2-year through 100-year profiles were obtained from MMSD (MMSD, 09/2007, Table 3, p. 9). This location is nearest the discharge location, slightly downstream of the Franklin gage but upstream of the confluence with the Root River Canal. The watershed area at this location is 59.2 square miles which is still significantly less than the watershed area at the discharge location (126.2 square miles). These flow rates were used as a conservative estimate of flow impacts from a return flow. The maximum return flow (18.5 mgd or 28.6 cfs) is less than 3 percent of the river flow during a 2-year frequency storm and would be an even a smaller percentage of flow during a flood. For example, the maximum return flow rate is less than 1 percent of the 100-year river flow (4,820 cfs) near the return flow location (MMSD, 2007). The maximum return flow rate would have even a smaller impact on the Root River flows in Racine. The 100-year river flow in Racine is 5,916 cfs. The maximum return flow rate would increase river flow rate by less than half of a percent in Racine (USGS, 02/2012b). This equates to a water depth change of 0.02 feet at each location for the 100-year return period flood. Additionally, discharging the maximum return flow rate is expected to occur infrequently. The future average day return flow is estimated as 11.7 mgd (16.9 cfs) and will result in an even smaller increase in the Root River flow.

The Wastewater Treatment Plant Facility Plan Amendment which is an attachment to the Return Flow Plan (Volume 4 of the Application) discusses potential outfall structure designs. The outfall structure will be designed to blend in with the streambanks along the Root River and not to affect regional flood elevations adversely.

5.1.2.2.3 Environmental Effects Comparison: Inland Waterways Size, Flows, and Floodplain
Adverse impacts from changes in the size, flow, and floodplain of inland waterways relate directly to aquatic habitat impacts and flooding. Level of relative impact for both aquatic habitat and flooding were developed to compare impacts. Impacts were compared based upon Table 5-12. The impact on aquatic habitats and flooding is discussed below. The inland waterway aquatic habitat and flooding impacts are summarized in Table 5-13. The comparison for aquatic habitat impacts for Lake Michigan is included in Section 5.1.1.

5.1.2.2.4 Aquatic Habitat

Lake Michigan Water Supply (City of Oak Creek) Alignment 2

A Lake Michigan water supply would change annual low flows in the Fox River by approximately 25 percent. The baseflow change of the Fox River flow at the Vernon Wildlife Area was estimated at 23 percent. Consequently, a minor adverse impact designation is given for impacts to the river during annual low flow conditions.

TABLE 5-12

Environmental Impact Category Description: Inland Waterways – Aquatic Habitat and Flooding

Category	Aquatic Habitat				Flooding	
	Habitat Creation	Baseflow Reduction in Warm Water Streams	Baseflow Reduction in Cold Water Streams	Substrate Change to Lake Michigan	Increase in Flooding Depth for 100-year Return Period Storm	Increase in River Flow for 100-Year Return Period Storm
No adverse impact	Temporary impacts from construction; Neutral or improved habitat creation and frequency of availability from operation	No baseflow reduction	No baseflow reduction	No measureable change	No increase (less than 0.01 feet) at structures	0.1% or less
Minor adverse impact	Minor habitat loss	Up to 25%	Up to 15%	Fewer than 10 acres	Greater than 0.01 feet, but less than 0.1 feet at structures	1% or less
Moderate adverse impact	Moderate habitat loss	Greater than 25%, but less than 50%	Greater than 15%, but less than 25%	Greater than 10 acres, but less than 20 acres	Greater than 0.1 feet, but less than 1.0 feet at structures	Greater than 1%, but less than 5%
Significant adverse impact	Significant habitat loss	50% or more	25% or more	Greater than 20 acres	Greater than 1.0 feet at structures	Greater than 5%

TABLE 5-13

Proposed Project Environmental Impact Comparison Summary: Inland Waterway Aquatic Habitat and Flooding

Proposed Project	Aquatic Habitat	Flooding
Water Supply		
Lake Michigan (City of Oak Creek) Alignment 2	Minor adverse impact	No adverse impact
Return Flow for Lake Michigan Water Supply		
Root River to Lake Michigan Alignment 2	No adverse impact	Minor adverse impact

Root River to Lake Michigan Return Flow Alignment 2

Return flow to the Root River would increase baseflow and also the quantity and availability of aquatic habitat. The greatest habitat benefits would occur during low flow conditions. Return flow to Root River would improve the aquatic habitat. Refer to Section 5.1.2.5 (Inland Waterway Flora and Fauna) for a detailed description of environmental benefits to flora and fauna within the Root River.

5.1.2.2.5 Flooding

Lake Michigan Water Supply (City of Oak Creek) Alignment 2

A Lake Michigan supply would not affect flooding in any surface waters, so it would cause no adverse impact to flooding.

Root River to Lake Michigan Return Flow Alignment 2

Return flow is a very small percentage of the river flow during a flood. The maximum return flow rate (28.6 cfs or 18.5 mgd) increases Root River flows by less than 0.6 percent for 100-year-frequency storm conservatively estimated at the discharge location and less than 0.5 percent in Racine. Therefore, the return flow to the potential discharge location would cause a minor adverse impact to flooding.

5.1.2.3 Water Quality

5.1.2.3.1 Affected Environment

Fox River

The Fox River will be affected by the project. The river receives the flow discharged from the Waukesha WWTP, so a change in discharge location would affect the river.

Water quality data gathered by the WDNR about 7 miles downstream of the Waukesha WWTP at County Highway I provide background information on Fox River water quality. Grab samples were taken for total suspended solids, dissolved oxygen, total phosphorus, and fecal coliform in February, April, July and October of 2011. The results are shown in Table 5-14 for WDNR Station numbers 683206 and 683096.

TABLE 5-14
Water Quality Data: Fox River

Parameter ^a	Average
Total suspended solids	19.75 mg/L ^b
Dissolved oxygen	10.46 mg/L
Total phosphorus	0.17 mg/L
Fecal coliform	230 MPN/100 mL ^b

^a Samples were gathered on 2/22/11, 4/12/11, 7/21/11, and 10/11/11.

^b Some samples received were not iced, or the ice had melted.

The Fox River near the WWTP outfall is on the 303(d) list for several impairments, including PCBs for fish consumption advisories, phosphorous for low dissolved oxygen concentration, and sediment for habitat impairment (WDNR, 01/2010). The WWTP operates under a chloride variance for discharge to the Fox River. New phosphorus water quality standards indicate the Fox River in the City of Waukesha has a phosphorus water quality standard of 0.075 mg/L (NR 102.06(3)(b)).

Root River

The Root River at the potential discharge location is on the 303(d) list for low dissolved oxygen and degraded biological community with reported causes from sediment and phosphorus. In addition, approximately the last 6 miles of the Root River upstream of Lake Michigan is on the 303(d) list for PCBs. These listings were all made in 1998. More recent SEWRPC water quality modeling found that dissolved oxygen concentrations met the standard between 99 percent of the time for the 11-year period of record analyzed (SEWRPC, 2007, Appendix N). The proposed 2012 303(d) list includes portions of the Root River in Milwaukee and Racine Counties for phosphorous (WDNR, 01/2013a).

Water quality information is gathered by a number of organizations in the Root River watershed. The USGS, MMSD and the City of Racine have obtained Root River water quality data, and SEWRPC has done extensive water quality modeling of the watersheds.

Water quality standards for dissolved oxygen are 5.0 milligrams per liter (mg/L) and recreational use fecal coliform standards are 200 counts/100 mL monthly geometric mean

and are not to exceed 400 counts/100 mL in more than 10 percent of all samples during any month (WDNR, NR 102.04(4)).

There are recent numeric phosphorus water quality standards in Wisconsin, with the Root River having a standard of 0.075 mg/L (NR 102.06(3)(b)). There are no numeric total suspended solids standards in Wisconsin, however a reference background concentration of 17.2 mg/L was used in SEWRPC's Regional Water Quality Management Plan Update (SEWRPC, 2007).

Water quality in the Root River was extensively studied in SEWRPC's (2007) *A Regional Water Quality Management Plan Update for the Greater Milwaukee Watersheds*. Findings for the 11-year period of record simulation under SEWRPC's existing condition scenario are summarized in Table 5-15 for four points downstream of the proposed return flow location (SEWRPC, 2007, Appendix J and N).

TABLE 5-15
Average Annual Water Quality Data Downstream of Root River Alignment 2 Return Flow Location

Dissolved oxygen	11.0 to 11.5 mg/L
Phosphorus (mg/L)	0.071 to 0.115 mg/L
Fecal coliform summer season geometric mean	2,687 to 3,327 per 100 mL
Total suspended solids	20.6 to 38.5 mg/L

Water quality data from the years after the SEWRPC study is provided in Table 5-16. The table summarizes water quality data for the sampling points slightly upstream and downstream of the return flow Alignment 2 location. MMSD recently released 2011 water quality monitoring data summary statistics for the Root River. In general, total phosphorus within the Root River has decreased and trends show some improvements to the river's water quality.

TABLE 5-16
Average Annual Water Quality Data at MMSD Sampling Locations near the Root River Alignment 2 Return Flow Location

Parameter ^d	Year Average ^a				
	2007 ^b	2008 ^b	2009 ^b	2010 ^b	2011 ^c
Dissolved Oxygen (mg/L)	7.11	7.52	7.90	6.45	7.45
Phosphorus (mg/L)	0.13	0.14	0.09	0.13	0.09
Fecal Coliform (cfu/100 mL)	2375	422	489	457	1003

^a The closest MMSD Sampling locations are RR-05 (upstream of the return flow location) and RR-06 (downstream of the return flow location).

^b Source: MMSD Water Quality Monitoring Data, Root River (RR-05 and RR06).

<http://www.waterbase.glwj.uwm.edu/mmsd/> Accessed January 2013.

^cMMSD, 2012

^d Each year 10 samples were analyzed.

Water quality data from August 2011 to August 2012 near the confluence of the Root River and Lake Michigan was recently released by the City of Racine. Table 5-17 displays water quality data for the four sampling points within the City of Racine, including at the WDNR's Steelhead egg hatchery facility. As evident, water quality downstream of the potential discharge location is relatively similar, but does not meet the phosphorus water quality standards.

TABLE 5-17
August 2011 to 2012 Water Quality Data of the Root River in the City of Racine

Dissolved oxygen (mg/L)	8.3 to 9.6 mg/L
Phosphorus (mg/L)	0.082 to 0.114 mg/L

Source: RHD Sampling Sites 1, 2, 3, and 4 (Kintzelman and Wright, 2012).

5.1.2.3.2 Environmental Effects

Water quality environmental effects will occur both during construction as well as during operation and maintenance. Potential impacts to aquatic resources generally associated with construction can be both direct and indirect. They will depend primarily upon the physical characteristics of the streams and time of year.

The primary temporary construction impacts to surface waters can be associated with elevated loads of suspended sediment resulting from in-stream trenching activities and erosion of cleared streambanks and rights-of-way from pipeline construction. Impact severity is a function of sediment load, particle size, streambank and streambed composition, flow velocity, turbulence, and duration of construction activities. Since the impacts will be temporary and will be crossed using BMPs designed to reduce the impact, turbidity and erosion created by construction will be minimal.

Without mitigation by implementing BMPs, temporary construction impacts can also elevate suspended sediment levels that increase turbidity and consequently reduce primary photosynthetic production, flocculate plankton, decrease visibility and food availability, and produce effects that are aesthetically displeasing (USFWS, 1982). However, Long (1975) concluded that most fish avoid turbid water and can survive for several days in waters where construction in a stream has caused turbidity. Since the construction impacts will be temporary and river crossings will use BMPs designed to reduce the impact, turbidity and erosion created by construction will be minimal.

Construction effects on water quality will be minimized by using BMPs as described in Appendix 5-2, "Example Wetland and Waterway Pipeline Construction Crossing Impact Minimization Techniques."

Operational and maintenance effects on water quality that are applicable regardless of the discharge location as first described and then operational and maintenance effects are described below for each inland waterway.

The WDNR commonly provides allowances for permitted discharges in the form of interim limits, variances, or other allowances when background levels are higher than water quality standards, when the water quality constituent cannot be removed by municipal WWTP best available technology permitted in Wisconsin, or water quality standards can be met after mixing or other processes in the receiving water. Water quality parameters may be addressed by similar regulatory approaches for allowances under current or future regulations.

The City has been implementing a Mercury Pollutant Minimization Program that began in 2007. The mercury concentration in the WWTP effluent will meet Fox River discharge or Lake Michigan basin return flow draft requirements. The City will continue the mercury source reduction program and based upon established performance either Fox River discharge or Lake Michigan return flow will meet requirements for the mercury water quality limits.

The permit for continued discharge to the Fox River provides a phosphorous compliance schedule because the limits are very low and will require significant capital investment in the WWTP. The phosphorus standard for the Fox River and the Root River is the same (0.075 mg/L) and the phosphorus concentration in these streams river is often higher than the standard (see above tables for phosphorus background data in each stream). Consequently, in the recently completed Facility Plan (Strand, 2011), the WWTP evaluated potentially having to

meet a phosphorus discharge limit equal to the water quality standard (0.075 mg/L). This would improve phosphorus water quality for a discharge in any of these streams.

The WDNR has adopted new thermal rules (NR 102 and 106) for the protection and propagation of aquatic life that applies to WPDES permit holders discharging to surface waters. In preparation for this new rule, the City has been collecting effluent temperature data for over a year. The WPDES permit indicates the mixing study demonstrates that the discharge mixes sufficiently to meet thermal discharge compliance guidance. The City has evaluated approaches to meet WDNR thermal discharge requirements following the rules and applicable guidance regardless of a discharge location (see the Return Flow Plan – Volume 4 of the Application). Consequently, discharge either to the Fox River or Lake Michigan basin return flow are expected to meet thermal discharge requirements.

Fox River

Lake Michigan Water Supply (City of Oak Creek) Alignment 2

A Lake Michigan supply regardless of the water source includes new aboveground impacts that are limited to only a new pump station less than a quarter acre in size; consequently, operational stormwater quality impacts will be insignificant and none to the Fox River.

Root River to Lake Michigan Return Flow Alignment 2

The City of Waukesha's return flow management plan goal will provide continuous return of the water at the WWTP (see the Return Flow Plan in Volume 4 of the Application). In general, the return flow management plan provides return flow up to the maximum day water demand if sufficient water is available at the WWTP. The portion of water at the WWTP in excess of this amount will continue to be discharged into the Fox River and meet permit limits. The Wisconsin Pollutant Discharge Elimination System (WPDES) values are intended to protect receiving streams. Consequently, significant water quality impacts to the Fox River are not anticipated with return flow to the Lake Michigan watershed instead of continuous discharge to the Fox River.

Root River

Lake Michigan Water Supply (City of Oak Creek) Alignment 2

A Lake Michigan supply regardless of the water source includes new aboveground impacts that are limited to only a new pump station less than a quarter acre in size; consequently, operational stormwater quality impacts will be insignificant to the Root River.

Root River to Lake Michigan Return Flow Alignment 2

All water returned to the Lake Michigan watershed, will meet WDNR water quality permit requirements. A summary of proposed discharge limits from the WDNR and a comparison to historical Waukesha WWTP performance are detailed in the Return Flow Plan (Volume 4 of the Application) (WDNR, 2011a). A comparison of the proposed WWTP limits and historical performance is shown in Table 5-18. The table also includes a comparison to two other discharge permits to Lake Michigan tributaries as a comparison.

Water softening would no longer be needed with a Lake Michigan water supply source. Consequently, a reduction in chloride concentration in return flow over time is expected. The City has evaluated chloride concentrations in return flow with a switch to Lake Michigan water and has developed a return flow chloride compliance plan. Major chloride reductions contained with the return flow chloride compliance plan include a switch in water source to Lake Michigan and the elimination of residential water softeners necessary

to treat the groundwater source. Together these chloride reduction practices could contribute a 50 percent reduction in the estimated annual chloride load (see the Return Flow Plan – Volume 4 of the Application). With a switch to Lake Michigan water, the chloride water quality standards evaluation demonstrates confidence in meeting the chloride water quality standard without a variance. Consequently, the water quality based effluent limit for chloride is expected to be met with this water supply.

The City of Waukesha's return flow management plan goal will provide continuous return of the water at the WWTP (see the Return Flow Plan in Volume 4 of the Application). In general, the return flow management plan provides return flow up to the maximum day water demand if sufficient water is available at the WWTP. The portion of water at the WWTP in excess of this amount will continue to be discharged into the Fox River and meet permit limits. Return flow ultimately ends up in Lake Michigan. Water quality impacts to Lake Michigan have been previously covered under Section 5.1.1.2 (Water Quality).

TABLE 5-18

Comparison of WDNR-Proposed WPDES Limits to Historical WWTP Performance and Other Direct and Lake Michigan Tributary Dischargers

Water Quality Parameter	City of Waukesha Potential Return Flow		Lake Michigan Tributary WWTP Discharger #1 ^b	Lake Michigan Tributary WWTP Discharger #2 ^c	Discharger Direct to Lake Michigan ^d	WDNR Limit for Continued Fox River Discharge ^e
	WDNR-Proposed Limit for Lake Michigan Tributary Return	Waukesha Historical Average ^a				
Biological oxygen demand, mg/L	≤ 5.7 to ≤ 10.0	1.8	≤ 10.0 to ≤ 15	≤ 30.0 monthly avg.	≤ 30.0 monthly avg.	≤ 8.2 to ≤ 10.0
Total suspended solids, mg/L	≤ 10.0	1.2	≤ 15.0	≤ 30.0 monthly avg.	≤ 30.0 monthly avg.	≤ 10.0
Dissolved oxygen, mg/L	≥ 7.0	9.2	≥ 6.0	≥ 6.0	No Limit	≥ 6.7
Phosphorus, mg/L	≤ 0.075 ^d	0.16	≤ 1.0	≤ 1.0	≤ 1.0	≤ 0.075
Ammonia (NH ₃ -N), mg/L	≤ 1.3 to ≤ 4.3	< 1.0	3.3 to 6.4 monthly avg.	6.3 to 12.0 monthly avg.	≤ 1.8 to 39 daily max.	≤ 2.0 to ≤ 6.0
Chlorides, mg/L	≤ 395	477	≤ 570	No Limit	No Limit	≤ 690 with a target value of 440
Temperature, oF (varies by month)	≤ 49 to 81	53 to 70	No Limit	No Limit	No Limit	Compliance through mixing

^aOctober 1, 2002, to August 31, 2009. March 15, 2006 to May 1, 2013 for Chlorides.

^bWPDES Permit No. WI-0020222-08-0

^cWPDES Permit No. WI-0020184-08-0

^dWPDES Permit No. WI-0025194-07-1

^eWater Quality Standard for Underwood Creek and Root River.

The Root River to Lake Michigan return flow Alignment 2 alternative considered water quality changes to the Root River. The 303(d) listings in the Root River should not be exacerbated with return flow. Near the potential discharge location, the Root River was originally listed for low dissolved oxygen from sediment and phosphorus in 1998. However, more recent SEWRPC water quality modeling found that dissolved oxygen concentrations met the standard between 99 percent of the time for the 11-year period of record analyzed (SEWRPC, 12/2007, Ap. N). No or little change in dissolved oxygen standard compliance occurs with return flow to the Root River based upon modeling results because historical WWTP performance has produced a BOD concentration less than 2 mg/L on average as described in the Return Flow Plan (Volume 4 of the Application).

The Root River is listed as impaired for phosphorus. The City will provide return flow at a water quality equal to or better than the 0.075 mg/L phosphorous water quality standard. This improvement will move the Root River towards delisting from the 303(d) impaired water list for phosphorus.

The Root River PCB 303(d) listing in the 6 miles of the river upstream of Lake Michigan will not be exacerbated because this chemical is not found in the return flow.

5.1.2.3.3 Environmental Effects Comparison: Inland Waterways Water Quality

Adverse impacts from changes in inland waterways water quality were compared based upon Table 5-19. For water quality impacts in inland waterways, a discussion of relative impact is included in Table 5-20. The comparison for water quality impacts for Lake Michigan is included in Section 5.1.1.2 (Water Quality).

TABLE 5-19

Environmental Impact Category Description: Water Quality

Category	Water Quality	Stream Water Quality Numeric Standards Compliance ^a	Increase in Average Annual Loading to Lake Michigan Near Milwaukee ^a
No adverse impact	Improves or remains approximately the same; Temporary construction impacts	River meets water quality standards or discharge is better than or equal to water quality standards	Contributes a de minimis change (<1%)
Minor adverse impact	Remains approximately the same	Discharge requires existing variance to water quality standards	Contributes a minor change (>1%, but <10%)
Moderate adverse impact	Moderate lowering of in-stream water quality	Discharge requires new variance to water quality standards	Contributes a moderate change (>10%, but <25%)
Significant adverse impact	Substantial lowering of in-stream water quality	New exceedences to water quality standards	Contributes a substantial change (>25%)

* Based upon expected water quality from historical wastewater treatment performance and draft permit limits where existing water quality exceedences occur, the receiving water quality will improve or stay the same with the discharge.

Lake Michigan Water Supply (City of Oak Creek) Alignment 2

A Lake Michigan water supply would not change water quality in Lake Michigan and have no adverse impact to other surface water resources. A Lake Michigan water supply source would eliminate the need for water softening. Consequently, discharge of chlorides in the WWTP from water softener salts would be eliminated from discharge to the environment over time. The Lake Michigan water supply consequently would produce no adverse impact on water quality.

TABLE 5-20

Proposed Project Environmental Impact Comparison Summary:
Inland Waterways Water Quality

Proposed Project	Water Quality
Water Supply	
Lake Michigan (City of Oak Creek) Alignment 2	No adverse impact
Return Flow for Lake Michigan Water Supply	
Root River to Lake Michigan Alignment 2	No adverse impact

Root River to Lake Michigan Return Flow Alignment 2

Return flow to the Root River would take flow currently discharged to the Fox River and send it to the Root River instead. The current Fox River discharge includes a permit allowance for chloride, which would no longer be discharged daily to the Fox River. Consequently, changes to Fox River water quality would occur, but because WDNR discharge permits are designed to protect receiving waters, no significant change in impacts to the Fox River is expected.

Potential discharge permit requirements provided by the WDNR for return flow discharge have been reviewed, and the WWTP can meet these requirements either based upon historical performance or from more recent analysis for chloride and thermal discharge. No variance for chloride would be expected and phosphorus concentration in the stream is expected to improve.

The phosphorus discharge concentration in the return flow is expected to be the 0.075 mg/L water quality standard in the Root River. The 0.075 mg/L is also the phosphorus water quality standard in the Fox River. The City of Waukesha will provide return flow with water quality that meets effluent requirements, regardless of the discharge location. Consequently, the water quality impacts to the Root River would be expected to have no adverse impacts.

5.1.2.4 Geomorphology and Sediments

5.1.2.4.1 Affected Environment

Fox River

In the vicinity of the City of Waukesha, the Fox River has reaches that are natural channel with minimal modifications, while other reaches are significantly altered by development. Within the City center upstream of the WWTP, the Fox River has been dammed to create the Barstow Impoundment, where the river banks consist of sheet pile, concrete, rock reinforcements, and vegetation. Upstream of the dam, large sediment depositions are reported to include pollutants that may cause human and aquatic health concern (WDNR, 01/2012a). Farther upstream, the Fox River meanders through developed landscapes including residential, golf course, commercial and transportation development. The river has mostly vegetated banks, with erosion and bank failures common in urban areas. The

river generally has a wide floodplain with connected wetlands and some encroachments from development. The river is generally low gradient and primarily consists of glides and pools. The sediments are primarily silts and sands in the pools and sand and gravel in glides.

Downstream of the Barstow Impoundment, the river is confined by development. The river banks are primarily placed rock and concrete retaining walls. The river is fairly narrow and higher gradient than upstream reaches, where the river is primarily riffles with gravel and cobble. Farther downstream of the City near the WWTP, the river returns to a low gradient meandering river. Similar to the upstream reaches, the banks are mostly vegetated with some erosion and bank failures typical of a developing watershed. Farther downstream, the river has a fairly low gradient, with sediments consisting primarily of silt and sand in pools, and sand in the glides. Occasional areas of gravel are also present. In the downstream reaches, sediment point bars, primarily consisting of sand have formed due to natural sediment transport dynamics and likely are from agricultural land runoff.

Root River

The Root River flows through parts of Milwaukee and Racine counties, and into Lake Michigan at the City of Racine. The river has a natural channel (that is, natural bottom substrate and vegetated river banks), and it has a mixture of land uses between its headwaters and Lake Michigan. The headwaters of the Root River are heavily urbanized, the middle reaches are primarily agriculture and lower density development, and the lower parts of the watershed near Lake Michigan are heavily urbanized. Throughout the many areas of the river, primarily at the upstream and downstream reaches, the river has been straightened or confined within a relatively narrow corridor with transportation, residential, and commercial land uses bordering the river and its floodplain. The middle reaches were straightened through agricultural fields.

The MMSD completed a comprehensive study of the Root River within their jurisdiction in 2007. The purpose of the study was to baseline the existing channel stability in the North Branch of the river and to provide hydrologic, hydraulic and sediment transport predictions on the vertical and lateral stability of the river and tributary channels (MMSD, 2007). The river has a mixture of gradients, with low-gradient reaches dominated by pools and glides with sand, silt, organic and glacial till bottom and bank sediments. Other reaches are higher-gradient with pool and riffle sequences with gravel, cobble and bedrock substrates. The banks of the river are mostly earthen, with vegetation providing bank stability, but there are some areas of erosion and bank failures typical of urbanizing watersheds. The lower reaches of the river in the highly urbanized area of the City of Racine have sheet pile banks.

5.1.2.4.2 Environmental Effects

Geomorphology impacts to the surface waters potentially affected by a Lake Michigan water supply and return flow are discussed below. The geomorphology of the surface waters are assessed based on the impact to the surface water geomorphic stability, change in erosion potential, or change in vertical or lateral stability.

Fox River

Impacts to the Fox River for a Lake Michigan water supply and return flow are discussed below. As described in the background information on the Fox River, the average annual stream flow is 110 cfs (71 mgd) over the period of record.

Lake Michigan Water Supply (City of Oak Creek) Alignment 2

A Lake Michigan water supply, regardless of supply location, would not adversely affect the Fox River with respect to geomorphology because groundwater pumping would cease. A Lake Michigan supply and cessation of shallow groundwater pumping would improve the subsurface flow to the Fox River and allow the baseflow from groundwater to be restored at least partially to conditions similar to pre-well conditions, by allowing the groundwater to contribute more baseflow to the river. This would improve the baseflow under current shallow groundwater pumping conditions and have the greatest benefit in the future when projected water demands are greater. The Lake Michigan supply would affect the Fox River the same, regardless of the return flow location.

A study by the USGS and University of Wisconsin Milwaukee reports that wastewater flows from Sussex, Brookfield, and Waukesha contribute 40 percent of the total Fox River flow during annual low flows (Cherkauer et al, 2010). The City of Waukesha's average annual WWTP flow is about 10 mgd, or 50 percent of the WWTP flow from the 3 communities. Using this percentage, the City of Waukesha WWTP contributes about 25 percent of the Fox River flow during annual low flow conditions. Thus, during the low flow periods, a 25 percent reduction in the Fox River annual low flow would occur. Annual low flow conditions generally do not adversely affect the geomorphic conditions in the river, so no significant impacts are expected to the geomorphic conditions of the Fox River with this change.

During higher river flows, the Waukesha WWTP discharge is even a smaller fraction of the total river flow. For example, over the period of record for the USGS stream gage upstream of the Waukesha WWTP (Gage ID 05543830 for water years 1964–2008), the average annual river flow was 71 mgd and the average annual peak river flow was 644 mgd. With an average annual Waukesha WWTP discharge of 10 mgd, the WWTP discharge represents 14 percent of the annual average river flow and only 1.6 percent of the average annual peak river flow. This small amount of flow reduction in the river would not have a significant adverse affect on the flow or geomorphic conditions in the river.

Root River to Lake Michigan Return Flow Alignment 2

Because a Lake Michigan supply would require return flow, impacts to the Fox River are assigned to the Lake Michigan water supply. Impacts of return flow to the Root River are described below.

Root River

Lake Michigan Water Supply (City of Oak Creek) Alignment 2

Impacts of a Lake Michigan water supply, regardless of supply location, are described below under return flow.

Root River to Lake Michigan Return Flow Alignment 2

Flow in the Root River sometimes is very low, and the functional habitat in the river is limited by the river flow. Augmentation of the return flow would eliminate the very low flow periods. Because the return flow rate is small compared to the higher flows in the river, return flow is not expected to affect the geomorphic stability of the river.

Root River flow rates at the discharge location for the 2-year through 100-year profiles were obtain from MMSD (MMSD, 09/2007, Table 3). This location is nearest the discharge location, slightly downstream of the Franklin USGS gage but upstream of the confluence with the Root River Canal. The watershed area at this location is 59.2 square miles which is

still significantly less than the watershed area at the discharge location (126.2 square miles). These flow rates were used as a conservative estimate of flow impacts from a return flow. Based upon this conservative assumption, during less frequent high flow events, such as a 2-year flow, return flow is less than 3% of the river flow (MMSD, 09/2007, Table 3).

These are similar to the Underwood Creek return flow findings, for which a detailed evaluation concluded that the return flow would not affect the geomorphic stability of the rehabilitated parts of the creek. The Return Flow Plan (Volume 4 of the Application) contains a detailed discussion of the geomorphic conditions.

A recent sediment transport study of the Root River concluded that the river stability is relatively insensitive to changes in flow because of the erosion resistance of the channel boundary materials, the relatively flat channel gradient, and the presence of a functional floodplain (MMSD, 09/2007, p. 1). For these reasons, a return flow would not adversely affect the geomorphic conditions in the river. Instead, the return flow would benefit Root River habitat during low-flow periods, because the return flow would provide additional baseflow in the river. Refer to Section 5.1.2.5 (Inland Waterway Flora and Fauna) for a full description of habitat benefits to the Root River.

5.1.2.4.3 Environmental Effects Comparison: Inland Waterway Geomorphology and Sediments

Adverse impacts from changes in inland waterway geomorphology and sediments are compared based upon Table 5-21.

Table 5-22 summarizes the impacts on geomorphology and sediments on inland waterways. Section 5.1.1.3 (Lake Michigan Geomorphology and Sediments) contains a comparison of geomorphology impacts to Lake Michigan.

Lake Michigan Water Supply (City of Oak Creek) Alignment 2

The Lake Michigan water supply would prevent baseflow reduction in inland waterways from groundwater pumping. Because geomorphology changes to the environment would depend only on the return flow location, the Lake Michigan water supply would have no adverse impacts on geomorphology.

TABLE 5-21
Environmental Impact Category Description: Flow and Sediments

Category	Channel Stability with Return Flow	Substrate Change to Lake Michigan
No adverse impact	Channel is stable for flows up to 2-year return where channel is currently stable	No substrate change
Minor adverse impact	Channel has some instability for flows up to 2-year return where channel is currently stable	Fewer than 10 acres
Moderate adverse impact	Channel has frequent instability for flows up to 2-year return where channel is currently stable	Greater than 10 acres, but less than 20 acres
Significant adverse impact	Channel is unstable at most flows where the channel is currently stable	Greater than 20 acres

TABLE 5-22
Proposed Project Environmental Impact Comparison Summary: Inland Waterways Geomorphology and Sediments

Proposed Project	Geomorphology and Sediments
Water Supply	
Lake Michigan (City of Oak Creek) Alignment 2	No adverse impact
Return Flow for Lake Michigan Water Supply	
Root River to Lake Michigan Alignment 2	No adverse impact

Root River to Lake Michigan Return Flow Alignment 2

Return flow to the Root River would reduce the baseflow in the Fox River by approximately 10 mgd, based upon historical WWTP operation. Geomorphic changes with reduced baseflows could result in channel change over time, but because channel stability is associated less with baseflow and is influenced more by larger channel-forming flows, baseflow reduction is not expected to cause a significant change in channel stability from existing conditions. Consequently, geomorphology changes to the Fox River would have no adverse impact.

Flow that formerly had been discharge to the Fox River would instead increase baseflow in the Root River. A recent sediment transport study of the Root River concluded that the river stability is relatively insensitive to changes in flow, because of the erosion resistance of the channel boundary materials, the relatively flat channel gradient, and the presence of a functional floodplain. Therefore, return flow to Root River would have no adverse impact on geomorphology.

5.1.2.5 Flora and Fauna

5.1.2.5.1 Affected Environment

Wildlife species require adequate food, water, cover, and living space for the survival of individuals and to maintain population viability. Aquatic resources affected by the proposed project consist generally of streams and wetlands, which include all inland waterways. Aquatic areas can provide habitat to a diverse wildlife population, some common species (beaver, muskrat, and herons) are dependent on aquatic habitats for food and shelter. Others (e.g., raccoon) are less restricted, but prefer to be close to water. Amphibians and many reptiles favor aquatic habitats; representative species include bullfrog and northern water snake.

Many of the Wisconsin's richest and most diverse streams and rivers were in the southeastern part of the state, but many have been degraded from nonpoint pollution sources from agriculture and urbanization. Most streambeds, banks, and channels within the project area have been modified by changes in land cover and have lost varying degrees of their biological productivity and diversity (WDNR, 09/2013a).

The rivers and streams within the project area are a combination of cold water communities and warm water communities. Cold water streams are capable of supporting cold water sport fish, such as trout, and other aquatic life, or serving as a spawning area for cold water fish species. Cold water streams, such as Pebble Creek and Mill Brook, contain relatively few fish species and are dominated by trout and sculpins. Warm water fisheries are capable of supporting sport fish such as bass, walleye, and northern pike, and forage fish such as, suckers, minnows, and darters. Warm water rivers include large rivers such as the Fox River, as well as smaller streams such as Underwood Creek and the Root River.

Most of the warm water streams and rivers within the project area are on the 303(d) list for impairments, such as, PCBs, fecal coliform, *E. coli* bacteria, phosphorous for low dissolved oxygen concentration, construction erosion, non-point-source contamination, sedimentation, beaver dams, and unspecified metals for chronic aquatic toxicity (WDNR, 01/2010). These impairments result in a loss of habitat within the waterway and water temperature fluctuations (WDNR, 2002a).

The USFWS and the WDNR were contacted to determine where federal- or state-listed species occur along the project corridor in Lake Michigan. The species identified by these agencies as potentially occurring within the project corridors are summarized for the proposed project in Section 5.1.3 (Proposed Project Wetlands) and all alternatives in Section 6.4.3 on Wetlands, since most of the potential impacts involve federal- or state-listed species associated with wetlands. A summary discussion of listed species potential habitat impacts for the proposed project is included in Section 5.1.3.2 (Wetlands Flora and Fauna).

Background information for inland waterways affected by the project is given below.

Fox River

Fisheries information for the Fox River downstream of the WWTP was obtained from the WDNR (2011b). The data were collected along roughly 2 miles of the Fox River between County Highway I and the confluence of Genesee Creek, about 6 miles downstream of the Waukesha WWTP discharge. Figure 5-1 shows the sampling locations relative to the WWTP. Fishery surveys were conducted in 1999, 2000, 2003, 2004, and 2006 (Table 5-23).

The surveys identified 35 species of fish (Table 5-24). The most abundant species collected were golden redhorse, common carp, bluegill, channel catfish, largemouth bass, white bass, northern pike, rock bass, common shiner, sand shiner, bluntnose minnow, emerald shiner, longnose gar, white sucker, and creek chub. Most are considered warm water species, although they may also be found in cool water habitats. The greater redhorse, a designated threatened species, also was collected in this stream reach. Several coldwater species (brook and brown trout) were noted at the confluence of Genesee Creek (a cold water fishery) and Fox River but were only present in small numbers.

TABLE 5-23
Location of WDNR Fox River Fishery Survey Site Numbers and Year of Survey

WDNR Site Number	Survey Number	Year	Location
62121	2664	1999	At confluence with Genesee Creek.
62129	2663	1999	0.6 river mile east of Site #62121.
62245	2608	1999	Upstream of County Hwy I.
62605	2609	2000	
	52059	2003	
	92051	2004	
	92253	2006	

Note: The WDNR lists Genesee Creek as an exceptional resource water and cold water fishery (WDNR, 2002a).

A separate fish survey was conducted at the confluence of the Fox River and Pebble Creek, 1.65 miles downstream of the Waukesha WWTP (Waukesha County and SEWRPC, 2008). Many species were the same as those collected in the WDNR surveys, but species not found farther downstream in the Fox River were collected. These were brook stickleback, spottail shiner, banded killifish, golden shiner, longear sunfish, orange-spotted sunfish, starhead topminnow, and tadpole madtom, all warm water species except for the brook stickleback, a cool water species. The longear sunfish is a designated threatened species in Wisconsin. The starhead topminnow and banded killifish are species of special concern.

FIGURE 5-1
Approximate Fish Sampling Locations Relative to the Waukesha WWTP

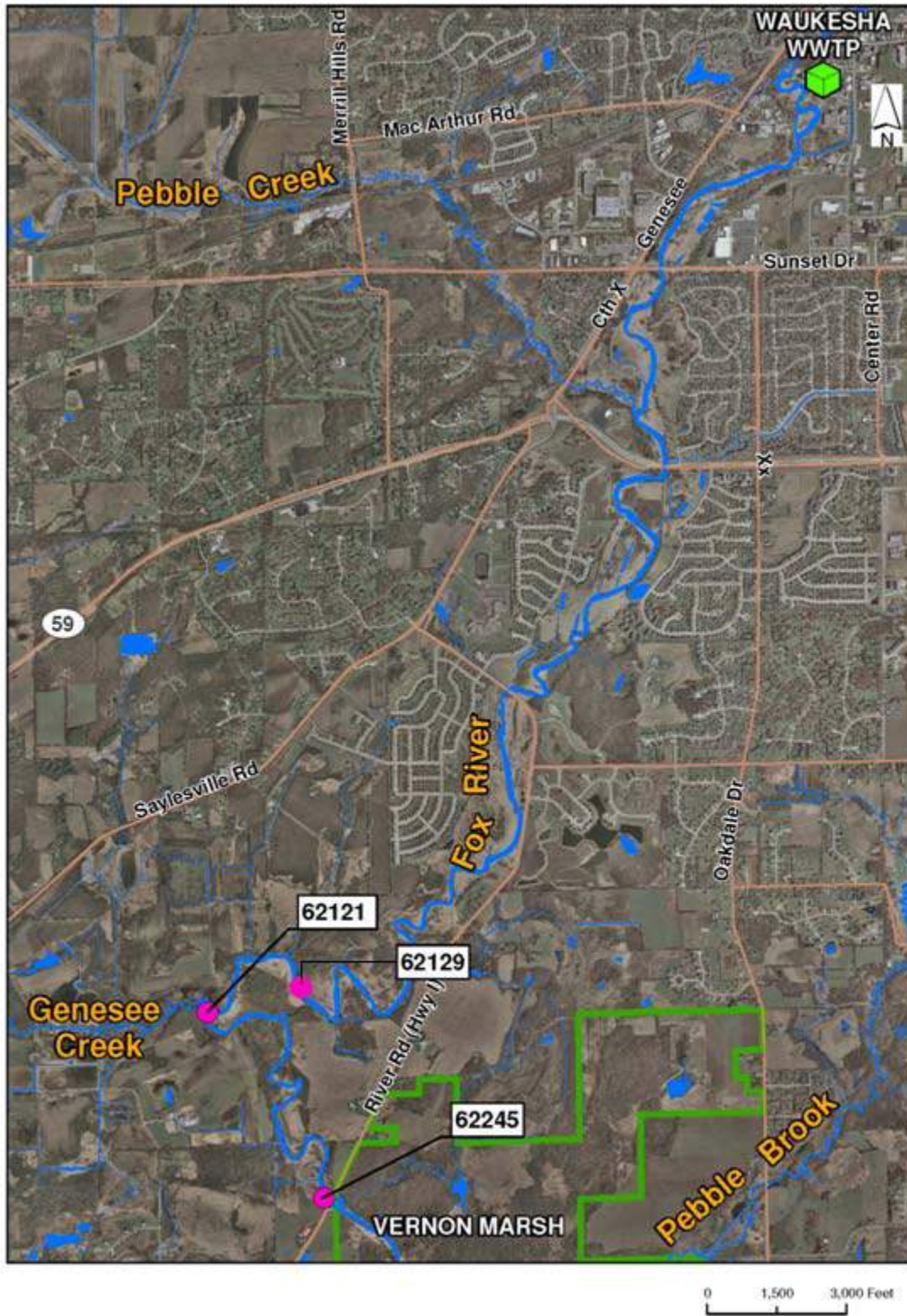


TABLE 5-24
Fisheries Data from WDNR Surveys in the Fox River Downstream of the Waukesha WWTP

Species	WDNR Site Numbers			
	62121	62129	62245	62605
Bigmouth shiner				X
Black bullhead			X	
Black crappie			X	
Blackstripe topminnow				X
Bluegill			X	X
Bluntnose minnow				X
Bowfin				X
Brook silverside				X
Brook trout	X	X		
Brown trout	X	X		
Central mudminnow	X	X		X
Central stoneroller				X
Channel catfish			X	X
Common carp			X	X
Creek chub	X	X		X
Emerald shiner				X
Golden redhorse			X	X
Grass pickerel	X			X
Greater redhorse			X	X
Green sunfish				X
Johnny darter				X
Largemouth bass	X			X
Longnose gar				X
Mottled sculpin	X	X		
Northern pike			X	X
Pumpkinseed			X	X
Quilback				X
Rock bass			X	X
Sand shiner				X
Spotfin shiner				X
Walleye				X
White bass				X
White sucker	X	X		X
Yellow bass				X
Yellow perch				X

Root River

Fisheries and habitat information for the Root River is summarized in the Return Flow Plan (Volume 4 of the Application) and here.

Fishery data for in the Root River watershed shows that 10 new species have been identified, but 10 of 64 recorded species have not been observed since 1986 (SEWRPC, 12/2007, pp. 200–14). The most recent fishery surveys, conducted in 2004, 2007 and 2010 by the USGS, identified 19 species in the Root River near the proposed return flow location (USGS, 01/2013). None of the fish species observed are state-listed species. Table 5-25 lists the fish species found at the USGS locations upstream of the proposed return flow location.

TABLE 5-25
Fisheries Data from USGS Fish Surveys in the Root River

Species	Found in the Root River		
	2004	2007	2010
Black bullhead		x	
Blacknose dace	x		x
Blackside darter	x		x
Bluegill	x		x
Bluntnose minnow	x		
Brook stickleback	x		x
Central mudminnow	x		x
Creek chub	x	x	x
Fathead minnow	x		
Green sunfish	x	x	x
Johnny darter	x	x	x
Largemouth bass	x		x
Longnose dace		x	
Northern pike	x		
Orangespotted sunfish			
Pumpkinseed	x	x	x
Sand shiner	x		
White sucker	x	x	x
Yellow perch	x		

Note: Fish surveys taken October 4, 2004, September 5, 2007, and September 14, 2010 at USGS Stream Gauge 04087214 in Greenfield, WI and USGS Stream Gauge 04087220 near Franklin.

Some of the new species were observed in reaches of the Root River between the confluence with Lake Michigan and the first dam, suggesting that Lake Michigan's fish community may be influencing the fish community of the lower reaches of the watershed. The Root River is a warm-water habitat, where the balance of fish species indicates a fair quality fishery overall in the watershed.

Several biological indices have been developed for three stream reaches along the Root River (WDNR, 2012c). These indices use benthic macroinvertebrates and fish as indicators of water quality and physical conditions present within the stream. The MIBI (benthic macroinvertebrate index) and IBI (fish index) were developed within each of three stream reaches of the Root River. In general the MIBI and IBI for the lower reach of the Root River (river miles 0 to 5.82) suggests fair to good water quality and physical habitat condition. The middle reach (river miles 5.82 to 20.48) ranges from poor to good, with most of the data suggesting fair conditions. The upper reach (river miles 20.48 to 43.95) also ranges from poor to good). This data suggests some limitation in water quality or physical habitat in the middle and upper reaches.

With the potential presence of one state-listed endangered and three state-listed threatened fish species, there appears to be areas of good quality within parts of the watershed, but there is also impairment because of agricultural and urban development. The Root River watershed has relatively few streambed and bank modifications, with less than 1 percent of the stream channel being in conduit and none lined with concrete. Although habitat conditions in the Root River are fair to good, habitat could be improved by providing more or higher quality habitat.

5.1.2.5.2 Environmental Effects

Environmental effects of the proposed project on the flora and fauna of inland waterways consist of impacts from construction and operational impacts from flow changes.

The primary temporary construction impacts can be associated with elevated loads of suspended sediment resulting from in-stream trenching activities and erosion of cleared streambanks and rights-of-way from pipeline construction. The severity of impact would be a function of sediment load, particle size, streambank and streambed composition, flow velocity, turbulence, and duration of construction activities. Turbidity and erosion created by construction would be minimal, because the construction period will be brief and BMPs will be employed to reduce the impact.

Without mitigation by implementing BMPs, temporary construction impacts can also elevate suspended sediment levels that increase turbidity and consequently reduce primary photosynthetic production, flocculate plankton, decrease visibility and food availability, and produce effects that are aesthetically displeasing (USFWS, 1982). However, Long (1975) concluded that most fish avoid turbid water and can survive for several days in waters where construction in a stream has caused turbidity. Since the construction impacts will be temporary and river crossings will use BMPs designed to reduce the impact, turbidity and erosion created by construction will be minimal.

Because these impacts are expected to be temporary and the crossings will be restored following construction, temporary impacts to flora and fauna are not discussed further.

It is not anticipated that a Lake Michigan supply and return flow would have a significant impact on mammals and birds in the various inland waterways discussed in this document. Mammals and birds that normally live in areas undergoing pipeline construction may be temporarily displaced during construction. However, habitat alteration will be relatively insignificant because of the small area affected and post-construction restoration efforts used to promote habitat recovery. Operational changes in water levels are anticipated to be approximately 2 inches or less in the Fox River and also minimal in the Root River. Because potential habitat affected by these small water depths is immediately adjacent to the ordinary high water mark, mammal, vegetative, and bird species associated with inland waterways are well adapted to withstand minor fluctuations in water elevation resulting from typical seasonal conditions, flood events, or drought. Consequently, the operational impacts to these species are expected to be insignificant.

Operational impacts to inland waterway flora and fauna occur from flow conditions in the waterways that can affect flora and fauna. Operational impacts would be ongoing and permanent. Consequently, the remainder of this impact evaluation focuses upon operational impacts due to flow changes.

Evaluation of impacts to wildlife, endangered resources, and natural communities in inland waterway is part of the comprehensive evaluation for all affected environments. It is included under Wetlands (Inland Waterways Section 5.1.3) because wetland species are most affected by the project. Impacts to individual inland waterways are summarized below.

Fox River

Lake Michigan Supply (City of Oak Creek) Alignment 2

A Lake Michigan supply, regardless of the return flow location, would have its primary discharge location in the Lake Michigan basin instead of to the Fox River. Consequently, these impacts are listed under the return flow.

Root River to Lake Michigan Return Flow Alignment 2

A Lake Michigan supply, regardless of return flow location, would not have in its primary discharge location on the Fox River at the Waukesha WWTP. Consequently return flow would change the flow in the Fox River (see Inland Waterways Section 5.1.2). The return flow requirement would change discharge to the Fox River for a Lake Michigan water supply.

Change in water depth and habitat available for fisheries is discussed in the Return Flow Plan (Volume 4 of the Application). Flow in the Fox River for 2005, a dry year, and 2008, a wet year, was analyzed to determine the change in flow in the Fox River and to estimate water depth change. The water depth change in both years was approximately 2 inches or less at the USGS flow gage in Waukesha.

The small reduction in depth is not expected to have a significant impact on the fishery. The individual fish habitat requirements for dominant species (Table 5-26) and threatened and endangered species (Tables 5-27 and 5-28) generally would still be met. Table 5-27 includes cold water and threatened and endangered species found during surveys used for this analysis. Table 5-28 includes threatened and endangered species not found during the surveys but included in the NHI list of species potentially in the vicinity. With such a small change in flow depth, aquatic vegetation and macroinvertebrate habitat would not be expected to change significantly. No significant adverse impacts to these species or the Fox River fishery are expected.

TABLE 5-26
Summary of Return Flow Effects on Habitat Characteristics for Dominant Fish Species in the Fox River

Dominant Fish Species	Preferred Current Velocity Range ^a	Stream Gradient ^a	General Habitat Characteristics ^a	Dominant Substrate Preference ^a	Potential Changes to Habitat with Return Flow
Channel catfish	Wide range	Not documented in reviewed literature	Wide range	Mud, sand, clay, gravel	With the wide range of preferred velocities, habitat characteristics, and substrate preference, no significant changes are expected.
Creek chub	< 0.98 ft/sec	3–23 m/km	Pools	Sand, gravel	Slightly less pool depth, but because pools are by definition deeper areas no significant changes expected. No significant changes expected to preferred substrate.
White sucker	1.31 ft/sec	Wide Range	Wide range	Gravel, sand	With the wide range of preferred habitat characteristics and substrate preference, no significant changes are expected.
Golden redborse	Not documented in reviewed literature	Not documented in reviewed literature	Pools in river bends	Sand, gravel	Slightly less pool depth, but because pools are by definition deeper areas no significant changes expected. No significant changes expected to preferred substrate.
Bluntnose minnow	Not documented in reviewed literature	Not documented in reviewed literature	Wide range	Gravel, sand	With the wide range of preferred habitat characteristics and substrate preference, no significant changes are expected.
Common carp	Not documented in reviewed literature	Not documented in reviewed literature	Wide range	Sand, gravel, clay	With the wide range of preferred habitat characteristics and substrate preference, no significant changes are expected.
White bass	Moderate currents	Not documented in reviewed literature	Generally occurs in waters 6m in depth or less	Sand, mud, rubble, gravel	With the wide range of preferred habitat characteristics and variety of substrate preference, no significant changes are expected.
Common shiner	Not documented in reviewed literature	Not documented in reviewed literature	Rocky pools near riffles	Hard bottom, gravel, sand, rubble	Slightly less pool depth, but because pools are by definition deeper areas no significant changes expected. No significant changes expected to preferred substrate.
Northern pike	Not documented in reviewed literature	Not documented in reviewed literature	Shallow vegetated areas	Vegetated areas	Shallow areas will become shallower on average, but approximately 2 inches or less water depth change would occur. With critical spawning times for northern pike during early spring when flows are high, water depth change would be even less. Consequently, no significant changes are expected.

TABLE 5-26
Summary of Return Flow Effects on Habitat Characteristics for Dominant Fish Species in the Fox River

Dominant Fish Species	Preferred Current Velocity Range ^a	Stream Gradient ^a	General Habitat Characteristics ^a	Dominant Substrate Preference ^a	Potential Changes to Habitat with Return Flow
Largemouth bass	> 0.33 ft/sec	Not documented in reviewed literature	Not documented in reviewed literature	Vegetated areas, sand, gravel, mud	With the wide range of preferred substrate preference, no significant changes are expected.
Rock bass	Not documented in reviewed literature	Not documented in reviewed literature	Preference for clear cool to warm water	Sand, gravel	No significant changes expected to general habitat characteristics or preferred substrate.
Emerald shiner	Not documented in reviewed literature	Not documented in reviewed literature	Wide range	Sand, gravel	With the wide range of preferred habitat characteristics and substrate preference, no significant changes are expected.
Bluegill	< 0.33 ft/sec	≤ 0.5 m/km	60% pool areas	Submerged vegetation/ logs, brush	Slightly less pool depth, but because pools are by definition deeper areas no significant changes expected. No significant changes expected to preferred substrate.
Longnose gar	Not documented in reviewed literature	Not documented in reviewed literature	Backwaters, quiet currents	Gravel, sand	No significant changes expected to general habitat characteristics or preferred substrate.

TABLE 5-27

Return Flow Effects on Preferred Habitat for State Threatened, Endangered, Special Concern, and Cold Water Species Recorded Since 1999 within the Fox River

Fish Species	Preferred Current Velocity Range ^a	Stream Gradient ^a	General Habitat Characteristics ^a	Dominant Substrate Preference ^a	Potential Changes to Habitat with Return Flow
Greater redhorse (threatened)	Not documented in reviewed literature	Not documented in reviewed literature	Pools and runs of medium to large rivers	Sandy to rocky pools	Slightly less pool depth, but because pools are by definition deeper areas no significant changes expected. No significant changes expected to preferred substrate.
Longear sunfish (threatened)	Not documented in reviewed literature	Not documented in reviewed literature	Slow moving rivers and streams	Shallow dense vegetation	Shallow areas will become shallower on average, but approximately 2 inches or less water depth change would occur. Consequently, no significant changes are expected.
Banded killifish (special concern)	Not documented in reviewed literature	Not documented in reviewed literature	Shallow sluggish streams	Sand/mud/near vegetation.	Shallow areas will become shallower on average, but approximately 2 inches or less water depth change would occur. No significant changes are expected to the preferred substrate. Consequently, no significant changes are expected.
Starhead topminnow (special concern)	Not documented in reviewed literature	Not documented in reviewed literature	Quiet pools and backwaters	Vegetated areas	Slightly less pool depth, but because pools are by definition deeper areas no significant changes expected. No significant changes expected to preferred substrate.
Brook trout (cold water species)	Not documented in reviewed literature	Not documented in reviewed literature	Clear, cool, well oxygenated streams	Sand/ gravel/rubble	Lower flow in the Fox River could extend cool water influence from Genesee Creek. No significant changes are expected to the preferred substrate. Consequently, no significant changes expected.
Brown trout (cold water species)	Not documented in reviewed literature	Not documented in reviewed literature	Cold, well oxygenated waters	Submerged rocks, undercut banks, overhanging vegetation	Lower flow in the Fox River could extend cool water influence from Genesee Creek. No significant changes are expected to the preferred substrate. Consequently, no significant changes expected.

TABLE 5-28

Return Flow Effects on Habitat Characteristics for Fish Species Identified in the WDNR Online NHI Database as State Threatened, Endangered, and Species of Special Concern in the Vicinity of the Fox River, but not Documented as Present in Recent Fish Surveys

Fish Species ^a	Preferred Current Velocity	Stream Gradient	General Habitat Characteristics	Dominant Substrate Preference	Potential Changes to Habitat with Return Flow
Striped shiner (endangered)	Not documented in reviewed literature	Not documented in reviewed literature	Clear to slightly turbid waters of runs and shallow pools, with dense aquatic vegetation	Cobble, boulders, silt, sand, mud or bedrock	Slightly less pool depth, but because pools are by definition deeper areas no significant changes expected. No significant changes expected to preferred substrate.
Slender madtom (endangered)	Not documented in reviewed literature	Not documented in reviewed literature	Prefers clear, moderate to swift currents of streams and wide rivers	Gravel and boulders interspersed with fine sand	Reduction in current velocity could occur during low periods, but no significant changes are expected. No significant changes expected to preferred substrate.
River herring (threatened)	Not documented in reviewed literature	Not documented in reviewed literature	Prefers moderate to swift currents in large river systems, including impoundments and pools	River bottoms of clean gravel.	The preferred habitat for this species likely does not exist in the Fox River because it is not a large river.
Pugnose shiner (threatened)	Not documented in reviewed literature	Not documented in reviewed literature	Prefers weedy shoals of glacial lakes and low-gradient streams	Mud, sand, cobble, silt, and clay	Some weedy areas may be exposed under low flow conditions, however no significant changes are expected. No significant changes expected to preferred substrate.
Lake chubsucker (special concern)	Not documented in reviewed literature	Not documented in reviewed literature	Prefers moderately clear lakes, oxbow lakes, sloughs of weedy lakes and their associated marshy streams	Organic debris over bottoms of cobble, sand, boulders, mud or silt.	The preferred habitat for this species likely does not exist in the Fox River because it is not a lake.
Least darter (special concern)	Not documented in reviewed literature	Not documented in reviewed literature	Prefers clear, warm, quiet waters of overflow ponds, pools, lakes and streams	Gravel, silt, sand, boulders, mud or clay with dense vegetation or filamentous algal beds	Slightly less pool depth, but because pools are by definition deeper areas no significant changes expected. No significant changes expected to preferred substrate.
Weed shiner (special concern)	Not documented in reviewed literature	Not documented in reviewed literature	Prefers sloughs, lakes, and still to sluggish sections of medium streams to large rivers	Sand, mud, clay, silt, detritus, gravel or boulders	Some slough areas may have less water in them under low flow conditions. No significant changes expected. No significant changes expected to preferred substrate.

^a WDNR. Online Natural Heritage Inventory Database: <http://dnr.wi.gov/org/land/er/nhi/CountyElements/>

Impacts to flora and fauna are closely associated with baseflow changes. Consequently, the information below is consistent with that found in Section 5.1.2.2 (Inland Waterways Size, Flow, and Floodplain) discussing the size, flow, and floodplain of inland waterways.

Root River

Lake Michigan Water Supply (City of Oak Creek) Alignment 2

No Lake Michigan supply itself would affect habitat in the Root River.

Root River to Lake Michigan Return Flow Alignment 2

An analysis of potential Root River habitat changes from an increase in flow from return flow was performed. The baseflow rate near the potential return flow location was 3 cfs and velocity was 0.11 ft/sec. The analysis found that the estimated increase in water surface elevation at baseflow conditions with a maximum return flow of 28.6 ft³/sec (18.5 mgd) was 0.91 foot and an increase in river velocity to 0.51 ft/sec during low-flow periods (MMSD, 09/2007, Table 3).

According to the literature, the slightly higher velocity generally still would be within the preferred velocity range for the dominant fish species in the Root River. Consequently, the slightly higher velocity is not expected to adversely affect the dominant fish species in the Root River. Table 5-29 summarizes the habitat preferences and potential changes to habitat with return flow for the dominant fish species in the Root River.

A search of the Wisconsin Natural Heritage Working List (WDNR, 2012b) and the WDNR Animals, Plants, and Natural Communities Database identified several threatened, endangered, or species of special concern in the Root River area (Table 5-30).

Return flow will increase the baseflow, which will have positive effects on water availability, amount of habitat, and also the fish species that depend upon the Root River. This is consistent with baseflow augmentation recommendations in prior Root River watershed reports. These anticipated positive effects are summarized below:

- The habitat for fish could be improved with additional flow during periods when low baseflows currently limit habitat availability.
- The WDNR's Root River Steelhead Facility could benefit from additional flow in the Root River. Since natural reproduction of trout and salmon does not occur in Wisconsin waters, the Lake Michigan's trout and salmon fishery is entirely dependent upon hatchery-raised fish. The Root River Steelhead Facility is Wisconsin's main source of rainbow trout (steelhead) eggs and brood (parent) stock and is the backup facility for the collection of eggs of other trout and salmon species. During some years when flow on the Root River is low, the WDNR has not met fish egg collection quotas. The WDNR has evaluated flow augmentation of the Root River to improve fish migration for egg collection, but determined it was cost prohibitive. Return flow provides the flow augmentation considered by the WDNR to allow more fish to reach the Steelhead Facility, meet egg collection quotas, and fish stocking goals (WDNR, 01/2013a).
- Under baseflow and low-flow conditions, return flow would provide additional water depth to improve fish passage through the riffle and shallow parts of the river, to deepen pools, and to provide more wetted perimeter habitat near the river banks and overhanging vegetation.

TABLE 5-29
Habitat Characteristics for Dominant Fish Species in the Root River

Dominant Fish Species	Preferred Current Velocity ^a	Stream Gradient ^a	General Habitat Characteristics ^a	Dominant Substrate Preference ^a	Potential Changes to Habitat with Return Flow
Creek chub	Less than 0.98 ft/sec	3 to 23 meters per kilometer (m/km)	Pools	Sand, gravel	Improved pool depth, especially during low-flow periods. Preferred velocity is out of range, but larger pools should offer more refuge. More substrate habitat could become available.
White sucker	1.31 ft/sec	Wide range	Wide range	Gravel, sand	Improved preferred current velocity. More substrate habitat could become available.
Long nose dace	More than 1.48 ft/sec	1.9 to 18.7 m/km	Riffles	Gravel, rubble	Improved preferred current velocity. More substrate habitat could become available.
Blunt nose minnow	Not documented in reviewed literature	Not documented in reviewed literature	Wide range	Gravel, sand	More substrate habitat could become available.
Black nose dace	0.49 to 1.48 ft/sec	11.4 to 23.3 m/km	Rocky runs and pools	Gravel, sand	Improved pool depth, especially during low-flow periods. Improvement in preferred current velocity. More substrate habitat could become available.
Green sunfish	Less than 0.33 ft/sec	0.2 to 5.7 m/km	50 percent pool areas	Vegetated cover	Improved pool depth, especially during low-flow periods. Preferred velocity is out of range, but larger pools should offer more refuge. No change in vegetated cover habitat expected.
Johnny darter	Not documented in reviewed literature	Not documented in reviewed literature	Pools	Sand, mud	Improvement pool depth, especially during low-flow periods. More substrate habitat could become available.
Central mud minnow	Not documented in reviewed literature	Not documented in reviewed literature	Quiet areas	Soft mud bottom/dense vegetation	More substrate habitat could become available.
Brook stickleback	Not documented in reviewed literature	Not documented in reviewed literature	Clear to slightly turbid waters of moderate currents	Sand, gravel and mud	More substrate habitat could become available.
Sand shiner	0.33 to 0.98 ft/sec	Wide Range	Prefers moderate currents and depths less than 0.33 ft	Sand, gravel-rubble/no aquatic vegetation	Improved preferred current velocity.

^a Main sources of information are from “Desktop Fisheries Analysis Assessment for Underwood Creek and Menomonee River Return Flow”, included as an attachment to the Return Flow Plan (Volume 4 of the Application), and Edwards, et al. (1988).

TABLE 5-30

Summary of Return Flow Effects on Habitat Characteristics for Fish Species Identified in WDNR Online Database as State Threatened, Endangered, and Species of Special Concern near Root River Return Flow Alignment 2 Discharge Location, but not Documented as Present in Recent Fish Surveys

Fish Species ^a	Preferred Current Velocity	Stream Gradient	General Habitat Characteristics	Dominant Substrate Preference	Potential Changes to Habitat with Return Flow
Longear Sunfish (threatened)	Not documented in reviewed literature	Not documented in reviewed literature	Slow moving rivers and streams	Shallow dense vegetation	More substrate habitat could become available.
Redfin shiner (threatened)	Not documented in reviewed literature	Not documented in reviewed literature	Prefers turbid waters of pools in low-gradient streams	Boulders, cobble, sand, silt or detritus	Improved pool depth, especially during low-flow periods.
Lake chubsucker (special concern)	Not documented in reviewed literature	Not documented in reviewed literature	Prefers moderately clear lakes, oxbow lakes, sloughs of weedy lakes and their associated marshy streams	Organic debris over bottoms of cobble, sand, boulders, mud or silt	Preferred habitat for this species is unlikely in this reach of the Root River; therefore no change expected.
Least darter (special concern)	Not documented in reviewed literature	Not documented in reviewed literature	Prefers clear, warm, quiet waters of overflow ponds, pools, lakes and streams	Gravel, silt, sand, boulders, mud or clay with dense vegetation or filamentous algal beds	Improved pool depth, especially during low-flow periods.

^a WDNR. Online Natural Heritage Inventory Database: <http://dnr.wi.gov/org/land/er/nhi/CountyElements/>.

- Return flow is expected to slightly increase shear stresses in the creek, which are insignificant to the geomorphic stability of the creek, but could improve the bottom substrate habitat by reducing embeddedness (fine sediment accumulation in coarse substrates) to support coarse sediment habitat, such as gravel.
- An increase in wetted perimeter would provide additional substrate for the production of macroinvertebrates, thus improving the quantity of the food base for fish. Where suitable habitat is available, the macroinvertebrate community in the Root River might change with return flow, but it would change to one that is more sustainable and adapted to the increased flows. The macroinvertebrate community with return flow would likely be more diverse since periods of no flow would no longer occur.
- As a result of this analysis, return flow to the Root River is expected to have a positive impact to fisheries in the Root River.

Return flow is not expected to have a significant adverse effect upon natural communities or wetlands adjacent to the waterway downstream of the return flow location. Because floodplain forest and emergent marsh habitats or similar habitats that may exist near return flow locations are immediately adjacent to the ordinary high water mark, mammal, vegetative, and bird species associated with floodplain forest and emergent marsh are well adapted to withstand minor fluctuations in water elevation resulting from typical seasonal conditions, flood events, or drought. Based upon the small water level changes expected to occur with return flow, no significant adverse impacts to emergent marsh, riparian species, or floodplain forests or the species that depend upon these habitats is expected.

Potential For Invasive Species

The City of Waukesha will use practices to reduce the potential of introducing or spreading invasive species and viruses (e.g. VHS) through the use of construction best management practices and ongoing operation practices.

During the construction phase of the water supply and return flow pipelines, best management practices will be used to reduce the potential introduction or spread of invasive species. The recently developed NR 40 *Invasive Species Identification, Classification and Control*, will be consulted and followed where applicable to implement best practices to control the spread of invasive species. Example practices that will be considered include washing equipment and timber mats before entering wetlands/water bodies, removing aquatic vegetation from equipment leaving waterways, steam cleaning and disinfecting equipment used in waterways where invasive species may exist, utilizing non-invasive construction techniques, and others. Post construction restoration methods will only use native species and it will consider methods to encourage existing native species to thrive to reduce the potential of the invasive species establishing a foothold. Using these approaches will reduce the potential for spreading invasive species during construction.

During the operation phase of the water supply and return flow pipelines, a Lake Michigan water supply source would have multiple barriers that would prevent the spread of invasive species through water delivered to the City of Waukesha. Drinking water treatment at any of the three potential Lake Michigan suppliers includes filters and disinfection procedures to remove and inactivate viruses. This level of treatment will not allow transfer of invasive species through the water distribution system. Once the water is

distributed in pipelines, an on-going disinfectant residual will be maintained, as required, to prevent microbial growth within the pipelines.

Once the drinking water is used and is collected in the sanitary sewer collection system, the City of Waukesha WWTP provides treatment before being discharged to the Fox River or as return flow. The WWTP is an advanced facility with settling and biological treatment systems, dual media sand filters, and ultraviolet light disinfection designed to meet WDNR water quality requirements. The treated wastewater is contained within the WWTP before being discharged as return flow. Consequently, there are no opportunities for invasive species or VHS from the Mississippi Basin to be introduced to the Lake Michigan basin from the return flow discharge.

5.1.2.5.3 Environmental Effects Comparison: Inland Waterways Flora and Fauna

Adverse impacts from changes in inland waterways flora and fauna are captured by impacts to aquatic habitat from baseflow changes. Baseflow changes have been previously documented in the Section 5.1.2.2 (Inland Waterways Size, Flow, and Floodplain) documenting baseflow changes. The threatened and endangered species identified by regulatory agencies as potentially occurring within the project corridors are summarized in Section 5.1.3 on Wetlands, since most of the potential impacts involve federal- or state-listed species associated with wetlands.

5.1.3 Wetlands

Federally jurisdictional wetlands are classified as “waters of the United States” and are protected under Section 404 of the Clean Water Act (34 USC 1344). The term “waters of the United States” covers both deepwater aquatic habitats and six categories of special aquatic sites (of which wetlands are one category) designated by the EPA in its Section 404(b)(1) guidelines (EPA, 2010b). The USACE and EPA jointly define wetlands as “areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that in normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.” Wetlands generally include swamps, marshes, bogs, and similar areas.

Wetland quality is decreased by various disturbances, including agricultural activities, civic culture, residential development, transportation and utility easements, drainage modifications (ditches, dams, drain tiles, stream channelization, etc.), and the invasion of exotic or nuisance plants. These disturbances usually alter the plant species composition or hydrological regime of an area, which in turn alter wetland quality.

For an area to be defined as a jurisdictional wetland, it must, under normal circumstances, possess positive indicators of each of three parameters: hydrophytic vegetation, hydric soils, and wetland hydrology.

- *Hydrophytic vegetation.* The prevalent vegetation must consist of plants adapted to life in hydric soils. These species, because of morphological, physiological, or reproductive adaptations, can and do persist in anaerobic soil conditions.
- *Hydric soils.* Soils in wetlands must be classified as hydric, or they must possess characteristics that are associated with reducing soil conditions. Hydric soils are soils that are “saturated, flooded, or ponded long enough during the growing season to

develop anaerobic conditions that favor the growth and regeneration of hydrophytic vegetation” (USACE, 1987).

- *Wetland hydrology.* The area must be permanently or periodically inundated or have soils that are saturated to the surface for some time during the growing season.

5.1.3.1 Location, Type, Size

5.1.3.1.1 Affected Environment

Wetlands crossed by the Lake Michigan supply and return flow routes were identified from the 2005 Wetlands Inventory provided by SEWRPC and WDNR (2005) to produce an accurate and comprehensive desktop wetlands inventory.

Table 5-31 lists the wetlands crossed by the Lake Michigan (City of Oak Creek) Alignment 2 supply and the Root River to Lake Michigan Alignment 2 return flow. Refer to the maps found in Appendix 3-1 of Section 3 for maps associated with the proposed project. Table 5-32 lists wetlands that would be affected by the pipeline or aboveground structure construction.

5.1.3.1.2 Environmental Effects

Wetland effects caused by the proposed project fall into two categories: impacts from construction, and operational impacts. Impacts from construction may be temporary construction impacts or operational impacts from new facilities, such as buildings or roads. Wetland loss from pipeline construction impacts are expected to be temporary in nature, whereas operational impacts will be ongoing permanent impacts. Some changes in wetland type from pipeline corridor maintenance are expected only where the pipeline corridor is not already maintained.

Wetland crossing acreages associated with the project are noted in Table 5-31, discussed below, and summarized in Table 5-32. A pipeline crossing a forested or scrub/shrub wetland would have a permanent wetland type change across the pipeline maintenance width. Maintenance would include managing woody vegetation. Consequently, pipeline maintenance would cause a shift from forested or scrub/shrub wetland to emergent marsh or wet meadow wetland type. Additional analysis on the significance of wetland acreages affected by the proposed project compared to other land use types can be found in Section 5.2.1.2, “Land Use.”

Before the City of Waukesha obtains a construction permit for the proposed project, the City will coordinate with the WDNR pursuant to the requirement of NR 103 to seek ways to reduce wetland impacts, whether temporary construction or long-term operational impacts. Such an analysis will look for ways to further reduce impacts, including adjustments to pipeline routes or construction methods to further minimize impacts.

Effects of Groundwater Drawdown on Wetlands

Groundwater drawdown impacts to wetlands are not associated with the proposed project. However, drawdown impacts to wetlands from groundwater water supply pumping are associated with alternatives to the proposed project as detailed in Section 6.

Impacts by Water Supply and Return Flow

The impacts to wetlands from a Lake Michigan water supply and return flow are described below.

TABLE 5-31
Wetland Crossings

Proposed Project	Wetland No.	Wetland Type	Crossing Width (ft)	Crossing Area (acres)
Lake Michigan Water Supply				
Lake Michigan (City of Oak Creek) Alignment 2	8714	Emergent/wet meadow	—	0.07
	9020	Forested	—	0.02
	9026	Forested	—	0.07
	9028	Forested	—	0.01
	10401	Emergent/wet meadow	—	<0.01
	10573	Emergent/wet meadow	—	<0.01
	11286	Scrub/shrub	—	0.01
	11290	Scrub/shrub	—	0.02
	11369	Scrub/shrub	—	0.02
	11376	Scrub/shrub	—	0.05
	11539	Scrub/shrub	—	<0.01
	11896	Forested	—	0.07
	11897	Forested	—	<0.01
	11900	Forested	—	0.13
	11906	Forested	—	0.03
	11914	Forested	—	<0.01
	12293	Forested	—	0.01
	12301	Forested	—	0.01
	12314	Forested	—	<0.01
	12392	Forested	—	0.01
	12399	Forested	—	<0.01
Return Flow for Lake Michigan Water Supply				
Root River to Lake Michigan Alignment 2	8714	Emergent/wet meadow	—	0.07
	9020	Forested	—	0.02
	9026	Forested	—	0.07
	9028	Forested	—	0.01
	10573	Emergent/wet meadow	—	<0.01
	11209	Flats/unvegetated wet ^a soil	12.96	0.04
	11286	Scrub/shrub	—	0.01
	11290	Scrub/shrub	—	0.02
	11369	Scrub/shrub	—	0.02

TABLE 5-31
Wetland Crossings

Proposed Project	Wetland No.	Wetland Type	Crossing Width (ft)	Crossing Area (acres)
	11376	Scrub/shrub	—	0.05
	11777	Forested	37.48	0.07
	11890	Forested	—	0.01
	11896	Forested	—	0.07
	11914	Forested	—	<0.01
	12263	Forested	—	0.11
	12314	Forested	—	<0.01
	12392	Forested	—	0.01
	12399	Forested	—	<0.01

^aIncluded in PEM summary because open flats will likely first transition to emergent vegetation.

Lake Michigan Water Supply (City of Oak Creek) Alignment 2
Three PEM, 5 PSS, and 13 PFO wetlands along this route could be affected by pipeline construction. As shown in Table 5-32, the supply route could affect less than 1 acre of wetlands. Less than 0.1 acre of permanent impact in the form of a wetland type change is anticipated.

TABLE 5-32
Wetlands Crossed by the Proposed Project

Wetland Types	Lake Michigan Supply: Lake Michigan (City of Oak Creek) Alignment ^a		Return Flow for Lake Michigan Water Supply: Root River to Lake Michigan Alignment ^a	
	Temporary Land Affected ^b (ac)	Permanent Land Affected ^c (ac)	Temporary Land Affected ^b (ac)	Permanent Land Affected ^c (ac)
Emergent/wet meadow	0.08	0	0.07	0
Scrub/shrub	0.1	0	0.1	0
Forested	0.36	0	0.36	0.01
Open water	0	0	0	0
Other ^d	0	0	0.04	0
Total	0.54	0	0.58	0.01

Source: WWI

^a Most of the pipeline alignments follow previously disturbed areas and maintained utility corridors. Forested wetlands are generally not present in maintained utility corridors. Potential permanent wetland impacts are consequently conservative.

^b Includes all areas being temporarily impacted by the construction of the supply and return flow routes. Total values are slightly different due to rounding.

^d Includes all land being disturbed permanently for groundwater drawdowns and the operation, which includes new access roads, new aboveground structures, and pipeline maintenance corridors, where applicable. Total values are slightly different due to rounding.

^d Includes filled/drained wetlands, and flats/unvegetated wet soil areas.

Root River to Lake Michigan Return Flow Alignment 2

Three PEM, 3 PSS, and 11 PFO wetlands along this route could be affected by pipeline construction. As shown in Table 5-32, the return flow route could affect less than 1 acre of wetlands, additionally less than 0.1 acre of permanent impact in the form of a wetland type change is anticipated.

Avoidance and Minimization

The construction areas for supply and return flow pipelines are co-located with existing infrastructure to the greatest extent feasible to minimize wetland impacts by using previously disturbed land and reducing habitat fragmentation.

Temporary construction impacts in wetlands may include loss of herbaceous and scrub-shrub vegetation, wildlife habitat disruption, soil disturbance associated with grading, trenching, and stump removal, sedimentation and turbidity increases, and hydrological profile changes. Impacts will be minimized by adherence to BMPs developed by coordination among the City and agency stakeholders, and state and local permit requirements.

5.1.3.1.3 Environmental Effects Comparison: Wetlands—Location, Type, and Size

Adverse impacts from changes to wetlands are summarized below. Impacts were compared based upon Table 5-33. Table 5-34 summarizes the impacts to wetlands.

Lake Michigan Water Supply (City of Oak Creek) Alignment 2

There would be less than one acre of temporary and permanent wetland impacts associated with this route. Since the alignment requires temporary impacts to wetlands, this would be a minor adverse impact.

Root River to Lake Michigan Return Flow Alignment 2

For return flow to the Root River, there would be less than 1 acre of temporary and permanent wetland impacts. Since the alignment requires temporary impacts to wetlands, this would be a minor adverse impact.

5.1.3.2 Flora and Fauna

5.1.3.2.1 Affected Environment

The regional landscape around the project originally was a combination of hardwood forest, prairie, savanna, and wetlands. Only parts of the hardwood forests and wetlands remain, because most of the project area has been converted to urban, suburban, and agricultural land. Wet prairies, southern sedge

TABLE 5-33
Environmental Impact Category Description: Wetlands

Category	Temporary Construction Impacts	Operational Impacts
No adverse impact	Less than 0.1 acres	Less than 0.1 acres
Minor adverse impact	Greater than 0.1 acres	Greater than 0.1 acres, but less than 5 acres
Moderate adverse impact	Not applicable	Greater than 5 acres, but less than 10 acres
Significant adverse impact	Not applicable	Greater than 10 acres

TABLE 5-34
Water Supply and Return Flow Alternative Environmental Impact Comparison Summary: Wetlands

Alternative	Wetlands
Water Supply	
Lake Michigan (City of Oak Creek) Alignment 2	Minor adverse impact
Return Flow Alternatives for Lake Michigan Water Supplies	
Root River to Lake Michigan Alignment 2	Minor adverse impact

meadows, emergent marshes, calcareous fens, shrub-carr, northern wet forests, and floodplain forests might be found within the project area. Sedge meadows and wet prairies are dominated by grasses and sedges. Fens support grasses, sedges, and a diversity of other herbaceous plants. Emergent marshes occur along the edges of lakes and streams, and consist of emergent and submergent vegetation. Shrub swamps are dominated by various wet shrubs, but they also may occur as a successional stage that follows herbaceous vegetation found in sedge meadows, fens or floodplains. Forested wetlands may be dominated by conifers or hardwoods (WDNR, 09/2011b).

The spatial arrangement of wetlands can provide essential habitat for wildlife. Wetlands form links between aquatic and upland areas, and can be a connection among upland communities. They provide water, food, and shelter for wildlife, and supply unique habitat conditions for many plant species. Wetlands have a higher rate of biological productivity than other types of ecosystems, partly because of the natural functions they provide. This allows them to support abundant plant and animal life and also rare species. Almost half of all federal-listed threatened and endangered species use wetlands at some point in their life cycles. In Wisconsin, about 32 percent of the state's listed species are wetland dependent (WDNR, 09/2013c).

Many bird and mammal species rely on wetlands, especially during migration and breeding. The large marshes throughout southeastern Wisconsin provide critical feeding, nesting, and resting habitat for numerous waterfowl. Natural, periodic flood flows, usually spurred by spring snowmelt and heavy rains, are important to the health of floodplain forests and wetlands, and to the maintenance of self-sustaining populations of wetland-spawning fish, such as walleye and northern pike. Aquatic life that is dependent upon rivers and floodwaters supports a variety of mammal and avian species. Unfortunately, most wetlands within the area have experienced widespread draining, ditching, grazing, and infestation by invasive plants, such as reed canary grass.

Natural Communities

According to correspondence from the USFWS (2013), no vegetation communities of special concern or critical habitat occur within the construction workspaces associated with the proposed Lake Michigan supply and return flow routes.

WDNR (2010c, 2011c, 2013c) identified vegetation communities of special concern (referred to as “natural communities”) that may occur within the Lake Michigan supply and return flow corridors. The pipeline alignments follow streets, alleys, bike paths, active and abandoned railroad corridors, utility corridors, city and county lands, and previously disturbed areas, so few impacts to natural communities are expected. Impacts to natural communities will be coordinated with the appropriate state and federal agencies, avoided, and minimized.

Natural communities include Lake Michigan, inland waterways, wetlands, and terrestrial habitats. However, discussion of all natural communities is included under “wetlands” because most of the natural community types are wetland communities.

The WDNR identified the following natural communities that could exist along the pipeline corridors in response to the Natural Heritage Inventory Environmental Review Request submitted by the Waukesha Water Utility (WDNR, 2010c, 2011c, 2013c):

- Southern dry mesic forest
- Southern mesic forest
- Southern dry forest
- Mesic prairie
- Wet prairie
- Emergent marsh
- Southern sedge meadow
- Oxbow lake
- Oak opening
- Calcareous fen
- Shrub-carr
- Southern tamarack swamp
- Northern wet forest
- Floodplain forest
- Springs and spring runs
- Warm-water stream
- Bird rookery
- Wet-mesic prairie

A habitat assessment was completed in July 2010 (Appendix 6-7) along the pipeline corridors which provided field verification of potential habitat types. The field observations noted specific natural communities at or immediately downstream of discharge locations are limited to floodplain forests, emergent marsh, and warm-water streams.

Oak opening and wet- mesic prairie natural community were identified by the WDNR in the most recent response to the Natural Heritage Inventory Environmental Review Request for the proposed project submitted by the Waukesha Water Utility (WDNR, 2013c). Evaluations of the oak opening and wet mesic prairie natural communities were added to the exhibits in Appendix 6-5 and the following analysis. With the alignment of the proposed project following street rights-of-way, impacts to natural communities were evaluated using the results of the field work and available spatial data. Descriptions of the communities affected and how they were evaluated include:

Bird Rookery

Bird rookeries require trees in or adjacent to open water or wetlands. Consequently, the relative potential occurrence of bird rookery habitat was compared by determining the total of all wetlands and all woodlands adjacent to bodies of water affected by the alternative. With the absence of a GIS data set specific to bird rookeries, the relative ranking of low, moderate, or high potential suitability was used. There has been no confirmed presence of a bird rookery for any of the alternatives. Appendix 6-5, Exhibit 2 compares potential bird rookery impacts.

Wet Prairie

Wet prairie shares characteristics with emergent aquatic communities. Thus, the relative occurrence of potential wet prairie impacts utilized the WWI emergent marsh GIS data set to evaluate potential wet prairie impacts. With the absence of a GIS data set specific to a wet prairie, the relative ranking of low, moderate, or high potential suitability was used. There has been no confirmed presence of wet prairie for any of the alternatives. Appendix 6-5, Exhibit 2 compares potential wet prairie impacts.

Springs and Spring Runs

The Wisconsin Geological and Natural History Survey (WGNHS) maintains an inventory of springs that was consulted to determine potential impacts to them. None was found within the construction footprint of the Lake Michigan water supply alternatives or the return flow alternatives. An analysis of springs potentially affected by groundwater drawdown had been done previously (see maps in Appendix 6-3). Another analysis was conducted to determine the number of WGNHS-documented springs within the project area for all alternatives. With the availability of a specific GIS data set addressing springs, a comparison

to the WGNHS data set was conducted. A ranking of low, moderate, or high suitability was developed using the number of springs, instead of the number of acres, affected. Springs and spring runs have been confirmed based upon literature documentation for the groundwater supply alternatives within the groundwater drawdown areas. Appendix 6-5, Exhibit 2 compares potential springs and spring run impacts.

Streams

Stream data are available through GIS data sets. A comparison was conducted using the data, and the relative ranking of low, moderate, or high potential suitability based upon acres impacted was used to evaluate impacts to streams listed as (slow, hard warm) by the WDNR. There has been no confirmed presence of a slow, hard warm stream within any of the alternatives. Appendix 6-5, Exhibit 2 compares potential stream impacts.

Oxbow Lake

No GIS data were available for oxbow lakes. The analysis for the potential of an oxbow lake was conducted by observing the location of bodies of water on aerial maps and through the habitat field survey conducted in 2010. There has been no confirmed presence of an oxbow lake within any of the alternatives. Appendix 6-5, Exhibit 2 compares potential oxbow lake impacts.

Emergent Marsh

Information on the presence and extent of emergent marshes was available through the WWI. The relative comparison of the potential for an alternative to impact emergent marsh habitat was conducted using GIS analysis. With the availability of a specific GIS data set, a numeric comparison of acres was made. Appendix 6-5, Exhibit 3 compares potential emergent marsh impacts.

Shrub-Carr Wetlands

Information on the presence and extent of the shrub-carr natural community is available through the WWI which identifies shrub-carr as “scrub-shrub” wetland. The relative comparison of the potential for an alternative to impact shrub-carr wetlands was conducted using GIS analysis. With the availability of a GIS data set specific to shrub-carr communities, a numeric comparison of acres impacted was made to conduct the relative comparison. Appendix 6-5, Exhibit 3 compares potential shrub-carr impacts.

Forested Floodplain

Information on the potential location of the forested floodplain natural community was analyzed using available GIS data sets for SEWRPC woodlands, WWI forested wetlands, and Federal Emergency Management Agency (FEMA) floodplains. All areas of woodlands and forested wetlands located within the mapped 100-year floodplain were assumed to represent forested floodplain. The calculated numeric acreages were used as the basis determining whether an alternative could affect a forested floodplain. Appendix 6-5, Exhibit 3 compares potential forested floodplain impacts.

Mesic Prairie

A mesic prairie is an open grassland habitat. Because a mesic prairie GIS data set was unavailable, information on the potential location of the mesic prairie natural community was analyzed using available GIS data sets for the SEWRPC open lands and observations made during the summer 2010 habitat assessment. The presence of open lands does not necessarily mean mesic prairie would exist but using the SEWRPC open lands data set

provides insight into the potential existence for this habitat type. With the absence of a GIS data set specific to the mesic prairie, the relative ranking of low, moderate, or high potential suitability based on open lands acreage and field observations was used. There has been no confirmed presence of a mesic prairie for any of the alternatives. Appendix 6-5, Exhibit 2 contains the relative comparison of potential mesic prairie impacts.

Southern Sedge Meadow

A southern sedge meadow is an open wetland community. Because a southern sedge meadow GIS data set was unavailable, information on the potential location of the southern sedge meadow natural community was analyzed using available GIS data sets for WWI emergent marsh. Southern sedge meadow is often found adjacent to emergent marsh; consequently, emergent marsh is a good indicator of the potential presence of southern sedge meadow. With the absence of a GIS data set specific to southern sedge meadow, the relative ranking of low, moderate, or high potential suitability based on emergent marsh acreage was used. There has been no confirmed presence of a southern sedge meadow for any of the alternatives. Appendix 6-5, Exhibit 4 compares potential southern sedge meadow impacts.

Calcareous Fen

Calcareous fens occur in areas receiving carbonate-enriched groundwater. Because a GIS data set for calcareous fen was unavailable, information on the potential location of the calcareous fen natural community was analyzed using available GIS data sets for WWI emergent marsh supplemented with 2010 field observations and communication with the Vernon Marsh Wildlife Area manager, who is aware of known calcareous fen locations in the Vernon Marsh Wildlife Area. Calcareous fens are often found adjacent to emergent marshes; consequently, emergent marsh is a good indicator of potential presence of calcareous fen. With the absence of a GIS data set specific to calcareous fen, the relative ranking of low, moderate, or high potential suitability based on emergent marsh acreage and field observations was used. There has been no confirmed presence of a calcareous fen for any of the alternatives. Appendix 6-5, Exhibit 4 compares potential calcareous fen impacts.

Northern Wet Forest

The potential presence of northern wet forest was analyzed using WWI forested wetlands, because a GIS data set specific to northern wet forest was unavailable. The presence of forested wetlands does not necessarily mean a northern wet forest would exist but using the WWI forested wetlands data set provides insight into the potential existence of this habitat type. With the absence of a community-specific specific GIS data set, the relative ranking of low, moderate, or high potential suitability based on forested wetlands acreage was used. There has been no confirmed presence of a northern wet forest for any of the alternatives. Appendix 6-5, Exhibit 5 compares potential northern wet forest impacts.

Southern Dry Forest

The potential presence of southern dry forest was analyzed using SEWRPC woodlands, because a GIS data set specific to southern dry forest was unavailable. The presence of woodlands does not necessarily mean a southern dry forest would exist but using the SEWRPC woodlands data set provides insight into the potential existence for this habitat type. With the absence of a GIS data set specific to southern dry forest, the relative ranking of low, moderate, or high potential suitability based on woodlands acreage was used. There has been no confirmed presence of a southern dry forest for any of the alternatives. Appendix 6-5, Exhibit 5 compares potential southern dry forest impacts.

Southern Dry Mesic Forest

The potential presence of southern dry mesic forest was analyzed using SEWRPC woodlands, because a GIS data set specific to southern dry mesic forest was unavailable. The presence of woodlands does not necessarily mean a southern dry mesic forest would exist but using the SEWRPC woodlands data set provides insight into the potential existence of this habitat type. With the absence of a GIS data set specific to southern dry mesic forest, the relative ranking of low, moderate, or high potential suitability based on woodlands acreage was used. There has been no confirmed presence of a southern dry mesic forest for any of the alternatives. Appendix 6-5, Exhibit 5 compares potential southern dry mesic forest impacts.

Southern Mesic Forest

The potential presence of southern mesic forest was analyzed using SEWRPC woodlands, because a GIS data set specific to a southern mesic forest was unavailable. The presence of woodlands does not necessarily mean a southern mesic forest would exist but using the SEWRPC woodlands data set provides insight into the potential existence for this habitat type. With the absence of a GIS data set specific to southern mesic forest, relative ranking of low, moderate, or high potential suitability based on woodland acreage was used. There has been no confirmed presence of a southern mesic forest for any of the alternatives. Appendix 6-5, Exhibit 5 compares potential southern mesic forest impacts.

Southern Tamarack Swamp

The potential presence of southern tamarack swamp was analyzed using WWI forested wetlands, because a GIS data set specific to southern tamarack swamp was unavailable. The presence of forested wetlands does not necessarily mean a southern tamarack swamp would be present but using the WWI forested wetlands data set provides insight into the potential existence of this habitat type. With the absence of a community-specific GIS data set, the relative ranking of low, moderate, or high potential suitability based on forested wetland acreage was used. There has been no confirmed presence of a southern tamarack swamp for any of the alternatives. Appendix 6-5, Exhibit 5 contains the relative comparison of potential southern tamarack swamp impacts.

Oak Opening

An oak opening is an oak dominated savanna community in which there is less than 50 percent tree canopy. The potential presence of an oak opening community was analyzed using SEWRPC open lands, because a GIS data set specific to an oak opening was unavailable. The presence of open lands does not necessarily mean an oak opening would exist but using the SEWRPC open lands data set provides insight into the potential existence for this habitat type. With the absence of a GIS data set specific to oak opening, relative ranking of low, moderate, or high potential suitability based on open lands acreage was used. There has been no confirmed presence of an oak opening for any of the alternatives. Appendix 6-5, Exhibit 5 compares potential oak opening impacts.

Wet-Mesic Prairie

Wet-mesic prairie shares characteristics with emergent aquatic communities. Thus, the relative occurrence of potential wet-mesic prairie impacts utilized the WWI emergent marsh GIS data set to evaluate potential wet-mesic prairie impacts. With the absence of a GIS data set specific to a wet-mesic prairie, the relative ranking of low, moderate, or high potential suitability was used. There has been no confirmed presence of wet-mesic prairie for any of the alternatives. Appendix 6-5, Exhibit 2 compares potential wet-mesic prairie impacts.

Natural Communities Near Return Flow Discharge Location

At the Root River Alignment 2 discharge location, natural communities potentially affected by the return flow include mesic prairie, southern dry-mesic forest, emergent marsh, shrub-carr, southern sedge meadow, and wet prairie (WDNR, 2013c). For those communities potentially located immediately adjacent to the Root River, they would be adapted to water level fluctuations and small changes in water level caused by return flow are not expected to affect these communities significantly.

Natural communities other than those adapted to live immediately adjacent to waterways may exist along the various alternatives and near the proposed return flow outfall location, but because of their topographical location within the southeastern Wisconsin landscape and distance from the discharge location, they are not likely to be affected by minor changes in water elevations and flow. They could, however, be affected by pipeline construction or groundwater drawdown, the impacts of which are described in Appendix 6-5 with a relative comparison summary in Table 5-35.

Endangered and Threatened Species

Endangered and threatened species are described for all habitat types (Lake Michigan, inland waterways, wetlands, and terrestrial habitats) under “Wetlands,” because the project would have the greatest environmental impact on the wetland habitat type.

The Endangered Species Act of 1973 (16 U.S. Code (USC) 1531-1543, Public Law 93-205) states that threatened and endangered plant and animal species are of aesthetic, ecological, educational, historic, and scientific value to the U.S., and that those species and their habitats must be protected. The Act protects fish, wildlife, plants, and invertebrates that are federally listed as endangered or threatened.

A federally endangered species is one that is in danger of extinction throughout all or a significant part of its range, with the exception of certain insect pests. A federally threatened species is one that is likely to become endangered in the foreseeable future throughout all or a significant part of its range. Species likely to become endangered or threatened in the foreseeable future may be listed as proposed endangered or threatened, or of special concern. Federal regulatory protection is also afforded to certain rare, natural vegetation communities, or critical habitats.

In Wisconsin, WDNR describes threatened and endangered species as one of three categories. An “endangered” species is one whose continued existence as a viable component of the state’s wild animals or wild plants is determined by WDNR to be in jeopardy on the basis of scientific evidence. A “threatened” species is one that appears likely, within the foreseeable future and on the basis of scientific evidence, to become endangered. A “special concern” species is one for which some problem of abundance or distribution is suspected but not yet proved. The main purpose of the last category is to focus attention on certain species before they become endangered or threatened.

Endangered and threatened species are characteristically in jeopardy because of ecosystem disruptions, including destruction, alteration, or curtailment of habitats; overexploitation; and the effects of disease, pollution, and predation. An individual species may be both state and federally listed.

The USFWS and the WDNR were contacted to determine federal- or state-listed species known to occur within the project corridor.

Federal-Listed Species

According to correspondence from the WDNR and USFWS (2013c, 2013), one federally listed threatened species occurred within a mile of the Lake Michigan (City of Oak Creek) Supply Alignment 2, but does not intersect the project's 75-foot construction corridor. The federally listed species is the Prairie White-fringed Orchid. USFWS stated that the prairie white-fringed orchid would not be expected within the projected area due to the historical nature of the occurrence (USFWS, 2013). The City plans to consult with the USFWS before construction to verify no federal-listed species have been identified within the selected workspace.

State-Listed Species

The City initiated consultation with WDNR Office of Energy, which assumes responsibility for the review of endangered resources for utility projects and works closely with the Bureau of Endangered Resources to implement the WDNR's policies and regulations regarding protection of endangered resources. WDNR (2013c) identified several State listed species as potentially intersecting the alignments and occurring within a mile of the proposed Lake Michigan supply and return flow. Table 5-37 displays the total number of species within a mile of the for the pipeline routes. The WDNR identified 31 NHI species within a mile of the Lake Michigan (City of Oak Creek) Supply Alignment 2, but the analysis showed potential habitat for only 10 of the 31 species intersects the alignment. Similarly, the WDNR identified 29 NHI species within a mile of the Root River to Lake Michigan Return Flow Alignment 2, but the analysis showed potential habitat for only 12 of the 29 species intersects the alignment. Due to the pipeline alignments following previously disturbed street rights-of-ways, few impacts to listed species are expected.

The City also consulted SEWRPC at the WDNR's request to inquire about threatened or endangered species or species of concern. The information obtained from SEWRPC is available in several reports, by watershed, and is consistent with information on listed species received from the WDNR.

Once the project has received regional approval, field surveys will be completed along the selected route to confirm the presence or absence of the species listed by the WDNR.

The tables in Appendix 6-6 summarize the listed species associated with the proposed project supply and return flow routes. In comparison to the alternatives, the proposed project supply and return flow routes affect the smallest number of NHI species. The attachment also documents correspondence with the WDNR and USFWS in regards to threatened and endangered species.

5.1.3.2.2 Environmental Effects

Potential impacts to wildlife, natural community, and endangered resources fall into three categories:

- **Temporary**—Temporary impacts are those that result only from construction. Use of construction techniques that minimize impacts and that restore the construction area is expected to limit temporary impacts to the duration of the construction period (typically less than a year). Areas temporarily disturbed by pipeline construction would be

restored to the same or better condition than what had existed initially. Temporary impacts would occur for a Lake Michigan water supply and return flow.

- **Permanent, associated with long-term groundwater drawdown that results in habitat-type changes** – An example of such an impact is groundwater drawdown in an emergent marsh that causes the marsh habitat to decrease in areal extent and at least partially transition to upland habitat.
- **Permanent, associated with new aboveground infrastructure or aboveground pipeline maintenance** – Aboveground infrastructure includes access roads and other aboveground structures. Pipeline corridor maintenance is a long-term impact in areas where routine mowing may result in a permanent habitat type change. Habitat type changes could occur in areas of natural vegetation where active maintenance is not currently performed. The only above ground structure is a quarter acre pump station associated with the Lake Michigan water supply and return flow. Section 5.1.2 (Inland Waterways) discusses potential impact minimization and avoidance measures for the major permanent impacts.

Impacts to Natural Communities

A natural community is an assemblage of different plants and animal species within a specific habitat. Appendix 6-5, Exhibit 1 contains the WDNR's description of each natural community identified by the NHI inventory potentially near the project and therefore potentially affected by the water supply and return flow routes. Exhibit 1 is provided separately because of the sensitive nature of potential habitat locations for threatened and endangered species.

An analysis of the NHI data received from the WDNR, supplemented by the findings from the 2010 field observations and aerial imagery, was conducted for each natural community to produce a relative comparison of impacts for the water supply and return flow routes. Impacts were evaluated based on the assumption of a conventional excavation installation technique without considering construction BMPs that could minimize impacts, such as directional drilling for pipelines. The City of Waukesha will work with the WDNR and other resource agencies to minimize natural community impacts with the proposed project. The process for evaluating the natural communities is described below, with the relative comparison for each route presented in Appendix 6-5, Exhibits 2 through 5 summarized below.

Relative Comparison Method

Because natural community-specific data in acres were not directly available in GIS data sets for all natural communities, general habitat information was used to generate a relative comparison of the potential impact. For example, no GIS layer specific for the bird rookery is available, so a relative comparison was conducted using other habitat-type information. Conversely, the estimated acreage impact to the emergent marsh natural community is available from the WWI GIS layer, and so the specific data were used for the analysis. The procedure for evaluating each natural community is described as follows.

The following suitability rating scale is meant to provide a measure of the potential of a given route to contain the natural communities listed by the WDNR:

- Absent – habitat is not present
- Low potential suitability – Up to 10 acres
- Moderate potential suitability – 10 to 20 acres
- High potential suitability – More than 20 acres

Summary of Natural Community Relative Comparisons

Evaluation of Appendix 6-5, Exhibits 2 through 5, indicated that alternatives to the proposed project have the highest overall potential impact to natural communities. Impacts to wetland areas and other natural communities from the Lake Michigan water supply and return flow routes are largely temporary or several orders of magnitude less than those associated with groundwater alternatives to the proposed project. Table 5-35 summarizes the relative impact ratings ranked “high,” whereby impacts would occur for each water supply and return flow route. All of the natural communities identified by the WDNR were ranked as either “low suitability” or not applicable for the proposed project, in large part because the pipeline alignment follows street rights-of-way.

TABLE 5-35

Summary of Natural Community High Suitability Ratings

Proposed Project	High Suitability Ratings (Out of 18 Natural Communities)
Water Supply	
Lake Michigan Supply	
Lake Michigan (City of Oak Creek) Alignment 2	none
Return Flow for Lake Michigan Water Supply	
Root River to Lake Michigan Alignment 2	none

The comparison of impacts to natural communities was not carried forward because the analysis was similar to that for the wetland and aquatic habitat categories already documented.

The actual impacts to natural communities may vary from those presented here, depending upon the final pipeline route, field verification of natural resources, and efforts to avoid, minimize, and mitigate impacts to natural communities, but the analysis conducted accurately depicts the relative impacts of the pipeline routes. The City of Waukesha will work with the WDNR and resource agencies to avoid, minimize, and mitigate impacts resulting from the project.

Impacts to Endangered and Threatened Species

Based on the consultation response from USFWS (2013), one federally-threatened species historically occurred within the nearby vicinity of the Lake Michigan (City of Oak Creek) Supply Alignment 2. The federally listed species was the Prairie White-fringed Orchid. According to the correspondence, due to the historical nature of this occurrence, the USFWS would not expect the Prairie White-fringed Orchid to still occur within the project area. Once the project receives regional approval, field surveys will be completed along the selected route to confirm the presence or absence of the listed species by the WDNR. By

following previously disturbed street rights-of-way, impacts to the prairie white-fringed orchid are unlikely.

The USFWS was contacted for further information on the federally threatened plant and any critical habitats of concern. USFWS stated that “if there is a lag between plan completion and construction this office should be contacted for updated species and critical habitat information [which is] updated every 6 months.” The City will resume consultation with the USFWS before construction to comply with its request and to meet requirements to protect federal-listed species or critical habitat.

The City selected pipeline routes through areas already developed or disturbed to minimize impacts to endangered and threatened species. The City will work with regulatory agencies to identify locations where such species could be affected and take measures to minimize impacts. Most of the project footprint for all alternatives is associated with pipeline construction, and the impacts of construction will be temporary.

Operational impacts are associated with the aboveground structures. The Lake Michigan water supply and return flow routes have insignificant operational surface impacts. Land Use Section 5.2.1.2, Table 5-41, summarizes the temporary construction and operational surface impacts.

The City coordinated with the WDNR to conduct a habitat assessment at locations along alternative infrastructure alignments in the summer of 2010. The information obtained was incorporated into identifying natural communities at locations along the alternative alignments and incorporated qualitatively in the analysis below. The proposed project which follows previously disturbed street right-of-ways was qualitatively reviewed using aerial imagery. The habitat assessment report is included as Appendix 6-7.

Relative Comparison of Endangered Species Impacts

The Lake Michigan water supply and return flow routes were analyzed for the impacts they could have on preferred habitat for threatened, endangered, or species of special concern.

Habitat Comparison

The preferred habitat for threatened species, endangered species, and species of special concern was summarized. SEWRPC land use data were used to document habitat affected. A 15-foot-wide permanent pipeline maintenance corridor was assumed to calculate permanent impacts where land was not already developed or within existing utility or transportation right-of-ways.

Temporary impacts for pipelines assumed a larger impact area to compensate for machinery and material staging for installing the pipeline. A 75-foot-wide temporary pipeline construction easement was assumed to calculate temporary impacts. After the pipeline is constructed, the construction area will be restored to a condition similar to or better than what existed prior to construction in accordance with recommendations from the WDNR and applicable resource agencies. Permanent impacts for pipelines exist only where long-term pipeline maintenance requires a change in land use. For example, existing transportation and utility corridors are already routinely maintained, so no additional maintenance of those areas would be needed. Long-term impacts from pipeline corridors are associated mainly with forest and scrub-shrub habitat areas, where new tree growth would conflict with maintenance goals.

Appendix 6-5, Exhibit 6, summarizes the temporary and permanent impacts. The tabulated data indicate that the dominant land uses affected by the proposed Lake Michigan water supply and return flow routes are transportation and residential.

Table 5-36 summarizes the permanently affected acres of wetlands and all land uses.

TABLE 5-36
Summary of Permanent Land Impacts to Wetlands and Total Acreage

Proposed Project	Wetland Impacts ^a (acres)	Total Impacts (acres)
Lake Michigan Water Supply		
Lake Michigan (City of Oak Creek) Alignment 2	<1	<1
Return Flow for Lake Michigan Water Supply		
Root River to Lake Michigan Alignment 2	<1	<1

^a Wetland types include emergent/wet meadow, scrub/shrub, forested, open water, other (filled/drained and flats/unvegetated wet soil areas), and no surface water.

Endangered Resource Inventory

The endangered resources are reviewed together in this wetlands section for all habitat types (wetland, aquatic, and terrestrial) because the species most affected by the proposed project are species with wetland habitat preferences.

Preferred habitat requirements for each of the threatened, endangered, and species of special concern, based upon NHI information, was summarized and correlated with SEWRPC land use types. For example, species listed by NHI as requiring forest habitat were categorized as woodland species according to the SEWRPC land use designations. It should be noted, that depending upon NHI habitat requirements, a particular species may be associated with multiple SEWRPC land use designations. The list of species, their habitat preferences, and the corresponding SEWRPC land use designation assignments are included in Appendix 6-5, Exhibits 7 and 8. Exhibits 7 and 8 are provided separately due to the sensitive nature of the potential habitat locations for threatened and endangered species. Each water supply and return flow route has a separate list of species.

Once each listed species was assigned to a SEWRPC land use, the number of occurrences for each land use type was calculated and used to determine which land use types are more likely to represent habitat for listed species. Appendix 6-5, Exhibit 9 compares rare species habitat occurrences by land use type. Individual wetlands types (emergent marsh, forested wetland, etc.) were used to designate habitat requirements for individual species, but all wetlands types were added together to simplify comparison.

Table 5-37 lists the land uses that scored highest for habitat requirements, the relative occurrence of habitat requirements for the top four habitat types (accounting for more than 90 percent of all listed species), and the total number of NHI species within a mile of each route.

TABLE 5-37

Relative Occurrence of State- and Federal-Listed Species per Land Use for the Proposed Project
Relative Comparison of Wildlife, Natural Community, and Endangered Resources

Proposed Project	Open Lands	Woodlands	Surface Water	Wetlands ^a	Total Listed Species per Route
Lake Michigan (City of Oak Creek) Alignment 2	11%	20%	20%	45%	31
Return Flow for Lake Michigan Water Supply					
Root River to Lake Michigan Alignment 2	12%	21%	19%	42%	29

Sources: SEWRPC Land Use Data and Wisconsin Dept. of Natural Resources, Natural Heritage Inventory Results

^a Includes all wetland types, including, emergent/wet meadow, scrub-shrub, forested, open water, and other. See Exhibit 6, Appendix 6-5.

Summary of Potential Listed Species Impacts

Appendix 6-5, Exhibit 9 and Table 5-37 show that wetlands habitat is needed for almost half the listed species habitat requirements along the supply and return flow routes. Of all habitats affected by the supply and return flow routes, wetlands have the greatest potential to provide habitat for listed species. For both the proposed supply and return flow routes, the amount of wetland habitat acres temporarily affected by the pipeline route is less than 1 acre. Exhibit 6 in Appendix 6-5 contains a comparison of the amount of wetland habitat acres temporarily and permanently affected by the Lake Michigan Supply (City of Oak Creek) Alignment 2 pipeline route and the Root River to Lake Michigan Alignment 2 return flow pipeline route. The proposed project permanently affects the smallest number of wetland acres (0.01 acre). As such, the proposed water supply and return flow would be expected to have minor adverse impacts to listed species habitat.

The comparison of impacts to listed species was not carried forward, because the listed species impact analysis is similar to the wetland impacts and aquatic habitat impacts and the listed species predominantly require wetland habitats. Once regional approval for the project has been received, further field surveys will be completed to confirm the presence or absence of the species listed by the WDNR. The City will work closely with the WDNR and other resource agencies as needed to avoid, minimize, or mitigate impacts to threatened or endangered species.

Should a threatened or endangered species be positively identified within the construction workspace, the City will:

- Avoid or minimize impacts to the species wherever feasible
- Stage construction to limit disturbance during sensitive time periods
- Conduct temporary removal by an approved scientist following established protocols

5.1.3.2.3 Functional Values

Until the latter half of the 20th century, wetlands often were viewed as wastelands, useful only when drained or filled. Wetlands are now known to provide critical habitat for wildlife, water storage to prevent flooding and improve water quality, and recreational opportunities for wildlife watchers, anglers, hunters, and boaters. These are known as “wetland functional values.” Wetlands provide the following different functions:

- Biodiversity of plants for food and shelter for many animal species at critical times during their life cycles
- Creating critical habitat for feeding, breeding, resting, nesting, escape cover, or travel corridors
- Essential habitat for smaller aquatic organisms in the food web, including crustaceans, mollusks, insects, and plankton
- Retention of stormwater to prevent rain and melting snow from rushing toward rivers and lakes, and reducing floodwater from rising streams
- Capacity in plants and soils to store and to filter pollutants, ranging from pesticides to animal wastes
- Protection against erosion by absorbing the force of waves and currents and by anchoring sediments. Roots of wetland plants bind lakeshores and streambanks, providing further protection.
- Wetlands can provide a valuable service of replenishing groundwater supplies.
- Open space in landscapes which are under development pressure, and have rich potential for hunters, anglers, scientists, and students (WDNR, 01/2012a)

Affected Environment

The proposed project has impacts upon wetlands, summarized in Section 5.1.3 (Wetlands), but is less than 1 acre of impacts each for water supply and return flow pipeline alignments for the proposed project.

All water supply and return flow routes follow utility and transportation corridors to minimize disturbance to wetlands. These existing utility and transportation corridors make use of previously disturbed areas that are developed or actively maintained in order to minimize impacts. Some utility corridors have paved or gravel access roads; unpaved corridors generally are maintained by removing woody vegetation and mowing. Most impacts to wetland functional values will be temporary.

Environmental Effects

Wetland impacts will be temporary during construction of pipelines. Impacts will be avoided or mitigated by constructing pipeline within previously disturbed areas and employing post-construction restoration techniques. During construction, only the trench line will be excavated, taking care to segregate topsoil from subsoil to the extent possible.

When crossing wetlands, construction techniques will be agreed upon with regulators to minimize impacts. Potential approaches could include building a temporary travel lane using timber mats or other similar materials, unless equipment can be supported without rutting that causes soil mixing. Subsoil and topsoil will be replaced to cover the installed pipeline in the correct order. Seed-free mulch or erosion control matting will be applied with appropriate seeding to meet restoration goals and to minimize the duration of temporary impacts.

5.1.4 Groundwater

The impact of groundwater withdrawals on surface water is a concern in Wisconsin, and human-induced and natural groundwater shortages occur. Regional aquifers and groundwater resources were identified for the areas underlying the supply and return flow routes. Aquifer data from published reports are provided by county. Groundwater quality data are provided by region and should be considered summary data.

The USEPA designates sole-source aquifers as part of its Wellhead Protection Program. There are no designated sole-source aquifers in the State of Wisconsin (EPA, 2010a).

5.1.4.1 Aquifers and Water Use

5.1.4.1.1 Affected Environment

The major aquifers in Waukesha and Milwaukee counties are the Quaternary and Late Tertiary unconsolidated sand and gravel aquifer, and Cambrian-Ordovician sandstone aquifer. Historical use of the aquifers is summarized below and discussed further in the Water Supply Service Area Plan, Volume 2 of the Application.

Shallow Aquifer

The unconsolidated sand-and-gravel aquifer consists of layers and lenses of sand and gravel interspersed with fine-grained or other low-permeability deposits. Well yields vary and are dependent on the permeability and thickness of the sand and gravel at any given location. Recharge occurs through infiltration through surface soils and directly into the aquifer. The shallow aquifer is known locally as the Troy Bedrock Valley Aquifer. The formation contains up to 500 feet of glacial deposits in its deepest parts (SEWRPC, 2010b). It is a source of water supply for the Villages of Mukwonago and East Troy, and the Cities of Waukesha and Muskego. The aquifer is hydraulically connected to sensitive environmental resources, including the Vernon Wildlife Area, Pebble Brook (a Class II trout stream), and Pebble Creek. The City currently obtains approximately 20 percent of their annual water supply from this aquifer. The Water Supply Service Area Plan, (Volume 2 of the Application) provides additional detail on the use of the shallow aquifer for water supply in the City of Waukesha.

Deep Aquifer

The sandstone aquifer consists of alternating sequences of Cambrian- and Ordovician-age sandstone and dolomite, along with some shale. The sandstone aquifer underlies a low permeability layer called the Maquoketa shale. Due to the thickness of the sandstone aquifer, large water quantities can be produced from wells within the aquifer. The City's deep aquifer wells are constructed to depths greater than 2,100 feet and withdraw water from 800 to 1,000 feet below ground. Since the nineteenth century (SEWRPC, 12/2010, pp. 108-09), the deep aquifer has been drawn down 500 to 600 feet. The deep aquifer supplies approximately 80 percent of annual water supply for the City of Waukesha.

Near Waukesha, recharge of this aquifer occurs further west where the Maquoketa shale does not exist. Figures 5-2 through 5-4 illustrate the constraints limiting recharge of the deep aquifer near the City of Waukesha.

FIGURE 5-2

Flow of Groundwater in the St. Peter Sandstone Deep Aquifer

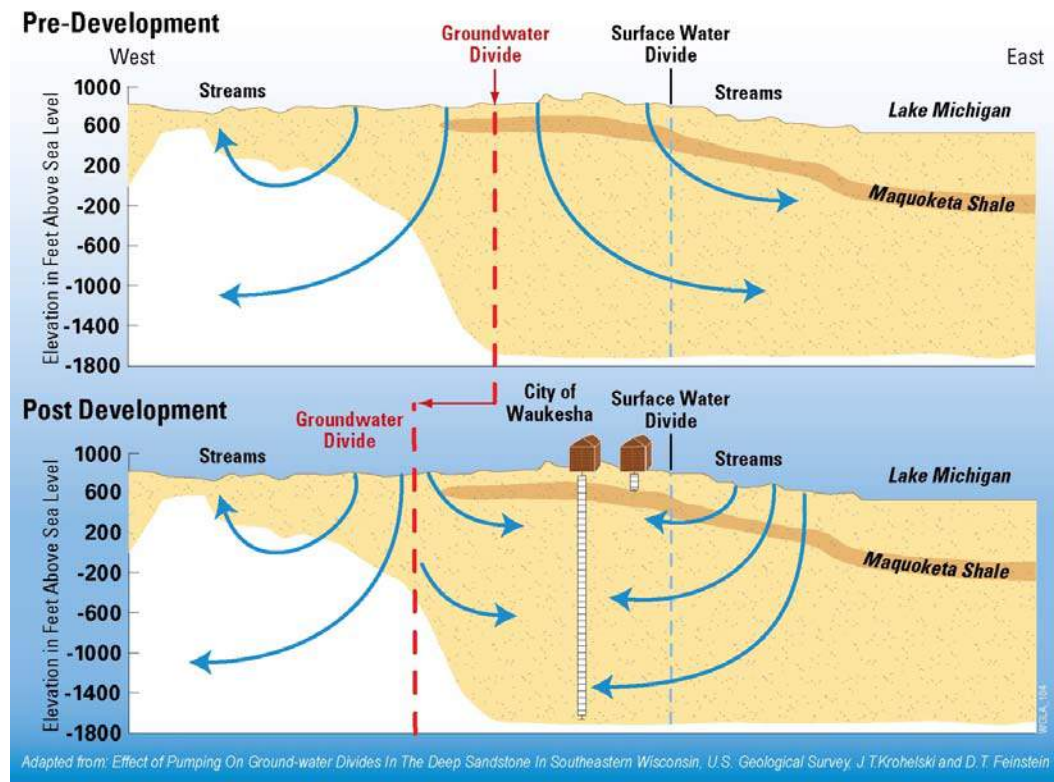
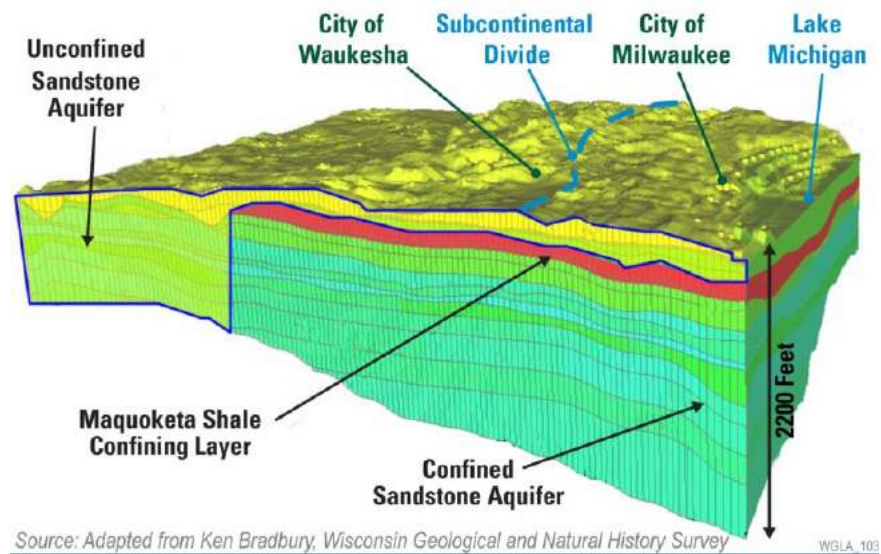


FIGURE 5-3

Hydrogeology of Southeastern Wisconsin



The Precambrian aquifer is present throughout Wisconsin. The Precambrian crystalline bedrock aquifer consists of all rocks of Precambrian age that underlie Wisconsin, primarily granitic and metamorphic rocks. The crystalline bedrock aquifer directly underlies the

sandstone aquifer (Deep Aquifer). Groundwater comes from fractures that exist in the crystalline rocks and yield small quantities of water (USGS, 2000, 2010; WDNR, 2010a).

Springs

Springs are known to exist in Waukesha County. The Wisconsin Geological and Natural History Survey maintains an inventory of springs (WGNHS, 2010). Wisconsin regulates groundwater pumping that may affect large springs under Act

310. Act 310 requires an environmental review of wells that may have a significant impact on springs that have a flow of at least 1 cubic feet per second at least 80 percent of the time. Potential impacts to springs were evaluated under Natural Communities in Section 5.1.3.2 (Flora and Fauna).

5.1.4.1.2 Environmental Effects

Potential impacts to the aquifers present near the supply and return flow routes being considered can be divided in to two categories: temporary construction-related impacts and long-term operational impacts.

Temporary construction impacts to shallow aquifers resulting from construction and placement of a 30-inch water main to the City generally less than 10 feet deep are not expected to be significant. Temporary impacts may include short-duration trench-dewatering efforts. It is anticipated that the shallow aquifers would return to preconstruction conditions following construction.

Long-term impacts related to the operation of a Lake Michigan supply and return flow will cause natural replenishment of the deep aquifer system since the deep aquifer will no longer be used by Waukesha as a water supply source.

Shallow Aquifer

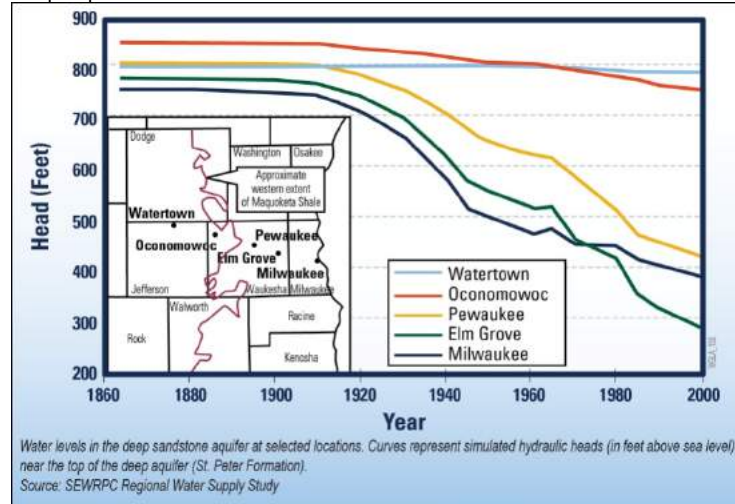
Lake Michigan Water Supply (City of Oak Creek) Alignment 2

Withdrawal from Lake Michigan would not involve groundwater withdrawals, except for the emergency purposes described in the Water Supply Service Area Plan. As a result, no adverse impacts to aquifers would occur. Withdrawal from Lake Michigan with return flow would have an insignificant change in lake water levels because of the volume of water present, and thus is not expected to result in adverse affects to regional aquifer supplies influenced by Lake Michigan.

Root River to Lake Michigan Return Flow Alignment 2

The impacts of the Root River return flow on groundwater are expected to be insignificant. Because of the small change in Lake Michigan tributary water depth from return flow,

FIGURE 5-4
Deep Aquifer Groundwater Levels in Several Locations



significant adverse affects are not expected to regional aquifer supplies that are influenced by a Lake Michigan tributary.

Deep Aquifer

Lake Michigan Water Supply (City of Oak Creek) Alignment 2

A water supply from Lake Michigan would involve discontinuing use of the deep aquifer except for emergency conditions when the Lake Michigan supply was temporarily unavailable. Thus, no adverse impacts to groundwater aquifers would occur. No longer using the deep aquifer would have the benefit of a partial rebound of the deep aquifer groundwater level.

Root River to Lake Michigan Return Flow Alignment 2

Groundwater impacts from Root River to Lake Michigan return flow are expected to be insignificant. Because of the small change in a Lake Michigan tributary water depth from return flow, no adverse effects to regional deep aquifer supplies are expected.

Springs

Lake Michigan Water Supply (City of Oak Creek) Alignment 2

A water supply from Lake Michigan would not affect springs. As a result, no adverse impacts to springs would occur. Springs are absent from the Lake Michigan pipeline routes based upon the WGNHS spring inventory.

Root River to Lake Michigan Return Flow Alignment 2

The Root River to Lake Michigan return flow impacts to springs are expected to be insignificant. Springs are absent from the pipeline corridor based upon the WGNHS spring inventory.

5.1.4.1.3 Environmental Effects Comparison: Groundwater—Aquifers and Water Use

Adverse impacts from changes to groundwater are summarized below. Impacts were compared based upon Table 5-38. Table 5-39 summarizes the impacts to groundwater.

TABLE 5-38
Environmental Impact Category Description: Groundwater Resources

Category	Deep Aquifer Drawdown	Shallow Aquifer Drawdown	Baseflow Reduction Streams from Groundwater Pumping
No adverse impact	Rebound or no additional drawdown	No drawdown	No stream flow reduction
Minor adverse impact	Pumping contributes less than 50 feet of drawdown	Less than 5 feet	Up to 25% reduction in warm water streams; Up to 15% reduction in cold water streams
Moderate adverse impact	Pumping contributes between 50 and 149 feet of drawdown	5 feet to 49 feet	Greater than 25%, but less than 50% reduction in warm water streams; Greater than 15%, but less than 25% reduction in cold water streams
Significant adverse impact	Pumping contributes greater than 150 feet of drawdown	Greater than 50 feet	50% or more reduction in warm water streams; 25% or more reduction in cold water streams

TABLE 5-39

Proposed Project Environmental Impact Comparison Summary: Groundwater Resources

Proposed Project	Groundwater Resources
Water Supply	
Lake Michigan (City of Oak Creek) Alignment 2	No adverse impact
Return Flow for Lake Michigan Water Supply	
Root River to Lake Michigan Alignment 2	No adverse impact

Lake Michigan Water Supply (City of Oak Creek) Alignment 2

The Lake Michigan water supply would eliminate the need for pumping the deep aquifer, which would cause a partial rebound in the deep aquifer in the City of Waukesha. The Return Flow Plan (Volume 4 of the Application) has been designed to meet the Compact requirements with a maximum return flow rate equivalent to the maximum withdrawal rate that also minimizes out of basin water in return flow. Withdrawal from Lake Michigan with return flow protects lake volume, and therefore it is not anticipated that withdrawal from the lake would result in adverse effects to regional aquifer supplies influenced by Lake Michigan. Lake Michigan water supply consequently produces no adverse impact on groundwater resources.

Root River to Lake Michigan Return Flow Alignment 2

Because of the small change in the Lake Michigan tributary water depth with return flow, no significant adverse impacts to regional aquifer supplies that are influenced by a Lake Michigan tributary are expected. Return flow to the Root River consequently would have no adverse impact on groundwater resources.

5.1.4.2 Groundwater Quality

5.1.4.2.1 Affected Environment

Aquifer Water Quality

Shallow Aquifer

The unconsolidated sand-and-gravel aquifer consists of layers and lenses of sand and gravel interspersed with other fine-grained or low-permeability deposits. Well yields vary and are dependent on the permeability and thickness of the sand and gravel at a particular location. Recharge occurs through infiltration through surface soils and directly into the aquifer.

Groundwater from the shallow aquifer may contain iron, manganese, and arsenic.

Deep Aquifer

The sandstone aquifer consists of alternating sequences of Cambrian- and Ordovician-age sandstone and dolomite, along with some shale. The sandstone aquifer underlies a low permeability layer called the Maquoketa shale. Due to the thickness of the sandstone aquifer, large water quantities can be produced from wells within the aquifer.

The City of Waukesha's groundwater supply has radium levels up to three times the USEPA's drinking water maximum contaminant level (MCL) of 5 picocuries per liter (pCi/L). The naturally occurring radioactive isotopes radium-226 and radium-228 are present in the aquifer because of parent elements in the sandstone. The radioactive isotopes are known to be carcinogenic (WDNR, 02/2012). The concentration of radium in the City's

groundwater supply is as high as 15 piC/L, among the highest in the country for a potable water supply.

City of Waukesha deep wells have observed high total dissolved solids (TDS). One well had TDS concentrations greater than 1,000 mg/L and was rehabilitated by blocking part of the well hole to reduce TDS, but in doing so well capacity was reduced more than 35 percent. Well capacity is also expected to decrease from the deep wells if the groundwater elevation continues to drop. Currently it is now more than 600 feet below predevelopment levels. The declining water level causes water quality problems in the form of increased TDS, radium, and gross alpha levels.

Existing Contamination Sites

Areas in Wisconsin where groundwater is most susceptible to contamination are those where most of the groundwater is stored in shallow aquifers (Schmidt, 1987). The WDNR Bureau of Remediation and Redevelopment oversees the Remediation and Redevelopment (RR) Program and has a Web-based mapping system—RR Sites Map (WDNR, 01/2013b)—that contains information about contaminated properties and other activities related to the investigation and cleanup of contaminated soil or groundwater in Wisconsin. The RR Sites Map GIS registry layers contain groundwater contamination sites and groundwater and soil contamination sites. The GIS registry (WDNR, 2013a) yielded the following information about contaminated sites along the various pipeline routes:

- Lake Michigan–Oak Creek Supply Alignment 2—no contamination sites
- Root River to Lake Michigan Return Flow Alignment 2—one closed soil-contamination site

According to the WDNR's online tracking system, which is part of the WDNR Contaminated Lands Environmental Action Network (CLEAN), Milwaukee County has approximately 5,288 environmental repair (ERP) and leaky underground storage tank (LUST) sites, Racine County has approximately 807 ERP and LUST sites, and Waukesha County has approximately 1,667 ERP and LUST sites (WDNR, 2013b).

5.1.4.2.2 Environmental Effects

Environmental effects on groundwater quality could occur either from the construction process or from operation and maintenance.

Potential groundwater impacts from spills of heavy equipment fuel, lubrication oil, or hydraulic oil as a result of construction will be minimized by implementing BMPs for storing such materials, refueling equipment, developing and implementing a spill prevention plan, and cleaning up lost materials that may present a danger to the aquifer. Preventive measures will be implemented to avoid such spills, including compliance with refueling zone practices. While BMPs will be used to prevent spills from occurring, if a spill were to occur, the material will be cleaned up to meet WDNR requirements. The volumes of petroleum-based fluids used during construction are likely to be minor, and so construction is not expected to represent a significant impact to regional aquifers. Prior to construction, the City will work with the applicable resource and municipal agency stakeholders to identify any high-risk areas for petroleum spills and coordinate the development of appropriate BMPs to protect important resources.

Aquifer Water Quality

Because the deep aquifer has had increasing TDS and gross alpha concentrations, continued pumping of the deep aquifer would continue to cause water quality to decline. A Lake Michigan water supply and return flow would lead to a partial recovery of the deep aquifer water level, which in turn could lead to better water quality.

Existing Contamination Sites

Since one ERP and LUST site occurs within the proposed return flow 75-foot-wide construction corridor and a significant number of ERP and LUST sites occur with Waukesha and Milwaukee counties, contaminated groundwater could be encountered during construction and operation. For final design, the City will work with WDNR to manage the crossing of contaminated-groundwater areas. If groundwater contamination is encountered, the City will work with the appropriate agencies to handle it appropriately.

5.1.4.2.3 Environmental Effects Comparison: Groundwater Quality

Operational impacts upon groundwater quality are associated with whether the deep aquifer continues to be used as a groundwater supply. Consequently, no additional comparison of groundwater quality is provided.

5.2 Terrestrial Resources

Terrestrial resource evaluations include considering impacts to geomorphology and soils as well as flora and fauna. Each is discussed below.

5.2.1 Geomorphology and Soils

This section provides information about the geomorphology and soils for water supply and return flow routes. The pipeline alignments overlaid onto a USGS map are found in Appendix 3-1 of Section 3.

5.2.1.1 Surficial and Bedrock Geology

5.2.1.1.1 Affected Environment

The maps in Appendix 6-8 show bedrock geology and surficial deposits for the State of Wisconsin and were the basis for preparation of this section.

Installation of water mains will require trenching to shallow depths of less than 10 feet. As a result, the supply and return flow routes are not expected to encounter significant bedrock and will have negligible temporary impacts to surficial geology during construction. Aboveground structures, will not involve construction or excavation deeper than 10 feet. Therefore will have only minor impacts on surficial geology.

Waukesha County exhibits the following types of bedrock: Silurian dolomite, Ordovician Maquoketa Formation of shale and dolomite, and Ordovician Sinnipee Group of dolomite, along with some limestone and shale. The project traverses only the Silurian dolomite bedrock areas, while the Ordovician Maquoketa Formation and Sinnipee Group exist in the western portion of the county (UW-Ext, 2005). The same depths to bedrock in Milwaukee County that are described above also exist within Waukesha County. Surficial deposits within Waukesha County are as follows: the very eastern edge of the county has clay deposits, similar to

Milwaukee County, but further west of the county, a mixture of sand and sand/gravel deposits become dominant, with small, isolated areas of clay (WDNR, 2010b).

Bedrock within Milwaukee County is dominated by Silurian dolomite, which is a sedimentary carbonate rock, but it also has very limited areas of Devonian dolomite and shale in the northeastern corner of the county (UW-Ext, 2005). The west central portion of the county, where the project is located, ranges in depth to bedrock from 100 feet to 50 feet, and 50 feet to 5 feet below the surface (WDNR, 2010a). All of Milwaukee County exhibits clay deposits, except for the northeast corner and the southern edge, where there are very small areas of sand and gravel surficial deposits (WDNR, 2010b).

There are no known geologic faults within Milwaukee, Racine, or Waukesha counties, and no known faults in Wisconsin have moved in millions of years. There are no recent faults or folds in Wisconsin (USGS, 2010a, b, c).

5.2.1.1.2 Environmental Effects

All water supply and return flow pipeline routes would cross similar geology. Information obtained from the geologic resources present will be used to develop the detailed design of the pipeline material, trench, and construction approaches. Construction within these geologic features is commonplace in southeastern Wisconsin. The WDNR has design review practices in place under the water supply review and wastewater plan review for design drawings and specifications for pipeline projects. No significant impacts to the local geology are expected from the proposed project.

5.2.1.2 Land Use

This section discusses land uses within corridors that could be affected by construction or operation. It identifies sensitive land uses near the routes, including residential areas, hospitals, public lands, recreation areas, and other similar special use areas. Except for the pump station for the Lake Michigan supply and return flow, all land will revert to existing land use after construction and consequently, little change and no adverse impact is anticipated.

5.2.1.2.1 Affected Environment

Land use data was assembled from the 2000 SEWRPC Digital Land Use Inventory and 2005 SEWRPC Park and Open Space Sites, both produced by SEWRPC's Land Use and GIS Divisions. The following descriptions were used in classifying land use in this section:

- *Residential.* Two-family and multifamily low-rise (up to three stories) and multifamily high-rise (four or more stories) buildings and low-, medium-, and high-density areas.
- *Commercial and Industrial.* Retail sales and service intensive areas; manufacturing, wholesaling and storage areas; and unused lands designated commercial or industrial.
- *Transportation and Communication Utilities.* Freeways, expressways, streets, and truck terminals; off-street parking areas; rail-related rights-of-way; and communication and utility areas/structures.
- *Government and Institutional.* Administrative, safety, or assembly areas, both local and regional; educational areas (local and regional); and cemeteries.

- *Recreational Areas.* Land-related recreational areas, both public and nonpublic.
- *Agricultural Lands.* Cropland, pasture, lowland pasture, farm buildings, and other agricultural areas.
- *Open Lands.* Urban and rural open areas.
- *Woodlands.* Open lands that are forested.
- *Surface Water.* Open lands that are bodies of water.
- *Wetlands.* Wetland areas in designated open land, transportation, and communication/utility areas.

Table 5-40 summarizes the total land impacts expected by the Lake Michigan supply and return flow routes.

TABLE 5-40
Summary of Land Acreage Impacts

Proposed Project	Land Affected (acres)	
	Overall ^a	During Operation ^b
Lake Michigan Water Supply		
Lake Michigan (City of Oak Creek) Alignment 2 ^c	176.8	0
Return Flow for Lake Michigan Water Supply		
Root River to Lake Michigan Alignment 2 ^c	183.7	0

^a Includes areas affected by the supply and return flow routes, both temporary and permanent.

^b Includes land disturbed during construction also regarded as permanent workspace, including new aboveground structures and new access roads.

^c A pump station may be required from the water provider. If required, it is expected to only be approximately 0.25 acres of impact and will be sited to minimize impacts.

^d Aboveground structures may include a pump station, to be constructed within the Waukesha WWTP site in a previously disturbed area.

5.2.1.2.2 Environmental Effects

Table 5-41 (see next page) provides quantitative data for land use types affected by temporary construction impacts and the operational impacts of the supply and return flow routes. Most of the land affected is categorized as transportation and communication utilities, most of which is made up of the roadways affected by the routes. This emphasizes the fact that the pipelines associated with this project primarily use public rights-of-way or utility corridors. Impacts are evaluated assuming a 75-foot right-of-way for construction. Note that Table 5-41 uses SEWRPC land use data. The SEWRPC wetland land use data is different from the WWI wetland data. Consequently, wetland acreage is different between Table 5-32 and Table 5-41. WWI wetland data was used for wetland analysis while SEWRPC wetland data was used for land use analysis.

TABLE 5-41
Land Use Impacts in Acres

Route	Residential	Commercial & Industrial	Transportation & Communication/ Utilities	Government. & Institutional	Recreational Areas	Agricultural Lands	Open Lands	Woodlands	Surface Water	Wetlands	Total ^a
Supply Routes											
Lake Michigan (City of Oak Creek) Alignment 2 ^b	5.60	0.25	165.57	0.36	0.25	2.62	1.18	0.48	0.00	0.49	176.79
Return Flow for Lake Michigan Water Supply											
Root River to Lake Michigan Alignment 2 ^b	6.39	0.43	167.62	1.13	0.22	3.92	3.51	0.09	0.05	0.36	183.70

Source: SEWRPC (2000).

^a Represents the total land that had a specific land use designation within the SEWRPC Digital Land Use Inventory.

^b Lake Michigan supply and return flow routes share the same workspace for about 15 miles. Actual land use totals would consequently be less than reported if a Lake Michigan Supply (City of Oak Creek) Alignment 2 and a Root River Alignment 2 return flow alternative are approved.

The return flow route follows streets, alleys, bike paths, active and abandoned railroad corridors, utility corridors, city and county lands, and previously disturbed areas. Table 5-42 includes the percentage of alignment closely associated with transportation corridors. Land designated for transportation use account for the vast majority of the area potentially affected by the proposed supply and return flow routes. Using previously disturbed areas that are developed or actively maintained minimizes disturbance to land uses and natural resources.

TABLE 5-42
Use of Existing Transportation Corridors

Water Supply or Return Flow Route	Percent Existing Transportation Corridors
Lake Michigan (City of Oak Creek) Alignment 2	94
Root River to Lake Michigan Alignment 2	95

The second largest land use category that could be affected under the proposed water supply and return flow routes is residential. The residential land within the assumed 75-foot construction corridor borders roads. The majority of residential land that could be affected by either alignment is described as single family low density. The construction corridor may be further minimized to avoid private property or temporary construction easements will be obtained by the City.

Once the proposed project has been constructed, land with temporary impacts from pipeline construction will be restored to or allowed to revert to its previous use.

5.2.1.2.3 Access Roads

Existing roads and highways would be used to gain access to workspaces along the supply and return flow routes, for both construction crews and delivery of pipe and equipment. Equipment would be moved across public roads that intersect workspaces as work progresses. This would be done in accordance with applicable safety requirements and with due regard for maintenance of existing road surface conditions. Use of access roads during the construction period would have a similar effect as other construction activities on adjacent land uses.

No new access roads would be required for the Lake Michigan supply or return flow. Existing public or private roads would be used. Table 5-43 summarizes proposed new access roads for each route.

TABLE 5-43
Access Roads

Proposed Project	New Access Roads	Acreage Affected by New Roads
Lake Michigan Water Supply		
Lake Michigan (City of Oak Creek) Alignment 2	None proposed ^a	—
Return Flow for Lake Michigan Water Supply		
Root River to Lake Michigan Alignment 2	None proposed ^a	—

^a Access is anticipated to be from existing municipal roadways and trails.

5.2.1.2.4 Aboveground Structures

Under the supply and return flow routes, all water main pipelines would be installed underground through Milwaukee or Waukesha counties. Table 5-44 summarizes the proposed aboveground structures and acreages associated with each of the route.

TABLE 5-44
Aboveground Structures

Proposed Project	Structures	Acre
Lake Michigan Water Supply		
Lake Michigan (City of Oak Creek) Alignment 2	Pump station ^a	—
Return Flow for Lake Michigan Water Supply		
Root River to Lake Michigan Alignment 2	Pump station ^b	—

^a If the water provider requires a pump station, it will be sited to minimize impacts. If required, it is expected to only be approximately 0.25 acres of impact.

^b Will be constructed within the Waukesha WWTP site, in a previously disturbed area.

5.2.1.2.5 Residential and Commercial Areas

The supply and return flow routes will be constructed to minimize impacts to residences. Four single private buildings in the City of Franklin, Milwaukee County, are partially located within the estimated 75-foot-wide construction corridor of the proposed supply project. The pipeline corridor is planned to be within existing street rights-of-way. These impacts should be able to be minimized by adjusting the construction technique at these locations. Based on a review of aerial photography, the structures appear to be two garages, one apartment complex and one storage shed. The City will coordinate with the owners of each structure if the proposed project is approved and minimize or avoid this impact. Appropriate mitigation measures will be taken to restore properties disturbed during construction.

Public or Conservation Land and Natural, Recreational, or Scenic Areas

The routes were evaluated to identify Public or Conservation Land and Natural, Recreational, or Scenic Areas within the respective routes' 75-foot-wide construction corridor. Table 5-45 summarizes the Public or Conservation Land and Natural, Recreational, or Scenic Areas within or adjacent to proposed workspaces. Public or Conservation Land and Natural, Recreational, or Scenic Areas may include the following:

- Federal or state wild and scenic rivers
- USFWS designated areas, USDA Forest Service areas
- U.S. National Parks
- National Wilderness Areas
- National Trails System
- National Historic Landmarks
- Critical habitat areas of NOAA Fisheries
- State designated natural areas and state managed lands
- State, county, and/or city parks
- Golf courses and athletic fields
- Designated green space corridors
- School properties

TABLE 5-45
Public or Conservation Lands within or Adjacent to the Proposed Project

Route Name	Name of Resource	Acres within Proposed 75-ft Construction Workspace
Lake Michigan Water Supply		
Lake Michigan (City of Oak Creek) Alignment 2	Franklin Woods Nature Center	0.65
	Hidden Lakes Park	0.38
	Hillcrest Park	0.04
	Park Arthur	0.48
	Prospect Hill School	0.62
Return Flow for Lake Michigan Water Supply		
Root River to Lake Michigan Alignment 2	Buchner Park	0.09
	Carroll College (Athletic Fields)	0.05
	Catholic Memorial High School	0.15
	Fox River Sanctuary	<0.01
	Hidden Lakes Park	0.38
	Park Arthur	0.48
	Prospect Hill School	0.62
	Randall School	0.18
	Root River Parkway	0.20

Source: Google Earth (2012); SEWRPC (2005).

A review of Google Earth (2012) and the SEWRPC Land Use Division and GIS Division, Park and Open Spaces Sites data (2005) indicated no federally designated or managed Public or Conservation Land and Natural, Recreational, or Scenic Areas would be affected by the supply and return flow routes.

Temporary construction impacts may occur to state and local Public or Conservation Land and Natural, Recreational, or Scenic Areas as a result of construction, depending on the final route. Impacts to state and local resources can be divided into two main categories: temporary and permanent construction-related impacts. Temporary construction-related impacts will be short in duration and minimized by implementing BMPs designed to reduce impacts to sensitive resources. At this time, no permanent aboveground structures are envisioned within areas designated as state or local Public or Conservation Land and Natural, Recreational, or Scenic Areas. Depending upon the final booster pump station location, a local public park could be affected, however the extent of impact would be limited to approximately 0.25 acres and would be coordinated with local public officials and the public.

Coastal Zone Management Areas

Coastal Zone Management Areas are enforced within Wisconsin counties that border the Great Lakes, including Milwaukee County. The Lake Michigan supply and Root River return flow routes are within Milwaukee County but do not affect coastal areas.

5.2.1.2.6 Environmental Effects Comparison: Terrestrial Resources—Land Use

Adverse impacts from changes to land use are summarized below. Level of relative impact to land use were developed to compare impacts. Impacts were compared based upon Table 5-46. Table 5-47 summarizes the impacts to land use.

Pipeline routes are in areas that have been already developed or disturbed to minimize impacts to Public or Conservation Land and Natural, Recreational, or Scenic Areas. The pipeline routes would be restored after construction. Consequently, all routes are similar and would have no significant adverse operational impacts to public or conservation land or to natural, recreational, or scenic areas.

TABLE 5-46
Environmental Impact Category Description: Land Use

No adverse impact	Temporary construction impacts and operational impacts that result in land use changes already frequently occurring in the area.
Minor adverse impact	Operational impacts result in land use changes to Public or Conservation Land and Natural, Recreational, or Scenic Areas less than 5 acres.
Moderate adverse impact	Operational impacts result in land use changes to Public or Conservation Land and Natural, Recreational, or Scenic Areas greater than 5, but less than 50 acres.
Significant adverse impact	Operational impacts result in land use changes to Public or Conservation Land and Natural, Recreational, or Scenic Areas greater than 50 acres.

5.2.1.3 Soil

Prime farmland soils crossed by the supply and return flow routes were identified and characterized using the Natural Resource Conservation Service (NRCS) 2009 Soil Survey Geographic (SSURGO) database. The prime farmland soils series were identified in a linear progression along the proposed routes.

Prime farmland is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is available for such use. It has the soil quality, growing season, and moisture supply needed to produce economically sustained high yields of crops when treated and managed according to acceptable farming methods, including water management. Prime farmlands have an adequate and dependable water supply from precipitation or irrigation, a favorable temperature and growing season, acceptable acidity or alkalinity, acceptable salt and sodium content, and few or no rocks.

Prime farmlands are not excessively erodible or saturated with water for long periods. They do not flood frequently or are protected from flooding. Not all areas designated prime farmland are active agriculturally. There may be locations that exhibit extensive historical disturbance from development, such as residential or roadway construction. The presence of active agricultural areas for each water supply and return flow route is discussed as follows.

TABLE 5-47
Proposed Project Environmental Impact Comparison Summary: Land Use

Proposed Project	Land Use
Water Supply	
Lake Michigan (City of Oak Creek) Alignment 2	No adverse impact
Return Flow for Lake Michigan Water Supply	
Root River to Lake Michigan Alignment 2	No adverse impact

5.2.1.3.1 Affected Environment

Soil series descriptions were obtained through SSURGO (NRCS, 2009). The descriptions provided are based on information available at the county level for soil series. Table 5-48 and Table 5-49 contain specific information on soil characteristics and limitations for the supply and return flow routes.

5.2.1.3.2 Environmental Effects

Construction will have short-term and permanent impacts to the soils within a given supply or return flow pipeline corridor. Impacts may include soil erosion on steep slopes by wind and water, mixing of topsoil and subsoil, soil compaction and rutting from construction equipment, and poor revegetation potential. These impacts will be mitigated by sustainable construction techniques and an ambitious revegetation program.

Because the pipeline routes follow previously disturbed areas (streets, alleys, bike paths, active and abandoned railroad corridors, utility corridors, and city and county lands), few impacts would occur to active agricultural lands, even if the soil is classified as prime agricultural land. Potential impacts to active agricultural lands are listed in Section 5.2.1.2 on Land Use, Table 5-41. Because the project is planned to be within existing street rights-of-ways, impacts to active agricultural lands are expected to be minimized.

If a route has impacts on active agricultural lands, crop production may be lost in the temporary workspaces if construction takes place during the growing season. Losses would be short term, because the land would be returned to production for the growing season following completion of construction. Topsoil would be carefully managed during construction to ensure that the productive capacity of the land would be retained after construction.

The land disturbed during construction would be restored as practicable to pre-construction conditions. The City would employ BMPs, such as topsoil segregation, sediment and erosion control measures, and site restoration, to minimize long-term impacts to construction areas. Information regarding specific BMPs and restoration measures proposed to be used will be provided to the appropriate agency stakeholders during the design process should active agricultural areas be impacted.

Acreage impacts are listed in the discussion below. Impacts are evaluated assuming a 75-foot right-of-way for construction.

Lake Michigan Water Supply (City of Oak Creek) Alignment 2

There are few facilities that alter the land use associated with this route. Impacts to active agricultural lands would be from pipeline construction, and thus temporary in nature. This alternative would affect soil classified as prime farmland (Table 5-48), but land in actual active agricultural use is much less. Land uses other than agricultural exist on most of the remaining soil that is prime farmland.

TABLE 5-48
Prime Farmlands Crossed by the Lake Michigan (City of Oak Creek) Alignment 2

Prime Farmland Soil Series	Soil Series Description	Acres Crossed
AsA	Ashkum silty clay loam, 0 to 3 percent slopes	16.52
AzB	Aztalan loam, 2 to 6 percent slopes	0.31
BIA	Blount silt loam, 1 to 3 percent slopes	22.74
BsA	Brookston silt loam, 0 to 3 percent slopes	0.25
CcB	Casco sandy loam, 2 to 6 percent slopes	0.42
CeB	Casco loam, 2 to 6 percent slopes	0.80
Cw	Colwood silt loam	0.76
FoB	Fox loam, 2 to 6 percent slopes	2.76
FsC2	Fox silt loam, 6 to 12 percent slopes, eroded	0.38
Ftb	Fox silt loam, loamy substratum, 2 to 6 percent slopes	0.85
GrB	Grays silt loam, 2 to 6 percent slopes	0.47
HeA	Hebron loam, 0 to 2 percent slopes	1.41
HeB	Hebron loam, 2 to 6 percent slopes	0.76
HmB	Hochheim loam, 2 to 6 percent slopes	7.94
HmB2	Hochheim loam, 2 to 6 percent slopes, eroded	5.40
HmC2	Hochheim loam, 6 to 12 percent slopes, eroded	13.07
HtA	Houghton muck, 0 to 2 percent slopes	2.93
JuA	Juneau silt loam, 1 to 3 percent slopes	0.95
KIA	Kendall silt loam, 1 to 3 percent slopes	1.16
LmB	Lamartine silt loam, 1 to 4 percent slopes	7.69
Lo	Lawson silt loam	0.66
MgA	Martinton silt loam, 1 to 3 percent slopes	1.67
MmA	Matherton silt loam, 1 to 3 percent slopes	1.93
MoB	Mayville silt loam, 2 to 6 percent slopes	2.35
MtA	Mequon silt loam, 1 to 3 percent slopes	9.05
Mzb	Montgomery silty clay loam	0.82
MzdB	Morley silt loam, 2 to 6 percent slopes	12.54
MzdB2	Morley silt loam, 2 to 6 percent slopes, eroded	19.87
MzdC2	Morley silt loam, 6 to 12 percent slopes, eroded	3.79
MzfA	Mundelein silt loam, 1 to 3 percent slopes	0.36
Oc	Ogden muck	0.11
OuB	Ozaukee silt loam, 2 to 6 percent slopes	2.02

TABLE 5-48

Prime Farmlands Crossed by the Lake Michigan (City of Oak Creek) Alignment 2

Prime Farmland Soil Series	Soil Series Description	Acres Crossed
OuB2	Ozaukee silt loam, 2 to 6 percent slopes, eroded	4.76
OuC2	Ozaukee silt loam, 6 to 12 percent slopes, eroded	1.18
Pa	Palms muck	0.88
Ph	Pella silt loam	2.74
ScB	St. Charles silt loam, 2 to 6 percent	1.54
SeA	St. Charles silt loam, gravelly substratum, 0 to 2 percent slopes	0.16
Sg	Sawhill silt loam, calcareous variant	0.05
ShB	Saylesville silt loam, 2 to 6 percent slopes	0.84
Sm	Sebewa silt loam	1.12
ThB	Theresa silt loam, 2 to 6 percent slopes	4.04
ThB2	Theresa silt loam, 2 to 6 percent slopes, eroded	8.39
ThC2	Theresa silt loam, 6 to 12 percent slopes, eroded	0.45
Ww	Wet alluvial land	0.06
Total		168.93

Root River to Lake Michigan Return Flow Alignment 2

There are few facilities that alter the land use associated with this route. Impacts to active agricultural lands would be from pipeline construction, and thus temporary in nature. This alternative would affect soil classified as prime farmland (Table 5-49), but land in actual active agricultural use is much less. Land uses other than agricultural exist on most of the remaining soil that is prime farmland.

TABLE 5-49

Prime Farmlands Crossed by the Root River to Lake Michigan Return Flow Alignment 2

Prime Farmland Soil Series	Soil Series Description	Acres Crossed
AsA	Ashkum silty clay loam, 0 to 3 percent slopes	11.94
AzB	Aztalan loam, 2 to 6 percent slopes	0.31
BIA	Blount silt loam, 1 to 3 percent slopes	25.61
BsA	Brookston silt loam, 0 to 3 percent slopes	0.25
CeB	Casco loam, 2 to 6 percent slopes	2.93
Cw	Colwood silt loam	0.76
FoA	Fox loam, 0 to 2 percent slopes	0.14
FoB	Fox loam, 2 to 6 percent slopes	3.97
GrB	Grays silt loam, 2 to 6 percent slopes	0.33
HmB	Hochheim loam, 2 to 6 percent slopes	13.26

TABLE 5-49

Prime Farmlands Crossed by the Root River to Lake Michigan Return Flow Alignment 2

Prime Farmland Soil Series	Soil Series Description	Acres Crossed
HmB2	Hochheim loam, 2 to 6 percent slopes, eroded	4.49
HmC2	Hochheim loam, 6 to 12 percent slopes, eroded	8.80
HtA	Houghton muck, 0 to 2 percent slopes	0.01
KIA	Kendall silt loam, 1 to 3 percent slopes	1.16
LmB	Lamartine silt loam, 1 to 4 percent slopes	6.37
Lo	Lawson silt loam	2.61
LyB2	Lorenzo loam, 2 to 6 percent slopes, eroded	0.98
MeB	Markham silt loam, 2 to 6 percent slopes	1.64
MgA	Martinton silt loam, 1 to 3 percent slopes	2.97
MmA	Matherton silt loam, 1 to 3 percent slopes	3.57
MoB	Mayville silt loam, 2 to 6 percent slopes	2.35
MtA	Mequon silt loam, 1 to 3 percent slopes	9.05
MzdB	Morley silt loam, 2 to 6 percent slopes	14.15
MzdB2	Morley silt loam, 2 to 6 percent slopes, eroded	20.98
MzdC2	Morley silt loam, 6 to 12 percent slopes, eroded	2.76
MzfA	Mundelein silt loam, 1 to 3 percent slopes	1.74
Oc	Ogden muck	0.11
OuB	Ozaukee silt loam, 2 to 6 percent slopes	2.02
OuB2	Ozaukee silt loam, 2 to 6 percent slopes, eroded	4.76
OuC2	Ozaukee silt loam, 6 to 12 percent slopes, eroded	1.18
Ph	Pella silt loam	2.71
ScB	St. Charles silt loam, 2 to 6 percent	1.54
SeA	St. Charles silt loam, gravelly substratum, 0 to 2 percent slopes	0.16
Sg	Sawhill silt loam, calcareous variant	0.61
Sm	Sebewa silt loam	1.12
ThB	Theresa silt loam, 2 to 6 percent slopes	3.61
ThB2	Theresa silt loam, 2 to 6 percent slopes, eroded	8.39
ThC2	Theresa silt loam, 6 to 12 percent slopes, eroded	0.45
Wa	Walkill silt loam	0.23
WeB	Warsaw loam, 2 to 6 percent slopes	7.36
WeC2	Warsaw loam, 6 to 12 percent slopes, eroded	0.49
Ww	Wet alluvial land	0.06
Total		177.91

5.2.1.3.3 Environmental Effects Comparison: Soils

Adverse impacts from changes to soils are summarized below. The level of relative impact (no adverse impact, minor adverse impact, etc.) to soils were developed to compare impacts. Impacts were compared based upon Table 5-50. Table 5-51 summarizes the impacts to soils.

Temporary construction-related impacts to soils are associated with the proposed project. All have pipeline routes that run through areas that have been already developed or disturbed to minimize impacts to vegetation and species of concern. This summary focuses upon operational impacts to soils that would occur from aboveground structures.

TABLE 5-50
Environmental Impact Category Description: Soils

No adverse impact	No operational impacts and only temporary construction impacts.
Minor adverse impact	Operational impacts are limited to soil types frequently found in the area.
Moderate adverse impact	Operational impacts occur to soil types infrequently occurring in the area.
Significant adverse impact	Operational impacts occur to soil types rarely occurring in the area.

Lake Michigan Water Supply (City of Oak Creek) Alignment 2

Other than a pump station approximately 0.25 acres in size which is not expected to be located in active agricultural areas, there would be no significant aboveground structures with these routes and thus insignificant impacts to prime farmland. Consequently, there would be no adverse impacts.

TABLE 5-51
Water Supply and Return Flow Alternative
Environmental Impact Comparison Summary: Soils

Alternative	Soils
Water Supply	
Lake Michigan (City of Oak Creek) Alignment 2	No adverse impact
Return Flow Alternatives for Lake Michigan Water Supplies	
Root River to Lake Michigan Alignment 2	No adverse impact

Root River to Lake Michigan Return Flow Alignment 2

There would be no significant aboveground structures other than a return flow pump station in a previously disturbed area at the Waukesha WWTP. This route thus has insignificant impacts to prime farmland. Consequently, there would be no adverse impacts.

5.2.2 Flora and Fauna

Game and nongame wildlife species are regulated and protected under various legislation including the State of Wisconsin's wild game regulations, Wisconsin's Endangered and Threatened Species regulations (NR 27), the federal Fish and Wildlife Conservation Act of 1980 (16 U.S.C. 2901-2911), the Endangered Species Act, and the Fish and Wildlife Coordination Act of 1958.

5.2.2.1 Affected Environment

Wildlife species require adequate food, water, cover, and living space for the survival of individuals and to maintain population viability. The various habitats within the project area support a variety of widespread and tolerant mammals, birds, reptiles, amphibians, and invertebrates. Refer to the maps found in Appendix 3-1 of Section 3 for maps associated

with the proposed project. The wildlife habitats along the proposed workspace fall into four categories and several subcategories:

- *Open Unforested Areas* that will be affected by the project generally include cropland (fallow and active), undeveloped nonforested areas, and scrub-shrub land. Farm crops may serve as a food source for certain species, including whitetail deer and Canada goose. Uncultivated grasslands, pasture, scrub-shrub land, and maintained rights-of-way may support herbaceous and low-level woody vegetation, offering protective cover and forage food sources. Open areas may function as travel corridors where adjacent land is wooded or developed. Open, uncultivated areas may sustain abundant populations of small mammals, such as deer mouse and meadow vole, larger herbivorous mammals, such as woodchuck and eastern cottontail rabbit, and predatory omnivores or carnivores, such as opossum, striped skunk, and red fox. Open areas may provide suitable habitat for bird species, including red-winged blackbird, Canada goose, meadowlark, mourning dove, American crow, American robin, European starling, common grackle, and various sparrows. Open areas bordered by woodland habitats or hedgerows are of particular value to birds and other wildlife because of the nesting and refuge opportunities they afford. Reptiles and amphibians that frequent open grassy areas include the eastern garter snake, blue racer, and American toad.
- *Wooded Areas* that will be affected by the project generally consist of deciduous upland forests. Forested areas exhibit a more complex structure than open areas and generally provide a higher-quality wildlife habitat. Large unfragmented tracts of forested land can provide important habitat for larger, territorial mammals (coyote, deer) and may provide habitat for migratory birds. Food sources from mature trees, as well as berries and other fruits from some understory shrubs and woody vines, are an important wildlife food source. Secondary canopy shrubs and saplings, brush piles, and fallen logs provide cover for various small- to medium-sized mammals. There will be little change in permanent forested riparian areas affected by the proposed aboveground structures, as shown in the maps found in Appendix 3-1 of Section 3. Impacts to forested riparian areas and wetlands may occur as a result of pipeline installation, but such impacts would be temporary and would be managed by avoidance, minimization, and mitigation measures developed in coordination with the appropriate regulatory agencies. As a result, temporary impacts do not represent a significant concern.
- *Aquatic Areas* that will be affected by the project consist generally of streams and wetlands from pipeline construction and return flow receiving waters, including Lake Michigan and its tributaries. Aquatic areas can provide habitat to a diverse wildlife population, and several common species (beaver, muskrat, herons, etc.) are dependent on aquatic habitat for food and shelter. Animals and birds such as beaver, muskrat, and herons depend on aquatic habitats for food and shelter. Others, such as raccoon, are less restricted but prefer to be close to water. Amphibians and many reptiles favor aquatic habitats. Representative species include bullfrog and northern water snake.
- *Developed Areas* that will be affected by the project generally consist of residential, commercial, and industrial land, and active recreational parks. These areas generally have asphalt and concrete surfaces, maintained turf grass, and landscape trees and shrubs. In general, they provide poor wildlife habitat, but opportunistic species such as raccoon,

opossum, squirrel, American crow, American robin, European starling, common grackle, various sparrows, and others have adapted well and thrive in urban and suburban settings. The landscape of the project area originally was a combination of hardwood forest, prairie, savanna, and wetlands. Today, most of the area is dominated by agriculture and urban development. Forests dominated by maple and beech trees are common forest types, along with oak-hickory dominated and lowland hardwood forest types. There are also some areas of wet-mesic and wet prairie, but only small preserves remain since the landscape is heavily disturbed and fragmented. Because of isolation, fragmentation, and disturbance, nonnative plants are abundant throughout the project area (WDNR, 12/2011a).

The USFWS and WDNR were contacted to determine federal- or state-listed species known to occur in the terrestrial areas along the project corridor. The species identified by the agencies as potentially occurring within all proposed project corridor alignments are summarized in Section 5.1.3, Wetlands, since most of the impacts would be to wetlands.

The maps found in Appendix 3-1 of Section 3 show an aerial view of the pipeline alignments, portraying land use and general vegetation along each route. Table 5-41 lists the land uses affected by each route.

U.S. Department of Agriculture's *Descriptions of the Ecoregions of the United States* (1995) contains a hierarchical classification system for ecological units on national and regional scales. Areas are described as being within a specific domain, division, province, section, subsection, and landscape. Southeast Wisconsin is within the Humid Temperate Domain, Hot Continental Division, and Eastern Broadleaf Forest Province (USDA, 2010). Descriptions of these ecoregions are as follows.

5.2.2.1.1 Humid Temperate Domain

The Humid Temperate Domain, located in the middle latitudes (30° to 60°N), has a climate governed by both tropical and polar air masses. The middle latitudes are subject to cyclones. Much of the precipitation in this belt comes from rising moist air along fronts within the cyclones. Pronounced seasons are the rule, with strong annual cycles of temperature and precipitation. Climates of the middle latitudes have a distinctive winter season, which tropical climates do not.

The Humid Temperate Domain contains forests of broadleaf deciduous and needleleaf evergreen trees. The variable importance of winter frost determines six divisions: warm continental, hot continental, subtropical, marine, prairie, and Mediterranean (USDA, 2010).

5.2.2.1.2 Hot Continental Division

The Hot Continental Division is characterized by hot summers and cool winters. The frost-free, or growing, season lasts 5 to 6 months in the division's warmer sections, and only 3 to 5 months in the colder sections. Snow cover is deeper and lasts longer in the northerly areas.

Vegetation in this climate division is winter deciduous forest, dominated by tall broadleaf trees that provide a continuous dense canopy in summer but shed their leaves completely in winter. Lower layers of small trees and shrubs are weakly developed. In spring, a ground cover of herbs develops quickly, but it is greatly reduced after trees reach full foliage and shade the ground.

Soils are chiefly inceptisols, ultisols, and alfisols, which are rich in humus and moderately leached, with a distinct light-colored leached zone under the dark upper layer. The ultisols have a low supply of bases and a horizon in which clay has accumulated. Where topography is favorable, diversified farming and dairying are the most successful agricultural practices.

Rainfall decreases with distance from the ocean. Therefore, this division is subdivided into moist oceanic and dry continental provinces (USDA, 2010).

5.2.2.1.3 Eastern Broadleaf Forest Province

Most of the Eastern Broadleaf Forest Province has rolling hills, but some parts have close to flat topography. In Wisconsin the province has been glaciated. Broadleaf deciduous forests dominate the province and, because of lower precipitation, the province supports the oak-hickory association. The Eastern Broadleaf Forest in northern states such as Wisconsin also supports the maple-basswood association (USDA, 2010).

5.2.2.1.4 Vegetation Communities of Special Concern

WDNR (2013c) identified several vegetation communities of special concern (referred to in Wisconsin as “natural communities”) that may be in the area of the supply and return flow routes. Because most of the natural communities that will be affected by the project are associated with wetland habitats, natural communities are discussed under Section 5.1.3 (Wetlands).

5.2.2.2 Environmental Effects

In general, impacts to wildlife resources from constructing supply and return flow pipelines will be minor and limited to temporary impacts during construction to tolerant opportunistic species. Clearing and grading the construction areas will result in loss of vegetative cover and may result in the mortality of less mobile fauna, such as small rodents, reptiles, and invertebrates, which may be unable to escape the construction area.

Construction likely will cause the temporary displacement of more mobile wildlife from workspaces and adjacent areas. Wooded habitat removed by construction will be replaced initially by nonwoody vegetation, which may provide food, shelter, and breeding space for small mammals and birds. Trees will be allowed to grow back on cleared workspace beyond the maintained maintenance corridor. Surface restoration will include coordination with regulatory agencies to provide preferred habitat vegetation applicable to adjacent land use and operational considerations.

After construction, wildlife is expected to return and recolonize. Because the pipeline routes follow streets, alleys, bike paths, active and abandoned railroad corridors, utility corridors, city and county lands, and other disturbed areas, long-term impacts to wildlife resources are only associated with the permanent aboveground structures (see Table 5-44). Plans will accommodate general and site-specific protective measures for sensitive wildlife habitats and species identified during the course of detailed design and permitting. Seasonal construction scheduling to accommodate reproductive and migratory patterns will be coordinated with state and federal agencies.

Pipeline routes were chosen to minimize the overall land use impact by using roadways, utility corridors, or previously disturbed areas.

Stream crossings will be constructed as quickly as possible and stream habitats restored upon completion of construction. State-approved BMPs will be used to minimize sedimentation, turbidity, and other impacts that may temporarily affect stream vegetation and wildlife.

The City will continue to work with local, state, and federal agencies, landowners, and soil conservation authorities so that construction and mitigation procedures are compatible with both site-specific and regional environmental protection objectives.

5.3 Air Quality

5.3.1 Affected Environment

The project area is located in an attainment area for carbon monoxide, lead, sulfur dioxide and 1-hour and 8-hour ozone. The project area is in a non-attainment area for particulate matter (PM/PM_{2.5}) (USEPA, 12/2012).

5.3.2 Environmental Effects

Particulate air emissions (fugitive dust) are expected to be generated by construction associated with the project. The emissions will be temporary and last only during the construction period. The impact of emissions will be highly localized and limited to areas where restoration of the construction corridor has not yet been completed. Fugitive dust will be minimized by requiring restoration as construction proceeds along the pipeline corridor. The City of Waukesha will take reasonable precautions to prevent fugitive dust from construction work from becoming airborne, such as by applying water as appropriate. Therefore, it is not anticipated that the construction-related emission will have a significant impact on air quality.

During operation, energy use to pump water to the City of Waukesha and to discharge treated wastewater effluent will release emissions. Table 5-52 compares the energy use and the greenhouse gas emissions.

TABLE 5-52
Estimated Energy Use and Greenhouse Gas Emissions

Proposed Project	Estimated Annual Energy Usage (MWh)	Estimated Annual GHG Emissions (tons CO ₂)
Water Supply		
Lake Michigan (City of Oak Creek) Alignment 2	14,200	15,700
Return Flow for Lake Michigan Water Supply		
Root River to Lake Michigan Alignment 2	7,300	6,800

Note: the energy use and greenhouse gas emission were conducted using an ADD of 10.1 mgd; greenhouse gas emissions will change proportionally with a change in ADD.

The Lake Michigan water sources with return flow would contribute fewer greenhouse gas emissions than what occurs currently. See Section 6 for a comparison to other water supply and return flow alternatives.

Other emissions could come from backup electrical generators at the water supply and return flow pump stations. Backup generators would operate only when primarily electrical supply from the regional electrical utility is unavailable; that is, rarely. Emissions from a backup electrical generator therefore would be minimal.

5.4 Socioeconomic Environment

This section describes socioeconomic resources that could be affected by Lake Michigan water supply and return flow and also the potential impacts.

The University of Wisconsin–Milwaukee (UWM) prepared an evaluation of the socioeconomic implications of water supply alternatives in support of SEWRPC's regional water supply plan (SEWRPC, 2010a). Based on recommendations by SEWRPC's Environmental Justice Task Force, SEWRPC contracted with the UWM Center for Economic Development (CED) in 2009 as a nonpartisan agency to evaluate the recommendations set forth in the regional water supply plan and the socioeconomic impact of the recommendations. *A Socio-Economic Impact Analysis of SEWRPC's Regional Water Supply Plan* was finalized and released in July 2010. The analysis included extensive interviews with planners and utility personnel from the communities, and considered a wide range of socioeconomic attributes. The analysis in this section summarizes the findings of the report. The alternatives evaluated as part of this environmental report are consistent with SEWRPC's regional water supply plan, the CED evaluation, SEWRPC's Environmental Justice Task Force recommendations, and *A Socio-Economic Impact Analysis of SEWRPC's Regional Water Supply Plan*.

This section summarizes data where reported in the SEWRPC Socio-Economic Impact Analysis report (UWM, 2010) using 2000 census data because the SEWRPC report was published prior to 2010 census data becoming available. For population information not readily available in the SEWRPC Socio-Economic Impact Analysis report, 2010 census data was used.

5.4.1 Population

5.4.1.1 Population Affected

Waukesha county population more than doubled between 1960 and 2007. This growth is much greater than that in the 7 county SEWRPC planning region. Whereas Waukesha accounted for only 10 percent of the regional population, it now represents almost 20 percent (Table 5-53). The City of Waukesha has experienced a similar population growth, increasing from 30,000 in 1960 to more than 64,000 in 2000. The rate of growth in the City is expected to decline over the next 25 years, reaching a projected total of 88,500 in 2035 (36 percent increase). The water supply needs for the City are partially based on these population projections, but the water needs include an enlarged water supply service area beyond the City and changes in manufacturing, commercial, industrial and other water-consuming sectors (see the Water Supply Service Area Plan, Volume 2 of the Application).

TABLE 5-53
Waukesha and Southeastern Wisconsin Regional Population

County	1960		2007		Change	
	Number	% of Region	Number	% of Region	Number	%
Waukesha	158,249	10.1	376,978	18.9	218,729	138.2
Southeastern Wisconsin	1,573,614	100.0	1,995,901	100.0	422,287	26.8

Source: US Census Bureau as reported in UWM, 2010

5.4.1.1.1 Age

Based on the results of the 2010 census, the median age in Waukesha County is 42 (USCB, 2010a). Table 5-54 summarizes age statistics for the state, Waukesha County, and the City of Waukesha.

TABLE 5-54
Waukesha and Southeastern Wisconsin Regional Population Age Statistics: 2010

State of Wisconsin		Waukesha County		City of Waukesha	
Age Group	% of Total	Age Group	% of Total	Age Group	% of Total
Under 5 years	6.3	Under 5 years	5.5	Under 5 years	7.1
5 to 9 years	6.5	5 to 9 years	6.7	5 to 9 years	6.8
10 to 14 years	6.6	10 to 14 years	7.2	10 to 14 years	6.1
15 to 19 years	7.0	15 to 19 years	6.8	15 to 19 years	6.7
20 to 24 years	6.8	20 to 24 years	4.7	20 to 24 years	7.8
25 to 29 years	6.5	25 to 29 years	5.1	25 to 29 years	8.6
30 to 34 years	6.1	30 to 34 years	5.2	30 to 34 years	8.1
35 to 39 years	6.1	35 to 39 years	6.0	35 to 39 years	7.0
40 to 44 years	6.7	40 to 44 years	7.3	40 to 44 years	6.7
45 to 49 years	7.7	45 to 49 years	8.8	45 to 49 years	7.0
50 to 54 years	7.7	50 to 54 years	8.8	50 to 54 years	6.8
55 to 59 years	6.8	55 to 59 years	7.5	55 to 59 years	5.8
60 to 64 years	5.5	60 to 64 years	6.1	60 to 64 years	5.1
65 to 69 years	4.0	65 to 69 years	4.2	65 to 69 years	3.2
70 to 74 years	3.1	70 to 74 years	3.1	70 to 74 years	2.2
75 to 79 years	2.5	75 to 79 years	2.7	75 to 79 years	1.9
80 to 84 years	2.1	80 to 84 years	2.2	80 to 84 years	1.6
85 and over	2.1	85 and over	2.0	85 and over	1.7
Median age	38.5	Median age	42	Median age	34.2

Source: USCB 2010a

5.4.1.1.2 Race and Ethnicity

The City of Waukesha is predominately white, but racial diversity has risen since 1960. The percent of nonwhites increased from 0.5 percent in 1960 to almost 9 percent in 2000, more than 5,500 nonwhite residents moved into the City over the period. The percent increase in nonwhites is similar to that in other communities in the southeastern Wisconsin region. The Waukesha County nonwhite population is projected to almost double by 2035, to almost 17 percent of the total population.

5.4.1.1.3 Health and Disabilities

In 2000 the national average of persons reporting one or more disabilities was 19.3 percent (UWM, 2010). Wisconsin reported a lower percentage at 14.7 percent of the state's population. Waukesha County provided an even lower percentage than the national and state average, with only 10.8 percent of the population reporting one or more disabilities. The City of Waukesha was slightly higher than the state average, with 14.9 percent of the population reporting one or more disabilities.

5.4.1.1.4 Population Trends

Changes in population are based on three variables: birth and death rates, migration of people moving into and out of the community, and the ability of a community/town to annex neighboring lands, which increases the size and population.

The birth and death rate, or the balance between births and deaths in a given area, is considered a population's "natural increase." According to SEWRPC, the region experienced a population increase of 120,800 people between 1990 and 2000. It is estimated that, of the 120,800 people, 116,900 were attributed to natural increase.

Based on *The Economic State of Milwaukee's Inner City: 2006* (Levine and Williams) and numerous SEWRPC technical reports the general trend over the past 50 years has been an outward population and job migration from larger cities along the lakeshore to outlying towns and counties (SEWRPC, 2004). The reduction in manufacturing jobs in the historically larger cities and the increased economic development within inland areas has reduced jobs in the large lakeshore cities and increased jobs in inland areas.

It is possible for population growth to be constrained by the unavailability of adjacent land for development. Unless a community has the capability to annex adjacent, developable land, it may experience "buildout" or near buildout conditions. Milwaukee, which is bordered by Lake Michigan, is an example of a community facing buildout conditions. Milwaukee has exhibited a population decline, which SEWRPC projects to continue partially because of the lack of available adjacent developable land. On the contrary, the City of Waukesha has developable land that will support population growth.

5.4.1.2 Population Effects

The water demand projections used to specify the water supply quantities for all sources (groundwater and Lake Michigan) were based partially on the population projections discussed above, and all alternative sources can meet the projected demand. Thus, meeting the demand using any alternative source would not have any constraints on population. Any of the water supply sources also can support the projected increase in nonwhite population in the City of Waukesha. This is consistent with conclusions in the CED

socioeconomic study, in which planners and utilities managers reported that the water supply source will not affect population growth or distribution.

5.4.2 Economy

5.4.2.1 Existing Economic Conditions

The economy in Waukesha County also has grown over the last 20 years. Economic growth in the City of Waukesha has been much greater than the overall southeastern Wisconsin region, increasing from nearly 5 percent of the total in 1960 to more than 22 percent in 2000 (Table 5-55). This is consistent with the regional trend of employment migration from the urban areas to the more suburban areas and the shift from manufacturing to service sector jobs in the southeastern Wisconsin region. Table 5-56 provides an overview of state, regional, and local leading industries (historical and present).

TABLE 5-55
Waukesha and Regional Economy

	Waukesha County		Southeastern Wisconsin	
	Jobs	%	Jobs	%
1960	32,600	4.8	673,000	100
1970	81,000	10.3	784,900	100
1980	132,800	14.0	948,200	100
1990	189,700	16.6	1,143,700	100
2000	270,800	22.1	1,222,800	100

Source: Bureau of Labor Statistics and the US Census Bureau as reported in UWMUWM, 2010.

The economy in Waukesha County is projected to increase by 67,000 jobs, or 25 percent, by 2035. This is considerably higher than for Milwaukee County (7 percent increase) but similar to the surrounding counties.

Much of the industry in the southeastern Wisconsin region is considered to be water-intensive, but many large industrial water users rely on private high-capacity groundwater wells rather than municipal water. A review of the large businesses in Waukesha County indicates there are no known major water-intensive businesses or industries using municipal supplies (UWM, 07/2010, p. 15).

5.4.2.1.1 Employment and Industry

As shown in Table 5-56, the leading industry in Wisconsin shifted from manufacturing in 2000 to educational services by 2010. In Waukesha County, educational services remained the leading industry from 2000 to 2010. Similar to the Wisconsin trend, the City of Waukesha experienced a shift in leading industries, from manufacturing in 2000 to educational services in 2010 (USCB, 2000 and 2010b).

5.4.2.1.2 Unemployment

Unemployment throughout the southeastern Wisconsin region has increased over the past decade. In 2000, Wisconsin's unemployment rate was 3.2 percent. It had risen to 6.1 percent in 2010; and in November of 2011, the Bureau of Labor Statistics (BLS, 2011) reported the state average at 7.3 percent.

TABLE 5-56
Leading Industries in 2000 and 2010

Geography	Industries											
	Manufacturing		Educational Services		Retail Trade		Recreation & Entertainment		Professional, Scientific, & Management		In Labor Force (population 16 years and older)	
	2000	2010	2000	2010	2000	2010	2000	2010	2000	2010	2000	2010
Wisconsin	22.2%	17.9%	20.0%	23.0%	11.6%	11.6%	7.3%	9.1%	6.6%	7.9%	69.1%	68.3%
Milwaukee County	18.5%	14.3%	22.4%	27.1%	10.4%	10.4%	7.7%	9.6%	9.3%	10.7%	65.4%	66.8%
City of Milwaukee	18.5%	13.6%	23.4%	27.7%	9.9%	11.0%	8.6%	10.4%	8.9%	11.2%	63.9%	66%
Waukesha County	14.1%	16.5%	19.9%	23.3%	11.7%	12.1%	7.9%	7.1%	9.3%	10.6%	63.9%	70.3%
City of Waukesha	22.0%	16.6%	20.5%	22.3%	12.0%	14.2%	6.8%	10.7%	9.2%	9.6%	73.2%	74.8%

Source: 2010 Census (USCB, 2010b); 2000 American Community Survey (USCB, 2000)

Waukesha County and the City of Waukesha reported similar unemployment trends over the past decade. The County's unemployment rate in 2000 was 3.7 percent. It had risen to 5.4 percent in 2010, and by November 2011 it had slightly increased to 5.7 percent (BLS, 2011). The City of Waukesha's unemployment rate was 2.5 percent in 2000. It had risen to 5.9 percent in 2010; and by November 2011 to 7.6 percent, which is slightly higher than the state average and nearly 2 percent higher than the surrounding county average (BLS, 2011).

5.4.2.1.3 Trends

As described in the report *A Socio-Economic Impact Analysis of the Regional Water Supply Plan for Southeastern Wisconsin* (UW M, 2010), Waukesha County experienced a significant increase in jobs from 1960 to 2000 by approximately 5.4 percent annually. Before 1960, less than 5 percent of the regional distribution of jobs was from Waukesha County. However, by 2000, Waukesha County provided 22 percent of the jobs in the southeastern Wisconsin region. Percent increases and decreases in the number of jobs in a specific area is considered separately from changes in employment and unemployment rates, which are based on the total number of employable persons in an area.

A similar increase was reflected in the historical labor force pattern. Before 1960, most of the regional labor force, about 68 percent, resided in Milwaukee County. Although Milwaukee County's labor force continued to grow through 1990, its share of the regional labor force decreased to 46.5 percent by 2000. Meanwhile, Waukesha County's share of the regional labor force grew from 9.1 percent in 1960 to 19.9 percent in 2000. Waukesha County experienced an average annual growth rate of 3.15 percent from 1960 to 2000, whereas Milwaukee County experienced an annual growth rate of only 0.21 percent. These changes in labor force percentages throughout the southeastern Wisconsin region show that, percentagewise, more workers are migrating to Waukesha County than Milwaukee County.

Table 5-56 provides a 10-year overview of leading industries and labor force records for the State, Milwaukee and Waukesha counties, and the cities of Milwaukee and Waukesha.

5.4.2.1.4 Tax Base

Municipal tax rates, known as tax base, are based on the total value of all taxable property in a particular municipality. To compare tax bases accurately across multiple municipalities, the State of Wisconsin equalizes assessed values by using tools such as market sales analysis, random appraisals, and local assessors' reports to bring all values to a uniform level. Tax base analysis uses

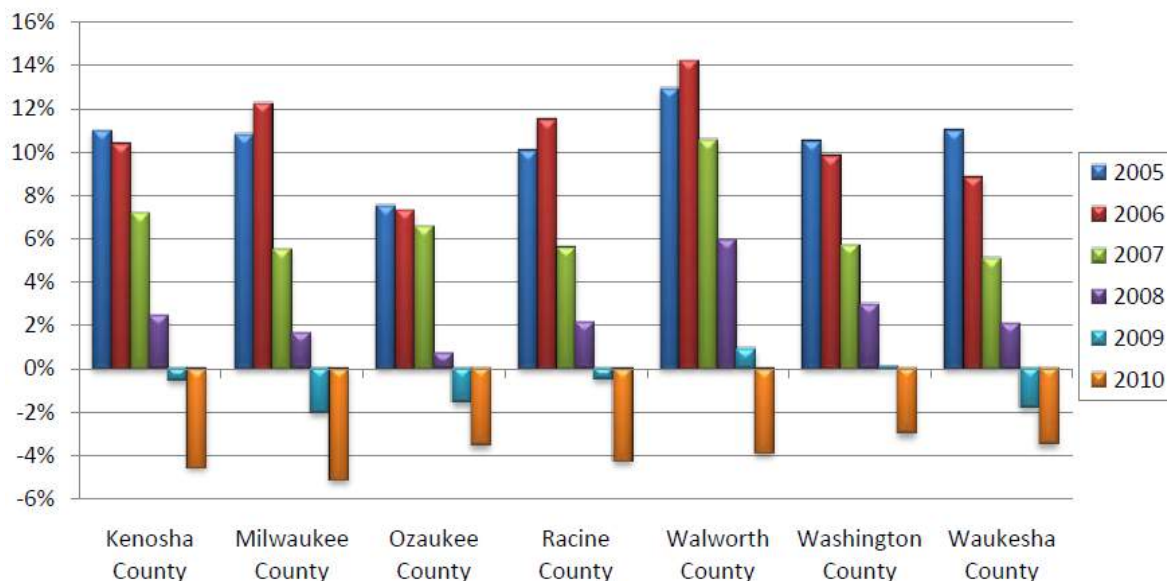
equalized values determined by the Wisconsin Department of Revenue. An overview of relevant equalized values for 2010 (Table 5-57), shows that, within the 7-county region of southeastern Wisconsin, Milwaukee County comprises 35 percent of the tax base and Waukesha County 28 (Public Policy Forum, 2011).

TABLE 5-57
2010 Total Equalized Value: Southeastern Wisconsin

Geography	2010 Total Equalized Value	1 Year Change in Property Value
Milwaukee County	\$63,403,508,200	-4.9%
City of Milwaukee	\$29,500,535,100	-5.6%
Waukesha County	\$50,270,294,500	-2.9%
City of Waukesha	\$5,904,933,100	-3.2%
SE Wisconsin (7 counties)	\$182,621,628,700	-4.2%

Source: Public Policy Forum, 2011

FIGURE 5-5
County Aggregate Changes in Property Values: 2005–2010



Source: Public Policy Forum, 2011

In recent years, property values in southeast Wisconsin have declined at least 3 percent in each 7 counties (Public Policy Forum, 2011). Milwaukee County has seen the greatest decline. Figure 5-5 provides a visual representation of property value trends in southeast Wisconsin from 2005 to 2010.

The Public Policy Forum (2011) reported that the major factors contributing to the decline in property values in southeast Wisconsin were the economic change in real estate values and the slowed growth of new construction in the region. Table 5-58 summarizes real estate values and money spent on new construction over the seven county region in 2009 and 2010. The noticeable decline of 5 percent is believed to be a result of declining property values. New construction is an important criterion in measuring real estate values, as “new construction drives total value growth because as parcels are used more intensively, they generate a higher land utility and thus a higher value” (Public Policy Forum, 2011).

TABLE 5-58
Changes in Aggregate Real Estate Values: 2009–2010 (USD)

County	2009 Real Estate Value	Economic Change	New Construction	Other Change	2010 Real Estate Value
Kenosha	\$14,641,117,700	(\$885,124,100)	\$237,637,200	(\$56,119,800)	\$13,937,511,000
Milwaukee	\$64,849,423,300	(\$3,611,491,400)	\$398,632,100	(\$213,156,700)	\$61,423,407,300
Ozaukee	\$11,053,112,400	(\$459,394,700)	\$89,167,800	(\$40,538,800)	\$10,642,346,700
Racine	\$15,584,722,400	(\$713,582,400)	\$69,673,000	(\$39,075,600)	\$14,901,737,400
Walworth	\$15,450,442,800	\$738,054,200)	\$134,579,100	\$1,621,600	\$14,848,589,300
Washington	\$13,857,974,100	(\$512,119,500)	\$120,946,200	(\$26,570,000)	\$13,440,230,800
Waukesha	\$51,011,477,100	(\$2,182,165,900)	\$394,097,100	(\$37,613,800)	\$49,185,794,500
SE Wisconsin	\$186,448,269,800	(\$9,101,932,200)	\$1,444,732,500	(\$411,453,100)	\$178,379,617,000
State of Wisconsin	\$499,856,206,900	(\$19,377,213,300)	\$4,575,602,300	(\$1,087,907,700)	\$483,966,688,200

Source: Public Policy Forum, 2011

5.4.2.2 Potential Changes in Economy

Projections of water demand take into account the City of Waukesha's economy and associated water demand as it relates to the City's water supply service area (see the Water Supply Service Area Plan, Volume 2 of the Application). By serving the projected demand, water supply would not constrain or otherwise affect economic growth and thus be consistent with all land use planning. The source of the supply does not affect the quantity; thus, all supply source alternatives are similar with respect to quantity and do not affect the economy.

The CED study found that the source of water is not a differentiating factor on development within a municipal service area (UWM, 07/2010, p. 19). The only exception to this view is related to groundwater with radium exceeding allowable levels. The study found some planners and utility managers in the southeastern Wisconsin region understood groundwater quality problems to be associated with radium contamination, when the groundwater was withdrawn from deep aquifer sources. There were no contamination concerns expressed for surface water sources, because contamination, specifically by radium, is associated only with deep aquifer sources.

5.4.3 Land Use, Zoning, and Transportation

5.4.3.1 Affected Land Use, Zoning, and Transportation

The pipeline routes associated with the project primarily use existing public right-of-way (see Table 5-42). Transportation lands account for approximately 95 percent of the total area affected by the supply and return flow routes.

All proposed project routes offer access to potential construction areas on existing public roadways. Public roadways should be sufficient access points, with no need for improvements.

5.4.3.2 Land Use, Zoning, and Transportation Effects

5.4.3.2.1 Land Use

After construction, land with temporary impacts from pipeline construction will be restored to its previous use. Numerous land use types would be traversed by the supply and return flow routes. Existing right-of-way corridors are the most common land use types. Section 5.2.1.2 (Land Use) of this environmental report provides a more detailed examination of existing land use. Table 5-41 lists quantitative data for land use types affected by a combination of temporary construction impacts and operation impacts.

5.4.3.2.2 Zoning

Construction and operation of a Lake Michigan water supply and return flow would not require changes to zoning conditions. Construction will not affect any areas subject to federal visual resource management standards, and no designated sensitive viewpoints are known to occur along the supply or return flow routes.

As required by the State of Wisconsin under Chapters NR 115 and NR 116, environmental corridors and isolated natural resource areas may be subject to local and county zoning regulations. Shorelands and floodplains are subject to local or county regulation.

The project would be designed to avoid zoning or rezoning issues to the greatest extent practicable. Once designed, the project will meet all federal, state, and local requirements before applicable permits will be issued.

5.4.3.2.3 Transportation

The regional transportation system would be minimally affected by construction and by the travel of construction workers and equipment. Since construction would move sequentially along the pipeline routes, any transportation impacts on any given roadway would be temporary. An increased number of vehicles would be encountered during morning and evening peak times, corresponding to normal workday hours.

The pipelines would be installed by boring underneath all major paved roadway crossings wherever possible. Crossing of roadways with less traffic would likely be performed by open trenching, which may cause minor disruptions in local traffic patterns. Where construction follows a road, work schedules will be communicated with local residents and local authorities to minimize impacts. Access across these roadways will be maintained for emergency vehicles and passenger vehicles through the use of metal plates and other measures. If roads are temporarily closed to through traffic, information will be shared with local first responders regarding roadway conditions. Appropriate control measures will be used during construction, such as detouring of traffic where possible, flagmen, signage, and flashing lights. Roadways will be repaired to their preconstruction condition when installation of the pipelines is completed.

Traffic from commuter (worker) traffic and from the transportation of equipment and materials for the project is expected to increase. The initial staging, which would involve transporting the bulk of the construction equipment and materials and the daily transportation of additional equipment and materials, may temporarily affect local transportation systems. To minimize the effect, delivery routes will be required to minimize traffic disruption when delivering equipment and materials to the project site. As construction progresses, much of the equipment movement will occur along the construction right-of-way. When it is necessary for construction equipment and material to cross roadways, traffic flow may be interrupted. The transportation of equipment and materials will be minimized through planning and coordination with local road jurisdictions. For example, the scheduling of heavy loads and delivery of materials can be coordinated so that it does not conflict with commuting hours.

No significant impact of transportation infrastructure is expected for any water supply or return flow route. Temporary and minor disruptions of traffic flow and pattern are expected to result from construction of the project.

5.4.4 Energy Use

5.4.4.1 Affected Energy Use

Water intake, treatment, and distribution in Waukesha is accomplished from the existing power grid. The supply is adequate and expected to accommodate projected population and economic growth.

5.4.4.2 Energy Use Effects

As described in Table 5-52 and in Section 6, energy use and greenhouse gas emissions are similar for the potential Lake Michigan suppliers and slightly less than the groundwater alternatives.

5.4.5 Recreation and Aesthetics

5.4.5.1 Affected Recreation and Aesthetics

5.4.5.1.1 Recreation

According to a review of Google Earth and the SEWRPC Land Use Division and GIS Division, Park and Open Spaces Sites data (2005), no federally designated or managed Public or Conservation Land and Natural, Recreational, or Scenic Areas would be affected by the supply and return flow routes. See Table 5-45 for a list of public (nonfederal) parks, golf courses, and wildlife areas associated with the supply and return flow routes.

5.4.5.1.2 Aesthetics

There are no areas subject to federal visual resource management standards. No designated sensitive viewpoints are known to occur along the supply and return flow routes.

5.4.5.2 Recreation and Aesthetics Effects

5.4.5.2.1 Recreation

Limited temporary construction impacts may occur to state and local public or conservation land and natural, recreational, or scenic areas as a result of construction.

At this time, no permanent aboveground structures are envisioned within areas designated as state or local Public or Conservation Land and Natural, Recreational, or Scenic Areas. Depending upon the final booster pump station location, a local public park could be affected, however the extent of impact would be limited to approximately 0.25 acres and would be coordinated with local public officials and the public.

Impacts to state and local resources can fall into two main categories: construction-related impacts, and impacts resulting from groundwater table drawdown. Construction-related impacts to resources can be further divided into temporary and permanent impacts. Temporary construction-related impacts will be short in duration and minimized by implementing BMPs designed to reduce impacts to sensitive resources. No permanent aboveground structures are expected to be built within areas designated as state or local public or conservation land and natural, recreational, or scenic areas. As a result, there will be no permanent construction-related impacts.

Permanent impacts resulting from a drawdown of the groundwater table is not applicable for the proposed project.

5.4.5.2.2 Aesthetics

Construction will not affect any areas subject to federal visual resource management standards, and no designated sensitive viewpoints are known to occur along the supply and return flow routes.

The Lake Michigan supply and return routes would not require aboveground facilities or would be limited to a pump station and small service building at an existing treatment

plant, water supply facility, or coordinated with local architectural requirements for a new site development. None of the proposed aboveground structures is located in any visually sensitive areas.

Visual impacts of the supply and return flow routes are expected to be minor and temporary. In agricultural areas, previously disturbed easements, roadway corridors, and residential properties, visual disturbance will be difficult to detect by the first growing season following completion of construction and surface restoration efforts.

5.4.6 Archeological and Historical Resources

5.4.6.1 Affected Resources

5.4.6.1.1 Archeological Resources

Archival investigations were conducted by The Public Service Archaeology & Architecture Program of the University of Illinois at Urbana-Champaign (PSAAP) to identify significant cultural resources within or adjacent to potential construction corridors of the proposed supply and return flow alternatives. The investigations included a review of the known archaeological sites and previous cultural resource surveys within 100 meters of each alternative's potential corridor. These findings contain archeologically sensitive and confidential information that is made available to necessary agencies for review. It is not summarized here, because it is not intended for public release.

Some of the alternatives evaluated share project corridors and thus have the potential to disturb the same cultural sites. Most alternatives corridors are separate, and therefore each alternative was investigated separately. The results of the archival investigations are summarized below.

Supply Alternatives

- Lake Michigan—Oak Creek Supply Alignment 2: 7 sites and 17 previous cultural resource surveys

Return Flow for Lake Michigan Water Supply

- Root River to Lake Michigan Alignment 2: 10 sites and 18 previous cultural surveys
- Appendix 5-3 contains additional information regarding potential sites.

5.4.6.1.2 Historical Resources

The National Parks Service's National Register of Historic Places (NRHP) was authorized under the National Historic Preservation Act of 1966. The NRHP is the official list of historic places throughout the U.S. and is part of a national program to coordinate and support efforts to identify, evaluate, and protect historic and archeological resources (NRHP, 2012).

No NRHP sites are located within 0.1 mile of the Lake Michigan-Oak Creek Supply Alignment 2 alternatives.

Eight NRHP sites were identified within 0.1 mile of the Root River to Lake Michigan return flow Alignment 2 alternative, all within Waukesha County; no NRHP sites were identified within the Milwaukee County section of the Root River to Lake Michigan return flow Alignment 2 (NRHP, 2012).

5.4.6.2 Environmental Effects

5.4.6.2.1 Archeological Resources

The City will meet regulatory requirements regarding archeological resources during the design and construction phases to prevent any significant impacts and mitigate impacts to known or potential sites. During operation, there will be no ground disturbance, and no impacts will occur to archeological resources.

5.4.6.2.2 Historical Resources

No NRHP sites will be affected by permanent structures associated with the project. The City will follow regulatory requirements to prevent significant impacts and to mitigate impacts to known or potential NRHP sites. During operation, there will be no ground disturbance, and no impacts will occur to historical resources.

5.4.7 Public Water Supply and Uses

5.4.7.1 Affected Public Water Supply and Uses

5.4.7.1.1 Groundwater

The City of Waukesha currently obtains approximately 80 percent of its water supply from the deep St. Peter Sandstone Aquifer. Near and east of the City, the aquifer is confined by a geological feature—the Maquoketa shale layer—that limits natural recharge of the aquifer. Continued use of the aquifer by the City and surrounding communities since the 19th century and the presence of the Maquoketa shale have led to the 500- to 600-foot decline in aquifer water levels (SEWRPC, 12/2010a, pp. 108–09). Reduced groundwater levels in southeastern Wisconsin have in turn affected regional surface waters, which now receive about 18 percent less in groundwater contribution as water migrates toward the deep aquifer (USGS, 2007). Significant water quality issues occur with declining water levels in the deep aquifer, including increased levels of salts and radium (a naturally occurring element in the deep aquifer that can cause cancer).

To provide drinking water with low levels of radium, the City treats some deep aquifer water to remove radium and mixes it with radium-free water from the shallow Troy Bedrock aquifer. The City obtains approximately 20 percent of its water supply from the shallow aquifer. Increased pumping of the shallow aquifer will stress surface water resources by reducing baseflows to local streams and wetlands (SEWRPC, 2010a).

5.4.7.1.2 Surface Water

The City is seeking a water supply to meet future water demands of the City's projected water service area as delineated by the SEWRPC. The City seeks sufficient water to serve customers within its delineated service area. Detailed demand numbers are found in the Water Supply Service Area Plan (Volume 2 of the Application).

Lake Michigan, the preferred water supply alternative, is bordered by four states and connected through the other Great Lakes to four other Great Lakes states and two Canadian provinces. Lake Michigan is the second largest of the Great Lakes and the only one entirely within the borders of the U.S. (WDNR, 03/2010a).

5.4.7.1.3 Water Uses

The City of Waukesha actively tracks water use by customer class for the following:

- **Residential.** Residential water demand typically includes indoor water-using activities, such as those for bathroom, kitchen, and laundry, and outdoor water use, such as that for lawn irrigation, swimming pools, and car washing. Waukesha's four categories of residential customers were analyzed:
 - Single-family Residential
 - Two-family Residential
 - Three-family Residential
 - Multi-family Residential (multi-family is tracked separately as outlined below)

For summary purposes, residential water use is measured in accordance with requirements set forth by the Public Service Commission of Wisconsin.

- **Industrial.** Manufacturing, processing, warehouses, foundries, and dairies.
- **Commercial.** Commercial water use is presented by customers such as retail, restaurants, office buildings, medical facilities, and private schools.
- **Public.** Public water use includes water demands for municipal buildings, public facilities, parks, public schools, and institutions.
- **Unsold Accounted for Water.** Water uses that are measured (or estimated) but not included in sales. Examples of this water use include water used in annual water main flushing to maintain water quality and water used in firefighting exercises.
- **Unaccounted for Water.** The difference between total pumpage and total water sales is termed nonrevenue water and is usually expressed as a percentage. The portion of nonrevenue water attributed to leakage, meter inaccuracies, and other unknown losses is often termed *unaccounted-for water*.

Water use categories aid the utility in effectively managing water, planning for future water demand, and in developing a strategic water conservation plan (CH2M HILL, 2012).

Water use by sector for 2010 is shown in Figure 5-6. Single family and multi-family residential water use accounts for nearly 60 percent of all water use in the City of Waukesha.

Unaccounted-for water in 2010 was 6.3 percent of all water use. The City's unaccounted-for water is below the American Water Works Association recommended value of 10 percent, and well below the Public Service Commission's recommended action level of 15 percent.

Trends in water use annually over the 1999 to 2010 period are shown in Figure 5-7. The figure combines multi-family water use with residential water use (one to three family buildings).

Seasonal water use patterns provide helpful information regarding the water use in the City's service area.

FIGURE 5-6
Water Use by Customer Class: Waukesha Water Utility

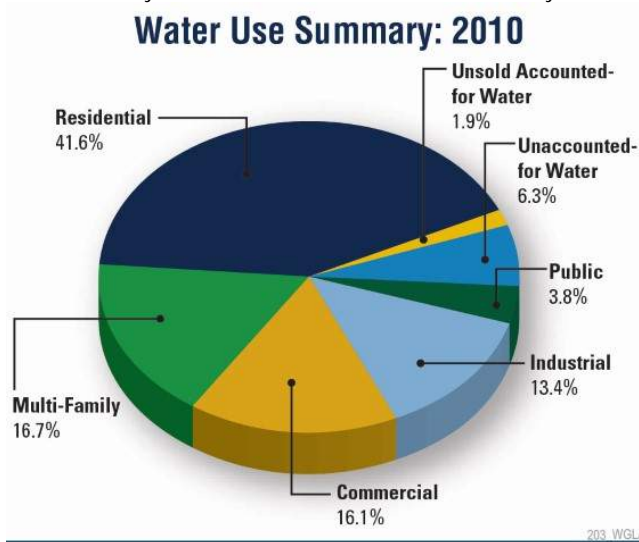


Figure 5-8 presents monthly water use in 2005 and 2010. In 2006, the City restricted outdoor water use by municipal ordinance to conserve water. Since then, seasonal peak demands have declined significantly. The City must plan for a peak pumping season from May through September, but its water demand forecasts for the future assume the City will continue to restrict peak season outdoor water use. Additional information on water conservation can be found in the City of Waukesha Water Conservation Plan (Volume 3 of the Application).

FIGURE 5-7

Annual Water Use Trend by Customer Class: Waukesha Water Utility

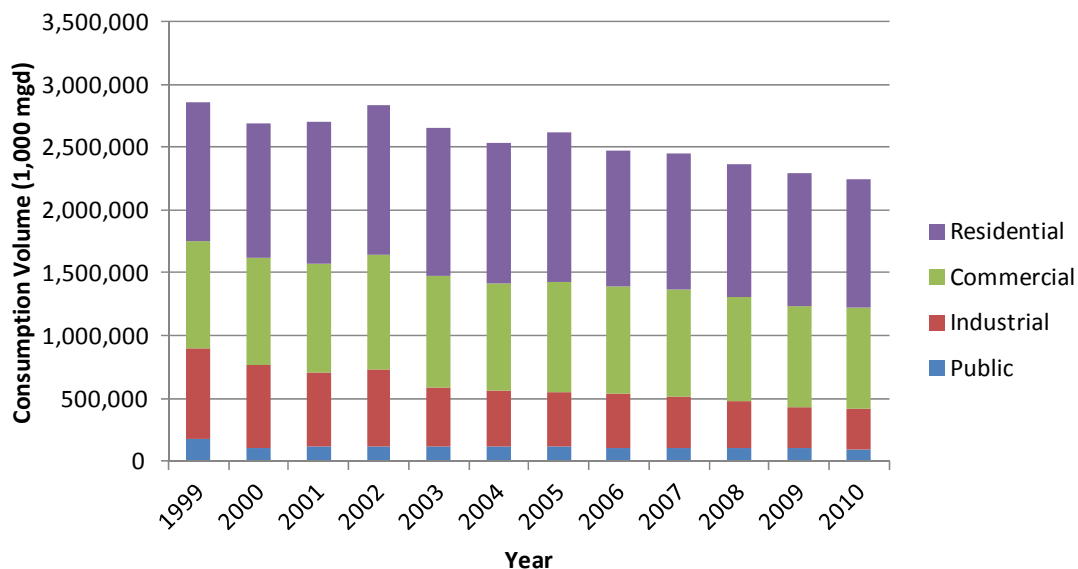
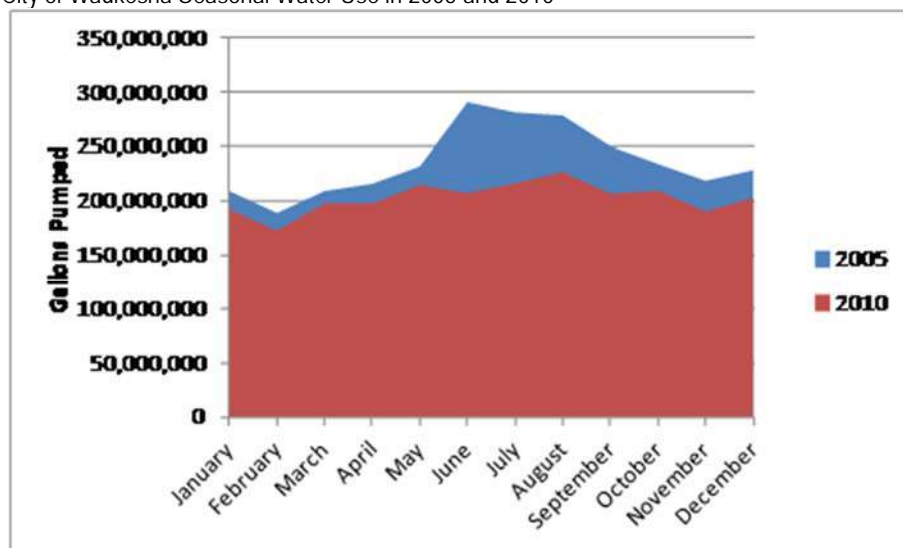


FIGURE 5-8

City of Waukesha Seasonal Water Use in 2005 and 2010



Source: City of Waukesha Annual Report to the Wisconsin Public Service Commission, 2010

5.4.7.2 Public Water Supply and Use Effects

5.4.7.2.1 Groundwater

A Lake Michigan water supply would eliminate the need to pump the deep aquifer, which would cause a partial rebound in the deep aquifer in the City of Waukesha. The Return Flow Plan (Volume 4 of the Application) has been designed to meet the Compact requirements with a maximum return flow rate equivalent to the maximum withdrawal rate that also minimizes out of basin water in return flow. Withdrawal from Lake Michigan with return flow protects lake volume, and therefore it is not anticipated that withdrawal from the lake would result in adverse effects to regional aquifer supplies influenced by Lake Michigan. Lake Michigan water supply consequently produces no adverse impact on groundwater resources.

5.4.7.2.2 Surface Water

The inland waterways are not used as water supply sources. There would be no change to water supply sources with these changes, since none of the surface waters is used for water supply.

The Return Flow Plan (Volume 4 of the Application) has been designed to meet the Compact requirements with a maximum return flow rate equivalent to the maximum withdrawal rate that also minimizes out of basin water in return flow. Withdrawal from Lake Michigan with return flow protects lake volume, and therefore it is not anticipated that withdrawal from the lake would result in adverse effects to regional aquifer supplies influenced by Lake Michigan. Lake Michigan water supply consequently produces no adverse impact on groundwater resources.

5.4.7.2.3 Water Uses

No changes in water use sectors are expected with a change in water supply source. Water use by residential, commercial, and industrial sectors is not dependent upon water source. Instead, it will change over time due to varying factors such regional economic conditions, impacts from water conservation, and climatic conditions.

5.4.8 Environmental Justice

Executive Order (EO) 12898 stipulates that Federal actions, or projects funded by Federal monies may not result in disproportionately high and adverse impacts to low-income or minority populations. *Low-income* means a household income at or below the Department of Health and Human Services poverty guidelines. *Minority* indicates a person who is Black, Hispanic, Asian American, American Indian, or Alaskan Native. EO 12898 directs federal agencies to consider environmental justice by identifying and mitigating disproportionately high and adverse human health and environmental effects. This includes the interrelated social and economic benefits of their programs, policies, and activities on low-income and minority populations.

No residents would be displaced by the construction or operation of the project and economic development projections are consistent under all the water supply alternatives. Therefore, no environmental justice populations would be displaced by the project or any of the alternatives, and the project operation is not expected to cause any adverse impacts to low income or minority populations.

5.4.9 Safety

5.4.9.1 Construction

Access to the construction site would be prohibited to nonconstruction workers or contractors unless special circumstances warranted entry, which would require pre-approval from the Construction Contractor. Signage, temporary fencing, or other means as appropriate to the location will be put in place to prevent trespassing. Appropriate safety procedures will be implemented to protect workers and the public. As needed, traffic warning signs, detour signs and other traffic control devices will be used as required by federal, state, and local Departments of Transportation and other regulating bodies. Road crossings will be completed in accordance with the requirements of road crossing permits.

5.4.9.2 Operation

5.4.9.2.1 Protection of Children

Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risk (FR: April 23, 1997, Volume 62, Number 78), specifies guidelines for the protection of children. This EO requires that Federal agencies make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children and to ensure that policies, programs, and standards address disproportionate risks to children that result from environmental health or safety risks.

None of the alternatives associated with the project would impose health or security risks to children. Additionally, temporary emissions from the construction equipment would fall within federal and state air quality standards, including those established to protect sensitive populations, such as children. The project would not cause an environmental risk that would disproportionately affect the health of children.

5.4.9.2.2 Protection of Sensitive Populations

The National Ambient Air Quality Standards include standards to protect public health and to protect public welfare and the environment. The USEPA established the standards for protection of public health through an evaluation of environmental health effects, which included a margin of safety to protect children and other sensitive populations.

Temporary emissions from the construction equipment would fall within federal and state air quality standards, including those established to protect sensitive populations, such as children. Emissions from the activities associated with operation of the project would be associated with electrical supply from regional electrical utilities and consequently would be very low and would not adversely affect the elderly or other sensitive populations. Electrical usage as shown above decreases from existing conditions, leading to fewer greenhouse gas emissions from electrical usage by the Waukesha Water Utility. Additionally, exposure to hazardous conditions is extremely unlikely.

5.4.10 Environmental Effects Comparison: Socioeconomics

Socioeconomic impacts are summarized below. Level of relative impact (no adverse impact, minor adverse impact, etc.) to the socioeconomic environment were developed to compare impacts. Although more than four areas of consideration are discussed in this socioeconomics section, Tables 5-59 and 5-60 evaluate four key areas of concern. Based on an initial review of potential socioeconomic impacts, neither the proposed project nor

alternatives to the proposed project would have significant adverse impacts to the socioeconomic environment. They are all similar and would all consistently have no adverse impact to the socioeconomic environment.

TABLE 5-59

Matrix for Determining Level of Potential Adverse Impact for Socioeconomic Environment

Key Considerations	No Adverse Impact	Minor Adverse Impact	Moderate Adverse Impact	Significant Adverse Impact
Population & Housing	No permanent adverse impacts; and little to no minor temporary adverse impacts to population numbers and available housing. Potential for reduction in population and adjacent housing market.	Temporary adverse impacts to population numbers and available housing. Potential for reduction in population and area housing market.	Long term adverse impacts to population numbers and available housing. Probable reduction in population and area housing market. Increased rental vacancy rates.	Permanent adverse impacts to population numbers and available housing. Potential for reduction in population and regional housing market.
Local Economy & Employment	No permanent adverse impacts; little to no minor temporary adverse impacts to local economic conditions. No adverse impact to existing employment and unemployment rates.	Temporary adverse impact to local economic conditions. Short-term increase in unemployment rates on a local level.	Long-term adverse impact to local economic conditions. Moderate increase in unemployment rates on a local and regional level.	Permanent adverse impacts to local economic conditions. Long-term increase in local and regional unemployment rates.
Environmental Justice	No disproportionately high and adverse human health or environmental effects on low-income populations, minority populations, or Indian tribes.	No displacement, but siting of project in area of localized low-income populations, minority populations, or Indian tribes. Potential for short-term minor hazardous exposure.	Temporary displacement or relocation of low-income populations, minority populations, or Indian tribes.	Displacement of or hazardous exposure to low-income populations, minority populations, or Indian tribes.
Safety	No reduction in the existing level of safety and security (including health and protection of children) will occur.	Potential for temporary impacts to existing level of safety and security (including health and protection of children) will occur as a result of construction or operation or Project.	Potential for short-term dangerous conditions or minimal exposure to toxins from construction and operation of the Project.	Potential for long-term dangerous conditions or exposure to toxins from construction and operation of the Project.

TABLE 5-60

Anticipated Socioeconomic Impacts

Proposed Project	Key Socioeconomic Considerations			
	Population & Housing	Local Economy & Employment	Environmental Justice	Safety
Water Supply				
Lake Michigan (City of Oak Creek) Alignment 2				No adverse impact
Return Flow for Lake Michigan Water Supply				
Root River to Lake Michigan Alignment 2				No adverse impact

Once the impact parameters were determined, each alternative was considered individually for the potential for impacts.

Because no individual alternative will result in moderate or significant impacts to the socioeconomic environment, a comprehensive discussion of each alternative is not included in this section, and socioeconomic impacts will not continue to be compared side by side with other impacts.

5.5 Proposed Project Impact Summary

The side by side environmental impact comparison tables were compiled to have one overall comparison of the environmental impacts for the proposed project. Where resource impact tables occurred more than once (for example, water quality summary tables occur for both Lake Michigan and inland waterways), the impacts were added together to account for impacts to both resources. The side by side comparison of the environmental impacts is included in Table 5-61. A side by side comparison of system alternatives (water supply with return flow) is included in Appendix 5-1.

Once the proposed project receives regional approval, and the proposed project progresses into detailed design, the City of Waukesha will continue to work with the regulatory agencies during final design to conduct any necessary field surveys, location refinements, mitigation planning, and to obtain required construction permits.

TABLE 5-61
Proposed Project Environmental Impact Comparison Summary

Water Supply Alternative	Groundwater Resources	Geomorphology and Sediments	Flooding	Aquatic Habitat	Water Quality	Wetlands	Soils	Land Use
Water Supply								
Lake Michigan (City of Oak Creek) Alignment 2	No adverse impact	No adverse impact	No adverse impact	Minor adverse impact	No adverse impact	Minor adverse impact	No adverse impact	No adverse impact
Return Flow for Lake Michigan Water Supply								
Root River to Lake Michigan Alignment 2	No adverse impact	No adverse impact	Minor adverse impact	No adverse impact	No adverse impact	Minor adverse impact	No adverse impact	No adverse impact

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Appendix 5-1
System Alternative Summary Tables –
Proposed Project

System Alternative Summary Tables— Proposed Project

This attachment contains system alternative tables that summarize impacts for various resource categories. The table numbers correspond to the table number in Section 5 with an “A” after the number. For example, the system alternative comparison table for “Table 5-8” in Section 5 is listed as “Table 5-8A” in this attachment.

Water supply and return flow alternatives were developed individually, while return flow alternatives were developed considering the Lake Michigan supply source. These individual water supply and return flow alternatives are combined to create a “system alternative”. A system alternative adds together the impacts from both water supply and treated wastewater discharge to provide the sum of the impacts with respect to the environment.

Impacts from individual water supply and return flow alternatives were added together to determine the system alternative impacts. This is a conservative approach because for resource impacts associated with the pipeline routes, the water supply pipeline route and the return flow pipeline route overlap, which creates some double counting of impacts.

Where impact categories are compared, the most severe impact was selected for the system alternative. For example, if a water supply had a “moderate adverse impact” designation and the return flow had a “no adverse impact” designation, the “moderate adverse impact” designation was assigned to the system alternative.

The following is a table listing for this attachment. Not all tables are directly applicable to system alternatives comparison. Consequently, not all tables in Section 5 are included below.

Tables

5-3A	System Alternatives Environmental Impact Comparison Summary – Lake Michigan Water Quality	2
5-5A	System Alternatives Environmental Impact Comparison Summary – Lake Michigan Geomorphology and Sediments	2
5-8A	System Alternatives Environmental Impact Comparison Summary – Lake Michigan Aquatic Habitat	2
5-11A	System Alternatives Environmental Impact Comparison Summary – Number of Water Body Crossings	3
5-13A	System Alternatives Environmental Impact Comparison Summary – Inland Waterway Aquatic Habitat and Flooding	3
5-20A	System Alternatives Environmental Impact Comparison Summary – Inland Waterway Geomorphology and Sediments	3
5-22A	System Alternatives Environmental Impact Comparison Summary – Inland Waterways Water Quality	3

5-32A	System Alternatives Environmental Impact Comparison Summary – Wetlands Crossed by Proposed Project	4
5-34A	System Alternatives Environmental Impact Comparison Summary – Wetlands.....	4
5-35A	System Alternatives Environmental Impact Comparison Summary – High Natural Community Suitability Ratings	4
5-39A	System Alternatives Environmental Impact Comparison Summary – Groundwater Resources.....	4
5-45A	System Alternatives Environmental Impact Comparison Summary – Public or Conservation Lands within or Adjacent to the Alternatives	5
5-47A	System Alternatives Environmental Impact Comparison Summary – Land Use	5
5-51A	System Alternatives Environmental Impact Comparison Summary – Soils.....	5
5-52A	System Alternatives Environmental Impact Comparison Summary – Estimated Energy Use and GHG Emissions	5
5-61A	Water Supply and Return Flow Alternative Environmental Impact Comparison Summary	6

For Table 5-3A, the more conservative of the water supply alternative and water return alternative designations was used to define the system alternative impact.

TABLE 5-3A

System Alternatives Environmental Impact Comparison Summary: Lake Michigan Water Quality

Water Supply Alternative	Water Return Alternative	Water Quality
Lake Michigan (City of Oak Creek) Alignment 2	Root River to Lake Michigan Alignment 2	No adverse impact

For Table 5-5A, the more conservative of the water supply alternative and water return alternative designations was used to define the system alternative impact.

TABLE 5-5A

System Alternatives Environmental Impact Comparison Summary: Lake Michigan Geomorphology and Sediments

Water Supply Alternative	Water Return Alternative	Geomorphology and Sediments
Lake Michigan (City of Oak Creek) Alignment 2	Root River to Lake Michigan Alignment 2	No adverse impact

For Table 5-8A, the more conservative of the water supply alternative and water return alternative designations was used to define the system alternative impact.

TABLE 5-8A

System Alternatives Environmental Impact Comparison Summary: Lake Michigan Aquatic Habitat

Water Supply Alternative	Water Return Alternative	Aquatic Habitat
Lake Michigan (City of Oak Creek) Alignment 2	Root River to Lake Michigan Alignment 2	No adverse impact

For Table 5-11A, the number of water body crossings of the water supply alternative was added to the number of water body crossings for the water return alternative to define the system alternative impact.

TABLE 5-11A

System Alternatives Environmental Impact Comparison Summary: Number of Water Body Crossings

Water Supply Alternative	Water Return Alternative	Number of Water Body Crossings
Lake Michigan (City of Oak Creek) Alignment 2	Root River to Lake Michigan Alignment 2	7

For Table 5-13A, the more conservative of the water supply alternative and water return alternative designations was used to define the system alternative impact.

TABLE 5-13A

System Alternatives Environmental Impact Comparison Summary: Inland Waterway Aquatic Habitat and Flooding

Water Supply Alternative	Water Return Alternative	Aquatic Habitat	Flooding
Lake Michigan (City of Oak Creek) Alignment 2	Root River to Lake Michigan Alignment 2	Minor adverse impact	Minor adverse impact

For Table 5-20A, the more conservative of the water supply alternative and water return alternative designations was used to define the system alternative impact.

TABLE 5-20A

System Alternatives Environmental Impact Comparison Summary: Inland Waterway Water Quality

Water Supply Alternative	Water Return Alternative	Water Quality
Lake Michigan (City of Oak Creek) Alignment 2	Root River to Lake Michigan Alignment 2	No adverse impact

For Table 5-22A, the more conservative of the water supply alternative and water return alternative designations was used to define the system alternative impact.

TABLE 5-22A

System Alternatives Environmental Impact Comparison Summary: Inland Waterways Geomorphology and Sediments

Water Supply Alternative	Water Return Alternative	Geomorphology and Sediments
Lake Michigan (City of Oak Creek) Alignment 2	Root River to Lake Michigan Alignment 2	No adverse impact

For Table 5-32A, the number of temporary and permanent wetland acres from the water supply alternative was added to the number of temporary and permanent wetland acres from the water return alternative to define the system alternative impact. This is a conservative approach because water supply and return flow routes share some common corridors, which would cause actual impacts to be less. Slight variations exist between alternatives due to rounding.

TABLE 5-32A

System Alternatives Environmental Impact Comparison Summary: Wetlands Crossed by the Proposed Project (acres)

Water Supply Alternative	Return Flow Alternative	Temporary Wetland Impacts (ac)	Permanent Wetland Impacts (ac)
Lake Michigan (City of Oak Creek) Alignment 2	Root River to Lake Michigan Alignment 2	1.12	0.01

For Table 5-34A, the more conservative of the water supply alternative and water return alternative designations was used to define the system alternative impact.

TABLE 5-34A

System Alternatives Environmental Impact Comparison Summary: Wetlands

Water Supply Alternative	Water Return Alternative	Temporary and Permanent Wetland Impacts
Lake Michigan (City of Oak Creek) Alignment 2	Root River to Lake Michigan Alignment 2	Minor adverse impact

For Table 5-35A, the number of high suitability ratings from the water supply alternative was added to the number of high suitability ratings from the water return alternative to define the system alternative impact.

TABLE 5-35A

System Alternatives Environmental Impact Comparison Summary: High Natural Community Suitability Ratings

Water Supply Alternative	Water Return Alternative	Number of Natural Community High Suitability Ratings (out of 18)
Lake Michigan (City of Oak Creek) Alignment 2	Root River to Lake Michigan Alignment 2	0

For Table 5-39A, the more conservative of the water supply alternative and water return alternative designations was used to define the system alternative impact.

TABLE 5-39A

System Alternatives Environmental Impact Comparison Summary: Groundwater Resources

Water Supply Alternative	Water Return Alternative	Groundwater Resources
Lake Michigan (City of Oak Creek) Alignment 2	Root River to Lake Michigan Alignment 2	No adverse impact

For Table 5-45A, the acres of land affected from the water supply alternative was added to the acres of affected by the water return alternative to define the system alternative impact.

TABLE 5-45A

System Alternatives Environmental Impact Comparison Summary: Public or Conservation Lands within or Adjacent to the Alternatives

Water Supply Alternative	Water Return Alternative	Number of Properties	Acres within Proposed 75ft Construction Workspace
Lake Michigan (City of Oak Creek) Alignment 2	Root River to Lake Michigan Alignment 2	14	4.32

For Table 5-47A and Table 5-51A, the more conservative of the water supply alternative and water return alternative designations was used to define the system alternative impact.

TABLE 5-47A

System Alternatives Environmental Impact Comparison Summary: Land Use

Water Supply Alternative	Water Return Alternative	Land Use
Lake Michigan (City of Oak Creek) Alignment 2	Root River to Lake Michigan Alignment 2	No adverse impact

TABLE 5-51A

System Alternatives Environmental Impact Comparison Summary: Soils

Water Supply Alternative	Water Return Alternative	Soils
Lake Michigan (City of Oak Creek) Alignment 2	Root River to Lake Michigan Alignment 2	No adverse impact

For Table 5-52A, the water supply alternative and water return alternative values were added together to define the system alternative impact.

TABLE 5-52A

System Alternatives Environmental Impact Comparison Summary: Estimated Energy Use and GHG Emissions

Water Supply Alternative	Water Return Alternative	Estimated Annual Energy Usage (MWh)	Estimated Annual GHG Emissions (tons CO ₂)
Lake Michigan (City of Oak Creek) Alignment 2	Root River to Lake Michigan Alignment 2	21,500	22,500

For Table 5-61A, the more conservative of the water supply alternative and water return alternative designations was used to define the system alternative impact.

TABLE 5-61A
Water Supply and Return Flow Alternative Environmental Impact Comparison Summary

Water Supply Alternative	Water Return Alternative	Groundwater Resources	Geomorphology and Sediments	Flooding	Aquatic Habitat	Water Quality	Wetlands	Soils	Land Use
Lake Michigan (City of Oak Creek) Alignment 2	Root River to Lake Michigan Alignment 2	No adverse impact	No adverse impact	Minor adverse impact	Minor adverse impact	No adverse impact	Minor adverse impact	No adverse impact	No adverse impact

Appendix 5-2
Example Wetland and Waterbody Pipeline
Construction and Mitigation Procedures

Example Wetland and Waterbody Pipeline Construction and Mitigation Procedures

This appendix outlines common practices that can be used to minimize the impact of constructing long pipelines through waterways or wetlands. The process of providing Lake Michigan water to the City of Waukesha, as discussed in the Environmental Report Update, will require the construction of pipelines crossing water bodies and wetlands. All of the preliminary design alternatives analyzed in the study have shown that they will cross a wetland or waterway of some kind (wetland, stream, etc.).

The list below provides examples of the techniques that may be used during construction of the pipeline. These techniques were identified from typical practices used for prior long pipeline construction projects in Wisconsin, including Federal Energy Regulatory Commission pipeline projects, among others. The actual procedures that will be implemented during construction will be agreed upon by the regulatory agencies during the final design of this project and may include some of these techniques as well as others.

1.01 INSTALLATION OF WATERBODY CROSSINGS

A. General Crossing Procedures:

1. Comply with the Corps of Engineers (COE), or its delegated agency, permit terms and conditions.
2. Construct crossings as close to perpendicular to the axis of the waterbody channel as engineering and routing conditions permit.
3. If the pipeline parallels a waterbody, attempt to maintain at least 15 feet of undisturbed vegetation between the waterbody (and any adjacent wetland) and the construction right-of-way.
4. Where waterbodies meander or have multiple channels, route the pipeline to minimize the number of waterbody crossings.
5. Maintain adequate flow rates to protect aquatic life, and prevent the interruption of existing downstream uses.
6. Waterbody buffers (extra work area setbacks, refueling restrictions, etc.) must be clearly marked in the field with signs and/or highly visible flagging until construction-related ground disturbing activities are complete.

B. Spoil Pile Placement and Control:

1. All spoil from minor and intermediate waterbody crossings, and upland spoil from major waterbody crossings, must be placed in the construction right-of-way at least 10 feet from the water's edge or in additional extra work areas as described in section V.B.2.
2. Use sediment barriers to prevent the flow of spoil or heavily silt laden water into any waterbody.

C. Equipment Bridges:

1. Only clearing equipment and equipment necessary for installation of equipment bridges may cross waterbodies prior to bridge installation. Limit the number of such crossings of each waterbody to one per piece of clearing equipment.
2. Construct equipment bridges to maintain unrestricted flow and to prevent soil from entering the waterbody. Examples of such bridges include:
 - a. Equipment pads and culvert(s).
 - b. Equipment pads or railroad car bridges without culverts.
 - c. Clean rock fill and culvert(s); and
 - d. Flexi-float or portable bridges.
3. Additional options for equipment bridges may be utilized that achieve the performance objectives noted above. Do not use soil to construct or stabilize equipment bridges.
4. Design and maintain each equipment bridge to withstand and pass the highest flow expected to occur while the bridge is in place. Align culverts to prevent bank erosion or streambed scour. If necessary, install energy dissipating devices downstream of the culverts.
5. Design and maintain equipment bridges to prevent soil from entering the waterbody.
6. Remove equipment bridges as soon as possible after permanent seeding unless the COE, or its delegated agency, authorizes it as a permanent bridge.
7. If there will be more than 1 month between final cleanup and the beginning of permanent seeding and reasonable alternative access to the right-of-way is available, remove equipment bridges as soon as possible after final cleanup.

D. Dry-Ditch Crossing Methods:

1. Unless approved otherwise by the appropriate state agency, install the pipeline using one of the dry-ditch methods outlined below for crossings of waterbodies up to 30 feet wide (at the water's edge at the time of construction) that are state-designated as either coldwater or significant coolwater or warmwater fisheries.
2. Dam and Pump:
 - a. The dam-and-pump method may be used without prior approval for crossings of waterbodies where pumps can adequately transfer streamflow volumes around the work area, and there are no concerns about sensitive species passage.
 - b. Implementation of the dam-and-pump crossing method
 - c. Must meet the following performance criteria:
 - 1) Use sufficient pumps, including on-site backup pumps, to maintain downstream flows;
 - 2) Construct dams with materials that prevent sediment and other pollutants from entering the waterbody (e.g., sandbags or clean gravel with plastic liner);
 - 3) Screen pump intakes;
 - 4) Prevent streambed scour at pump discharge; and
 - 5) Monitor the dam and pumps to ensure proper operation throughout the waterbody crossing.
3. Flume Crossing: The flume crossing method requires implementation of the following steps:
 - a. Install flume pipe before any trenching;
 - b. Use sand bag or sand bag and plastic sheeting diversion structure or equivalent to develop an effective seal and to divert stream flow through the flume pipe (some modifications to the stream bottom may be required in to achieve an effective seal);
 - c. Properly align flume pipe(s) to prevent bank erosion and streambed scour;
 - d. Do not remove flume pipe during trenching, pipelaying, or backfilling activities, or initial streambed restoration efforts; and;
 - e. Remove all flume pipes and dams that are not also part of the equipment bridge as soon as final cleanup of the stream bed and bank is complete.

4. Horizontal Directional Drill (HDD): To the extent they were not provided as part of the pre-certification process, for each waterbody or wetland that would be crossed using the HDD method, provide a plan that includes:
 - a. Site-specific construction diagrams that show the location of mud pits, pipe assembly areas, and all areas to be disturbed or cleared for construction;
 - b. A description of how an inadvertent release of drilling mud would be contained and cleaned up; and
 - c. A contingency plan for crossing the waterbody or wetland in the event the directional drill is unsuccessful and how the abandoned drill hole would be sealed, if necessary.
- E. Crossings of Minor Waterbodies: Where a dry-ditch crossing is not required, minor waterbodies may be crossed using the open-cut crossing method, with the following restrictions:
 1. Except for blasting and other rock breaking measures (if applicable), complete instream construction activities (including trenching, pipe installation, backfill, and restoration of the streambed contours) within 24 hours. Streambanks and unconsolidated streambeds may require additional restoration after this period;
 2. Limit use of equipment operating in the waterbody to that needed to construct the crossing; and
 3. Equipment bridges are not required at minor waterbodies that do not have a state-designated fishery classification (e.g., agricultural or intermittent drainage ditches). However, if an equipment bridge is used it must be constructed as described.
- F. Crossings of Intermediate Waterbodies: Where a dry-ditch crossing is not required, intermediate waterbodies may be crossed using the open-cut crossing method, with the following restrictions:
 1. Complete instream construction activities (not including blasting and other rock breaking measures, if applicable) within 48 hours, unless site specific conditions make completion within 48 hours infeasible;
 2. Limit use of equipment operating in the waterbody to that needed to construct the crossing; and
 3. All other construction equipment must cross on an equipment bridge as specified.
- G. Crossings of Major Waterbodies: Before construction, the project sponsor shall develop a plan for each major water body crossing. This plan should be developed in

consultation with the appropriate state and Federal agencies and should include extra work areas, spoil storage areas, sediment control structures, etc., as well as mitigation for navigational issues.

1.02 INSTALLATION OF WETLAND CROSSINGS

A. Extra Work Areas and Access Roads:

1. Locate all extra work areas (such as staging areas and additional spoil storage areas) at least 50 feet away from wetland boundaries, unless site constraints require a narrower buffer, except where the adjacent upland consists of actively cultivated or rotated cropland or other disturbed land.
2. The project sponsor shall develop a site-specific construction plan for each extra work area with a less than 50-foot setback from wetland boundaries (except where adjacent upland consists of actively cultivated or rotated cropland or other disturbed land) and a site-specific explanation of the conditions that will not permit a 50-foot setback.
3. Limit clearing of vegetation between extra work areas and the edge of the wetland to the certificated construction right-of-way.
4. The construction right-of-way may be used for access when the wetland soil is firm enough to avoid rutting or the construction right-of-way has been appropriately stabilized to avoid rutting (e.g., with timber riprap, prefabricated equipment mats, or terra mats). In wetlands that cannot be appropriately stabilized, all construction equipment other than that needed to install the wetland crossing shall use access roads located in upland areas. Where access roads in upland areas do not provide reasonable access, limit all other construction equipment to one pass through the wetland using the construction right-of-way.
5. The only access roads, other than the construction right-of-way, that can be used in wetlands, are those existing roads that can be used with no modification and no impact on the wetland.

B. Crossing Procedures:

1. Comply with COE, or its delegated agency, permit terms and conditions.
2. Assemble the pipeline in an upland area unless the wetland is dry enough to adequately support skids and pipe or pipe material necessitates a different implementation approach.
3. Use "directional drill" or "floating mat" techniques to place the pipe in the trench where water and other site conditions allow.

4. Minimize the length of time that topsoil is segregated and the trench is open.
5. Limit construction equipment operating in wetland areas to that needed to clear the construction right-of-way, dig the trench, fabricate and install the pipeline, backfill the trench, and restore the construction right-of-way.
6. Cut vegetation just above ground level, leaving existing root systems in place, and remove it from the wetland for disposal.
7. Limit pulling of tree stumps and grading activities to directly over the trenchline. Do not grade or remove stumps or root systems from the rest of the construction right-of-way in wetlands unless safety-related construction constraints require grading or the removal of tree stumps from under the working side of the construction right-of-way.
8. Segregate the top 1 foot of topsoil from the area disturbed by trenching, except in areas where standing water is present or soils are saturated or frozen. Immediately after backfilling is complete, restore the segregated topsoil to its original location.
9. Do not use rock, soil imported from outside the wetland, tree stumps, or brush riprap to support equipment on the construction right-of-way.
10. If standing water or saturated soils are present, or if construction equipment causes ruts or mixing of the topsoil and subsoil in wetlands, use low-ground-weight construction equipment, or operate normal equipment on timber riprap, prefabricated equipment mats, or terra mats.
11. Do not cut trees outside of the approved construction work area to obtain timber for riprap or equipment mats.
12. Attempt to use no more than two layers of timber riprap to support equipment on the construction right-of-way.
13. Remove all project-related material used to support equipment on the construction right-of-way upon completion of construction.

Appendix 5-3
Archeological and Historical Resources

Archeological and Historical Resources

The City of Waukesha (the City) needs a long-term water source that can meet water supply demands, is protective of human health and the environment, and is sustainable. The water supply source will be used for public water supply and consider year 2035 and ultimate buildout water demand.

A variety of water supply alternatives have been evaluated for adverse impacts to cultural resources, including groundwater, surface water sources in the Mississippi River basin, and Lake Michigan. The Great Lakes–St. Lawrence River Basin Water Resources Compact regulates Lake Michigan as a water supply as a diversion for the City of Waukesha and requires return flow back to the Great Lakes Basin. Consequently, the Lake Michigan water supply alternative also has included an evaluation of return flow alternatives.

Section 106 of the National Historic Preservation Act (NHPA; 16 USC 470)) and its implementing regulations (36 CFR 800) require federal agencies (such as the U.S. Army Corps of Engineers [USACE] when issuing a Section 404 permit) to take into account the effects of their undertakings on historic properties listed in or eligible for listing in the National Register of Historic Places (NRHP; 36 CFR 60). Each of the water supply alternatives being considered will likely trigger federal permit requirements and subsequent Section 106 compliance. The NHPA and the regulations also require federal agencies to consult with the appropriate State Historic Preservation Officers (SHPOs) and federally-recognized Native American tribes for undertakings with the potential to affect NRHP-listed or -eligible properties. In order to comply with NHPA, the City will initiate the necessary consultations and conduct cultural resources surveys once the construction workspace has been determined. The construction workspace will be determined once the proposed project has received regional approval.

In addition, if the City applies for a Chapter 30 Wetland Water Quality Certification and/or a Wisconsin Pollutant Discharge Elimination System (WPDES) permit from the WDNR, then a cultural resource review will also be triggered. The permit review process involves a preliminary desktop cultural resources review by the WDNR to identify cultural resources or sites potentially impacted by the proposed supply and return flow alternatives. A request for cultural resource surveys may be initiated and required by the WDNR if the preliminary review results in cultural resources or sites being located along or within the construction workspace. If cultural resource surveys are required by the WDNR or SHPO in order to be in compliance with Section 106 of the National Historic Preservation Act, the City will work with an archeologist to conduct the necessary cultural resource surveys.

A majority of each alternative co-locates along previously disturbed utility corridors, roadways, railroad ROWs, or recreational trails, which is likely to minimize impacts to previously undisturbed resources. The City will follow any applicable requirements to protect cultural resources regardless of what alternative is chosen, and the City will implement minor adjustments to alignments or other disturbance minimization measures, if

necessary, in order to avoid potential impacts. Consequently, no significant impacts to known cultural resources will occur.

A. Identified Archeological and Historical Resources

1. Archeological Resources

Archival investigations were conducted by The Public Service Archaeology & Architecture Program of the University of Illinois at Urbana-Champaign (PSAAP) to identify significant cultural resources within or adjacent to potential construction corridors of the proposed supply and return flow alternatives. The investigations included a review of the known archaeological sites and previous cultural resource surveys within 100 meters of each alternative's potential corridor. These findings contain archeologically sensitive and confidential information that is made available to necessary agencies for review, but is not summarized here because the information is not intended for public release.

Although some of the alternatives evaluated share project corridors and thus have the potential to disturb the same cultural sites, most alternatives' corridors are separate, and therefore each alternative was investigated separately. The results of the archival investigations are listed below and summarized below.

Supply Alternatives

- Deep and Shallow Aquifers: 9 sites
- Shallow Aquifer and Fox River Alluvium: 10 sites
- Lake Michigan—Milwaukee Supply: 5 sites
- Lake Michigan—Oak Creek Supply Alignment 1: 11 sites
- Lake Michigan—Oak Creek Supply Alignment 2: 7 sites
- Lake Michigan—Racine Supply: 2 sites

Return Flow Alternatives

- Underwood Creek to Lake Michigan: 6 sites
- Root River to Lake Michigan Alignment 1: 9 sites
- Root River to Lake Michigan Alignment 2: 10 sites
- Direct to Lake Michigan: 17 sites

Details regarding each of the sites are available in Tables 1 and 2.

2. Previous Cultural Resource Surveys

The archival investigations of the supply and return flow alternatives involved an evaluation of previous cultural resource surveys within 100 meters of the proposed alignments. Documentary research was conducted using a variety of historical references. Due to the fact that the results of the archival investigations are based on existing records the number of sites identified along each alternative does not reflect potential resources that may be present in previously unsurveyed areas. The results of the archival investigations for previous cultural resource surveys are summarized below by study location.

Supply Alternatives

- Deep and Shallow Aquifers: 2 previous surveys conducted
- Shallow Aquifer and Fox River Alluvium: 2 previous surveys conducted

- Lake Michigan—Milwaukee Supply: 6 previous surveys conducted
- Lake Michigan—Oak Creek Supply Alignment 1: 11 previous surveys
- Lake Michigan—Oak Creek Supply Alignment 2: 17 previous surveys
- Lake Michigan—Racine Supply: 7 previous surveys

Return Flow Alternatives

- Underwood Creek to Lake Michigan: 7 previous surveys
- Root River to Lake Michigan: 2 previous surveys
- Root River to Lake Michigan Alignment 2: 18 previous surveys
- Direct to Lake Michigan: 7 previous surveys

3. Historical Resources

The National Parks Service's (NPS) National Register of Historic Places (NRHP) was authorized under the National Historic Preservation Act of 1966. The NRHP is the official list of historic places throughout the United States and is part of a national program to coordinate and support efforts to identify, evaluate, and protect historic and archeological resources (NRHP, 2010a).

The NRHP database, which can be used through Google Earth®, provides the locations of NRHP sites for the Midwest Region, including Wisconsin. No NRHP sites are located within 0.10 mile of the Lake Michigan—Milwaukee Supply, Lake Michigan—Oak Creek Supply Alignment 1, Lake Michigan—Oak Creek Supply Alignment 2, or Lake Michigan—Racine Supply alternatives.

There are 25 NRHP sites within 0.10 mile of the Deep and Shallow Aquifers and Shallow Aquifer and Fox River Alluvium supply alternatives in Waukesha County (Google Earth, 2010; NHRP, 2010b). Thirteen NRHP sites were identified within 0.10 mile of the Underwood Creek to Lake Michigan return flow alternative, all within Waukesha County; no NRHP sites were identified within the Milwaukee County portion of the Underwood Creek to Lake Michigan return flow alternative. There are 10 NRHP sites within 0.10 mile of the Root River to Lake Michigan return flow alternative Alignment 1, of which all are within Waukesha County. There are eight NRHP sites within 0.10 mile of the Root River to Lake Michigan return flow Alignment 2 alternative, of which all are within Waukesha County. There are 10 NRHP sites within 0.10 mile of the Direct to Lake Michigan return flow alternative within Waukesha County and two NRHP sites within Milwaukee County (Google Earth, 2010; NHRP, 2010b, NHRP, 2012).

B. Archeological and Historical Resources Effects

1. Archeological Resources

Regardless of the alternatives selected, the City will meet regulatory requirements regarding archeological resources during the design and construction phases to prevent any significant impacts and mitigate impacts to known or potential sites. During operation, there will be no ground disturbance and no impacts will occur to archeological resources.

2. Historical Resources

No NRHP sites will be impacted by permanent structures associated with the project. Regardless of the alternatives selected, the City will follow regulatory requirements to prevent any significant impacts and mitigate impacts to known or potential NRHP sites. During operation, there will be no ground disturbance and no impacts will occur to historical resources.

3. Status of Native American Consultation

Research regarding the various supply and return flow alternatives was based on a desktop-level analysis using available survey data in order to preliminarily quantify the extent and nature of cultural resources that may be present. In order to comply with Section 106 of the NHPA, and to determine whether or not the Project affects any cultural properties of a Native American Nation or Tribe, consultation will be conducted with Native American groups. Coordination will occur once a Lake Michigan water supplier has been determined and a return flow location has been approved.

4. Consultation with the SHPO and Cultural Resources Surveys

The City will conduct comprehensive field surveys of all proposed work spaces as required by Section 106 of the NHPA, to protect archeological resources and coordinate appropriately with the SHPO regarding potential impacts from construction once a defined Lake Michigan water supplier has been determined and a return flow location has been approved. At that time, should eligible historic properties be identified in association with the alternative to be implemented the City will work with a qualified archeologist to prepare the appropriate evaluation reports and corresponding SHPO-approved cultural resource protection plan.

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TABLE 1
Archeological Sites within 100m of Centerline of City of Waukesha Water Supply Alternatives

Site Name	Township	Range	Description	Consultation Requirements
Supply Alternative: Deep and Shallow Aquifers^a				
Ludy Jan Site	6N	19E	Unknown Historic Indian campsite/village/workshop. A large amount of archaeological material is distributed on a sandy ridge. It appears to be a multicomponent site with a variety of material ranging from Archaic to Historic.	Update 1979: Following Phase II investigations, the site was determined <i>not</i> to be eligible for listing on the National/State Register of Historic Places. Current recommendations may differ from the original findings, and site status should be confirmed with WHS.
Gienke #3	6N	19E	Unknown prehistoric campsite/village/workshop adjacent to the Fox River.	The current status is unknown, and additional investigations may need to be completed. Consultation with WHS is necessary.
Gienke #1	6N	19E	Unknown prehistoric campsite/village/workshop. This site consists of a scatter of fire-cracked rock, debitage, and nondiagnostic lithic tools.	Update 2007: Intensive surface survey failed to relocate this site. The extended cultivation of this land has likely disturbed and deflated the site. The current status is unknown and additional investigations may be necessary. Consultation with WHS is necessary.
Gienke #2	6N	19E	Late Archaic to Middle Woodland campsite/village/workshop. The distribution of material was widely scattered.	The current status is unknown, and additional investigations may need to be completed. Consultation with WHS is necessary.
Stephen Peet's Mounds	6N	19E	A group of mounds. Due to the vague nature of the report, the site is not mapped. No other information is available.	This burial site is not catalogued, but is protected under Wis. Stats 157.70. Consultation with WHS is required.
Prairie Home Cemetery	6N	19E	A Historic Euro-American cemetery/burial. This site consists of a marked Euro-American cemetery established 1841 and possibly as early as 1835. The site occupies an 8-acre parcel and has expanded to 80 acres, due to transfers from other, smaller cemeteries. Prairie Home also has a potter's field.	This burial site is catalogued and subject to the provisions of Wis. Stats 157.70. Consultation with WHS is required.
Tcheegascoutak	6N	19E	Historic Indian campsite/village. The Potawatomi settlement of Tcheegascoutak is reported for this location. Historic records indicate that the large village may have been inhabited by as many as 4,000 people around 1827.	This site is listed on the National/State Register of Historic Places and may be afforded special consideration pursuant to state and/or federal law. Consultation with WHS is necessary.
Main Street Mounds	6N	19E	Late Woodland mounds—conical, effigy, linear. The site consists of a group of one panther effigy, one linear, and one conical mound. No other information is available.	This burial site is not catalogued, but is protected under Wis. Stats 157.70. Consultation with WHS is required.

TABLE 1
Archeological Sites within 100m of Centerline of City of Waukesha Water Supply Alternatives

Site Name	Township	Range	Description	Consultation Requirements
Court House Mounds	6N	19E	Late Woodland mounds—conical, effigy, linear, and historic Indian, historic Euro-American trading/fur post. The Waukesha Museum was erected over the location of the turtle mound, and two mounds were located in the middle of modern Main St. This site consists of a group of mounds. A postcontact grave had been excavated into one of the turtle mounds.	Update 2000: The Vieau-Juneau Trading Post has been reported at this location. This Burial Site is not catalogued, but is protected under Wis. Stats 157.70. Consultation with WHS is required.
Supply Alternative: Shallow Aquifer and Fox River Alluvium ^a				
Dreger Site	6N	19E	Unknown prehistoric campsite/village/workshop.	Current status unknown and additional investigations may need to be completed. Consultation with WHS is necessary.
Ludy Jan Site	6N	19E	Unknown Historic Indian campsite/village/workshop. It appears to be a multicomponent site with a variety of material ranging from Archaic to Historic.	Update 1979: Following Phase II investigations, the site was determined <i>not</i> to be eligible for listing on the National/State Register of Historic Places. Current recommendations may differ from the original findings, and site status should be confirmed with WHS.
Gienke #3	6N	19E	Unknown prehistoric campsite/village/ workshop.	The current status is unknown and additional investigations may need to be completed. Consultation with WHS is necessary.
Gienke #1	6N	19E	Unknown prehistoric campsite/village/ workshop. This site consists of a scatter of fire-cracked rock, debitage, and nondiagnostic lithic tools.	Update 2007: Intensive surface survey failed to relocate this site. The extended cultivation of this land has likely disturbed and deflated the site. The current status is unknown and additional investigations may be necessary. Consultation with WHS is necessary.
Gienke #2	6N	19E	Late Archaic to Middle Woodland campsite/ village/workshop. The distribution of material was widely scattered.	Current status is unknown and additional investigations may need to be completed. Consultation with WHS is necessary.
Stephen Peet's Mounds	6N	19E	A group of mounds. Due to the vague nature of the report, the site is not mapped. No other information is available.	This Burial Site is not catalogued, but is protected under Wis. Stats 157.70. Consultation with WHS is required.

TABLE 1
Archeological Sites within 100m of Centerline of City of Waukesha Water Supply Alternatives

Site Name	Township	Range	Description	Consultation Requirements
Prairie Home Cemetery	6N	19E	Historic Euro-American cemetery/burial. This site consists of a marked Euro-American cemetery established 1841 and possibly as early as 1835. The site occupies an 8-acre parcel and has expanded to 80 acres, due to transfers from other, smaller cemeteries. Prairie Home also has a potter's field.	This Burial Site is catalogued and subject to the provisions of Wis. Stats 157.70. Consultation with WHS is required.
Tcheegascoutak	6N	19E	Historic Indian campsite/ village. The Potawatomi settlement of Tcheegascoutak is reported for this location. Historic records indicate that the large village may have been inhabited by as many as 4,000 people around 1827.	Listed on the National/State Register of Historic Places and may be afforded special consideration pursuant to state and/or federal law. Consultation with WHS is necessary.
Main Street Mounds	6N	19E	Late Woodland mounds—conical, effigy, linear. The site consists of a group of one panther effigy, one linear and one conical mound. No other information is available.	This Burial Site is not catalogued, but is protected under Wis. Stats 157.70. Consultation with WHS is required.
Court House Mounds	6N	19E	Late Woodland mounds—conical, effigy, linear, and historic Indian, historic EuroAmerican trading/fur post. The Waukesha Museum was erected over the location of the turtle mound, and two mounds were located in the middle of modern Main St. This site consists of a group of mounds. A postcontact grave had been excavated into one of the turtle mounds.	Update 2000: The Vieau-Juneau Trading Post has been reported at this location. This Burial Site is not catalogued, but is protected under Wis. Stats 157.70. Consultation with WHS is required.

Supply Alternative: Lake Michigan—Milwaukee Supply^a

Calhoun Mounds	6N	20E	This site was located on the J. Elger property south of Calhoun Station and consists of two conical mounds (Woodland Mounds-Conical). They had disappeared through cultivation of the land by July 8, 1903.	This Burial Site is not catalogued, but is protected under Wis. Stats 157.70. Consultation with WHS is required.
Highland Memorial Park	6N	20E	Historic Euro-American cemetery/ burial. Records for this cemetery are complete but are not available to the public.	This Burial Site is not catalogued, but is protected under Wis. Stats 157.70. Consultation with WHS is required.
Root River Parkway	6N	21E	Unknown prehistoric isolated finds.	The current status is unknown and additional investigations may need to be completed. Consultation with WHS is necessary.

TABLE 1
Archeological Sites within 100m of Centerline of City of Waukesha Water Supply Alternatives

Site Name	Township	Range	Description	Consultation Requirements
Beloit Corners Burials	6N	21E	Middle Archaic cemetery/burial.	This burial site is not catalogued, but is protected under Wis. Stats 157.70. Consultation with WHS is required.
Blessed Sacrament Cemetery	6N	21E	Historic Euro-American cemetery/burial. This is a very small cemetery, with many fallen stones.	This burial site is not catalogued, but is protected under Wis. Stats 157.70. Consultation with WHS is required.
Supply Alternative: Lake Michigan Supply—Oak Creek Alignment 1^a				
Calhoun Mounds	6N	20E	Consists of two conical mounds (Woodland Mounds—Conical). They had disappeared through cultivation of the land by July 8, 1903.	This Burial Site is not catalogued, but is protected under Wis. Stats 157.70. Consultation with WHS is required.
Highland Memorial Park	6N	20E	Historic Euro-American cemetery/burial. Records for this cemetery are complete, but are not available to the public.	This Burial Site is not catalogued, but is protected under Wis. Stats 157.70. Consultation with WHS is required.
Root River Parkway	6N	21E	Unknown prehistoric isolated finds.	Current status is unknown, and additional investigations may need to be completed. Consultation with WHS is necessary.
Beloit Corners Burials	6N	21E	Middle Archaic cemetery/burial.	This burial site is not catalogued, but is protected under Wis. Stats 157.70. Consultation with WHS is required.
Jungblut Gravel Pit	6N	21E	Campsite/ village, cemetery/burial. This site consists of a Menominee habitation area and a cemetery.	The site may or may not be on the Jungblut farm. Current status is unknown and additional investigations may need to be completed. Consultation with WHS is necessary.
Whitnall Park Burial	6N	21E	Late Archaic, Early Woodland cemetery/burial.	This Burial Site is not catalogued, but is protected under Wis. Stats 157.70. Consultation with WHS is required.
Unnamed Site #1	5N	21E	Located along the banks of the Root River. Culture unknown.	Current status is unknown and additional investigations may need to be completed. Consultation with WHS is necessary.
Unnamed Site #2	5N	21E	The site, an unknown Prehistoric campsite/ village.	Current status site is unknown and additional investigations may need to be completed. Consultation with WHS is necessary.
Chicago Short	5N	21E	Unknown Prehistoric campsite/ village.	Determined not eligible. Current status is unknown and additional investigations may need to be completed. Consultation with WHS is necessary.

TABLE 1
Archeological Sites within 100m of Centerline of City of Waukesha Water Supply Alternatives

Site Name	Township	Range	Description	Consultation Requirements
Unnamed Site #3	5N	22E	Unknown Prehistoric site. Contains lithics scatter. Patricia B. Richards investigated the site in 1993. No artifacts were recovered within the survey corridor.	Due to previous road construction and maintenance activities, all deposits within the right-of-way probably have been extensively disturbed.
St. Matthews Cemetery	5N	22E	The site is a Euro-American cemetery/burial.	This Burial Site is not catalogued, but is protected under Wis. Stats 157.70. Consultation with WHS is required.
Supply Alternative: Lake Michigan Supply—Oak Creek Alignment 2^a				
Unnamed Site	5N	21E	Unknown Prehistoric site. Contains lithics scatter. Lynn Rushc and Charles Whyte investigated the site.	Current status is unknown and additional investigations may need to be completed. Consultation with Wisconsin Historical Society is necessary.
Tess Corners Creek	5N	21E	Unknown Historic/Prehistoric campsite/village.	Current status is unknown and additional investigations may need to be completed. Consultation with Wisconsin Historical Society is necessary.
Sunnyside Cemetery	6N	20E	Historic Euro-American cemetery/burial. The site contains a marked cemetery established in 1887 with at least 360 individuals buried.	This Burial Site is not catalogued, but is protected under Wis. Stats 157.70. Consultation with WHS is required.
Sittle Cemetery	6N	20E	Historic Euro-American cemetery/burial.	This Burial Site is catalogued and subject to the provisions of Wis. Stats 157.70. Consultation with WHS is required.
Evangelical and Reformed Church of New Berlin Cemetery	6N	20E	Historic Euro-American cemetery/burial. Cemetery records are possibly kept in a box at the United Church of Christ-First Evangelical and Reformed Church in Waukesha.	This Burial Site is catalogued and subject to the provisions of Wis. Stats 157.70. Consultation with WHS is required.
Town Cemetery	6N	20E	Historic Euro-American cemetery/burial. Cemetery was established during the Civil War with the last burial in 1962.	This Burial Site is not catalogued, but is protected under Wis. Stats 157.70. Consultation with WHS is required.
St. Joseph Cemetery	6N	19E	Historic Euro-American cemetery/burial. Cemetery records are located at St. Joseph Church	This Burial Site is not catalogued, but is protected under Wis. Stats 157.70. Consultation with WHS is required.
Supply Alternative: Lake Michigan—Racine^a				
Tews Site	5N	20E	Unknown Prehistoric campsite/village/workshop.	Current status is unknown and additional investigations may need to be completed. Consultation with Wisconsin Historical Society is necessary.

TABLE 1
Archeological Sites within 100m of Centerline of City of Waukesha Water Supply Alternatives

Site Name	Township	Range	Description	Consultation Requirements
Heinrich	5N	20E	Middle-Late woodland campsite/village/ workshop.	Current status is unknown and additional investigations may need to be completed. Consultation with Wisconsin Historical Society is necessary.

^aTo protect cultural resources, section and quarter section locations have been omitted.

WHS, Wisconsin Historical Society.

Sources: Becker (1988); Brazeau (1979); Brown (1906b, 1906c, 1923b, 1923d, 1925, 1930a, 1930b); Bruhy (1979a, 1979b); Haas (1998); Harvey (2008); Hendrickson (1995); Holliday (1989); Goldstein (1994); Kolb and Jalbert (2006); Kubicek (2008); Lapham (1836, 1855); Overstreet and Brazeau (1978a, 1978b, 1978c, 1978d, 1979); Phillips (1923); Salkin (1986, 1993, 1999); Van Dyke (1988, 1996, 2008, 2010).

TABLE 2
Archaeological Sites within 100m of Centerline of Flow Return Alternatives

Site Name	Township	Range	Description	Consultation Requirements
Flow Return Alternative: Underwood Creek^a				
Stephen Peet's Mounds	6N	19E	A group of mounds. Due to the vague nature of the report, the site is not mapped. No other information is available.	This Burial Site is not catalogued, but is protected under Wis. Stats 157.70. Consultation with WHS is required.
Industrial School Mound	6N	19E	This site consists of a single conical mound 40 feet in diameter and one and a half feet high.	Updated 1995: No surface indications of a mound were found during a 1994 field check. This Burial Site is not catalogued, but is protected under Wis. Stats 157.70. Consultation with WHS is required.
Dwell's Cornfields	6N	19E	Historic Indian campsite/village/corn hills/garden beds. The site is associated with the early 19th century Potawatomi occupation of Waukesha.	Current status is unknown and additional investigations may need to be completed. Consultation with WHS is necessary.
Charles Street Mounds	6N	19E	Woodland, Late Woodland conical and linear mounds. This site consists of a group of five conical mounds and one linear mound, destroyed prior to 1906.	This Burial Site is not catalogued, but is protected under Wis. Stats 157.70. Consultation with the Wisconsin Historical Society is required.
Calhoun Mounds	6N	20E	This site consists of two conical mounds (Woodland Mounds-Conical). They had disappeared through cultivation of the land by July 8, 1903.	This Burial Site is not catalogued, but is protected under Wis. Stats 157.70. Consultation with the Wisconsin Historical Society (WHS) is required.
Highland Memorial Park	6N	20E	Historic Euro-American cemetery/burial. Records for this cemetery are complete, but are not available to the public.	This Burial Site is not catalogued, but is protected under Wis. Stats 157.70. Consultation with WHS is required.
Flow Return Alternative: Root River Alignment 1^a				
Stephen Peet's Mounds	6N	19E	A group of mounds. Due to the vague nature of the report, the site is not mapped. No other information is available.	This Burial Site is not catalogued, but is protected under Wis. Stats 157.70. Consultation with WHS is required.
Industrial School Mound	6N	19E	Consists of a single conical mound forty feet in diameter and one and a half feet high.	Updated 1995: No surface indications of a mound were found during a 1994 field check. This Burial Site is not catalogued, but is protected under Wis. Stats 157.70. Consultation with WHS is required.
Dwell's Cornfields	6N	19E	Historic Indian campsite/village/cornhills/garden beds. The site is associated with the early 19th century Potawatomi occupation of Waukesha.	Current status is unknown and additional investigations may need to be completed. Consultation with WHS is necessary.

TABLE 2
Archaeological Sites within 100m of Centerline of Flow Return Alternatives

Site Name	Township	Range	Description	Consultation Requirements
Charles Street Mounds	6N	19E	Woodland, Late Woodland conical and linear mounds. This site consists of a group of five conical mounds and one linear mound, destroyed prior to 1906.	This Burial Site is not catalogued, but is protected under Wis. Stats 157.70. Consultation with the Wisconsin Historical Society is required.
Calhoun Mounds	6N	20E	Consists of two conical mounds (Woodland Mounds–Conical). They had disappeared through cultivation of the land by July 8, 1903.	This Burial Site is not catalogued, but is protected under Wis. Stats 157.70. Consultation with the Wisconsin Historical Society (WHS) is required.
Highland Memorial Park	6N	20E	Historic Euro-American cemetery/burial. Records for this cemetery are complete, but are not available to the public.	This Burial Site is not catalogued, but is protected under Wis. Stats 157.70. Consultation with WHS is required.
Root River Parkway	6N	21E	Unknown prehistoric isolated finds.	Current status is unknown and additional investigations may need to be completed. Consultation with WHS is necessary.
Beloit Corners Burials	6N	21E	Middle Archaic cemetery/burial.	This Burial Site is not catalogued, but is protected under Wis. Stats 157.70. Consultation with WHS is required.
Jungblut Gravel Pit	6N	21E	Campsite/village, cemetery/burial. This site consists of a Menominee habitation area and a cemetery.	The Jungblut farm is listed in Section 29 on archival plats. However, the site may or may not be on the Jungblut farm.

Flow Return Alternative: Root River Alignment 2^a

Unnamed Site #1	5N	21E	Unknown Prehistoric campsite/village.	Current status is unknown and additional investigations may need to be completed. Consultation with WHS is necessary.
Unnamed Site #2	5N	21E	Unknown cornhills/garden beds.	Current status is unknown and additional investigations may need to be completed. Consultation with WHS is necessary.
Unnamed Site #3	5N	21E	Unknown campsite/village.	Current status is unknown and additional investigations may need to be completed. Consultation with WHS is necessary.
Burrwood Cemetery	5N	21E	Historic Euro-American cemetery/burial. Located on the Milwaukee County House of Correction lands. A Milwaukee County Historical Landmark, the Carmen Family Cemetery is located on the grounds.	This Burial Site is catalogued and subject to the provisions of Wis. Stats 157.70. Consultation with WHS is required.

TABLE 2
Archaeological Sites within 100m of Centerline of Flow Return Alternatives

Site Name	Township	Range	Description	Consultation Requirements
Tess Corners Creek	5N	21E	Unknown Historic/Prehistoric campsite/village.	Current status is unknown and additional investigations may need to be completed. Consultation with Wisconsin Historical Society is necessary.
Sunnyside Cemetery	6N	20E	Historic Euro-American cemetery/burial. The site contains a marked cemetery established in 1887 with at least 360 individuals buried.	This Burial Site is not catalogued, but is protected under Wis. Stats 157.70. Consultation with WHS is required.
Sittle Cemetery	6N	20E	Historic Euro-American cemetery/burial.	This Burial Site is catalogued and subject to the provisions of Wis. Stats 157.70. Consultation with WHS is required.
Evangelical and Reformed Church of New Berlin Cemetery	6N	20E	Historic Euro-American cemetery/burial. Cemetery records are possibly kept in a box at the United Church of Christ-First Evangelical and Reformed Church in Waukesha.	This Burial Site is catalogued and subject to the provisions of Wis. Stats 157.70. Consultation with WHS is required.
Town Cemetery	6N	20E	Historic Euro-American cemetery/burial. Cemetery was established during the Civil War with the last burial in 1962.	This Burial Site is not catalogued, but is protected under Wis. Stats 157.70. Consultation with WHS is required.
Industrial School Mound	6N	19E	Woodland mounds-conical. Site was investigated by Charles E. Brown in 1923.	This Burial Site is not catalogued, but is protected under Wis. Stats 157.70. Consultation with WHS is required.

Flow Return Alternative: Direct to Lake Michigan^a

Stephen Peet's Mounds	6N	19E	A group of mounds. Due to the vague nature of the report, the site is not mapped. No other information is available.	This Burial Site is not catalogued, but is protected under Wis. Stats 157.70. Consultation with WHS is required.
Industrial School Mound	6N	19E	Consists of a single conical mound forty feet in diameter and one and a half feet high.	Updated 1995: No surface indications of a mound were found during a 1994 field check. This Burial Site is not catalogued, but is protected under Wis. Stats 157.70. Consultation with WHS is required.
Dwell's Cornfields	6N	19E	Historic Indian campsite/village/corn hills/garden beds. The site is associated with the early 19th century Potawatomi occupation of Waukesha.	Current status is unknown and additional investigations may need to be completed. Consultation with WHS is necessary.
Charles Street Mounds	6N	19E	Woodland, Late Woodland conical and linear mounds. This site consists of a group of five conical mounds and one linear mound, destroyed prior to 1906.	This Burial Site is not catalogued, but is protected under Wis. Stats 157.70. Consultation with the Wisconsin Historical Society is required.

TABLE 2
Archaeological Sites within 100m of Centerline of Flow Return Alternatives

Site Name	Township	Range	Description	Consultation Requirements
Calhoun Mounds	6N	20E	This site consists of two conical mounds (Woodland Mounds–Conical). They had disappeared through cultivation of the land by July 8, 1903.	This Burial Site is not catalogued, but is protected under Wis. Stats 157.70. Consultation with WHS is required.
Highland Memorial Park	6N	20E	Historic Euro-American cemetery/burial. Records for this cemetery are complete, but are not available to the public.	This Burial Site is not catalogued, but is protected under Wis. Stats 157.70. Consultation with WHS is required.
Indian Fields	6N	21E	Consists of a habitation area and a large group of mounds. In 1836, the site was described as showing “recent signs of Indian occupancy and cultivation.” The mounds were probably segregated into several distinct groups, but the site is so vaguely described that little can be said about its structure.	Current status is unknown and additional investigations may need to be completed. Consultation with WHS is necessary.
Pilgrims’ Rest Cemetery	6N	21E	Historic Euro-American cemetery/burial. Pilgrims’ Rest Cemetery was established in 1880 by St. Stephen’s Congregation and was managed by a church cemetery committee. It was sold in June 1996 to Good Hope Pilgrims Rest Cemetery corp.	This Burial site is not catalogued, but is protected under Wis. Stats 157.70. Consultation with WHS is required.
Jackson Park Burial	6N	21E	Unknown Prehistoric campsite/village, Woodland cemetery/burial.	This Burial site is not catalogued, but is protected under Wis. Stats 157.70. Consultation with WHS is required.
Jackson Park	6N	21E	Unknown Prehistoric isolated finds.	Current status is unknown and additional investigations may need to be completed. Consultation with WHS is necessary.
Unnamed Site #1	6N	22E	Unknown Prehistoric campsite/village.	Current status is unknown and additional investigations may need to be completed. Consultation with WHS is necessary.
Unnamed Site #2	6N	22E	Unknown enclosure/earthworks.	Current status is unknown and additional investigations may need to be completed. Consultation with WHS is necessary.
Greenwood Cemetery	6N	22E	Historic Euro-American cemetery.	This Burial site is not catalogued, but is protected under Wis. Stats 157.70. Consultation with WHS is required.
Forest Home Cemetery	6N	22E	Historic Euro-American cemetery. This is a large cemetery that has early burial records on microfilm.	This Burial site is not catalogued, but is protected under Wis. Stats 157.70. Consultation with WHS is required.

TABLE 2
Archaeological Sites within 100m of Centerline of Flow Return Alternatives

Site Name	Township	Range	Description	Consultation Requirements
Austin's Gravel Pit Burials	6N	22E	Unknown cemetery/burial. Various references place this site in different sections.	This Burial site is not catalogued, but is protected under Wis. Stats 157.70. Consultation with WHS is required.
Unnamed Site #3	6N	22E	Historic Euro-American cemetery/burial site.	This Burial site is not catalogued, but is protected under Wis. Stats 157.70. Consultation with WHS is required.
Unnamed Site #4	6N	22E	Unknown site.	Current status is unknown and additional investigations may need to be completed. Consultation with WHS is necessary.

^aTo protect cultural resources, section and quarter section locations have been omitted.

WHS, Wisconsin Historical Society.

Sources: Becker (1988); Brazeau (1979); Brown (1906b, 1906c, 1923b, 1923d, 1925, 1930a, 1930b); Bruhy (1979a, 1979b); Haas (1998); Harvey (2008); Hendrickson (1995); Holliday (1989); Goldstein (1994); Kolb and Jalbert (2006); Kubicek (2008); Lapham (1836, 1855); Overstreet and Brazeau (1978a, 1978b, 1978c, 1978d, 1979); Phillips (1923); Salkin (1986, 1993, 1999); Van Dyke (1988, 1996, 2008, 2010).

Section 6

**Alternatives to the Proposed Project: Affected
Environment and Environmental Effects**

SECTION 6

Alternatives to the Proposed Project: Affected Environment and Environmental Effects

6.1 Water Supply and Return Flow Alternatives

The process documenting the various water supply and return flow alternatives considered is discussed in Section 2. This process produced the following water supply and return flow alternatives (Table 6-1) and system alternatives (Table 6-2), the descriptions of which are detailed below. The list of alternatives includes elements of the proposed project so that the impacts of various alternatives can be compared side by side. As described in Section 3, the proposed project includes Lake Michigan supply from the City of Oak Creek via pipeline Alignment 2 with return flow to the Root River via pipeline Alignment 2.

TABLE 6-1
Water Supply and Return Flow Alternatives

Water Supply Alternative

Deep and Shallow Aquifers
Shallow Aquifer and Fox River Alluvium
Lake Michigan (City of Milwaukee)
Lake Michigan (City of Oak Creek) Alignment 1
Lake Michigan (City of Oak Creek) Alignment 2
Lake Michigan (City of Racine)

Return Flow Alternatives (for Lake Michigan Water Supplies)

Underwood Creek to Lake Michigan
Root River to Lake Michigan Alignment 1
Root River to Lake Michigan Alignment 2
Direct to Lake Michigan

TABLE 6-2
Water Supply and Return Flow System Alternatives

Water Supply Alternative	Lake Michigan Return Flow Alternative
Mississippi River Basin System Alternatives	
Deep and Shallow Aquifers	None – Continued Discharge to Fox River
Shallow Aquifer and Fox River Alluvium	None – Continued Discharge to Fox River
Lake Michigan System Alternatives	
Lake Michigan (City of Milwaukee)	Underwood Creek to Lake Michigan
Lake Michigan (City of Milwaukee)	Root River to Lake Michigan Alignment 1
Lake Michigan (City of Milwaukee)	Direct to Lake Michigan
Lake Michigan (City of Oak Creek) Alignment 1	Underwood Creek to Lake Michigan
Lake Michigan (City of Oak Creek) Alignment 1	Root River to Lake Michigan Alignment 1
Lake Michigan (City of Oak Creek) Alignment 1	Direct to Lake Michigan
Lake Michigan (City of Oak Creek) Alignment 2	Root River to Lake Michigan Alignment 2
Lake Michigan (City of Racine)	Underwood Creek to Lake Michigan
Lake Michigan (City of Racine)	Root River to Lake Michigan Alignment 1
Lake Michigan (City of Racine)	Direct to Lake Michigan

6.2 Water Supply Alternatives

A long term water supply source for the City of Waukesha has been studied for many years and has examined many alternatives as summarized in Section 2. Various water supply sources have been screened out and eliminated from further analysis. The water sources, supply pipelines, water supply treatment, and water distribution for the six water supply alternatives listed in Table 6-1 are evaluated in detail and summarized below. The proposed project and alternatives to the proposed project are included in this analysis to provide a side by side comparison of the remaining alternatives considered in detail. The environmental impacts of these alternatives are detailed later in this section. Environmental impacts of systems alternatives where Lake Michigan water supply alternatives are paired with return flow alternatives are summarized in Appendix 6-2.

A map showing pipeline alignments and other infrastructure associated with the alternatives is found in Appendix 3-1 in Section 3 for maps associated with the proposed project and Appendix 6-1 at the end of this section for maps associated with alternatives to the proposed project.

The environmental impacts determined in this section are based on conservative potential water supply service area water demand that the City can expect unless otherwise noted. Impacts of a water supply are based upon 10.9 million gallons per day (mgd) to meet future average day water demands and a future maximum day demand of 18.5 mgd. If the final water supply demand is determined to be less than this analysis, the environmental impacts of the proposed project would change proportionally. For example, a reduced water demand would not change the pipeline length or construction corridor, but could proportionally change stream flows and groundwater drawdown. Table 1-1 illustrates the anticipated changes to environmental impacts based on changes in water demand.

Note: The environmental impacts determined in this section are conservative and are based on conservative potential water demand values. Analysis of the environmental impacts in this ER has occurred with an MDD of 18.5 mgd and an ADD of 10.9 mgd as documented in the February 2012 ER unless otherwise noted. The water demand forecasts have changed slightly since the February 2012 ER (10.1 mgd ADD compared to 10.9 mgd ADD). Water demands may vary depending upon the final water demand forecasts. The official water request is as documented in the Application Summary (Volume 1 of 5). If values are less, then the impacts documented in this document will be conservative for impact comparison purposes. Regardless, a small change in water demand will have either no significant change to impacts or a proportional change to impacts. See Table 1-1 for a description of how impacts change with a change in water demand.

6.2.1 Water Source

6.2.1.1 Deep and Shallow Aquifers

This alternative consists of continued use of the deep aquifer (St. Peter sandstone) and shallow aquifer south of Waukesha (Troy Bedrock Valley).

The deep aquifer groundwater levels have fallen over 600 feet from predevelopment levels. The City's deep aquifer wells vary in age from 30 to 75 years and several wells have been abandoned because of contamination and decreasing capacity. One well had TDS concentrations greater than 1,000 mg/L and was rehabilitated to reduce the TDS (blocking off

part of the well hole). In doing so, the well capacity was reduced by over 35 percent. The Future Water Supply Study warned that many of the wells were not constructed to current well codes and could experience physical failures such as casing leaks or borehole collapse, which would require extensive rehabilitation or replacement (CH2M HILL, 2002). The capacity is expected to decrease from the deep aquifer wells because the groundwater elevation continues to drop due to current pumping demands. For this alternative, the existing capacity is estimated to decrease 30 percent in the future.

To meet a future average day demand of 10.9 mgd and a maximum day demand of 18.5 mgd, infrastructure would be in place for 7.6 mgd firm capacity (capacity with the largest well out of operation) from the deep wells and firm capacity of 10.9 mgd from the shallow wells. Because the deep aquifer well capacity is expected to decrease, additional shallow aquifer wells are needed to meet the future demands. The maximum capacity from shallow wells would be achieved by relying upon the current 1.2 mgd firm capacity from existing wells 11, 12, and 13, with the additional 9.7 mgd firm capacity achieved by installing 14 new wells south of Waukesha near Vernon Marsh Wildlife Area in the Troy Bedrock Valley aquifer.

Note: A 10.1 mgd average day demand with a maximum day demand of 16.7 mgd would have 2 fewer wells. See the Water Supply Service Area Plan (Volume 2 of the Application). To be conservative, impacts are assumed for 14 new shallow wells. Fewer wells will have proportionally fewer impacts.

Figure 6-1 and Appendix 6-1 shows the wells, pipelines, and treatment facilities for this alternative.

6.2.1.2 Shallow Aquifer and Fox River Alluvium Water Supply

This alternative uses the shallow aquifer south of Waukesha for the City's entire water supply. To meet a future average day demand of 10.9 mgd and a maximum day demand of 18.5 mgd, infrastructure would be built for 4.5 mgd of firm capacity through 4 new wells along the Fox River south of Waukesha, in what is called the Fox River alluvium (riverbank inducement). Another 12.8 mgd firm capacity would be obtained through 14 new wells in the Troy Bedrock Valley south of Waukesha and adjacent to Vernon Marsh. The remaining 1.2 mgd firm capacity would be obtained from Waukesha's existing shallow wells 11 through 13.

Note: A 10.1 mgd average day demand with a maximum day demand of 16.7 mgd would have 2 fewer shallow aquifer wells. See the Water Supply Service Area Plan (Volume 2 of the Application). To be conservative, impacts are assumed for 18 new shallow wells. Fewer wells will have proportionally fewer impacts.

Figure 6-2 and Appendix 6-1 shows the wells, pipelines, and treatment facilities for this alternative.

6.2.1.3 Lake Michigan Water Supply (City of Milwaukee)

This alternative includes obtaining Lake Michigan water by connecting to the City of Milwaukee's existing distribution system on the west side of Milwaukee. A new pipeline and booster pump station would be constructed to connect to this supply.

Figure 6-3 and Appendix 6-1 shows the booster pump station and pipeline for this alternative.

6.2.1.4 Lake Michigan Water Supply (City of Oak Creek) Alignment 1

This alternative includes obtaining Lake Michigan water by connecting to the City of Oak Creek's existing distribution system near the water treatment plant. A new pipeline and booster pump station would be constructed to connect to this supply.

Figure 6-4 and Appendix 6-1 shows the booster pump station and pipeline for this alternative.

6.2.1.5 Lake Michigan Water Supply (City of Oak Creek) Alignment 2

This alternative is part of the proposed project. The water source is described in Section 3.

This alternative includes obtaining Lake Michigan water by connecting to the City of Oak Creek's existing distribution system near 27th Street and Puetz Road. A new pipeline and booster pump station would be constructed to connect to this supply.

Figure 3-1 and Appendix 3-1 in Section 3 shows the pipeline alignment for this alternative.

6.2.1.6 Lake Michigan Water Supply (City of Racine)

This alternative includes obtaining Lake Michigan water by connecting to the City of Racine's existing distribution system on the west side of Racine. A new pipeline and booster pump station would be constructed to connect to this supply.

Figure 6-5 and Appendix 6-1 shows the booster pump station and pipeline for this alternative.

6.2.2 Supply Pipeline

6.2.2.1 Deep and Shallow Aquifers

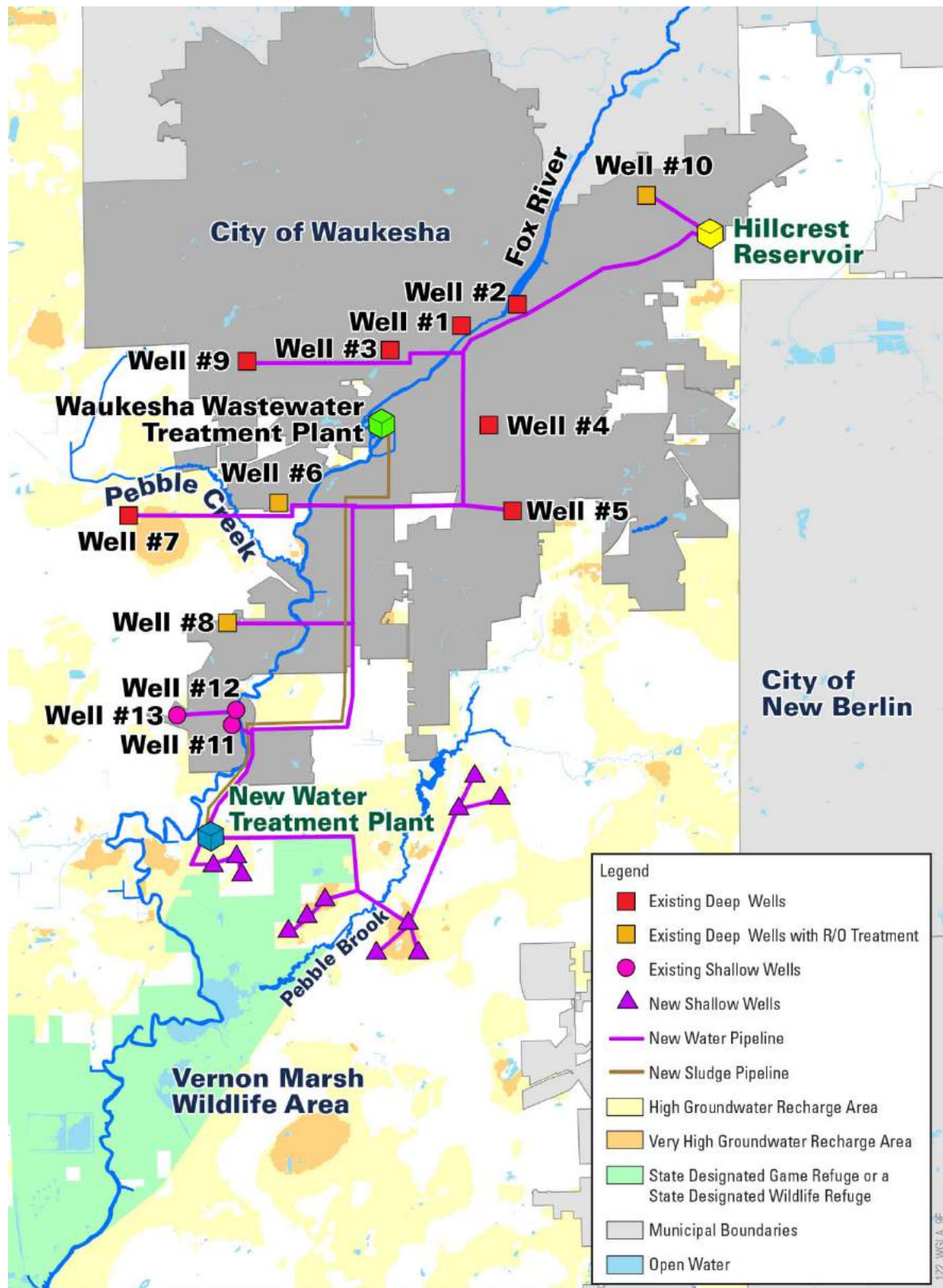
The existing deep aquifer wells included in this alternative are already connected to the City's distribution system. No new pipes would be required for the deep wells to connect to the city's distribution system.

New pipes would be required from each of the shallow aquifer wells to connect the wells with the new water treatment plant needed in this alternative (discussed below). These pipes would cross the Fox River, Pebble Brook and wetlands adjacent to the Vernon Marsh Wildlife Area between the wells and the water treatment plant. From the water treatment plant, a new pipe would follow existing roads to convey the treated water to the City's distribution system and to the Hillcrest reservoir (the largest reservoir in Waukesha used as a point to deliver water to the City). New pipelines would also be required from the deep wells that do not have dedicated water treatment plants to allow the water from these wells to be blended with other deep and shallow aquifer water at the Hillcrest reservoir.

A new sludge pipeline from the water treatment plant would also be required to convey water treatment solids (sludge) generated as part of the treatment processes at the new water treatment plant to the wastewater treatment plant. The sludge pipeline would parallel the treated water pipeline for most of its distance to minimize impacts and costs of constructing both pipes.

Figure 6-1 and Appendix 6-1 show the wells, pipelines, and treatment facilities for this alternative.

FIGURE 6-1
Facilities for Deep and Shallow Aquifers Water Supply

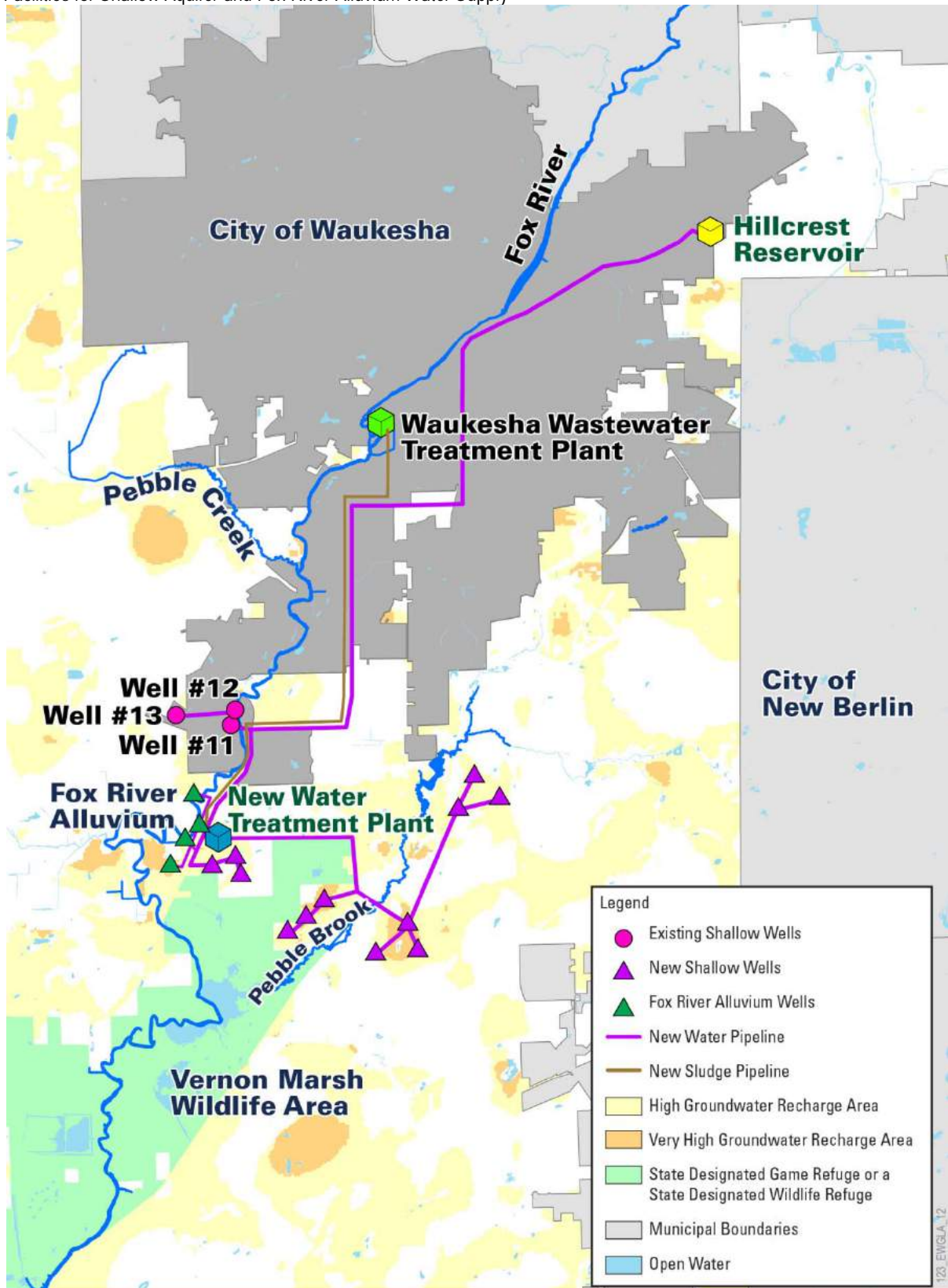


6.2.2.2 Shallow Aquifer and Fox River Alluvium Water Supply

New pipes (discussed below) would be required from each of the shallow aquifer and Fox River Alluvium wells to connect the wells with the new water treatment plant needed in this alternative. These pipes would cross the Fox River, Pebble Brook and wetlands adjacent to the Vernon Marsh Wildlife Area between the wells and the water treatment plant. From the water treatment plant, a new pipe would follow existing roads to convey the treated water to the City's distribution system and to the Hillcrest reservoir (the largest reservoir in Waukesha used as a point to deliver water to the City). A new sludge pipeline from the water treatment plant would also be required to convey water treatment solids (sludge) generated as part of the treatment processes at the new water treatment plant to the wastewater treatment plant. The sludge pipeline would parallel the treated water pipeline for most of its distance to minimize impacts and costs of constructing both pipes.

Figure 6-2 and Appendix 6-1 show the wells, pipelines, and treatment facilities for this alternative.

FIGURE 6-2
Facilities for Shallow Aquifer and Fox River Alluvium Water Supply



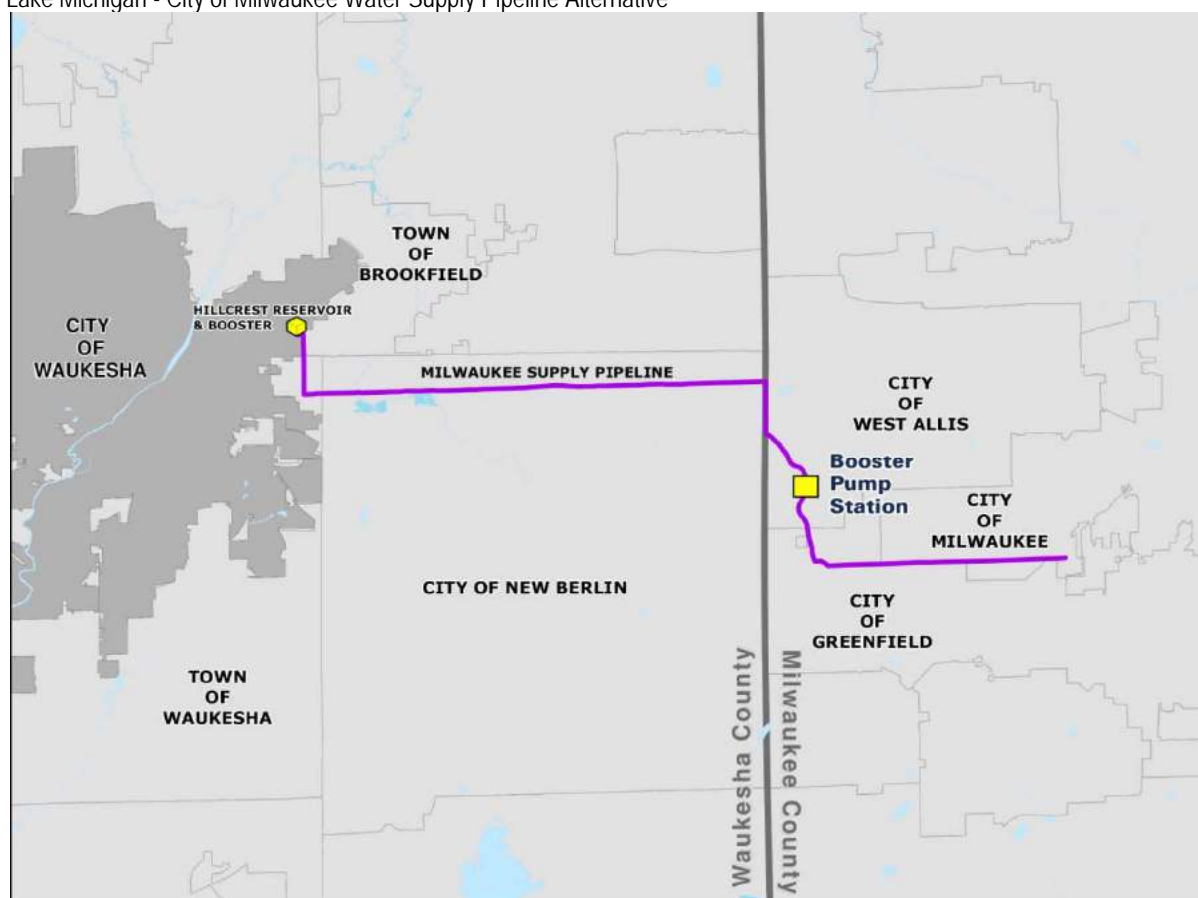
6.2.2.3 Lake Michigan Water Supply (City of Milwaukee)

This is an alternative to the proposed project. This alternative includes a connection to the City of Milwaukee's distribution system near 60th Street and Howard Avenue. This location is assumed because there is a large transmission main nearby. From this connection, a 30-inch pipeline would head west and follow City and Milwaukee County streets for about 6 miles. Along this segment a booster pump station would be constructed. From the booster pump station, the pipeline would continue west for about 6 miles along a utility corridor. The last segment of pipe (about 1 mile) would continue on City streets and lightly developed areas with a connection at the Hillcrest reservoir.

Figure 6-3 and Appendix 6-1 show the facilities for this alternative.

FIGURE 6-3

Lake Michigan - City of Milwaukee Water Supply Pipeline Alternative



6.2.2.4 Lake Michigan Water Supply (City of Oak Creek) Alignment 1

This is an alternative to the proposed project. This alternative includes a connection to the City of Oak Creek's distribution system near the water treatment plant. A location close to the water treatment plant is assumed because there are no large transmission mains further west with sufficient capacity to serve the City of Waukesha. A pump station would be constructed at the existing water treatment plant.

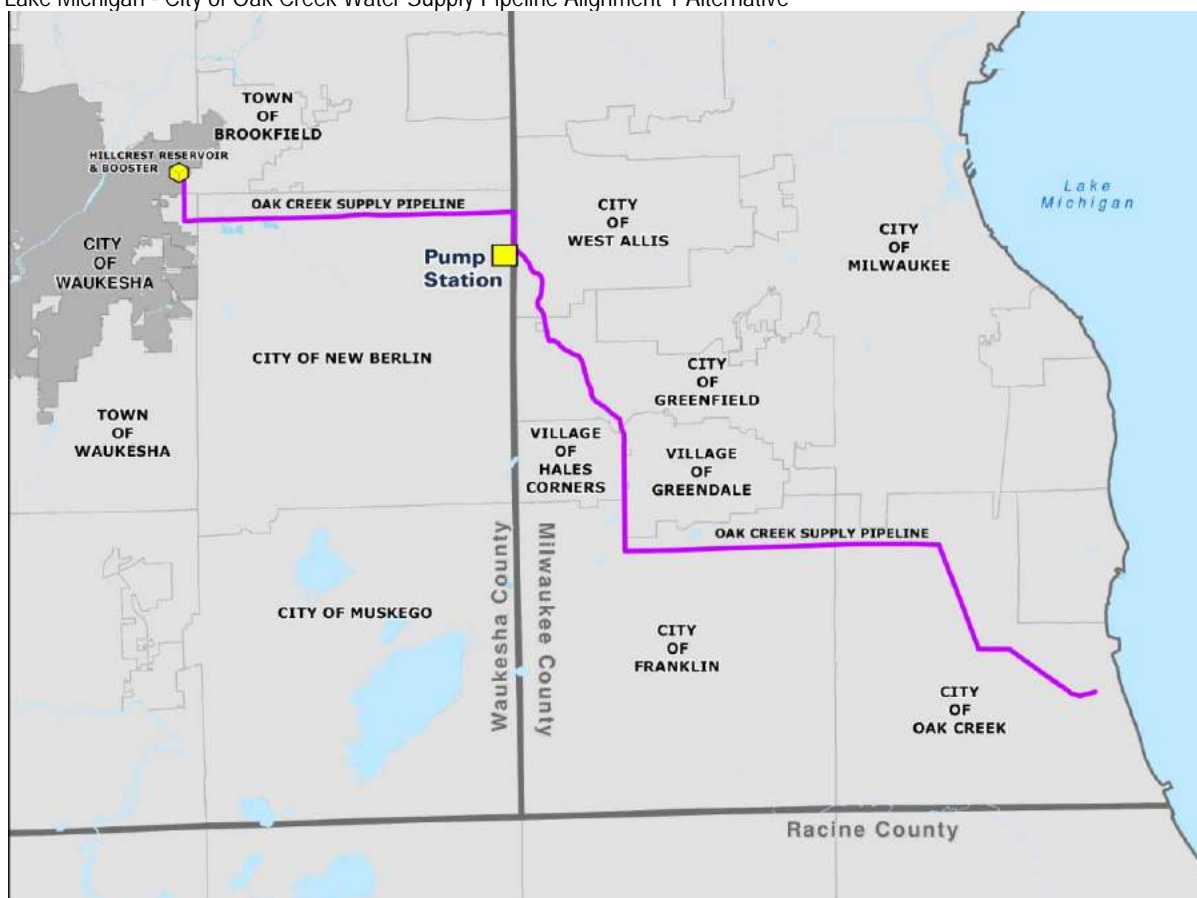
From this connection, a 30-inch pipeline would head west and follow utility corridors and City and Milwaukee County streets for about 15 miles. A booster pump is assumed to be

constructed along this segment of pipeline. The remaining 10 miles of pipeline is the same as the City of Milwaukee supply where it follows City and County streets and a utility corridor. The same as the City of Milwaukee supply, a City of Oak Creek supply would connect at the Hillcrest reservoir.

Figure 6-4 and Appendix 6-1 show the facilities for this alternative.

FIGURE 6-4

Lake Michigan - City of Oak Creek Water Supply Pipeline Alignment 1 Alternative



6.2.2.5 Lake Michigan Water Supply (City of Oak Creek) Alignment 2

This alternative is part of the proposed project. The water source is described in Section 3.

This alternative includes obtaining Lake Michigan water by connecting to the City of Oak Creek's existing distribution system near 27th Street and Puetz Road. A new pipeline and booster pump station would be constructed to connect to this supply.

Figure 3-1 and Appendix 3-1 in Section 3 shows the pipeline alignment for this alternative.

Note: The Water Supply Service Area Plan Lake Michigan (City of Oak Creek) water supply alternative describes the ER Lake Michigan (City of Oak Creek) Alignment 2 alternative. The ER retains the Lake Michigan (City of Oak Creek) Alignment 1 water supply alternative for alternative comparison purposes.

6.2.2.6 Lake Michigan Water Supply (City of Racine)

This is an alternative to the proposed project. This alternative includes a connection to the City of Racine's distribution system near Hwy C and Newman Road. A pump station would be constructed at the connection point to the City of Racine. This location is assumed because there is an existing water reservoir nearby.

From this connection, a 30-inch pipeline would head west and follow city, state and county roads, and utility corridors for the entire distance. A booster pump station would be constructed along the alignment. The last 2 miles of the alignment are the same as the Cities of Milwaukee and Oak Creek alignments, where it follows a utility corridor for about 1 mile and city streets and lightly developed areas for the final mile before its connection at the Hillcrest reservoir.

Figure 6-5 and Appendix 6-1 show the facilities for this alternative. Table 6-3 includes a summary of the pipe size and length anticipated for the alternatives.

FIGURE 6-5
Lake Michigan - City of Racine Water Supply Pipeline Alternative

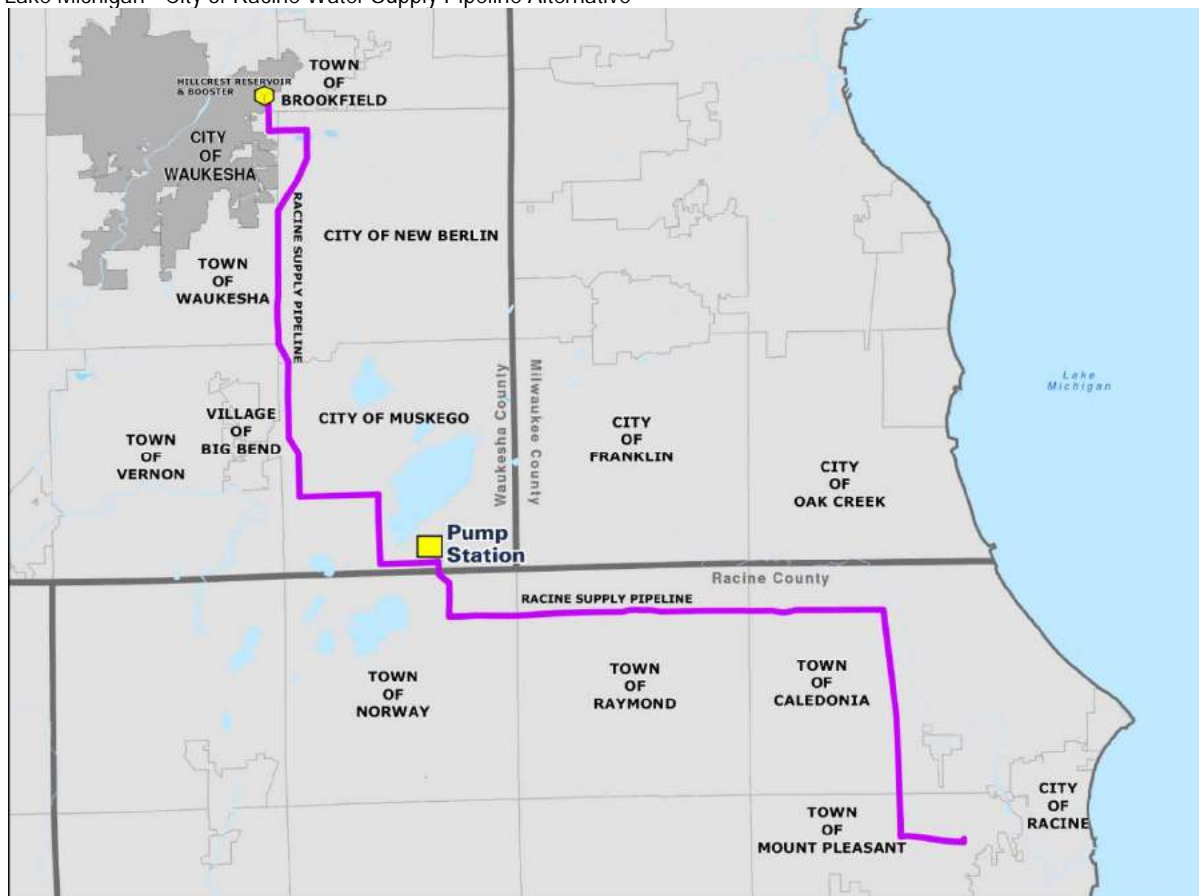


TABLE 6-3
Water Supply Pipeline Alternatives Summary

Supply Alternatives	Diameter (In.)	Length (miles)	Counties
Deep and Shallow Aquifers	8 to 30	13.9	Waukesha
Shallow Aquifer and Fox River Alluvium	8 to 30	14.7	Waukesha
Lake Michigan (City of Milwaukee)	30	15	Milwaukee and Waukesha
Lake Michigan (City of Oak Creek) Alignment 1	30	27	Milwaukee and Waukesha
Lake Michigan (City of Oak Creek) Alignment 2	30	19.4	Milwaukee and Waukesha
Lake Michigan (City of Racine)	30	38	Racine and Waukesha

Note: The final pipeline diameter may be 30 or 36 inches depending upon final detailed design considerations. For either diameter pipe, the construction width for environmental impacts is the same width due to construction staging requirements.

6.2.3 Water Supply Treatment

6.2.3.1 Deep and Shallow Aquifers

The declining water levels in the deep aquifer causes water quality problems with increased TDS, radium, and gross alpha levels. As a result, treatment would be installed at the three largest deep wells (No. 6, 8, and 10) to reduce TDS and radium. Since the deep wells are on small lots, adjacent residential property would need to be purchased and homes demolished to make room for the additional treatment facilities. It was assumed that the three deep wells will each have their own treatment facility, and that water from the remaining deep wells and shallow wells would be blended at the Hillcrest reservoir.

Water from the shallow wells would require treatment for iron, manganese and microorganism removal. The recent discovery of arsenic in the shallow aquifer at planned future well sites means arsenic treatment would be required as well. The shallow well water would be pumped from the wells to a new water treatment plant. A new pump station and 30 inch diameter pipeline would convey treated water to the City of Waukesha and connect with the water distribution system and Hillcrest reservoir.

6.2.3.2 Shallow Aquifer and Fox River Alluvium Water Supply

The shallow and Fox River alluvium wells would pump water to a central treatment plant south of the City of Waukesha. The water would be treated for iron, manganese, arsenic and microorganism removal. A pump station and 30 inch diameter pipeline would convey treated water to the Hillcrest reservoir and to the distribution system.

6.2.3.3 Lake Michigan Water Supply (City of Milwaukee)

This alternative would utilize treatment from the City of Milwaukee's two existing drinking water treatment plants.

6.2.3.4 Lake Michigan Water Supply (City of Oak Creek) Alignment 1 and Alignment 2

This alternative would utilize treatment from the City of Oak Creek's existing drinking water treatment plant.

6.2.3.5 Lake Michigan Water Supply (City of Racine)

This alternative would utilize treatment from the City of Racine's existing drinking water treatment plant.

6.2.4 Water Distribution and Use

All of the water supply alternatives will use the City's existing water distribution system and will serve the same customers. Water use is discussed in detail in Section 3.

6.3 Return Flow Alternatives

Return Flow alternatives are only associated with a Lake Michigan water supply source. For groundwater sources, discharge would continue to the Fox River. It is assumed from an alternative analysis standpoint, that the Lake Michigan suppliers could be paired with the return flow alternatives as listed below.

6.3.1 Wastewater Treatment

The City of Waukesha's wastewater treatment plant (WWTP) is an activated sludge treatment facility with tertiary dual media filtration (sand and anthracite) and ultraviolet (UV) light disinfection. The plant consistently produces high quality effluent that has very low BOD (biochemical oxygen demand), TSS (total suspended solids), $\text{NH}_3\text{-N}$ (ammonia) and TP (total phosphorus) that meets all of its permit requirements. The City of Waukesha's WWTP currently discharges to the Fox River, which is in the Mississippi River watershed. A Lake Michigan water supply would require a new pump station, return flow pipeline, and outfall for the return flow to the Lake Michigan watershed.

The City has recently completed a Wastewater Treatment Facility Plan that identified improvements and WWTP expansion projects for the next 20 years. Included in that plan were provisions for UV disinfection and reaeration improvements (Strand, 2011). An amendment to that facility plan (see the Return Flow Plan, Volume 4 of the Application) was developed that identified improvements required for a return flow to the Lake Michigan basin. Most notably is a return flow pump station that would be located at the City's WWTP to return treated wastewater to the Lake Michigan basin.

6.3.2 Return Flow Pipeline

Table 6-4 lists the water supply pipeline lengths and diameters.

6.3.2.1 Continued Discharge to Fox River

Regardless of the water supply alternatives discussed above, the City's WWTP would provide wastewater treatment. For a water supply from the Mississippi River basin (the Deep and Shallow Aquifer as well as the Shallow Aquifer and Fox River Alluvium alternatives) the City's WWTP would continue to discharge 100 percent of its treated wastewater through its existing outfall to the Fox River. No new pipelines are needed for discharge to the Fox River.

TABLE 6-4
Return Flow Pipeline Alternative Summary

Return Flow Alternative	Diameter (In.)	Length (miles)	Counties
Underwood Creek to Lake Michigan	30	11.5	Milwaukee and Waukesha
Root River to Lake Michigan Alignment 1	30	15.5	Milwaukee and Waukesha
Root River to Lake Michigan Alignment 2	30	20.2	Milwaukee and Waukesha
Direct to Lake Michigan	30	22.5	Milwaukee and Waukesha

Note: The final pipeline diameter may be 30 or 36 inches depending upon final detailed design considerations. For either diameter pipe, the construction width for environmental impacts is the same width due to construction staging requirements.

For a Lake Michigan water supply, the City's WWTP would continue to provide treatment of the wastewater with return flow sent to the Lake Michigan basin. Discharge to the Fox River would continue for the portion of the WWTP flow rates greater than the MDD because the City's wastewater treatment plant generally receives more wastewater than drinking water supplied to its customers. Therefore, the City's Fox River outfall would be utilized consistent with the management plan outlined in the Return Flow Plan (Volume 4 of the Application). No new pipelines are needed for a discharge to the Fox River.

6.3.2.2 Underwood Creek to Lake Michigan Return Flow

A screening level layout was developed for the return flow pipeline (Figure 6-6 and Appendix 6-1). It begins at the City of Waukesha WWTP, and proceeds north and east through a City park and along an alley and minor streets for about 1.3 miles. The pipeline continues east for another 1.3 miles following an abandoned railroad corridor planned for a future recreational trail, where it joins with a utility corridor and bike trail and runs for another 7 miles. The pipeline continues north 1.9 miles along a street and bike path until it ends near the confluence of the north and south branch of Underwood Creek, near Bluemound Road. In total, the pipeline consists of about 11.5 miles of 30-inch pipe.

FIGURE 6-6

Return Flow Alignment to Underwood Creek (creek and river shown only downstream of the return flow)

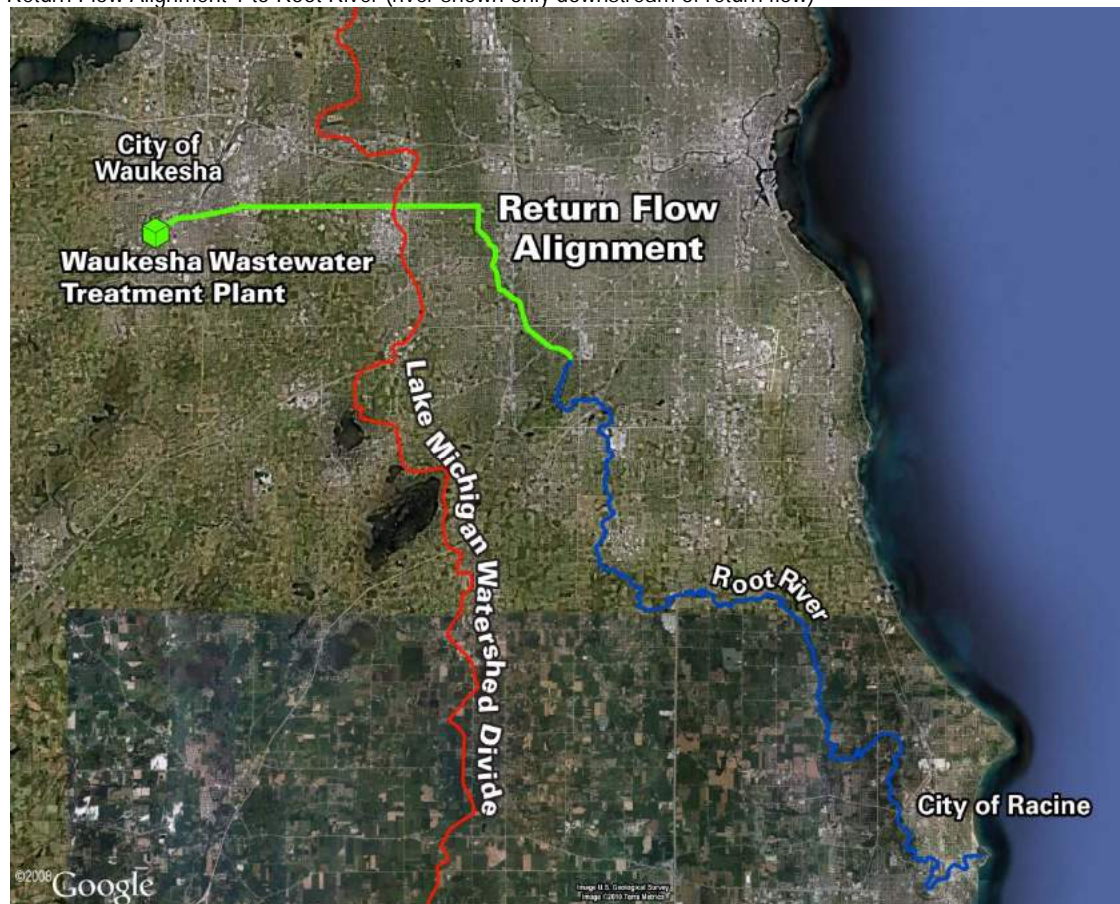


6.3.2.3 Root River to Lake Michigan Return Flow Alignment 1

The conceptual pipeline alignment (Figure 6-7 and Appendix 6-1) for return flow to the Root River via Alignment 1 is the same as the pipeline for Underwood Creek for about the first 9.6 miles. Where the Underwood Creek pipeline heads north toward Underwood Creek, the Root River pipeline would head southeast for 6 miles toward the Root River following streets, a parkway, and a bike trail. In total, the pipeline consists of about 15.5 miles of 30-inch diameter pipe.

FIGURE 6-7

Return Flow Alignment 1 to Root River (river shown only downstream of return flow)



6.3.2.4 Root River to Lake Michigan Return Flow Alignment 2

This alternative is the proposed project. The return flow pipeline is described in Section 3. See Figure 3-8 and Appendix 3-1 for this proposed pipeline alignment.

Note: The Return Flow Plan Root River to Lake Michigan return flow alternative describes the ER Root River to Lake Michigan Alignment 2 return flow alternative. The ER retains the Root River to Lake Michigan Alignment 1 return flow alternative for alternative comparison purposes.

6.3.2.5 Direct to Lake Michigan Return Flow

A screening-level alignment for return flow directly to Lake Michigan was developed to evaluate the environmental effects and costs (Figure 6-8 and Appendix 6-1). The conceptual pipeline alignment is the same as that for Underwood Creek and Root River Alignment 1 for the first 9.6 miles. Where the two pipelines diverge, the Lake Michigan alignment continues east about 11.2 miles parallel to a railroad corridor. As the alignment nears Lake Michigan, it continues east about 1.2 miles along a city street where it intersects with the Lake. The alignment extends into Lake Michigan about 0.5 miles to provide an offshore outfall. In total, the pipeline consists of about 23.5 miles of 30-inch diameter pipe.

FIGURE 6-8

Direct to Lake Michigan Return Flow Alignment Near Milwaukee and Oak Creek



6.3.3 Effluent Discharge

The Wisconsin Pollutant Discharge Elimination System (WPDES) permit for the City of Waukesha WWTP is effective until December 31, 2012 and continues to remain in effect until a new permit is received. The WPDES permit is included as an attachment to the Return Flow Plan (Volume 4 of the Application). The WWTP is an activated sludge treatment facility with tertiary dual media filtration (sand and anthracite) and ultraviolet light disinfection. The plant consistently produces high quality effluent that has very low BOD (biochemical oxygen demand), TSS (total suspended solids), $\text{NH}_3\text{-N}$ (ammonia) and TP (total phosphorus). The WWTP meets all of its permit requirements and is committed to doing so when a new permit is issued.

The City is anticipating lower effluent limits for TP. The WDNR has provided the City with revised limits and the City has completed WWTP facility planning assuming the new effluent limit of 0.075 mg/L (compared to the current limit of 1.0 mg/L and recent average annual historical performance of 0.16 mg/L). This limit is equal to the water quality criteria for the Fox River, Underwood Creek, and the Root River at the discharge locations (NR 102). This limit is also significantly more strict than the 0.6 mg/L interim limit¹ set for a discharge to Lake Michigan.

¹ NR 217 states the following for a Lake Michigan discharge: *For discharges directly to the Great Lakes, the department shall set effluent limits consistent with near shore or whole lake model results approved by the department. The department may set an interim effluent limit based on the best readily available phosphorus removal technology commonly used in Wisconsin.*

The WDNR has adopted new thermal rules (NR 102 and 106) for the protection and propagation of aquatic life that applies to WPDES permit holders discharging to surface waters. In preparation for this new rule, the City has been collecting effluent temperature data. The City has evaluated approaches to meet WDNR thermal discharge requirements following the rules and applicable guidance regardless of a discharge location (see the Return Flow Plan – Volume 4 of the Application).

PHYSICAL AND BIOLOGICAL ENVIRONMENT

The impact of the proposed project on the physical and biological environment falls into three main categories:

- Aquatic resource impacts
- Terrestrial resource impacts
- Air quality

The environmental impacts of water supply and return flow alternatives are compared side by side for each resource category documented in this section. A summary table of overall resource impacts is included at the end of this section. The resource impacts were developed for individual water supply and return flow alternatives to easily compare one water supply or return flow alternative to another.

Resource impacts for system alternatives, where a Lake Michigan water supply alternative is combined with a return flow to the Lake Michigan basin, are estimated by adding the water supply impact with the return flow impact to obtain an overall system alternative impact. This approach conservatively estimates system alternative impacts because portions of the water supply and return flow pipeline corridors are shared which leads to double counting some resource impacts, such as impacts to wetlands. System alternative impacts are summarized in Appendix 6-2.

The No Action alternative only effects groundwater and socioeconomic resources. Consequently, the No Action alternative is only discussed for these resources.

6.4 Aquatic Resources

Aquatic resources have been further subdivided into: Lake Michigan, inland waterways, wetlands, and groundwater. Each of these resources is discussed sequentially.

6.4.1 Lake Michigan

Lake Michigan will be affected only by the proposed project and other Lake Michigan water supply and return flow alternatives. The groundwater supply alternatives do not significantly affect Lake Michigan or tributaries to Lake Michigan.

Note: At the time this rule was promulgated, December 1, 2010, the best readily available phosphorus removal technology indicates a limit of 0.6 mg/L.

6.4.1.1 Physical Description

6.4.1.1.1 Affected Environment

Lake Michigan is bordered by four states and is connected through the other Great Lakes to the eight Great Lakes states and two Canadian provinces. Lake Michigan is the second largest of the Great Lakes and is the only Great Lake entirely within the borders of the U.S. (WDNR, 03/2010a) Lake Michigan is 307 miles long, up to 118 miles wide, and up to 925 feet deep. Lake Michigan has a surface area of 22,300 square miles, an average depth of 279 feet, and a volume of 1,180 cubic miles (1,300 trillion gallons), and a retention time of 99 years (USEPA and Environment Canada, 2012).

In recent years, nuisance algae (genus *Cladophora*) growth has been observed along the Lake Michigan shoreline. The algae grow underwater attached to rocks, are dislodged by waves, and then washed up on shore. The decaying algae create nuisance odors. Similar algae growths were observed in the mid-1950s and again during the 1960s and 1970s, before this most recent occurrence. The cause of this latest resurgence in algae growth is uncertain, but it may be due in part to changes in water clarity and phosphorous availability brought on by the prevalence of invasive zebra and quagga mussels (WDNR, 03/2010b).

The Milwaukee Harbor estuary is designated a Great Lakes Area of Concern because of the presence of legacy contaminants and other impairments. The harbor suffers from urban stresses similar to those experienced in other highly urban areas at the other 42 areas of concern throughout the Great Lakes. Priorities for the Milwaukee Area of Concern include remediation of contaminated sediments in tributaries and nearshore waters of Lake Michigan, prevention of eutrophication, non-point-source pollution control, improvement of beach water quality, enhancement of fish and wildlife populations, and habitat restoration (EPA, 03/2010). Even though the Milwaukee Harbor estuary has these stresses, the fishery is reported to contain a high abundance and diversity of species because the fishery is connected to the rest of Lake Michigan and the parts of the Milwaukee, Menomonee, and Kinnickinnic Rivers that achieve full fish and aquatic life standards (SEWRPC, 2007, p. 205).

6.4.1.1.2 Environmental Effects

The groundwater supply alternatives will not affect Lake Michigan because the water supply and discharge from the Waukesha WWTP will not be within the Lake Michigan basin.

A Lake Michigan water supply and return flow, regardless of supply and return flow locations, will not affect the physical features of Lake Michigan, except for small changes as described below in Lake Michigan Geomorphology and Sediment. Lake Michigan size, volume, and floodplain will not be altered because a Lake Michigan water supply will provide return flow back to the Lake Michigan basin consistent with the Compact. The Return Flow Plan (Volume 4 of the Application) has been designed to meet the Compact requirements with a maximum return flow rate equivalent to the maximum withdrawal rate that also minimizes out of basin water in return flow. Consequently, no significant adverse impacts are expected to Lake Michigan's size, volume, or floodplain.

6.4.1.2 Water Quality

6.4.1.2.1 Affected Environment

SEWRPC and the Milwaukee Metropolitan Sewerage District (MMSD) have been measuring water quality in the Greater Milwaukee area since the 1960s (SEWRPC, 2007, p. 149). Notable

water quality improvements have been documented since the MMSD's deep tunnel system came online in 1994 to reduce the number of combined sewer overflows (CSOs). Water quality trends at sampling stations in the Milwaukee outer harbor and nearshore Lake Michigan areas over this historical monitoring period have indicated (SEWRPC, 2007, p. 155):

- Fecal coliform concentration has trended down.
- Biological oxygen demand has trended down.
- Dissolved oxygen concentration has trended down or stayed the same and generally meets standards.
- Total suspended solids concentration trends varied with some stations increasing and others staying the same.
- Total phosphorus concentration has trended down in the outer harbor and up in the nearshore area. Since 1986, average annual concentrations have been less than 0.1 mg/L, except for 1 year. The recently developed phosphorous standard for the near shore and open waters of Lake Michigan is 0.007 mg/L (NR 102.06(5)(b)), however, an interim effluent limit for discharge to Lake Michigan was set at 0.6 mg/L (NR 217.13(4)) for all dischargers.

Table 6-5 summarizes the water quality data.

Annual pollutant loadings to Lake Michigan from the Greater Milwaukee watersheds are documented in SEWRPC's *A Regional Water Quality Management Plan Update for the Greater Milwaukee Watersheds* (2007). Average annual loadings for select parameters are as follows:

- Fecal coliform: 83,435 trillion cells
- Total phosphorus: 767,230 pounds
- Total suspended solids: 184,435,700 pounds

TABLE 6-5
Average Water Quality Data at Select Locations in Lake Michigan near the Greater Milwaukee Watersheds

Dissolved oxygen	9.6 to 11.5 mg/L
Phosphorus	0.062 to 0.087 mg/L
Fecal coliform summer season geometric mean	603 to 770 per 100/mL
Total suspended solids	10.3 to 19.4 mg/L

Additional detail on these and other water quality parameters is found in SEWRPC's *A Regional Water Quality Management Plan Update for the Greater Milwaukee Watersheds* (2007).

6.4.1.2.2 Environmental Effects

Water quality environmental effects will occur during both construction as well as during operation and maintenance. Potential impacts to aquatic resources generally associated with construction can be both direct and indirect. They will depend primarily upon the physical characteristics of Lake Michigan and time of year.

The primary temporary construction impact to surface waters can be associated with elevated loads of suspended sediment resulting from trenching activities and with erosion of cleared banks and rights-of-way from pipeline construction. Impact severity is a function of sediment load, particle size, and duration of construction activities. Since the construction near Lake Michigan will require appropriate environmental permits and the construction contractor will be required to use BMPs designed to reduce the impact on turbidity and erosion, construction impacts will be minimized.

Without mitigation by implementing BMPs, temporary construction impacts can also elevate suspended sediment levels that increase turbidity and consequently reduce primary photosynthetic production, flocculate plankton, decrease visibility and food availability, and produce effects that are aesthetically displeasing (USFWS, 1982). However, Long (1975) concluded that most fish avoid turbid water and can survive for several days in waters where construction in a stream has caused turbidity. Since the construction impacts will be temporary and river crossings will use BMPs designed to reduce the impact, turbidity and erosion created by construction will be minimal.

Example construction best management practices are described in Section 5, Appendix 5-2, “Example Wetland and Waterway Pipeline Construction Crossing Impact Minimization Techniques.”

Operational and maintenance effects on water quality could include changes in storm water runoff quality from new above ground construction and changes in water quality from discharge to Lake Michigan or to a Lake Michigan tributary.

The WDNR commonly provides allowances for permitted discharges in the form of interim limits, variances, or other allowances when background levels are higher than water quality standards, when the water quality constituent cannot be removed by municipal WWTP best available technology permitted in Wisconsin, or water quality standards can be met after mixing or other processes in the receiving water. Water quality parameters may be addressed by similar regulatory approaches for allowances under current or future regulations.

For example, the Waukesha WWTP currently discharging to the Fox River has an allowance for chloride discharge in the form of an interim limit governed by NR 106.83(2)(b). In the WPDES permit for continued discharge to the Fox River, the Waukesha WWTP has a chloride variance that includes a mandatory source reduction program with an interim discharge limit (WDNR, 2013d). A significant source of chloride in the Waukesha WWTP is residential water softening. The need to continue to have a chloride variance varies significantly depending upon the water source, treatment, and discharge location (for example: continued deep aquifer groundwater source with discharge to the Fox River or a Lake Michigan source with return flow to the Lake Michigan basin), as described below.

The City has been implementing a Mercury Pollutant Minimization Program that began in 2007. Since then, the mercury concentration in the WWTP effluent has further improved to levels that will meet Fox River discharge or Lake Michigan basin return flow draft requirements. The City will continue the mercury source reduction program and based upon established performance either Fox River discharge or Lake Michigan return flow will meet requirements for the mercury water quality limits.

The WDNR has adopted new thermal rules (NR 102 and 106) for the protection and propagation of aquatic life that applies to WPDES permit holders discharging to surface waters. In preparation for this new rule, the City has been collecting effluent temperature data for over a year. The City has evaluated approaches to meet WDNR thermal discharge requirements following the rules and applicable guidance regardless of a discharge location (see the Return Flow Plan – Volume 4 of the Application).

Potential operational changes to Lake Michigan water quality are described below for each water supply and return flow alternative and are used as the primary comparison of relative impacts.

Deep and Shallow Aquifers, and Shallow Aquifer and Fox River Alluvium Water Supplies

These alternatives would not affect Lake Michigan water quality.

Lake Michigan Water Supply (Cities of Milwaukee, Oak Creek Alignments 1 and 2, and Racine)

A Lake Michigan supply, regardless of the water source includes new aboveground impacts limited to only a new pump station less than a quarter acre in size located far from Lake Michigan. Consequently, operational stormwater quality impacts to Lake Michigan will be insignificant. All Lake Michigan supply options will include return flow water quality impacts, which are described below.

Underwood Creek, Root River Alignments 1 and 2, and Direct to Lake Michigan Return Flow

All water returned to the Lake Michigan watershed will meet WDNR water quality permit requirements. A summary of proposed discharge limits from the WDNR and a comparison to historical Waukesha WWTP performance are detailed in the Return Flow Plan (Volume 4 of the Application). For phosphorus, the Fox River, the Root River, and Underwood Creek have the same water quality standard of 0.075 mg/L, which will require WWTP improvements already planned. A comparison of historical WWTP discharge quality to other Lake Michigan tributary dischargers is shown in Table 6-26 in the Inland Waterways section.

Water softening no longer would be needed with a Lake Michigan water supply source. Consequently, a reduction in chloride concentration in return flow over time is expected. The City has evaluated chloride concentrations in return flow with a switch to Lake Michigan water and has developed a chloride compliance plan. The chloride reduction plan identifies chloride reduction elements to meet the chloride water quality standards with return flow (see the Return Flow Plan— Volume 4 of the Application).

Return flow will switch discharge from the Fox River to the Lake Michigan watershed. The return flow management plan is discussed in Volume 4 of the Application. In general, the return flow management plan provides return flow up to the maximum day water demand if sufficient water is available at the WWTP. The portion of water at the WWTP in excess of this amount will continue to be discharged into the Fox River and meet permit limits as discussed in Section 5.1.2.3, Water Quality. The Return Flow Plan analysis shows that no less than 100 percent of the water volume will be returned to the Great Lakes basin.

Flow from return flow ultimately ends up in Lake Michigan. Water quality information was reviewed for overall water quality parameter loadings from the greater Milwaukee watersheds tributary to Lake Michigan. SEWRPC compiled total annual water quality parameter loadings for all the greater Milwaukee watersheds (SEWRPC, 2007, Tables 54–56). The contribution of the City of Waukesha return flow loadings was calculated using the information from the water quality modeling documented in the Return Flow Plan (Volume 4 of the Application) using Root River water quality modeling information for comparison to Lake Michigan loadings and to SEWRPC. The Root River analysis indicated the following:

- Fecal coliform contribution in the return flow under very conservative, worst-case conditions is only 0.18 percent of all fecal coliform loading from the greater Milwaukee watersheds.

- Total suspended solids contribution in the return flow under very conservative, worst-case conditions is only 0.19 percent of all total suspended solids loading from the greater Milwaukee watersheds.
- Phosphorus contribution in the return flow is only 0.35 percent of all phosphorus loading under very conservative worst-case conditions. Both Underwood Creek and the Root River now have a phosphorus water quality standard of 0.075 mg/L. The interim limit for direct discharge to Lake Michigan is 0.6 mg/L.

The comparison of water quality loading for a direct to Lake Michigan alternative has been assumed to be the same as that for a Lake Michigan tributary return flow. Due to the higher mixing available for a direct to Lake Michigan return flow, higher annual discharge of some water quality parameters may be protective of the environment. It is estimated that the return flow would contribute less than 1 percent of the annual load to Lake Michigan from the greater Milwaukee watersheds for phosphorus, TSS, and bacteria.

6.4.1.2.3 Environmental Effects Comparison: Lake Michigan Water Quality

Level of relative impact (no adverse impact, minor adverse impact, etc.) in water quality was developed to compare one alternative to another. Impacts were compared based upon Table 6-6.

TABLE 6-6
Environmental Impact Category Description: Water Quality

Category	Water Quality	Stream Water Quality Numeric Standards Compliance ^a	Increase in Average Annual Loading to Lake Michigan Near Milwaukee ^a
No adverse impact	Improves or remains approximately the same; Temporary construction impacts	River meets water quality standards or discharge is better than or equal to water quality standards	Contributes a de minimus change (<1%)
Minor adverse impact	Remains approximately the same	Discharge requires existing variance to water quality standards	Contributes a minor change (>1%, but <10%)
Moderate adverse impact	Moderate lowering of in-stream water quality	Discharge requires new variance to water quality standards	Contributes a moderate change (>10%, but <25%)
Significant adverse impact	Substantial lowering of in-stream water quality	New exceedences to water quality standards	Contributes a substantial change (>25%)

^a Based upon expected water quality from historical wastewater treatment performance and draft permit limits. Where existing water quality exceedences occur, the receiving water quality will improve or stay the same with the discharge.

For water quality in Lake Michigan only, a discussion of relative impact for the various alternatives is included below. Section 6.4.2.3, Water Quality, contains a comparison for water quality for inland waterways.

Table 6-7 compares the water quality impact on Lake Michigan.

Deep and Shallow Aquifers Water Supply

This alternative does not involve Lake Michigan. Consequently the effect on Lake Michigan water quality is not applicable.

Shallow Aquifer and Fox River Alluvium Water Supply

This alternative does not involve Lake Michigan, so an effect on Lake Michigan water quality is not applicable.

Lake Michigan Water Supply (Cities of Milwaukee, Oak Creek Alignment 1 and Alignment 2, and Racine)

The Lake Michigan water supply alternatives would not change water quality in Lake Michigan or adversely affect other surface water resources. Use of Lake Michigan water would eliminate the need for water softening, which still would be necessary under the Deep and Shallow Aquifers

groundwater supply alternative. Over time, the use of water softener salts would cease and chloride discharged from the WWTP to the environment would reduce. The Lake Michigan water supply consequently would produce no adverse impact on water quality.

TABLE 6-7

Water Supply and Return Flow Alternative Environmental Impact Comparison
Summary: Lake Michigan Water Quality

Alternatives	Water Quality
Water Supply	
Deep and Shallow Aquifers	Not applicable
Shallow Aquifer and Fox River Alluvium	Not applicable
Lake Michigan (City of Milwaukee)	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 1	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 2	No adverse impact
Lake Michigan (City of Racine)	No adverse impact
Return Flow Alternatives for Lake Michigan Water Supplies	
Underwood Creek to Lake Michigan	No adverse impact
Root River to Lake Michigan Alignment 1	No adverse impact
Root River to Lake Michigan Alignment 2	No adverse impact
Direct to Lake Michigan	No adverse impact

Underwood Creek to Lake Michigan Return Flow

Water quality impacts to Lake Michigan would be the same no adverse impacts described for return flow to the Root River.

Root River to Lake Michigan Return Flow Alignments 1 and 2

Water quality loading to Lake Michigan from the watersheds around greater Milwaukee was reviewed and found to be only 0.18 percent of all fecal coliform loading and only 0.19 percent of all total suspended solids loading under conservative, worst-case conditions. Phosphorus loading was found to be only 0.35 percent of all phosphorus loading under worst-case conditions. Consequently, the water quality impacts to Lake Michigan would be expected to have no adverse impacts.

Direct to Lake Michigan Return Flow

Water quality impacts to Lake Michigan would be the same no adverse impacts described for return flow to the Root River.

6.4.1.3 Geomorphology and Sediments

6.4.1.3.1 Affected Environment

The geomorphology of surface waters is assessed based on the impact to the surface water geomorphic stability, change in erosion potential, or change in vertical or lateral stability. The geology of Lake Michigan was developed during the Pleistocene Epoch as continental glaciers repeatedly advanced across the Great Lakes region and Lake Michigan. The glacial advance and repeat retreat deepened and enlarged the basins of the Great Lakes (USEPA

and Environment Canada, 2012). Near Milwaukee, the near-shore geomorphology is varied. Example lakebed substrates include: rock, cobble and sand, sand, and clay outcrops (WPSC, 2003).

Groundwater flow into Lake Michigan is a significant component of overall flow. Direct and indirect groundwater inflow contribute 33.8 percent of Lake Michigan water (USGS, 2000).

The deep aquifer currently used as a water supply for the City of Waukesha extends east from Waukesha under Lake Michigan. A report by the United State Geological Survey (USGS) estimated 30 percent of the 33 mgd of water pumped by the deep aquifer wells in southeastern Wisconsin originate from inside the Lake Michigan Basin (USGS, 2006).

6.4.1.3.2 Environmental Effects

Deep and Shallow Aquifers Water Supply

This water supply alternative will affect flow within Lake Michigan because increased pumping of the deep aquifer will continue to draw groundwater from the Lake Michigan basin (USGS, 2006). Because this water supply alternative includes discharging the water to the Fox River through the City of Waukesha WWTP, the volume of water is lost from the Great Lakes Basin. The volume from the Lake Michigan basin is considered to have no adverse impact. This alternative is not expected to affect the geomorphology or sediments of Lake Michigan.

Shallow Aquifer and Fox River Alluvium Water Supply

Under this water supply alternative, pumping of the deep aquifer for the City of Waukesha will cease, and consequently some minor decrease in groundwater flow away from Lake Michigan will occur. This will have a small benefit to the Lake Michigan basin. There is no adverse impact on the flow, geomorphology, or sediment of Lake Michigan with this alternative.

Lake Michigan Water Supply and Return Flow

Flow within Lake Michigan will not be affected by a Lake Michigan water supply or return flow, because the City of Waukesha's return flow management plan goal will provide continuous return of the water at the WWTP (see the Return Flow Plan in Volume 4 of the Application). In general, the return flow management plan provides return flow up to the maximum day water demand if sufficient water is available at the WWTP. The portion of water at the WWTP in excess of this amount will continue to be discharged into the Fox River and meet permit limits. The geomorphology and sediment of Lake Michigan will not be adversely affected by any Lake Michigan water supply alternative because, the supply will use the treatment plant intakes in the lake, and no construction is expected to occur within the lake for a water supply.

For the Underwood Creek and Root River return flow alternatives, the geomorphology of these streams has been shown to be stable, as documented in Section 6.4.2.4, Geomorphology and Sediments for Inland Waterways. The geomorphology and sediment of Lake Michigan will not be affected by the return flow alternatives except for return flow directly to Lake Michigan. In that case, an outfall will be required on the bottom of the Lake to provide an offshore discharge. The pipe in the lake will change the lake substrate composition along the pipe alignment. The approximately 6.2-acre area in Lake Michigan affected by the pipeline is

summarized in the land use changes documented in Section 6.5.1.2 Lane Use, and is expected to have a minor adverse impact to the lake's geomorphology.

6.4.1.3.3 Environmental Effects Comparison: Lake Michigan Geomorphology and Sediments

Level of relative impact (no adverse impact, minor adverse impact, etc.) in geomorphology and sediment quality was developed to compare one alternative to another. Impacts were compared based upon Table 6-8. For geomorphology and sediment impacts in Lake Michigan only, the relative impact of the various alternatives is discussed below. The comparison for geomorphology and sediments for inland waterways is included in Section 6.4.2.4, Geomorphology and Sediments. Table 6-9 summarizes the Lake Michigan geomorphology and sediment impact.

TABLE 6-8

Environmental Impact Category Description: Geomorphology and Sediments

Category	Channel Stability with Return Flow	Substrate Change to Lake Michigan
No adverse impact	Channel is stable for flows up to 2-year return where channel is stable.	No substrate change
Minor adverse impact	Channel has some instability for flows up to 2-year return where channel is stable.	Fewer than 10 acres
Moderate adverse impact	Channel has frequent instability for flows up to 2-year return where channel is stable.	Greater than 10 acres, but less than 20 acres
Significant adverse impact	Channel is unstable at most flows where the channel is stable.	Greater than 20 acres

Deep and Shallow Aquifers Water Supply

This alternative would not affect the geomorphology or sediments of Lake Michigan, because the increased change in flow to Lake Michigan would be small. The baseflow increase to Lake Michigan from reduced pumping of the deep aquifer would produce no adverse impact to geomorphology.

Shallow Aquifer and Fox River Alluvium Water Supply

This alternative would not affect the geomorphology or sediments of Lake Michigan because the increased flow to Lake Michigan would be small. The baseflow increase to Lake Michigan from reduced pumping of the deep aquifer would produce no adverse impact to geomorphology.

TABLE 6-9

Water Supply and Return Flow Alternative Environmental Impact Comparison Summary: Lake Michigan Geomorphology and Sediments

Alternative	Geomorphology and Sediments
Water Supply	
Deep and Shallow Aquifers	No adverse impact
Shallow Aquifer and Fox River Alluvium	No adverse impact
Lake Michigan (City of Milwaukee)	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 1	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 2	No adverse impact
Lake Michigan (City of Racine)	No adverse impact
Return Flow Alternatives for Lake Michigan Water Supplies	
Underwood Creek to Lake Michigan	No adverse impact
Root River to Lake Michigan Alignment 1	No adverse impact
Root River to Lake Michigan Alignment 2	No adverse impact
Direct to Lake Michigan	Minor adverse impact

Lake Michigan Water Supply (Cities of Milwaukee, Oak Creek Alignments 1 and 2, and Racine)

The Lake Michigan water supply alternatives prevent the need for baseflow reduction to inland waterways from groundwater pumping. The changes in geomorphology are dependent upon only the return flow location. Thus, the Lake Michigan water supply alternatives would have no adverse impacts on geomorphology.

Underwood Creek to Lake Michigan Return Flow

A geomorphic study was conducted analyzing channel stability of return flow to Underwood Creek and found that the increased baseflows do not adversely impact the channel stability. There are no direct impacts upon Lake Michigan with this alternative. Return flow to Underwood Creek consequently would have no adverse impact on the geomorphology of Lake Michigan.

Root River to Lake Michigan Return Flow Alignments 1 and 2

A recent sediment transport study of the Root River concluded that the river stability is relatively insensitive to changes in flows, because of the erosion resistance of the channel boundary materials, the relatively flat channel gradient, and the presence of a functional floodplain. There are no direct impacts upon Lake Michigan with this alternative. Return flow to the Root River consequently would have no adverse impact on the geomorphology of Lake Michigan.

Direct to Lake Michigan Return Flow

To send water directly into Lake Michigan, a new outfall would be required on the bottom of the Lake. The pipe would change the lake substrate composition along the pipe alignment. An estimated 6.2 acres (see Land Use Section 6.5.1.2) could be affected. Return flow direct to Lake Michigan consequently would produce a minor adverse impact on geomorphology and sediment in the lake.

6.4.1.4 Flora and Fauna

6.4.1.4.1 Affected Environment

Wildlife species require adequate food, water, cover, and living space for the survival of individuals and to maintain population viability. Aquatic resources affected by the proposed project consist generally of streams and wetlands but also include Lake Michigan. Aquatic areas can provide habitat to a diverse wildlife population, and some common species (beaver, muskrat, herons) depend on aquatic habitats for food and shelter. Others (e.g., raccoon) are less restricted but prefer to be close to water. Amphibians and many reptiles favor aquatic habitats; representative species include bullfrog and northern water snake. The Lake Michigan shoreline is an essential ecological area for migratory birds.

Lake Michigan is primarily cold water and relatively infertile. Historically, the fish fauna consisted mostly of lake trout, whitefish, and sculpins. Over the last century, the fisheries of Lake Michigan have experienced dramatic alterations because of fishery exploitation, overharvesting, and nutrient loading changes stimulating algae or plant growth (typically tolerant species). Invasive, or exotic, species, such as the sea lamprey, have caused a significant decline in the population of native species, such as lake herring. The biota is dominated by such introduced or invasive species as the Pacific salmon and trout, alewife, rainbow smelt, ruffe, white perch, goby, zebra mussel (*Dreissena polymorpha*), quagga mussel (*Dreissena bugensis*), and exotic zooplankton (WDNR, 12/2001).

The main source of pollution in Lake Michigan is human activity such as habitat alteration, which has affected water quality within the lake. The habitats in Lake Michigan have been altered by increased shoreline degradation, as most of the coastline and wetlands along it have been permanently affected. The loss of natural shoreline habitat has allowed increased urban and agricultural runoff into the lake, the alteration of watershed hydrology, the increase of the water temperature, and led to a reduction of open space (US Coast Guard and USEPA, 2008). Increased algae (genus *Cladophora*) growth has been observed along the shoreline in the last few years. The cause of the latest resurgence in algae growth is not known with certainty, but it could be from changes in water clarity and phosphorous availability resulting from the increased dominance of invasive zebra and quagga mussels (WDNR, 03/2010b).

The Milwaukee Harbor estuary within Lake Michigan is designated a Great Lakes Area of Concern because of legacy contaminants present and other impairments. The harbor suffers from urban stresses similar to those experienced in other highly urban areas at the other 42 areas of concern throughout the Great Lakes. Even though the Milwaukee Harbor estuary has these stresses, the fishery is reported to contain a high abundance and diversity of species, because the fishery is connected to the rest of Lake Michigan and to parts of the Milwaukee, Menomonee, and Kinnickinnic Rivers that achieve full fish and aquatic life standards (SEWRPC, 2007, p. 205).

The near-shore areas along Lake Michigan are within the southern Lake Michigan coastal ecological landscape and are characteristic mainly of glacial lake influence, along with ridge and swale topography, clay bluffs, and lake plains. Ground moraine inland from the lakeshore is the dominant landform, with soils generally consisting of silt-loam surface overlying loamy and clayey tills. Most of the near-shore areas along the lake are dominated by agriculture and urban development. Very few forested areas exist, but the remaining stands are dominated by maple and beech trees and also contain oak, hickory, and lowland hardwood species. There are also areas of wet-mesic and wet prairie, but they are limited and occur only in small preserves because of the landscape being heavily disturbed and fragmented. Because of fragmentation and significant disturbance, non-native plants are abundant in those areas.

The USFWS and the WDNR were contacted to determine where federal- or state-listed species occur along the project corridor in Lake Michigan. The species identified by these agencies as potentially occurring within the project corridors are summarized for all alternatives in Section 6.4.3, Wetlands, since most of the potential impacts involve federal- or state-listed species associated with wetlands.

A literature review of historical information on biological components of Lake Michigan indicates the following represent typical biological components in the project area.

Benthic Invertebrates

A survey of the Great Lakes in 1998 identified 20 taxa of benthic macroinvertebrates in Lake Michigan with an average of about 7 taxa per sampling site (Barbiero et al., 2000). The amphipod *Diporeia* (formerly *Pontoporeia*), tubificid oligochaetes, and sphaeriid snails dominate the Lake Michigan benthic macroinvertebrate community. However, in near-shore areas, oligochaetes are the dominant taxonomic group. The density of benthic macroinvertebrates typically ranges from 1,500 to 6,500 organisms per square meter. Surveys performed in 2002 near the Great Lakes Water Institute with headquarters in

Milwaukee revealed that oligochaetes and chironomidae are present, as are freshwater sponges, *Ectoprocta*, mayflies, leeches, isopods, and amphipods. Dreissenid mussel infestations (zebra and quagga) were confirmed on most suitable habitat (USGS, 2011).

Over the past several decades, the southern basin of Lake Michigan has been invaded by the zebra (*Dreissena polymorpha*) and quagga (*Dreissena bugensis*) mussels and has undergone major shifts in nutrient loading.

Reductions in nutrient loadings have reduced the overall productivity of the lake and produced a decline in the density of benthic macroinvertebrate fauna, particularly oligochaetes and snails, observed between 1980 and 1987 (Nalepa et al., 1998). The year 1988 marked the beginning of colonization of southern Lake Michigan by the zebra mussel and the beginning of a decline in the abundance of *Diporeia*. Filter feeding by zebra mussels in near-shore waters was thought to have decreased the amount of food available to the amphipod (Nalepa et al., 1998).

Plants

Macrophytes

The outfall is expected to be in a water depth greater than the maximum rooting depth of macrophytes (Eurasian water milfoil, coontail, *Elodea*) commonly found in Lake Michigan (WPSC, 2003). Areas along the outfall pipe that might be shallow enough to be within the range of water depths supportive of macrophyte growth are subject to long-shore drift and high-energy wave action.

Algae

Free-floating or planktonic algae are present in Lake Michigan, dominated by the diatoms (represented by *Synedra*, *Fragilaria*, *Tabellaria*, *Asterionella*, *Melosira*, *Cyclotella* and *Rhizosolenia*), among others. Concentrations of free-floating algae fluctuate during the year, subject to the availability of sunlight, water temperatures, and in the cases of diatoms, bioavailability of silicon (WPSC, 2003).

Algae typically found attached to substrate are also present in Lake Michigan. These include *Cladophora*, *Ulothrix*, *Tetraspora*, *Stigeoclonium*, and red algae *Asterocytis*.

Fish

Table 6-10 summarizes the fish species which occur in near-shore waters of Lake Michigan (WPSC, 2003).

6.4.1.4.2 Environmental Effects

Impacts to Lake Michigan aquatic flora and fauna pertain to overall potential aquatic habitat impacts in Lake Michigan. These are limited to return flow alternatives, because no construction in Lake Michigan occurs with the water supply alternatives. Section 6.4.2.5.2 discusses how the project alternatives will protect against the spread of invasive species.

Temporary construction impacts on shoreline vegetative cover may include alteration or temporary loss at pipeline alignments. Submergent and emergent vegetation, logs, and rocks provide cover for fish and other aquatic biota. Fish that normally live in such areas may be displaced during construction. However, habitat alteration will be relatively insignificant because of the small area affected and restoration techniques used after construction to promote habitat recovery.

TABLE 6-10
Fish Species in Near-Shore Waters of Lake Michigan

Common Name	Scientific Name	Common Name	Scientific Name
Alewife	<i>Alosa pseudoharengus</i>	Round whitefish	<i>Prosopium cylindraceum</i>
Bowfin	<i>Amia calva</i>	Bloater	<i>Coregonus hoyi</i>
Brook trout	<i>Salvelinus fontinalis</i>	Rainbow smelt	<i>Osmerus mordax</i>
Brown trout	<i>Salmo trutta</i>	Gizzard shad	<i>Dorosoma cepedianum</i>
Common carp	<i>Cyprinus carpio</i>	Lake chub	<i>Couesius plumbeus</i>
Freshwater drum	<i>Aplodinotus grunniens</i>	Emerald shiner	<i>Notropis atherinoides</i>
Lake sturgeon	<i>Acipenser fulvescens</i>	Spottail shiner	<i>Notropis hudsonius</i>
Longnose sucker	<i>Catostomus catostomus</i>	Longnose dace	<i>Rhinichthys cataractae</i>
Muskellunge	<i>Esox masquinongy</i>	Bluntnose minnow	<i>Pimephales notatus</i>
Northern pike	<i>Esox lucius</i>	Sand shiner	<i>Notropis stramineus</i>
Pumpkinseed	<i>Lepomis gibbosus</i>	Fathead minnow	<i>Pimephales promelas</i>
Rainbow trout	<i>Oncorhynchus mykiss</i>	Burbot	<i>Lota lota</i>
Rock bass	<i>Ambloplites rupestris</i>	Slimy sculpin	<i>Cottus cognatus</i>
Smallmouth bass	<i>Micropterus dolomieu</i>	Largemouth bass	<i>Micropterus salmoides</i>
White bass	<i>Morone chrysops</i>	Walleye	<i>Stizostedion vitreum</i>
White sucker	<i>Catostomus commersoni</i>	Johnny darter	<i>Etheostoma nigrum</i>
Yellow perch	<i>Perca flavescens</i>	Trout-perch	<i>Percopsis omiscomaycus</i>
Lake trout	<i>Salvelinus namaycush</i>	Three spine stickleback	<i>Gasterosteus aculeatus</i>
Chinook salmon	<i>Oncorhynchus tshawytscha</i>	Nine spine stickleback	<i>Pungitius pungitius</i>
Coho salmon	<i>Oncorhynchus kisutch</i>	Brook stickleback	<i>Culaea inconstans</i>
Lake whitefish	<i>Coregonus clupeaformis</i>	Round goby	<i>Neogobius melanpostomus</i>

Evaluation of Potential Impacts to Invertebrates, Plants, and Fish

Given the discharge water quality requirements for return flow to Lake Michigan, no significant permanent impacts to the common invertebrates, plants, and fish in the lake are expected.

The WDNR informed the City of Waukesha that the City will have to meet future water quality effluent standards at least as stringent as those imposed on discharge to the Fox River. Given that future WPDES discharge requirements (likely no less stringent than those currently in place) will be designed to protect receiving waters, water quality is not expected to have a significant permanent pollutant loading or other effects upon

invertebrates, plants, or fish in Lake Michigan. Based upon revised effluent limits proposed by the WDNR, these annual estimates are conservative (see an attachment to the Return Flow Plan - Volume 4 of the Application - for additional information). The City of Waukesha will work with the WDNR and regulatory community to avoid, minimize, and mitigate potential temporary and permanent impacts.

An evaluation of Lake Michigan wildlife, endangered resources, and natural communities impacts has been included as part of a comprehensive evaluation for all affected environments

in Wetlands (Section 6.4.3), because most of the sensitive natural communities and endangered resources identified for the project alternatives are associated with wetlands.

Environmental Effects Comparison: Lake Michigan Flora and Fauna

Level of relative impact in aquatic habitat was developed to compare one alternative to another. Impacts were compared based upon Table 6-11 and summarized in Table 6-12. For aquatic habitat impacts in Lake Michigan only, the relative impact of the various alternatives is discussed below. The comparison for aquatic habitat for inland waterways is included in Section 6.4.2.2.4, Aquatic Habitat, and summarized in Table 6-17.

TABLE 6-11
Environmental Impact Category Description: Aquatic Habitat

Category	Habitat Creation	Baseflow Reduction in Warm Water Streams	Baseflow Reduction in Cold Water Streams	Substrate Change to Lake Michigan
No adverse impact	Temporary impacts from construction; Neutral or improved habitat creation and frequency of availability from operation	No baseflow reduction	No baseflow reduction	No measureable change
Minor adverse impact	Minor habitat loss	Up to 25%	Up to 15%	Fewer than 10 acres
Moderate adverse impact	Moderate habitat loss	Greater than 25%, but less than 50%	Greater than 15%, but less than 25%	Greater than 10 acres, but less than 20 acres
Significant adverse impact	Significant habitat loss	50% or more	25% or more	Greater than 20 acres

Impacts to aquatic habitat resulting from the operations (i.e., post-construction) of the water supply and return flow alternative are described below.

Deep and Shallow Aquifers Water Supply

This alternative would not have any direct effects upon Lake Michigan aquatic habitat.

Shallow Aquifer and Fox River Alluvium Water Supply

This alternative would not have any direct effects upon Lake Michigan aquatic habitat.

TABLE 6-12
Water Supply and Return Flow Alternative Environmental Impact Comparison Summary: Lake Michigan Aquatic Habitat

Alternative	Aquatic Habitat
Water Supply	
Deep and Shallow Aquifers	Not applicable
Shallow Aquifer and Fox River Alluvium	Not applicable
Lake Michigan (City of Milwaukee)	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 1	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 2	No adverse impact
Lake Michigan (City of Racine)	No adverse impact
Return Flow Alternatives for Lake Michigan Water Supplies	
Underwood Creek to Lake Michigan	No adverse impact
Root River to Lake Michigan Alignment 1	No adverse impact
Root River to Lake Michigan Alignment 2	No adverse impact
Direct to Lake Michigan	Minor adverse impact

Lake Michigan Water Supply (Cities of Milwaukee, Oak Creek Alignments 1 and 2, and Racine)

Lake Michigan water supply from the City of Oak Creek would have negligible effect on the lake's aquatic habitat. No new infrastructure is needed in Lake Michigan to provide water to Waukesha, so no construction impacts to aquatic habitat in the lake will occur. In addition, the Return Flow Plan returns the water to Lake Michigan while minimizing out of basin water (see Volume 4 of the Application). Consequently, no change is expected in Lake Michigan habitat due to volume changes.

Underwood Creek or Root River Alignments 1 and 2 to Lake Michigan Return Flow

A geomorphology analysis of Underwood Creek (see the Return Flow Plan - Volume 4 of the Application) indicated return flow would not cause a change in channel stability. A geomorphology study of the Root River concluded that the river stability is relatively insensitive to changes in flows because of the erosion resistance of the channel boundary materials, the relatively flat channel gradient, and the presence of a functional floodplain (MMSD, 2007, TM 6, p. 1). Because the waterways potentially receiving return flow are stable with return flow, there would be no significant increases in sediment flowing to Lake Michigan. Thus, there would be no adverse impacts to Lake Michigan aquatic habitat with return flow to either stream.

Direct to Lake Michigan Return Flow

The aquatic habitat would be affected only with a direct return flow discharge to Lake Michigan, because this alternative requires construction of a discharge pipeline in Lake Michigan. The pipeline within Lake Michigan will likely change the bottom substrate of the lake along the alignment from natural substrate. An estimated 6.2 acres of substrate could be affected by this alternative. A change in natural substrate would have a minor adverse impact on Lake Michigan aquatic habitat.

6.4.2 Inland Waterways

Inland waterways are differentiated from Lake Michigan for the purposes of the affected environment analysis. Inland waterways are affected by the proposed project through pipeline crossings and discharge of return flow. Inland waterways are affected by alternatives to the proposed project through pipeline crossings, continued discharge of effluent, and groundwater drawdown from pumping. The types of information included within each of these affected environments vary because the effects the various water supply and return flow alternatives have on these surface waters also vary. Consequently, detailed information on water quality and aquatic habitat is provided for surface waters potentially receiving the return flow while such information is not provided for surface waters where new discharges do not occur within any of the alternatives. Streams crossed by pipelines will only experience pipeline construction related impacts, which are described below and is applicable to all inland waterways affected by the project.

According to the Wisconsin Administrative Code (WAC), Chapter NR 102 Water Quality Standards for Wisconsin Surface Waters, Wisconsin categorizes surface waters per five fishery "use" subcategories (WDNR, 2010d). Stream use is determined by fish species or other aquatic organisms capable of being supported by a natural stream system. The designation of an appropriate use class is based on the ability of a stream to supply habitat and water quality requirements for a class of organisms:

- Cold water communities (COLD)—capable of supporting cold water sport fish
- Warm water sport fish communities (WWSF)—capable of supporting warm water sport fish
- Warm water forage fish communities (WWFF)—capable of supporting an abundant, diverse community of warm water forage fish
- Limited forage fish communities (LFF)—capable of supporting limited tolerant or very tolerant forage or rough fish, or tolerant macroinvertebrates
- Limited aquatic life (LAL)—capable of supporting very tolerant macroinvertebrates or no aquatic life

Wisconsin NR Code 104 classifies all LFF and LAL water bodies as “variance” waters. Streams without a known designation by default are classified warm water sport fisheries and are considered WWSF or WWFF waters (WDNR, 2010e).

An Outstanding Resource Water is “a lake or stream having excellent water quality, high recreational and aesthetic value, high-quality fishing and is free from point source or nonpoint source pollution.” An Exceptional Resource Waters is “a stream exhibiting the same high quality resource values as outstanding waters, but may be impacted by point source pollution or have the potential for future discharge from a small sewer community.”

According to Wisconsin NR Code 102.10 and 102.11, none of the inland waters affected by the project (Underwood Creek, Menomonee River, Root River, and Fox River) are Outstanding or Exceptional Resource Waters. Genesee Creek in Waukesha County west of Vernon Marsh is an Exceptional Resource Water upstream of State Highway 59, but that area is outside the influence of the project.

6.4.2.1 Location, Existing Designations/Classifications

6.4.2.1.1 Affected Environment

Inland waterways that receive effluent under one or more alternatives or are affected by groundwater pumping are described below. The following inland waters are discussed:

- Fox River
- Pebble Brook
- Pebble Creek
- Mill Brook
- Underwood Creek and Menomonee River
- Root River

Tables 6-13 through 6-15 list surface waters that are crossed with a water supply or return flow pipeline and receive only temporary construction impacts. A water bodies and stream GIS dataset were used to determine the number and acreage of surface water crossings.

TABLE 6-13
Water Body Crossings

Alternative	Water Body/ Stream No.	Water Body Name	Water Body Type	Approximate Crossing Width (ft)	Crossing Area (acres)	Fisheries Classification ^a
Supply						
Deep and Shallow Aquifers	3	Fox River	Perennial	139.4	0.24	WWSF
	2855	Unnamed	Intermittent/ephemeral	17.4	0.03	—
	2931	Pebble Brook	Perennial	46.5	0.08	Unknown
	2973	Unnamed	Intermittent/ephemeral	11.6	0.02	—
Shallow Aquifer and Fox River Alluvium	3	Fox River	Perennial	342.7	0.59	WWSF
	2855	Unnamed	Intermittent/ephemeral	17.4	0.03	—
	2931	Pebble Brook	Perennial	46.5	0.08	Unknown
	2973	Unnamed	Intermittent/ephemeral	11.6	0.02	—
Lake Michigan (City of Milwaukee)	1845	Poplar Creek	Perennial	16.8	0.03	Unknown
	3294	Unnamed	Intermittent/ephemeral	—	0.002	—
	3305	Unnamed	Intermittent/ephemeral	—	0.005	—
	3315	Deer Creek	Perennial	—	0.02	WWSF
	4310	Honey Creek	Perennial	—	0.002	—
	22799	North Branch Root River	Perennial	—	0.17	WWSF
	22800	North Branch Root River	Perennial	19.8	0.04	WWSF
Lake Michigan (City of Oak Creek) Alignment 1	1845	Poplar Creek	Perennial	16.8	0.03	Unknown
	3294	Unnamed	Intermittent/ephemeral	1.7	0.003	—
	3305	Unnamed	Intermittent/ephemeral	2.9	0.005	—
	3315	Deer Creek	Perennial	11.6	0.02	WWSF
	4887	North Branch Root River	Perennial	18.9	0.04	WWSF
	5103	Unnamed	Perennial	36.4	0.02	—
	5637	Oak Creek	Perennial	22.3	0.01	—
	6272	North Branch Root River	Perennial	19.8	0.04	WWSF
	6663	Unnamed	Perennial	46.0	0.027	—
	22799	North Branch Root River	Perennial	—	0.17	WWSF
Lake Michigan (City of Oak Creek) Alignment 2	3732	Unnamed	Intermittent/ephemeral	14.3	0.02	Unknown

TABLE 6-13
Water Body Crossings

Alternative	Water Body/ Stream No.	Water Body Name	Water Body Type	Approximate Crossing Width (ft)	Crossing Area (acres)	Fisheries Classification ^a
Lake Michigan (City of Racine)	3932	North Branch Root River	Perennial	49.7	0.09	WWSF
	5109	Unnamed	Intermittent/ephemeral	18.9	0.04	Unknown
	1845	Poplar Creek	Perennial		0.03	Unknown
	3280	Poplar Creek	Perennial	—	1.09	Unknown
	3333	Unnamed	Intermittent/ephemeral	—	0.07	—
	3335	Unnamed	Intermittent/ephemeral	—	0.05	—
	3408	Unnamed	Intermittent/ephemeral	—	0.02	—
	3413	Unnamed	Intermittent/ephemeral	—	0.08	—
	3432	Muskego Drainage Canal	Perennial	—	0.51	Unknown
	3459	Unnamed	Intermittent/ephemeral	—	0.20	—
	3484	Unnamed	Intermittent/ephemeral	—	0.02	—
	3486	Unnamed	Intermittent/ephemeral	—	0.06	—
	8339	Unnamed	Intermittent/ephemeral	—	0.24	—
	210	Husher Creek	Perennial	2.5	0.01	—
	668	Hoods Creek	Perennial	11.5	0.02	—
	1827	Goose Lake Branch Canal	Perennial	3.9	2.23 ^b	—
	2282	Root River Canal	Perennial	35.4	0.07	—
	20172	Mill Creek	Perennial	4.2	0.01	
Return						
Underwood Creek to Lake Michigan	1738	Unnamed	Intermittent/ephemeral	—	0.002	—
	1845	Poplar Creek	Perennial	—	0.03	Unknown
	3052	Unnamed	Intermittent/ephemeral	—	0.01	—
	3054	Unnamed	Intermittent/ephemeral	—	0.08	—
	3055	Unnamed	Intermittent/ephemeral	—	0.001	—
	3294	Unnamed	Intermittent/ephemeral	—	0.003	—
	3305	Unnamed	Intermittent/ephemeral	—	0.005	—
	3315	Deer Creek	Perennial	—	0.02	WWSF

TABLE 6-13
Water Body Crossings

Alternative	Water Body/ Stream No.	Water Body Name	Water Body Type	Approximate Crossing Width (ft)	Crossing Area (acres)	Fisheries Classification ^a
Root River to Lake Michigan Alignment 1	1845	Poplar Creek	Perennial	—	0.03	Unknown
	3052	Unnamed	Intermittent/ephemeral	—	0.01	—
	3054	Unnamed	Intermittent/ephemeral	—	0.08	—
	3055	Unnamed	Intermittent/ephemeral	—	0.001	—
	3294	Unnamed	Intermittent/ephemeral	—	0.003	—
	3305	Unnamed	Intermittent/ephemeral	—	0.005	—
	3315	Deer Creek	Perennial	—	0.02	WWSF
	4887	North Branch Root River	Perennial	10.6	0.03	WWSF
	5985	North Branch Root River	Perennial	—	0.006	WWSF
	7437	North Branch Root River	Intermittent	—	0.03	WWSF
	22799	North Branch Root River	Perennial	—	0.21	WWSF
Root River to Lake Michigan Alignment 2	3732	Unnamed	Intermittent/ephemeral	14.3	0.02	—
	4264	North Branch Root River	Perennial	38.7	0.07	WWSF
	4325	North Branch Root River	Perennial	6.6	0.17	WWSF
	5109	Unnamed	Intermittent/ephemeral	18.9	0.04	—
Direct to Lake Michigan	1845	Poplar Creek	Perennial	—	0.03	Unknown
	3052	Unnamed	Intermittent/ephemeral	—	0.01	—
	3054	Unnamed	Intermittent/ephemeral	—	0.08	—
	3055	Unnamed	Intermittent/ephemeral	—	0.001	—
	3294	Unnamed	Intermittent/ephemeral	—	0.003	—
	3305	Unnamed	Intermittent/ephemeral	—	0.005	—
	3315	Deer Creek	Perennial	—	0.02	WWSF
	5428	Lake Michigan	Lake	—	6.24	—
	6566	Kinnickinnic River	Perennial	74.5	0.07	—

^a WDNR (2010d).

^b The current theoretical project alignment for Lake Michigan–Racine Supply is parallel to the Goose Lake Branch Canal, but the actual construction corridor would be narrowed to avoid impacts to the water body.

TABLE 6-14
Summary of Acres of Water Body Crossings

Name	Deep and Shallow Wells	Shallow Aquifer and Fox River Alluvium	Lake Michigan–Milwaukee Supply	Lake Michigan–Oak Creek Supply A1	Lake Michigan–Oak Creek Supply A2	Lake Michigan–Racine Supply	Underwood Creek to Lake Michigan Return Flow	Root River to Lake Michigan Return Flow A1	Root River to Lake Michigan Return Flow A2	Direct to Lake Michigan Return Flow
Deer Creek	—	—	0.02	0.02	—	—	0.02	0.02	—	0.02
Lake Michigan	—	—	—	—	—	—	—	—	—	6.24
Muskego Drainage Canal	—	—	—	—	—	0.51	—	—	—	—
Fox River	0.24	0.59	—	—	—	—	—	—	—	—
Pebble Brook	0.08	0.08	—	—	—	—	—	—	—	—
Poplar Creek	—	—	0.03	0.03	—	1.12	0.03	0.03	—	0.03
North Branch Root River	—	—	0.21	0.25	0.09	—	—	0.28	0.24	0.21
Husher Creek	—	—	—	—	—	0.01	—	—	—	—
Hoods Creek	—	—	—	—	—	0.02	—	—	—	—
Oak Creek	—	—	—	0.01	—	—	—	—	—	—
Goose Lake Branch Canal	—	—	—	—	—	2.23	—	—	—	—
Root River Canal	—	—	—	—	—	0.07	—	—	—	—
Mill Creek	—	—	—	—	—	0.01	—	—	—	—
Kinnickinnic River	—	—	—	—	—	—	—	—	—	0.07
Unnamed	0.05	0.05	0.01	0.06	0.06	0.74	0.11	0.10	0.06	0.10
Grand Total	0.37	0.72	0.27	0.37	0.15	4.71	0.16	0.43	0.30	6.46

All water bodies and all streams ranked as major that intersect the estimated 75-foot-wide construction corridor for impact evaluation purposes are included in Tables 6-13 through 6-15. Based on an investigation of minor ranked streams using the WDNR's Surface Water Data Viewer, the majority of streams ranked as minor crossed within the alternatives proposed construction corridor are considered unnamed ditches or canals and therefore were not included in the impact analysis.

Fox River

The Fox River will be affected by all the water supply alternatives considered. It is classified for WDNR fish and aquatic life standards and is a WWSF community. The Fox River currently receives the flow from the Waukesha Wastewater Treatment Plant (WWTP) discharge. A change in discharge location will affect the Fox River. Two of the water supply alternatives include pumping from shallow wells near the Fox River, which may change baseflows in the river.

Just downstream of the City of Waukesha are several perennial Fox River tributaries — Genesee Creek, Mill Brook, Pebble Creek, and Pebble Brook — all listed as supporting cold water communities. The potential sources of impairments in the watershed are non-point-source discharges, contaminated sediments, and discharges from municipal separate storm sewer systems (WDNR, 2010f).

Pebble Brook

Pebble Brook will only potentially be affected by the alternatives that pump shallow groundwater that may otherwise flow into Pebble Brook. Pebble Brook is not affected by the Lake Michigan water supply and return flow alternatives.

Pebble Brook is a narrow 9-mile-long perennial trout stream located in southeastern Waukesha County. It is a tributary to the Fox River south of the City of Waukesha. The WDNR has classified Pebble Brook as a cold water fishery (NR 102.04(3)). Cold water fisheries are surface waters capable of supporting a community of cold water fish and other aquatic life or serving as a spawning area for cold water fish species. Cold water streams receive much of their flow from groundwater entering the stream which enables their temperature to remain cold. Mill Creek is a tributary to Pebble Brook. In groundwater modeling analysis, baseflow reduction to Mill Creek was analyzed (RJN Environmental Services, 2010, 2013) and these baseflow reductions are reported in the Water Supply Service Area Plan (Volume 2 of the Application). For purposes of the ER, impacts to Mill Creek are included in the broader watershed context of Pebble Brook.

TABLE 6-15
Number of Water Body Crossings

Water Supply	
Deep and Shallow Aquifers	4
Shallow Aquifer and Fox River Alluvium	4
Lake Michigan (City of Milwaukee)	8
Lake Michigan (City of Oak Creek) Alignment 1	11
Lake Michigan (City of Oak Creek) Alignment 2	3
Lake Michigan (City of Racine)	16
Return Flow Alternatives for Lake Michigan Water Supplies	
Underwood Creek to Lake Michigan	9
Root River to Lake Michigan Alignment 1	11
Root River to Lake Michigan Alignment 2	4
Direct to Lake Michigan	9

Pebble Creek

Pebble Creek is a narrow, 6-mile-long perennial trout stream in southeastern Waukesha County. It is a tributary to the Fox River south of the City of Waukesha. The WDNR has classified Pebble Creek as a Cold water fishery. Pebble Creek would be affected only by the alternatives that pump shallow groundwater that may otherwise flow into Pebble Creek. It would not be affected by the Lake Michigan water supply and return flow alternatives.

Mill Brook

Mill Brook is a narrow, 5-mile-long perennial trout stream in southeastern Waukesha County. It is a tributary to the Fox River south of the City of Waukesha, and the WDNR classifies it as a cold water fishery. Mill Brook would be affected only by alternatives that pump shallow groundwater that may otherwise flow into Mill Brook. Mill Brook would not be affected by the Lake Michigan water supply and return flow alternatives.

Underwood Creek and Menomonee River

Underwood Creek and the Menomonee River would be affected only by the Lake Michigan water supply alternatives for return flow to Underwood Creek. The groundwater supply alternatives do not affect Underwood Creek or the Menomonee River.

Underwood Creek is tributary to the Menomonee River, which in turn flows to Lake Michigan. Return flows would be discharged to Underwood Creek in Waukesha County, near the crossing of Underwood Creek and Bluemound Road. At that location, Underwood Creek flows about 2.6 river miles to its confluence with the Menomonee River in Wauwatosa. All of Underwood Creek is lined with concrete except for a 2,400-foot reach that was rehabilitated in 2009 to a natural channel. Future concrete channel rehabilitation to create a natural channel has been proposed for sections of the stream. The Menomonee River from the Underwood Creek confluence flows another 10 river miles to Lake Michigan in the City of Milwaukee.

Underwood Creek is designated for WDNR fish and aquatic life standards and are WWSF communities. Underwood Creek also has a variance in Milwaukee County for dissolved oxygen and fecal coliform. The Menomonee River downstream of Underwood Creek is classified for WDNR fish and aquatic life standards, but it has the same dissolved oxygen and fecal coliform variances from Honey Creek to the mouth of the river (about 5 miles downstream of the proposed return flow location).

Root River

Root River would be affected only by the Lake Michigan water supply alternatives for return flow to the Root River and by Lake Michigan water supply or return flow pipeline alignments that cross the Root River. The groundwater supply alternatives would not affect the Root River.

The Root River flows through parts of Milwaukee and Racine counties, and into Lake Michigan at Racine. The river has more natural bottom substrate and vegetated river banks than does Underwood Creek, and it has a mixture of land uses between its headwaters and Lake Michigan. The headwaters of the Root River are heavily urbanized, the middle reaches are primarily agriculture and lower density development, and the lower parts of the watershed near Lake Michigan are heavily urbanized. The Root River is classified for WDNR fish and aquatic life standards and is a WWSF community (WDNR, 2002b).

Other Surface Waters

Other surface waters within the affected environment are those that are crossed with a water supply or return flow pipeline and receive only temporary construction impacts. These surface waters are listed in Tables 6-13 and 6-14.

6.4.2.1.2 Environmental Effects

As described below in Section 6.4.2.2, Size, Flows, and Floodplain, the flows in the cold water streams (Pebble Brook, Pebble Creek, and Mill Brook) will be reduced under the groundwater supply alternatives. Reduced groundwater flow to these cold water streams could potentially change their classification to warm water.

There are no other changes to the designations or classifications of inland waterways with the proposed project or alternatives to the proposed project. Impacts to stream crossings will be temporary during construction, the impacts of which are discussed below. Streams crossed only by a pipeline are not evaluated further as a result. Many of the surface waters listed in Tables 6-13 and 6-14 cross the proposed project alignments in areas where the stream flows through a culvert underneath roads. Since the pipeline alignments follow previously disturbed transportation or utility corridors, minimal temporary construction impacts are expected.

6.4.2.2 Size, Flows, and Floodplain

6.4.2.2.1 Affected Environment

Fox River

The Fox River receives the WWTP discharge and drains 151 square miles at the southern end of the City of Waukesha. The upper Fox River, flowing through the City of Waukesha, is a perennial stream (WDNR, 2002a). At the USGS Fox River stream gage 05543830 in the City of Waukesha, average annual stream flow is 110 cfs (71 mgd) over the period of record, 1963 to 2009 (USGS, 04/2010a). The WDNR designates Fox River a WWSF with the following uses: fish and aquatic life, recreation, public health and welfare, and fish consumption.

Pebble Brook

Pebble Brook is a narrow 9-mile-long perennial trout stream in southeastern Waukesha County (WDNR, 2002a). It is a tributary to the Fox River south of the City of Waukesha. Flow data in the watershed is unavailable because it does not have a flow measurement gage. Flow change estimates were made within the environmental effects section based upon groundwater modeling (RJN Environmental Services, 2010, 2013).

Pebble Creek

Pebble Creek is a narrow, 6-mile-long perennial trout stream in southeastern Waukesha County (WDNR, 2002a). It is a tributary to the Fox River south of the City of Waukesha. The WDNR has classified Pebble Creek as a Cold water fishery. Flow data in the watershed is unavailable because it does not have a flow measurement gage. Flow change estimates were made within the environmental effects section based upon groundwater modeling (RJN Environmental Services, 2010, 2013).

Mill Brook

Mill Brook is a narrow, 5-mile-long perennial trout stream in southeastern Waukesha County (WDNR, 2002a). It is a tributary to the Fox River south of the City of Waukesha. The WDNR

has classified Mill Brook as a cold water fishery. Flow data in the watershed is unavailable because it does not have a flow measurement gage. Flow change estimates were made within the environmental effects section based upon groundwater modeling (RJN Environmental Services, 2010, 2013).

Underwood Creek and Menomonee River

Underwood Creek is a tributary stream to the Menomonee River, which in turn flows to Lake Michigan. Discharge of return flow to Underwood Creek is expected to occur in Waukesha County, near the crossing of Underwood Creek and Bluemound Road. At that location, Underwood Creek flows about 2.6 river miles to its confluence with the Menomonee River in Wauwatosa. Underwood Creek is lined with concrete except for the 2,400-foot reach that was rehabilitated in 2009 to a natural channel. Future rehabilitation of other concrete-lined sections has been proposed. The Menomonee River from the Underwood Creek confluence flows another 10 river miles to Lake Michigan in the City of Milwaukee.

The Underwood Creek and Menomonee River watersheds in the Milwaukee area are highly developed, with residential and commercial buildings very near, sometimes within, the 100-year flood plain. To protect public and private property, there have been significant and ongoing investment in flood control projects. For example, downstream of the return flow location, the MMSD has invested \$48 million in the Hart Park flood control project, completed in 2007 (MMSD, 01/2010a), and \$99 million in the County Grounds flood control project, completed in 2010 (MMSD, 01/2010b). Other projects have been completed or are planned elsewhere in the watershed. Each project contributes to providing flood protection to neighboring and downstream residents.

During a flood in the watershed, floodwaters rise and then subside quickly. For example, to protect downstream properties, conveying floodwaters to the Milwaukee County Grounds floodwater management facility is estimated to last only 6 hours for the 100-year return period storm (HNTB, 2006).

At the USGS Underwood Creek stream gage 04087088 in the City of Wauwatosa downstream of the return flow location, the average annual stream flow is 15.1 cfs (9.8 mgd) over the period of record from 1974 to 2009 (USGS, 04/2010c).

At the USGS Menomonee River stream gage 04087120 in the City of Wauwatosa downstream of the return flow location, the average annual stream flow is 108 cfs (69 mgd) over the period of record from 1961 to 2009 (USGS, 04/2010b).

Root River

The Root River flows through parts of Milwaukee and Racine counties, and into Lake Michigan at Racine. The river has more natural channel (e.g., natural bottom substrate and vegetated river banks) than does Underwood Creek, and it has a mixture of land uses between its headwaters and Lake Michigan. The headwaters of the Root River are heavily urbanized, the middle reaches are primarily agriculture and lower density development, and the lower parts of the watershed near Lake Michigan are heavily urbanized.

WDNR (2002b) classifies the Root River a WWSF community for fish and aquatic life standards.

At USGS Root River stream gage 04087220 near the City of Franklin, about 2 miles upstream of the proposed project return flow location, the average annual stream flow is 45.6 cfs (29.5 mgd) over the period of record 1964 to 2011 (USGS, 12/2012a).

At USGS Root River stream gage 04087240 in the City of Racine, approximately 20 miles downstream of the proposed project return flow location, the average annual stream flow is 157.8 cfs (102.0 mgd) over the period of record 1964 to 2012 (USGS, 12/2012b).

6.4.2.2.2 Environmental Effects

There is no long-term change to inland waterway size, although pipeline stream crossings will cause temporary aquatic habitat impacts. All water supply alternatives have pipelines that cross surface waters. Tables 6-13 through 6-15 list the extents of the perennial and intermittent surface water crossings for each alternative. Refer to the maps found in Appendix 3-1 of Section 3 and to Appendix 6-1 at the end of this section for maps associated with the proposed project and alternatives to the proposed project. All crossings would have temporary impacts during construction. Once construction is complete, the surface water crossing will be restored. Operational and maintenance impacts are expected to be negligible.

Temporary construction impacts on in-stream and shoreline vegetative cover may include alteration or temporary loss at pipeline water crossings. Submergent and emergent vegetation, in-stream logs and rocks, and undercut banks provide cover for fish and other aquatic biota. Fish that live in these areas may be displaced during construction, this habitat alteration will be insignificant because of the small area affected at each crossing location and because the streambanks will be restored to promote regrowth of riparian vegetation. During design, the City of Waukesha will work with the resource agencies to determine the appropriate construction techniques for each crossing to minimize and mitigate temporary impacts. Techniques that could be used are discussed in Appendix 5-2, Example Wetland and Waterway Pipeline Construction Crossing Impact Minimization Techniques. Impacts to aquatic habitat resulting from post-construction operation are described below.

There are two kinds of operational flow changes to inland waterways: baseflow changes and flooding changes. Baseflow changes can affect aquatic habitat by changing the water depth and wetted surface area available to aquatic species, and also water temperature. For example, if flow decreases in cold water streams in the summer, the water temperature increases. The potential effect the proposed project on baseflow is evaluated for each inland waterway.

Flooding is a concern in urbanized communities, especially in southeastern Wisconsin where extensive flood mitigation projects have been constructed and more are planned. Floodplain impacts for the water supply and return flow alternatives were evaluated based on their impact on flooding along affected surface water resources. Each major water resource analyzed is discussed below. The proposed project would have no significant baseflow or flooding changes to any other inland waterways not described below.

Fox River

Baseflow Changes

Impacts to aquatic habitat in the Fox River are discussed below. As noted, the average annual stream flow is 110 cfs (71 mgd) over the period of record.

Deep and Shallow Aquifers Water Supply Water Supply

Baseflow reductions to the Fox River would occur under this alternative because of the shallow groundwater pumping. The City of Waukesha WWTP would continue to discharge treated wastewater to the Fox River. The WWTP discharges would be greater than the baseflow reduction, so the discharges would partially offset the baseflow reduction caused by pumping. However, groundwater pumping would reduce the volume of water in the Fox River compared to current conditions because the pumping would draw baseflow from the river.

Pumping the shallow groundwater would draw down the aquifer and intercept groundwater flow to surface waters. The resulting change in surface water flow is documented in previous studies and groundwater modeling for this specific alternative (RJN Environmental Services, 2010, 2013).

SEWRPC identified adverse impacts from baseflow reduction to the Fox River. For a similar water supply alternative mixing deep and shallow groundwater sources, SEWRPC noted that parts of the Fox River could experience a baseflow decrease greater than 10 percent (SEWRPC, 2010a). A subsequent study estimated significant baseflow reductions near Waukesha when only 3.9 mgd of shallow groundwater was pumped and artificial recharge was used (Cherkauer, 2009).

Detailed groundwater modeling of this alternative found that average groundwater baseflows to the river could decrease significantly (RJN Environmental Services, 2010, 2013). For example, compared to the base scenario, groundwater baseflow to the river would be reversed. Groundwater pumping under this alternative would draw water away from the Fox River. Groundwater pumping is estimated to reduce baseflow in the Fox River by 2.3 mgd, which is approximately a 5 percent reduction in baseflow.²

Because the WWTP discharges to the Fox River upstream of where the groundwater drawdown occurs, the baseflow reduction would not have significant adverse impacts between the WWTP discharge and the downstream extent of the groundwater drawdown (see drawdown maps in Appendix 6-3). But groundwater pumping would have an adverse impact on the flow in the Fox River downstream of the areas affected by the groundwater drawdown (downstream of the Vernon Marsh), the flow would be removed from the Fox River (i.e., 2.3 mgd would be continuously intercepted between groundwater pumping and the WWTP and therefore would be removed from the flow in the river in the downstream reaches). This flow change is less than 25 percent of the baseflow condition (see Lake Michigan Water Supply discussion below). Because there would be less flow in the river, there would be less aquatic habitat.

Shallow Aquifer and Fox River Alluvium Water Supply

The Shallow Aquifer and Fox River Alluvium alternative has greater reductions to Fox River baseflow. This alternative would continue to use the municipal WWTP for the discharge of treated wastewater. The WWTP discharges are larger than the baseflow reduction, so the WWTP discharges are expected to partially supplement the baseflow reduction caused by the groundwater pumping. Groundwater pumping will reduce the volume of water in the Fox River compared to current conditions because the groundwater pumping draws baseflow from the river. The baseflow reduction impacts to the Fox River would be expected

² Fox River baseflow and percent reduction was estimated from groundwater drawdown modeling (RJN Environmental Services, 2013) and adjusted to represent the Q80 Fox River flow (Fox River Q80 flow at USGS Gauge 05543830 at the City of Waukesha + Waukesha WWTP average flow + Q80 flow in downstream tributaries).

to be more than or similar to those documented in previous studies by SEWRPC and Cherkaur, as described under the Deep and Shallow Aquifers alternative.

Detailed groundwater modeling of this alternative found average groundwater baseflows to the river could be reduced significantly (RJN Environmental Services, 2010, 2013). For example, compared to the base scenario, groundwater baseflow to the river would be reversed, whereby groundwater pumping would draw water away from the Fox River. Groundwater pumping is estimated to reduce baseflow in the Fox River by 4.8 mgd, which is approximately an 11 percent reduction in baseflow.

Because the WWTP discharges to the Fox River upstream of where the groundwater drawdown occurs, the baseflow reduction would not have significant adverse impacts between the WWTP discharge and the downstream extent of the groundwater drawdown (see drawdown maps in Appendix 6-3). However, groundwater pumping would adversely affect flow in the Fox River downstream of the areas affected by groundwater drawdown (downstream of the Vernon Marsh), because baseflow would be removed from the Fox River (i.e., 4.8 mgd would be continuously intercepted between groundwater pumping and the WWTP, and therefore be removed from the flow in the river in the downstream reaches). This flow change is less than 25 percent of the baseflow condition (see Lake Michigan Water Supply discussion below).

Because there would be less flow in the river under this alternative, there would be less aquatic habitat.

Lake Michigan Water Supply (Cities of Milwaukee, Oak Creek Alignments 1 and 2, and Racine)

Any of the Lake Michigan water supply alternatives would have an effect on the aquatic habitat in the Fox River. As discussed in the Return Flow Plan (Volume 4 of the Application), a Lake Michigan supply would return flow from the City of Waukesha WWTP to the Lake Michigan basin. A Lake Michigan supply also would affect the Fox River, regardless of the return flow location.

A Lake Michigan supply and cessation of shallow groundwater pumping would improve the subsurface flow to the Fox River, and allow the baseflow to be restored at least partially to conditions similar to pre-well conditions, because the groundwater would contribute more baseflow to the river. This would improve the baseflow under current shallow groundwater pumping conditions and have the greatest benefit in the future when water demand is projected to be greater.

A Lake Michigan supply will require a shifting of the WWTP discharge from the Fox River to the Lake Michigan basin, but a return flow will not eliminate discharge to the Fox River. The City of Waukesha's return flow management plan goal will provide continuous return of the water at the WWTP (see the Return Flow Plan in Volume 4 of the Application). In general, the return flow management plan provides return flow up to the maximum day water demand if sufficient water is available at the WWTP. The portion of water at the WWTP in excess of this amount will continue to be discharged into the Fox River and meet permit limits. The Return Flow Plan analysis shows that no less than 100 percent of the water volume will be returned to the Great Lakes basin.

Because the WWTP flow to the Fox River will be reduced with a Lake Michigan supply, less water will be available in the river, reducing the amount of aquatic habitat. However, removal

of the WWTP flow from the Fox River does not cause drawdown in smaller Fox River tributary streams that are sensitive to changes in baseflow from groundwater pumping. The Compact requires that the minimum return flow be at least the water withdrawn less an allowance for consumptive use. The Compact also requires that the return flow minimize out-of-basin water sent into the Great Lakes basin. These two requirements established minimum and maximum return flow rates to provide the water balance between the withdrawal and return, as described in the return flow management plan. As a result, WWTP flow will still occur at times to the Fox River with any Lake Michigan water supply.

A study by the USGS and University of Wisconsin Milwaukee reports that wastewater flows from Sussex, Brookfield, and Waukesha contribute 40 percent of the total Fox River flow during annual low flows (Cherkauer et al., 2010). The City of Waukesha's average annual WWTP flow is about 10 mgd, or 50 percent of the WWTP flow from the 3 communities. Using this percentage, the City of Waukesha WWTP contributes about 25 percent of the Fox River flow during annual low flow conditions. Thus, during low flow periods, Fox River annual low flow would be reduced by roughly 25 percent. Lower flows change the amount of aquatic habitat available, however as described in the Return Flow Plan (Volume 4 to the Application), water depth change is expected to be approximately 2 inches or less. Consequently, significant habitat change is not expected. The reduction in flow, and thus in aquatic habitat, would have an impact. The baseflow change of the Fox River flow at the Vernon Wildlife Area was estimated at 23 percent. Consequently a minor adverse impact designation is given for impacts to the river during annual low flow conditions.

Return Flow Alternatives

Because a Lake Michigan supply would also include return flow, any impacts to the Fox River are assigned to the Lake Michigan water supply alternatives. Impacts with return flow alternatives are described in the following subsections.

Flooding Changes

Deep and Shallow Aquifers Water Supply

The Deep and Shallow Aquifers supply alternative would not affect flooding on the Fox River, because there would be no floodplain changes and the City of Waukesha WWTP would continue to discharge treated wastewater to the river. The aboveground structures associated with this alternative would be located outside the regulatory floodplain, so they would not be damaged by a 100-year return period flood.

Shallow Aquifer and Fox River Alluvium Water Supply

The Shallow Aquifer and Fox River Alluvium supply alternative would not affect the Fox River flooding for the reasons given above for the Deep and Shallow Aquifer alternative. The aboveground structures associated with this alternative would be located outside the regulatory floodplain, so they would not be damaged by a 100-year return period flood.

Lake Michigan Water Supply and Return Flow

No Lake Michigan water supply alternative would affect flooding on the Fox River, because Lake Michigan is in a different watershed.

Return flow would not affect flooding on the Fox River. The City of Waukesha's return flow management plan goal will provide continuous return of the water at the WWTP (see the Return Flow Plan in Volume 4 of the Application). In general, the return flow management plan provides return flow up to the maximum day water demand if sufficient water is

available at the WWTP. The portion of water at the WWTP in excess of this amount will continue to be discharged into the Fox River and meet permit limits. This would maintain the same flow in the Fox River during flooding events as the groundwater supply alternatives and as occurs now. Therefore, a Lake Michigan water supply with the return flow would not adversely change flooding on the Fox River.

Two small aboveground pump stations are associated with this alternative: one for water from a Lake Michigan water supplier, and one at the Waukesha WWTP for return flow. The stations would be located and designed so there would no damage from a 100-year return period flood.

Pebble Brook, Pebble Creek, and Mill Brook

Baseflow Changes

Deep and Shallow Aquifers Water Supply

Shallow groundwater pumping would drawdown the aquifer and intercept groundwater flow to these cold water streams. Detailed groundwater modeling of this alternative found average groundwater baseflows to these cold water streams could be reduced significantly (RJN Environmental Services, 2010, 2013). For example, groundwater baseflow to Pebble Brook would be reduced by 34 percent, to Pebble Creek by 0 percent, and to Mill Brook by 85 percent. Geomorphic changes with reduced baseflows could result in a smaller channel over time. Because channel stability is less associated with baseflow and more influenced by larger channel-forming flows generally in the 1- to 2-year return period flow range, baseflow reduction is not expected to cause a significant change in channel stability from what currently exists. The baseflow reductions could, however, have a significant adverse impact to the flow in the channels (especially Pebble Brook and Mill Brook because of the 34 and 85 percent reduction in baseflow) during low flow periods, when groundwater baseflow accounts for most of the flow in the channels.

Shallow Aquifer and Fox River Alluvium Water Supply

Shallow groundwater pumping would drawdown the aquifer and intercept groundwater flow to these cold water streams. Detailed groundwater modeling of this alternative found average groundwater baseflows to these cold water streams could be reduced significantly, and more than under the Deep and Shallow Aquifer alternative (RJN Environmental Services, 2010, 2013). For example, groundwater baseflow to Pebble Brook would be reduced by 34 percent, to Pebble Creek by 13 percent, and to Mill Brook by 77 percent. Geomorphic changes with reduced baseflows could result in a smaller channel over time. Because channel stability is less associated with baseflow and more influenced by larger channel forming flows generally in the 1- to 2-year return period flow range, baseflow reduction is not expected to cause a significant change in channel stability from what exists. The baseflow reductions could, however, have a significant adverse impact to the flow in the channels during low flow periods, when groundwater baseflow accounts for most of the flow in the channels.

Lake Michigan Water Supply and Return Flow

There would be no groundwater pumping under this alternative, and consequently the cold water streams are not affected.

Flooding Changes

None of the water supply or return flow alternatives would affect flooding on the cold water streams, because flows in these inland waterways would not increase.

Underwood Creek and Menomonee River

Baseflow Changes

Deep and Shallow Aquifers, and Shallow Aquifer and Fox River Alluvium Water Supplies

There would be no flow change in Underwood Creek and the Menomonee River with the groundwater water supply alternatives.

Lake Michigan Water Supply (Cities of Milwaukee, Oak Creek Alignments 1 and 2, and Racine)

There would be no shallow groundwater pumping with this alternative, and consequently these inland waterways would not be affected.

Underwood Creek to Lake Michigan Return Flow

The average annual stream flow is 15.1 cfs (9.8 mgd) for Underwood Creek and 108 cfs (69 mgd) for the Menomonee River over the period of record.

The Return Flow Plan (Volume 4 of the Application) contains a detailed analysis of the flow and geomorphic conditions of these waterways. In summary, return flow to Underwood Creek will increase the flow in the creek and river downstream of the return flow location. Underwood Creek has periods of no flow, and so a return flow could constitute 100 percent of the creek flow at such times and create year-round aquatic habitat. During less frequent high flow events, such as a 2-year flow, a return flow is less than 2 percent of the creek flow and even a lower percentage of the river flow. Because of the small percentage of return flow in the creek and river, a return flow will increase baseflow but not adversely affect flow or geomorphic conditions in either watercourse. Instead, it will benefit Underwood Creek flow during low and no-flow periods, because the return flow will provide a baseflow in the creek at all times and create year-round aquatic habitat.

Flow changes in Underwood Creek with return flow for 2005 and 2008 were simulated as documented in the Return Flow Plan (Volume 4 of the Application). The year 2005 was selected because it is a relatively dry year in recent past, and 2008 was a relatively wet year. The analysis found the change in baseflow throughout the year, with the maximum increase in baseflow of 13.8 cfs (8.9 mgd) in 2005 and 12.3 cfs (8.0 mgd) in 2008. This compares to average annual flows in Underwood Creek without return flow of 9.1 cfs (5.9 mgd) in 2005 and 26.1 cfs (16.9 mgd) in 2008. Return flow represents an increase in annual average flow of approximately 50 to 150 percent in these years. While this analysis was conducted under a prior return flow management plan, the new management plan could potentially increase baseflows further, creating additional habitat. Consequently, the benefits of baseflow increases are conservatively estimated.

Root River to Lake Michigan Return Flow Alignments 1 and 2

There would be no flow change in Underwood Creek and the Menomonee River under this alternative.

Direct to Lake Michigan Return Flow

There would be no flow change in Underwood Creek and the Menomonee River under this alternative.

Flooding Changes

Deep and Shallow Aquifers, and Shallow Aquifer and Fox River Alluvium Water Supplies

There would be no flow change in Underwood Creek and the Menomonee River with the groundwater water supply alternatives.

Lake Michigan Water Supply (Cities of Milwaukee, Oak Creek Alignments 1 and 2, and Racine)

Change in flow would be documented under the return flow alternatives, since there is no change in surface water flow based solely upon a Lake Michigan supply. No Lake Michigan water supply alternative would not affect flooding in inland waterways because the water intake in all cases would be in Lake Michigan.

Underwood Creek to Lake Michigan Return Flow

Return flow is less than 2 percent of the creek flow during a 2-year frequency storm and is an even a smaller percentage of flow during a flood. SEWRPC has updated flood flow projections for Underwood Creek and Menomonee River that account for the Milwaukee County Grounds flood control project (SEWRPC, 2011). The 100-year flow rates in Underwood Creek range from 3,080 cfs to 6,910 cfs between the proposed return flow discharge location and the confluence with the Menomonee River. The 100-year flow rates in Menomonee River range from 9,300 cfs to 16,000 cfs between the confluence with Underwood Creek and the mouth of the Menomonee River.

Return flow is a small fraction of the flood flow rates. Using the maximum return flow rate the percent of return flow in Underwood Creek during flood flows is less than 1 percent. For the Menomonee River, the fraction of the maximum return flow rate during flood flows is less than 0.5 percent.

A flooding analysis completed by the Wisconsin Department of Transportation for the Zoo Interchange drainage improvements affecting Underwood Creek and the Menomonee River concluded that the interchange reconstruction and drainage reconfiguration would not have a statistically significant affect on regional flood flows (WisDOT, 2012). This analysis showed that the improvements reduced the 100-year flow rates between 25 and 29 cfs along Underwood Creek downstream of the proposed return flow location. Further downstream along the Menomonee River where river flow rates are significantly larger, flow reductions ranged between 14 and 29 cfs. For all locations downstream of the return flow, the average flow reduction was 24 cfs. While these flow reductions were determined to be not statistically significant the modeled reduction in flow rates are similar to the anticipated maximum return flow rate.

The MMSD Milwaukee County Grounds flood detention facility was originally designed with criteria to receive 3,300 cfs of flow from Underwood Creek for the 100-year flood (MMSD, 2007). Based on updated modeling by SEWRPC, the detention facility reduces flow by 3,830 cfs, 530 cfs greater than the design criteria. Consequently, return flow is not anticipated to negatively affect the function of the detention facility.

The Wastewater Treatment Plant Facility Plan Amendment (see the Return Flow Plan - Volume 4 of the Application) discusses potential outfall structure designs. The outfall structure will be designed to blend in with the streambanks along Underwood Creek and not to affect regional flood elevations adversely.

Root River to Lake Michigan Return Flow Alignments 1 and 2

There would be no flow change in Underwood Creek and the Menomonee River with this alternative.

Direct to Lake Michigan Return Flow

There would be no flow change in Underwood Creek and the Menomonee River with this alternative.

Root River*Baseflow Changes**Deep and Shallow Aquifers, and Shallow Aquifer and Fox River Alluvium Water Supplies*

There would be no flow change in the Root River under the groundwater water supply alternatives.

Lake Michigan Water Supply (Cities of Milwaukee, Oak Creek, and Racine)

Change in flow is documented under the return flow alternatives, because there would be no change in surface water flow based solely upon a Lake Michigan supply.

Underwood Creek to Lake Michigan Return Flow

There would be no flow change in the Root River under this alternative.

Root River to Lake Michigan Return Flow Alignments 1 and 2

At USGS Root River stream gage 04087220 near the City of Franklin, about 2 miles upstream of the proposed project return flow location, the average annual stream flow is 45.6 cfs (29.5 mgd) over the period of record 1964 to 2011 (USGS, 12/2012a).

At USGS Root River stream gage 04087240 in the City of Racine, approximately 20 miles downstream of the proposed project return flow location, the average annual stream flow is 157.8 cfs (102.0 mgd) over the period of record 1964 to 2012 (USGS, 12/2012b).

The Return Flow Plan (Volume 4 of the Application) contains additional information on the Root River flow and geomorphic conditions. In summary, return flow to the Root River will increase the flow in the river downstream of the return flow location. The average annual flow from the Waukesha WWTP is 18.1 cfs (11.7 mgd). The maximum return flow rate will be 28.6 cfs (18.5 mgd).

During low-flow periods, the return flow would constitute 80 to 90 percent of the river flow (USGS, 12/2012a). Flow in the Root River sometimes is very low, and the functional habitat in the river is limited by the river flow. Augmentation of the return flow would eliminate the very low-flow periods and provide more aquatic habitat.

A sediment transport study of the Root River concluded that the river stability is insensitive to changes in flow because of the erosion resistance of the channel boundary materials, the relatively flat channel gradient, and the presence of a functional floodplain.³ For these reasons, return flow will have no significant adverse impact on the baseflow or geomorphic conditions in the river. Instead, it will benefit Root River flow during low-flow periods because the return flow will provide additional baseflow in the river.

Direct to Lake Michigan Return Flow

There would be no flow change in the Root River under this alternative.

³ MMSD, 2007, Page 1.

Flooding Changes

Deep and Shallow Aquifers, and Shallow Aquifer and Fox River Alluvium Water Supplies

There would be no change in flow in the Root River under the groundwater water supply alternatives.

Lake Michigan Water Supply (Cities of Milwaukee, Oak Creek Alignments 1 and 2, and Racine)

Change in flow is documented under the return flow alternatives, because there would be no change in surface water flow based solely upon a Lake Michigan water supply. No Lake Michigan supply would affect flooding in this watercourse, because in all cases the water intake would be in Lake Michigan.

Underwood Creek to Lake Michigan Return Flow

There would be no flow change in the Root River under this alternative.

Root River to Lake Michigan Return Flow Alignments 1 and 2

Root River flow rates at the discharge location for the 2-year through 100-year profiles were obtain from MMSD⁴. This location is nearest the discharge location, slightly downstream of the Franklin gage but upstream of the confluence with the Root River Canal. The watershed area at this location is 59.2 square miles which is still significantly less than the watershed area at the discharge location (126.2 square miles). These flow rates were used as a conservative estimate of flow impacts from a return flow. The maximum return flow (18.5 mgd or 28.6 cfs) is less than 3 percent of the river flow during a 2-year frequency storm and would be an even a smaller percentage of flow during a flood. For example, the maximum return flow rate is less than 1 percent of the 100-year river flow (4,820 cfs) near the return flow location (MMSD, 2007). The maximum return flow rate would have even a smaller impact on the Root River flows in Racine. The 100-year river flow in Racine is 5,916 cfs. The maximum return flow rate would increase river flow rate by less than half of a percent in Racine (USGS, 12/2012b). This equates to a water depth change of 0.02 feet at each location for the 100-year return period flood. Additionally, discharging the maximum return flow rate is expected to occur infrequently. The future average day return flow is estimated as 11.7 mgd (16.9 cfs) and will result in an even smaller increase in the Root River flow.

The Wastewater Treatment Plant Facility Plan Amendment which is an attachment to the Return Flow Plan (Volume 4 of the Application) discusses potential outfall structure designs. The outfall structure will be designed to blend in with the streambanks along the Root River and not to affect regional flood elevations adversely.

Direct to Lake Michigan Return Flow

There would be no flow change in the Root River under this alternative.

6.4.2.2.3 Environmental Effects Comparison: Inland Waterways Size, Flows, and Floodplain

Adverse impacts from changes in the size, flow, and floodplain of inland waterways relate directly to aquatic habitat impacts and flooding. Level of relative impact for both aquatic habitat and flooding were developed to compare alternatives. Impacts were compared based upon Table 6-16. The impact of the various alternatives on aquatic habitats and flooding is discussed below. The inland waterway aquatic habitat and flooding impacts are summarized in Table 6-17. The comparison for aquatic habitat impacts for Lake Michigan is included in Section 6.4.1.4, Flora and Fauna.

⁴ MMSD, 2007 Table 3, page 9.

TABLE 6-16

Environmental Impact Category Description: Inland Waterways – Aquatic Habitat and Flooding

Category	Aquatic Habitat				Flooding	
	Habitat Creation	Baseflow Reduction in Warm Water Streams	Baseflow Reduction in Cold Water Streams	Substrate Change to Lake Michigan	Increase in Flooding Depth for 100-year Return Period Storm	Increase in River Flow for 100-Year Return Period Storm
No adverse impact	Temporary impacts from construction; Neutral or improved habitat creation and frequency of availability from operation	No baseflow reduction	No baseflow reduction	No measureable change	No increase (less than 0.01 feet) at structures	0.1% or less
Minor adverse impact	Minor habitat loss	Up to 25%	Up to 15%	Fewer than 10 acres	Greater than 0.01 feet, but less than 0.1 feet at structures	1% or less
Moderate adverse impact	Moderate habitat loss	Greater than 25%, but less than 50%	Greater than 15%, but less than 25%	Greater than 10 acres, but less than 20 acres	Greater than 0.1 feet, but less than 1.0 feet at structures	Greater than 1% , but less than 5%
Significant adverse impact	Significant habitat loss	50% or more	25% or more	Greater than 20 acres	Greater than 1.0 feet at structures	Greater than 5%

TABLE 6-17

Water Supply and Return Flow Alternative Environmental Impact Comparison Summary: Inland Waterway Aquatic Habitat and Flooding

Alternative	Aquatic Habitat	Flooding
Water Supply		
Deep and Shallow Aquifers	Significant adverse impact	No adverse impact
Shallow Aquifer and Fox River Alluvium	Significant adverse impact	No adverse impact
Lake Michigan (City of Milwaukee)	Minor adverse impact	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 1	Minor adverse impact	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 2	Minor adverse impact	No adverse impact
Lake Michigan (City of Racine)	Minor adverse impact	No adverse impact
Return Flow Alternatives for Lake Michigan Water Supplies		
Underwood Creek to Lake Michigan	No adverse impact	Minor adverse impact
Root River to Lake Michigan Alignment 1	No adverse impact	Minor adverse impact
Root River to Lake Michigan Alignment 2	No adverse impact	Minor adverse impact
Direct to Lake Michigan	No adverse impact	No adverse impact

6.4.2.2.4 Aquatic Habitat

Deep and Shallow Aquifers Water Supply

This alternative would affect aquatic habitats, because increased pumping of the shallow aquifer would decrease baseflow to various streams. Reduced baseflow can decrease the frequency and availability of aquatic habitat, including wetlands. Groundwater modeling indicates the Fox River would experience 2.3 mgd less flow (RJN Environmental Services, 2010, 2013). The change in aquatic habitat from baseflow reduction to the Fox River would be a minor adverse impact.

Pebble Brook, Pebble Creek, and Mill Brook would undergo baseflow reduction from groundwater pumping, with Mill Brook experiencing a baseflow reduction of 85 percent, and even more during low flow conditions. The baseflow reductions would decrease habitat in these streams. Baseflow reduction in the cold water streams would have a significant adverse impact to aquatic habitat.

Shallow Aquifer and Fox River Alluvium Water Supply

Impacts to aquatic habitat would occur with this alternative because increased pumping of the shallow aquifer would decrease baseflow to various streams. Reduced baseflow can decrease the frequency and availability of aquatic habitat. Groundwater modeling of this alternative indicates the Fox River would experience 4.8mgd less flow (RJN Environmental Services, 2010, 2013). The aquatic habitat change from baseflow reduction to the Fox River from would be a minor adverse impact.

Pebble Brook, Pebble Creek, and Mill Brook also would experience baseflow reduction from groundwater pumping, with Mill Brook experiencing a baseflow reduction of 77 percent on average, and even more during low flow conditions. Baseflow reductions would decrease habitat in the streams and be a significant adverse impact.

Lake Michigan Water Supply (Cities of Milwaukee, Oak Creek Alignments 1 and 2, and Racine)

The Lake Michigan water supply alternatives would change baseflows in the Fox River by approximately 23 percent. The baseflow change of the Fox River flow at the Vernon Wildlife Area was estimated at 23 percent. Consequently, a minor adverse impact designation is given for impacts to the river during annual low flow conditions.

Underwood Creek to Lake Michigan Return Flow

Return flow to Underwood Creek would increase baseflow and also the quantity and availability of aquatic habitat. The greatest habitat benefits would occur during low flow conditions. Return flow to Underwood Creek would improve the aquatic habitat.

Root River to Lake Michigan Return Flow Alignments 1 and 2

Return flow to the Root River would increase baseflow and also the quantity and availability of aquatic habitat. The greatest habitat benefits would occur during low flow conditions. Return flow to the Root River consequently would improve the aquatic habitat.

Direct to Lake Michigan Return Flow

Return flow directly to Lake Michigan would not change the flow volume to inland waterways. Impacts to Lake Michigan are discussed under Section 6.4.1, Lake Michigan.

6.4.2.2.5 Flooding

Deep and Shallow Aquifers Water Supply

Flooding impacts would not occur under this alternative, because flow would continue to be discharged to the Fox River. Groundwater pumping would have no adverse flooding impact.

Shallow Aquifer and Fox River Alluvium Water Supply

Flooding impacts would not change under this alternative, because flow would continue to be discharged to the Fox River. Groundwater pumping would produce no adverse impact to flooding.

Lake Michigan Water Supply (Cities of Milwaukee, Oak Creek Alignments 1 and 2, and Racine)

A Lake Michigan supply would not affect flooding in any surface waters, so it would cause no adverse impact to flooding.

Underwood Creek and Root River Alignments 1 and 2 Return Flow

Return flow is a very small percentage of the river flow during a flood whether to Underwood Creek or the Root River. The maximum return flow rate (28.6 cfs or 18.5 mgd) increases flows by less than 1 percent for 100-year-frequency storm in either waterway. Therefore, the return flow to the either Lake Michigan tributary would cause a minor adverse impact to flooding.

Direct to Lake Michigan Return Flow

The return flow directly to Lake Michigan would not affect flooding. This would lower flow in the Fox River during flooding.

6.4.2.3 Water Quality

6.4.2.3.1 Affected Environment

Fox River

The Fox River will be affected by all the water supply alternatives considered. The river receives the flow discharged from the Waukesha WWTP, so a change in discharge location would affect the river. Two water supply alternatives include pumping from shallow wells near the Fox River, which also could change baseflow in the river.

Water quality data gathered by the WDNR about 7 miles downstream of the Waukesha WWTP at County Highway I provides background information on Fox River water quality. Grab

samples were taken for total suspended solids, dissolved oxygen, total phosphorus, and fecal coliform in February, April, July and October of 2011. The results are shown in Table 6-18 for WDNR Station numbers 683206 and 683096.

The Fox River near the WWTP outfall is on the 303(d) list for several impairments, including PCBs for fish consumption advisories, phosphorous for low dissolved oxygen concentration, and sediment for habitat impairment (WDNR, 01/2010). The WWTP operates under a chloride variance for discharge to the Fox River. New phosphorus water quality

TABLE 6-18
Water Quality Data: Fox River

Parameter ^a	Average
Total suspended solids	19.75 mg/L ^b
Dissolved oxygen	10.46 mg/L
Total phosphorus	0.17 mg/L
Fecal coliform	230 MPN/100 ML ^b

^a Samples were gathered on 2/22/11, 4/12/11, 7/21/11, and 10/11/11.

^b Some samples received were not iced, or the ice had melted.

standards indicate the Fox River in the City of Waukesha has a phosphorus water quality standard of 0.075 mg/L (NR 102.06(3)(b)).

Pebble Brook

Pebble Brook is not listed for use impairments (WDNR, 2002a).

Pebble Creek

Use impairments to Pebble Creek include unspecified non-point-source contamination, sedimentation, and beaver dams. These impairments result in a loss of habitat within the waterway and water temperature fluctuations (WDNR, 2002a).

Mill Brook

Use impairments to Mill Brook include construction erosion, unspecified non-point-source contamination, sedimentation, and beaver dams. These impairments result in water temperature fluctuations (WDNR, 2002a).

Underwood Creek and Menomonee River

Underwood Creek is designated for WDNR fish and aquatic life standards. Underwood Creek also has a variance in Milwaukee County for dissolved oxygen and fecal coliform. The Menomonee River downstream of Underwood Creek is classified for WDNR fish and aquatic life standards, but it has the same dissolved oxygen and fecal coliform variances from Honey Creek to the mouth of the river (about 5 miles downstream of the proposed return flow location).

A reach of Underwood Creek upstream of the discharge in Waukesha County is included on the 2010 303(d) list for fecal coliform as a recreational restriction (WDNR, 01/2010). The proposed 2012 303(d) list includes the South Branch of Underwood Creek, which is upstream of the proposed return flow location, for phosphorous (WDNR, 12/2011d). The last 2.67 miles of the Menomonee River are included on the 2010 303(d) list for fecal coliform as recreational restrictions. The Menomonee River is on the 303(d) list in the same stretch of river for PCBs from contaminated sediment, *E. coli* bacteria for recreational restrictions, total phosphorus for low dissolved oxygen, and unspecified metals for chronic aquatic toxicity. These listings were made in 1998. A total maximum daily load (TMDL) is under development for Underwood Creek and the Menomonee River for phosphorus, total suspended solids, and bacteria (MMSD, 12/2011). The City of Waukesha is an active stakeholder in the TMDL development.

Note: Because a total maximum daily load (TMDL) was started on Underwood Creek and a TMDL allocation has not yet been established for return flow, the WDNR has determined that an Underwood Creek return flow could not be approved until a TMDL allocation is available. Consequently, this alternative would not be implementable at this time and is not being pursued at this time. Waukesha return flow will be considered in the TMDL evaluation and the TMDL will be developed to be protective of water quality. Relative impacts upon water quality are assessed consistent with the other return flow alternatives.

Water quality information is gathered by a number of organizations in the Underwood Creek and Menomonee River watersheds. The USGS and the MMSD have obtained water quality data, and SEWRPC has done extensive water quality modeling of the watersheds.

Water quality standards for dissolved oxygen are 5.0 milligrams per liter (mg/L) and recreational use fecal coliform standards are 200 counts/100 mL monthly geometric mean and are not to exceed 400 counts/100 mL in more than 10 percent of all samples during any month Wis. Admin. Code ch. NR 102.04(4)). Dissolved oxygen variances are also applicable to these waters in some areas. The dissolved oxygen variance is 2.0 mg/L and the fecal coliform variances are 1,000 counts/100 mL monthly geometric mean and is not to exceed 2,000 counts/100 mL in more than 10 percent of all samples during any month (Wis. Admin. Code ch. NR 102.06).

There are recent numeric phosphorus water quality standards in Wisconsin, with Underwood Creek having a standard of 0.075 mg/L and the Menomonee River having a standard of 0.10 mg/L (NR 102.06(3)(b)). There are no numeric total suspended solids standards in Wisconsin, however a reference background concentration of 17.2 mg/L was used in SEWRPC's Regional Water Quality Management Plan Update (SEWRPC, 2010a).

The USGS conducted water quality sampling at USGS gage 04087088 on Underwood Creek at Wauwatosa with data obtained from February 2004 through August 2005 (USGS, 02/2010). Table 6-19 lists concentration ranges for dissolved oxygen, phosphorus, and fecal coliform.

TABLE 6-19
Underwood Creek Water Quality Data

Parameter	Samples	Minimum	Maximum	Mean
Dissolved oxygen	12	8.3 mg/L	14.2 mg/L	11.8 mg/L
Phosphorus (P) of unfiltered water	12	0.02 mg/L	0.35 mg/L	0.114 mg/L
Fecal coliform	12	120 per 100 mL	16,000 per 100 mL	3,018 per 100 mL

Source: USGS 2004, 2005.

The MMSD (2008) water quality sampling produced a report Underwood Creek Water Quality Baseline Report. Generally, eight samples were taken annually from 2003 through 2005. The sampling was conducted for a variety of parameters and throughout the Underwood Creek watershed. Table 6-20 summarizes the average of annual sample results at locations downstream of the expected return flow location.

The USGS water quality sampling occurred at USGS gage 04087120 on the Menomonee River at Wauwatosa with data obtained primarily from 1991 to 1993 and again from 2004 to 2009 (USGS, 02/2010). Table 6-21 lists concentration ranges for dissolved oxygen, phosphorus, and fecal coliform.

TABLE 6-20
Average Water Quality Range in Underwood Creek: 2003–2005

Dissolved oxygen	11.8 to 17.8 mg/L
Phosphorus	0.102 to 0.203 mg/L
Fecal coliform	1,915 to 23,677 per 100 mL)

TABLE 6-21
Menomonee River Water Quality Data

Parameter	Samples	Minimum	Maximum	Mean
Dissolved oxygen	429	7.5 mg/L	16 mg/L	11.7 mg/L
Phosphorus (P) of unfiltered water	380	0.02 mg/L	1.4 mg/L	0.228 mg/L
Fecal coliform	47	10 per 100 mL	800,000 per 100 mL	21,793 per 100 mL

Source: USGS 1991–1993, 2004–2009.

Note: Dissolved oxygen samples are from gage operation; phosphorus and fecal coliform are from field samples

Water quality in Underwood Creek and the Menomonee River was extensively studied in SEWRPC's (2007) *A Regional Water Quality Management Plan Update for the Greater Milwaukee Watersheds*. Findings for the 11-year period of record simulation under SEWRPC's existing condition scenario are summarized in Table 6-22 for three points closest to the proposed return flow location (SEWRPC, 2007, Appendix N).

TABLE 6-22
Average Annual Water Quality Data Downstream of Underwood Creek Return Flow Location

Dissolved oxygen	11.0 to 11.1 mg/L
Phosphorus (mg/L)	0.066 to 0.111 mg/L
Fecal coliform summer season geometric mean	351 to 496 per 100 mL
Total suspended solids	15.6 to 16.8 mg/L

Root River

The Root River at the potential discharge locations is on the 303(d) list for low dissolved oxygen and degraded biological community with reported causes from sediment and phosphorus. In addition, approximately the last 6 miles of the Root River upstream of Lake Michigan is on the 303(d) list for PCBs. These listings were all made in 1998. More recent SEWRPC water quality modeling found that dissolved oxygen concentrations met the standard between 99 percent of the time for the 11-year period of record analyzed (SEWRPC, 2007, Appendix N). The proposed 2012 303(d) list includes portions of the Root River in Milwaukee and Racine Counties for phosphorous (WDNR, 01/2013c).

Water quality information is gathered by a number of organizations in the Root River watershed. The USGS, MMSD and the City of Racine have obtained Root River water quality data, and SEWRPC has done extensive water quality modeling of the watersheds.

Water quality standards for dissolved oxygen are 5.0 milligrams per liter (mg/L) and recreational use fecal coliform standards are 200 counts/100 mL monthly geometric mean and are not to exceed 400 counts/100 mL in more than 10 percent of all samples during any month Wis. Admin. Code ch. NR 102.04(4)).

There are recent numeric phosphorus water quality standards in Wisconsin, with the Root River having a standard of 0.075 mg/L (NR 102.06(3)(b)). There are no numeric total suspended solids standards in Wisconsin, however a reference background concentration of 17.2 mg/L was used in SEWRPC's Regional Water Quality Management Plan Update (2007).

Water quality in the Root River was extensively studied in SEWRPC's (2007) *A Regional Water Quality Management Plan Update for the Greater Milwaukee Watersheds*. Findings for the 11-year period of record simulation under SEWRPC's existing condition scenario are summarized in Table 6-23 for four points downstream of the proposed return flow location (SEWRPC, 2007, Appendix J and N).

TABLE 6-23

Average Annual Water Quality Data Downstream of Root River Alignment 2 Return Flow Location

Dissolved oxygen	11.0 to 11.5 mg/L
Phosphorus (mg/L)	0.071 to 0.115 mg/L
Fecal coliform summer season geometric mean	2,687 to 3,327 per 100 mL
Total suspended solids	20.6 to 38.5 mg/L

Water quality data from the years after the SEWRPC study is provided in Table 6-24. The table summarizes water quality data for the sampling points slightly upstream and downstream of the river. MMSD recently released 2011 water quality monitoring data summary statistics for the Root River. In general, total phosphorus within the Root River has decreased and trends show some improvements to the river's water quality.

TABLE 6-24

Average Annual Water Quality Data at MMSD Sampling Locations near the Root River Alignment 2 Return Flow Location

Parameter ^d	Year Average ^a				
	2007 ^b	2008 ^b	2009 ^b	2010 ^b	2011 ^c
Dissolved Oxygen (mg/L)	7.11	7.52	7.90	6.45	7.45
Phosphorus (mg/L)	0.13	0.14	0.09	0.13	0.09
Fecal Coliform (cfu/100 mL)	2375	422	489	457	1003

^a The closest MMSD Sampling locations are RR-05 (upstream of the return flow location) and RR-06 (downstream of the return flow location).

^b Source: MMSD Water Quality Monitoring Data, Root River (RR-05 and RR06). <http://www.waterbase.glwj.uwm.edu/mmsd/> Accessed January 2013.

^c MMSD, 2012

^d Each year 10 samples were analyzed.

Water quality data from August 2011 to August 2012 near the confluence of the Root River and Lake Michigan was recently released by the City of Racine. Table 6-25 displays water quality data for the four sampling points within the City of Racine, including at the WDNR's Steelhead egg hatchery facility. As evident, water quality downstream of the potential discharge location is relatively similar, but does not meet the phosphorus water quality standards.

TABLE 6-25

August 2011 to 2012 Water Quality Data of the Root River in the City of Racine

Dissolved oxygen (mg/L)	8.3 to 9.6 mg/L
Phosphorus (mg/L)	0.082 to 0.114 mg/L

Source: RHD Sampling Sites 1, 2, 3, and 4 (Kintzelman and Wright, 2012).

6.4.2.3.2 Environmental Effects

Water quality environmental effects will occur both during construction as well as during operation and maintenance. Potential impacts to aquatic resources generally associated with construction can be both direct and indirect. They will depend primarily upon the physical characteristics of the streams and time of year.

The primary temporary construction impact to surface waters can be associated with elevated loads of suspended sediment resulting from in-stream trenching activities and erosion of cleared streambanks and rights-of-way from pipeline construction. Impact severity is a function of sediment load, particle size, streambank and streambed composition, flow velocity, turbulence, and duration of construction activities. Since the impacts will be temporary and will be crossed using BMPs designed to reduce the impact, turbidity and erosion created by construction will be minimal.

Without mitigation by implementing BMPs, temporary construction impacts can also elevate suspended sediment levels that increase turbidity and consequently reduce primary photosynthetic production, flocculate plankton, decrease visibility and food availability, and produce effects that are aesthetically displeasing (USFWS, 1982). However, Long (1975) concluded that most fish avoid turbid water and can survive for several days in waters where construction in a stream has caused turbidity. Since the construction impacts will be temporary and river crossings will use BMPs designed to reduce the impact, turbidity and erosion created by construction will be minimal.

Construction effects on water quality will be minimized by using BMPs as described in Appendix 5-2, "Example Wetland and Waterway Pipeline Construction Crossing Impact Minimization Techniques."

Operational and maintenance effects on water quality that are applicable regardless of the discharge location as first described and then operational and maintenance effects are described below for each inland waterway.

The WDNR commonly provides allowances for permitted discharges in the form of interim limits, variances, or other allowances when background levels are higher than water quality standards, when the water quality constituent cannot be removed by municipal WWTP best available technology permitted in Wisconsin, or water quality standards can be met after mixing or other processes in the receiving water. Water quality parameters may be addressed by similar regulatory approaches for allowances under current or future regulations.

For example, the Waukesha WWTP currently discharging to the Fox River has an allowance for chloride discharge in the form of an interim limit governed by NR 106.83(2)(b). In the WPDES permit for continued discharge to the Fox River, the Waukesha WWTP has a chloride variance that includes a mandatory source reduction program with an interim discharge limit (WDNR, 2013d). A significant source of chloride in the Waukesha WWTP is residential water softening. The need to continue to have a chloride variance varies significantly depending upon the water source, treatment, and discharge location (for example: continued groundwater source with discharge to the Fox River or Lake Michigan source with return flow to the Lake Michigan basin), as described below.

The City has been implementing a Mercury Pollutant Minimization Program that began in 2007. The mercury concentration in the WWTP effluent will meet Fox River discharge or Lake Michigan basin return flow draft requirements. The City will continue the mercury source reduction program and based upon established performance either Fox River discharge or Lake Michigan return flow will meet requirements for the mercury water quality limits.

The permit for continued discharge to the Fox River provides a phosphorous compliance schedule because the limits are very low and will require significant capital investment in the WWTP. The phosphorus standard for the Fox River, Root River, and Underwood Creek is the same (0.075 mg/L) and the existing phosphorus concentration in these streams river is often higher than the standard (see above tables for phosphorus background data in each stream). Consequently, in the recently completed Facility Plan (Strand, 2011), the WWTP evaluated potentially having to meet a phosphorus discharge limit equal to the water quality standard (0.075 mg/L). This would improve phosphorus water quality for a discharge in any of these streams.

The WDNR has adopted new thermal rules (NR 102 and 106) for the protection and propagation of aquatic life that applies to WPDES permit holders discharging to surface waters. In preparation for this new rule, the City has been collecting effluent temperature data for over a year and has conducted mixing studies of the WWTP discharge with the Fox River flow. The WPDES permit indicates the mixing study demonstrates that the discharge mixes sufficiently to meet thermal discharge compliance guidance. The City has evaluated approaches to meet WDNR thermal discharge requirements following the rules and applicable guidance regardless of a return flow discharge location (see the Return Flow Plan – Volume 4 of the Application). Consequently, discharge either to the Fox River or Lake Michigan basin return flow are expected to meet thermal discharge requirements.

Fox River

Deep and Shallow Aquifers Water Supply

The Deep and Shallow Aquifers supply alternative includes new aboveground impacts to over 30 acres (see Table 6-51) that will produce stormwater pollution runoff from previously undeveloped land. The increased runoff could affect stormwater water quality and the Fox River, although the runoff will be managed to meet the WDNR's stormwater quality management requirements for new development NR 151 *Runoff Management* (WDNR, 2010g) as well as local stormwater management requirements.

Operational and maintenance effects on water quality are associated with WWTP discharge to the Fox River for this groundwater supply alternative. Existing WWTP permit limits from the WDNR and performance for many water quality parameters has been documented in the Return Flow Plan (Volume 4 of the Application). Historical performance is included in the discussion of Underwood Creek water quality in Table 6-26.

This groundwater water supply alternative continues WWTP discharge to the Fox River. The Waukesha WWTP meets permit requirements currently, so no change in the plant permit limits is expected with a switch in water sources. The permit for the Fox River discharge indicates a chloride variance will still be necessary. The deep aquifer water would be treated with reverse osmosis. However, treatment of the shallow aquifer water would not have an impact upon the need for private water softener use (see the Water Supply Service Area Plan – Volume 2 of the Application). Consequently, continued private water softening is expected with this alternative. The permit for the Fox River discharge has a schedule and task list for chloride reductions, which includes the consideration for switching water sources. The City has evaluated chloride concentrations in return flow with a switch to Lake Michigan water and has developed a return flow chloride compliance plan consistent with the permit. Major chloride reductions contained with the return flow chloride compliance plan include a switch in water source to Lake Michigan and the elimination of residential

and commercial/industrial water softeners necessary to treat the groundwater source. Together these chloride reduction practices could contribute a 50 percent reduction in the estimated annual chloride load (see the Return Flow Plan – Volume 4 of the Application). Without a switch to Lake Michigan water, it is uncertain what chloride sources are possible to reduce in order to eventually no longer need a chloride variance. Consequently, a continued variance for chloride is expected with this water supply alternative.

Shallow Aquifer and Fox River Alluvium Water Supply

The Shallow Aquifer and Fox River Alluvium supply alternative includes new aboveground impacts to over 50 acres (see Table 6-51), which will produce stormwater pollution runoff from previously undeveloped land. The increased runoff will have stormwater water quality impacts that drain to the Fox River. The runoff will be managed to meet the WDNR's stormwater quality management requirements for new development NR 151 *Runoff Management* as well as local stormwater management requirements.

This groundwater water supply alternative continues WWTP discharge to the Fox River. The Waukesha WWTP meets permit requirements currently, so no change in the plant permit limits is expected with a switch in water sources. The permit for the Fox River discharge indicates a chloride variance will still be necessary. The Fox River alluvium is expected to require surface water treatment technologies, which can include lime softening (See the Water Supply Service Area Plan – Volume 2 of the Application). The surface water treatment technology should eliminate the need for private water softening. Like the Lake Michigan water source chloride reduction evaluation, major chloride reductions could include the elimination of residential and commercial/industrial water softeners necessary to treat the groundwater source. Together these chloride reduction practices could contribute a 50 percent reduction in the estimated annual chloride load (see the Return Flow Plan – Volume 4 of the Application). Consequently, it is likely the chloride water quality based effluent limit could be met under this water supply alternative.

Lake Michigan Water Supply (Cities of Milwaukee, Oak Creek, and Racine)

A Lake Michigan supply regardless of the water source includes new aboveground impacts that are limited to only a new pump station less than a quarter acre in size; consequently, operational stormwater quality impacts will be insignificant and none to the Fox River.

Underwood Creek, Root River Alignments 1 and 2, and Direct-to-Lake-Michigan Return Flow

The City of Waukesha's return flow management plan goal will provide continuous return of the water at the WWTP (see the Return Flow Plan in Volume 4 of the Application). In general, the return flow management plan provides return flow up to the maximum day water demand if sufficient water is available at the WWTP. The portion of water at the WWTP in excess of this amount will continue to be discharged into the Fox River and meet permit limits. The WPDES values are intended to protect receiving streams. Consequently, significant water quality impacts to the Fox River are not anticipated with return flow to the Lake Michigan watershed instead of continuous discharge to the Fox River.

Pebble Brook, Pebble Creek, and Mill Brook

Deep and Shallow Aquifers Water Supply

The groundwater draw down will also effect baseflow in Pebble Brook, Pebble Creek, and Mill Brook, three cold water streams south of Waukesha tributary to the Fox River as described above. Lower baseflows occur in these cold water streams under this alternative

(see Section 6.4.2.2.2, Inland Waterways, Size, Flow, and Floodplain). For example, groundwater baseflow to Pebble Brook would be reduced by 34 percent, to Pebble Creek by 0 percent, and to Mill Brook by 85 percent. Lower baseflows in these cold water streams will lead to warmer temperatures and potential temperature impairment. Water temperature fluctuation to streams affected by baseflow reduction would be expected to worsen.

Shallow Aquifer and Fox River Alluvium Water Supply

The groundwater draw down will also effect baseflow in Pebble Brook, Pebble Creek, and Mill Brook, three cold water streams south of Waukesha tributary to the Fox River as described above. Lower baseflows occur in these cold water streams under this alternative (see Section 6.4.2.2.2, Inland Waterways, Size, Flow, and Floodplain). For example, groundwater baseflow to Pebble Brook would be reduced by 34 percent, Pebble Creek would be reduced by 13 percent, and Mill Brook would be reduced by 77 percent. Lower baseflows in these cold water streams will lead to warmer temperatures and potential temperature impairment. Pebble Creek is already listed for water temperature fluctuation and this impairment would be expected to worsen.

Lake Michigan Water Supply (Cities of Milwaukee, Oak Creek, and Racine)

A Lake Michigan supply regardless of the water source includes new aboveground impacts that are limited to only a new pump station less than a quarter acre in size; consequently, operational stormwater quality impacts will be insignificant and none to Pebble Brook, Pebble Creek, and Mill Brook.

Underwood Creek, Root River Alignments 1 and 2, and Direct-to-Lake-Michigan Return Flow

Return flow will switch discharge up to a maximum amount from the Fox River to the Lake Michigan watershed. However, there will be no impact upon Pebble Brook, Pebble Creek, or Mill Brook water quality with a switch in discharge from the Fox River to a return flow location in the Lake Michigan watershed.

Underwood Creek and Menomonee River

Because a total maximum daily load (TMDL) was started for phosphorus, total suspended solids, and bacteria on Underwood Creek and a TMDL allocation has not yet been established for return flow, the WDNR has determined that an Underwood Creek return flow could not be approved until a TMDL allocation is available. Consequently, this alternative would not be implementable at this time and is not being pursued at this time. Waukesha return flow will be considered in the TMDL evaluation and the TMDL will be developed to be protective of water quality. Relative impacts upon water quality are assessed consistent with the other watersheds.

Deep and Shallow Aquifers, and Shallow Aquifer and Fox River Alluvium Water Supplies

The groundwater supply alternatives do not affect Underwood Creek or the Menomonee River. Consequently, there are no impacts to Underwood Creek under these alternatives.

Lake Michigan Water Supply (Cities of Milwaukee, Oak Creek, and Racine)

A Lake Michigan supply regardless of the water source includes new aboveground impacts that are limited to only a new pump station less than a quarter acre in size; consequently, operational stormwater quality impacts will be insignificant to Underwood Creek and the Menomonee River.

Underwood Creek to Lake Michigan Return Flow

All water returned to the Lake Michigan watershed, will meet WDNR water quality permit requirements. A summary of proposed discharge limits from the WDNR and a comparison to historical Waukesha WWTP performance are detailed in the Return Flow Plan (Volume 4 of the Application) (WDNR, 2011a). A comparison of the proposed WWTP limits and historical performance is shown in Table 6-26. The table also includes new limits for continued discharge to the Fox River along with two other discharge permits to Lake Michigan tributaries as a comparison.

TABLE 6-26

Comparison of WDNR-Proposed WPDES Limits to Historical WWTP Performance and Other Direct and Lake Michigan Tributary Dischargers

Water Quality Parameter	City of Waukesha Potential Return Flow		Lake Michigan Tributary WWTP Discharger #1 ^b	Lake Michigan Tributary WWTP Discharger #2 ^c	Discharger Direct to Lake Michigan ^d	WDNR Limit for Continued Fox River Discharge ^e
	WDNR-Proposed Limit for Lake Michigan Tributary Return	Waukesha Historical Average ^a				
Biological oxygen demand, mg/L	≤ 5.7 to ≤ 10.0	1.8	≤ 10.0 to ≤ 15	≤ 30.0 monthly avg.	≤ 30.0 monthly avg.	≤ 8.2 to ≤ 10.0
Total suspended solids, mg/L	≤ 10.0	1.2	≤ 15.0	≤ 30.0 monthly avg.	≤ 30.0 monthly avg.	≤ 10.0
Dissolved oxygen, mg/L	≥ 7.0	9.2	≥ 6.0	≥ 6.0	No Limit	≥ 6.7
Phosphorus, mg/L	≤ 0.075 ^d	0.16	≤ 1.0	≤ 1.0	≤ 1.0	≤ 0.075
Ammonia (NH ₃ -N), mg/L	≤ 1.3 to ≤ 4.3	< 1.0	3.3 to 6.4 monthly avg.	6.3 to 12.0 monthly avg.	≤ 1.8 to 39 daily max.	≤ 2.0 to ≤ 6.0
Chlorides, mg/L	≤ 395	477	≤ 570	No Limit	No Limit	≤ 690 with a target value of 440
Temperature, oF (varies by month)	≤ 49 to 81	53 to 70	No Limit	No Limit	No Limit	Compliance through mixing

^aOctober 1, 2002, to August 31, 2009. March 15, 2006 to May 1, 2013 for Chlorides.

^bWPDES Permit No. WI-0020222-08-0

^cWPDES Permit No. WI-0020184-08-0

^dWPDES Permit No. WI-0025194-07-1

^eWater Quality Standard for Underwood Creek and Root River.

Water softening would no longer be needed with a Lake Michigan water supply source. Consequently, a reduction in chloride concentration in return flow over time is expected. The City has evaluated chloride concentrations in return flow with a switch to Lake Michigan water and has developed a return flow chloride compliance plan. Major chloride reductions contained with the return flow chloride compliance plan include a switch in water source to Lake Michigan and the elimination of residential and commercial/industrial water softeners necessary to treat the groundwater source. Together these chloride reduction practices could

contribute a 50 percent reduction in the estimated annual chloride load (see the Return Flow Plan – Volume 4 of the Application). With a switch to Lake Michigan water, the chloride water quality standards evaluation demonstrates confidence in meeting the chloride water quality standard without a variance. Consequently, the water quality based effluent limit for chloride is expected to be met with this water supply alternative.

Return flow ultimately ends up in Lake Michigan. Water quality impacts to Lake Michigan have been previously evaluated in Section 5.1.1.2, Lake Michigan Water Quality.

The Underwood Creek to Lake Michigan return flow alternative considered water quality changes to Underwood Creek and downstream reaches of the Menomonee River.

Water quality modeling was conducted for return flow to Underwood Creek. Modeling included existing conditions in Underwood Creek with expected Waukesha return flow concentration and also a “worse case” scenario having high flows and higher concentrations in the discharge (but still within permit limits). Volume 4 of the Application contains the detailed water quality modeling conclusions.

The water quality modeling found that average water quality improved or continued to meet water quality standards or background reference concentrations for fecal coliform, dissolved oxygen, and total suspended solids. The phosphorus TMDL currently underway, which the City of Waukesha is a stakeholder in, may lead to reduced phosphorus discharge concentration in the return flow. For analysis purposes, the phosphorus discharge limit is not expected to be lower than the 0.075 mg/L water quality standard in Underwood Creek. The 0.075 mg/L is also the phosphorus water quality standard in the Fox River. The City of Waukesha will provide return flow with water quality that meets effluent requirements, regardless of the discharge location. If a discharge were to occur to Underwood Creek, it would have to be in compliance with the TMDL which is protective of water quality. Consequently, the allowance of a discharge meeting the TMDL phosphorus requirements would have no adverse impact.

The other 303(d) listings for Underwood Creek and the Menomonee River will not become worse with return flow. The fecal coliform recreational restriction 303(d) listing for Underwood Creek and the Menomonee River will not be exacerbated with return flow because the fecal coliform concentration in the discharge has averaged between 2 and 49 cells/100 mL during the recreational season, which is well below the standard of 400 cells/100 mL. The proposed 2012 303(d) phosphorus listing for the South Branch of Underwood Creek is not affected by the return flow because return flow is downstream of the South Branch, however, phosphorous discharge to Underwood Creek will meet WDNR phosphorus requirements.

The listing for PCBs from contaminated sediment will not become worse because the return flow does not include this chemical.

The listing of total phosphorus for low dissolved oxygen does not appear accurate because this listing goes all the way back to 1998, and a more-recent SEWRPC detailed analysis of water quality in the Menomonee River found that the dissolved oxygen variance standard was always met for the 11-year period of record analyzed (SEWRPC, 2007, Appendix N).

The water quality modeling of the Menomonee River found no change in dissolved oxygen standard compliance with return flow. No change in dissolved oxygen standard compliance is in part due to the very good performance of the Waukesha WWTP which produces effluent with a very low biological oxygen demand (BOD) concentration. As described in Volume 4 of the Application, historical WWTP performance has produced a BOD concentration less than 2 mg/L on average.

Finally, the listing of unspecified metals for chronic aquatic toxicity will not be exacerbated because the WWTP WPDES permit process has analyzed metals concentrations and found that they are below toxic levels.

Water quality analysis for Underwood Creek is summarized in the Return Flow Plan (Volume 4 of the Application) with additional detailed modeling found in an attachment to the Return Flow Plan.

Root River and Direct-to-Lake-Michigan Return Flow

These return flow alternatives do not have any discharge to Underwood Creek. Consequently, there are no impacts to Underwood Creek.

Root River

Deep and Shallow Aquifers, and Shallow Aquifer and Fox River Alluvium Water Supplies

The groundwater supply alternatives do not affect the Root River. Consequently, there are no impacts to the Root River under these alternatives.

Lake Michigan Water Supply (Cities of Milwaukee, Oak Creek Alignments 1 and 2, and Racine)

A Lake Michigan supply regardless of the water source includes new aboveground impacts that are limited to only a new pump station less than a quarter acre in size; consequently, operational stormwater quality impacts will be insignificant to the Root River.

Underwood Creek and Direct-to-Lake-Michigan Return Flow

These return flow alternatives do not have any discharge to the Root River. Consequently, any impacts to the Root River are insignificant.

Root River to Lake Michigan Return Flow

All water returned to the Lake Michigan watershed, will meet WDNR water quality permit requirements. A summary of proposed discharge limits from the WDNR and a comparison to historical Waukesha WWTP performance are detailed in the Return Flow Plan (Volume 4 of the Application). Historical performance is included in the discussion of Underwood Creek water quality in Table 6-26 (WDNR, 2011a). The table also includes a comparison to two other discharge permits to Lake Michigan tributaries as a comparison.

Water softening would no longer be needed with a Lake Michigan water supply source. Consequently, a reduction in chloride concentration in return flow over time is expected. The City has evaluated chloride concentrations in return flow with a switch to Lake Michigan water and has developed a return flow chloride compliance plan. Major chloride reductions contained with the return flow chloride compliance plan include a switch in water source to Lake Michigan and the elimination of residential water softeners necessary to treat the groundwater source. Together these chloride reduction practices could contribute a 50 percent reduction in the estimated annual chloride load (see the Return Flow Plan – Volume 4 of the Application). With a switch to Lake Michigan water, the chloride water quality standards evaluation demonstrates confidence in meeting the chloride water

quality standard without a variance. Consequently, the water quality based effluent limit for chloride is expected to be met with this water supply alternative.

The City of Waukesha's return flow management plan goal will provide continuous return of the water at the WWTP (see the Return Flow Plan in Volume 4 of the Application). In general, the return flow management plan provides return flow up to the maximum day water demand if sufficient water is available at the WWTP. The portion of water at the WWTP in excess of this amount will continue to be discharged into the Fox River and meet permit limits. The Return Flow Plan analysis shows that no less than 100 percent of the water volume will be returned to the Great Lakes basin. Return flow ultimately ends up in Lake Michigan. Water quality impacts to Lake Michigan have been previously covered under Section 5.1.1.2, Lake Michigan Water Quality.

The Root River to Lake Michigan return flow Alignment 2 alternative considered water quality changes to the Root River. The 303(d) listings in the Root River should not be exacerbated with return flow. Near the potential discharge location, the Root River was originally listed for low dissolved oxygen from sediment and phosphorus in 1998. However, more recent SEWRPC water quality modeling found that dissolved oxygen concentrations met the standard between 99 percent of the time for the 11-year period of record analyzed (SEWRPC, 2008, Ap. N). No or little change in dissolved oxygen standard compliance occurs with return flow to the Root River based upon modeling results because historical WWTP performance has produced a BOD concentration less than 2 mg/L on average as described in the Return Flow Plan (Volume 4 of the Application).

The Root River PCB 303(d) listing in the 6 miles of the river upstream of Lake Michigan will not be exacerbated because this chemical is not found in the return flow.

6.4.2.3.3 Environmental Effects Comparison: Inland Waterways Water Quality

Adverse impacts from changes in inland waterways water quality were compared based upon Table 6-27.

TABLE 6-27
Environmental Impact Category Description: Water Quality

Category	Water Quality	Stream Water Quality Numeric Standards Compliance ^a	Increase in Average Annual Loading to Lake Michigan Near Milwaukee ^a
No adverse impact	Improves or remains approximately the same; Temporary construction impacts	River meets water quality standards or discharge is better than or equal to water quality standards	Contributes a de minimus change (<1%)
Minor adverse impact	Remains about the same	Discharge requires existing variance to water quality standards	Contributes a minor change (>1%, but <10%)
Moderate adverse impact	Moderate lowering of in-stream water quality	Discharge requires new variance to water quality standards	Contributes a moderate change (>10%, but <25%)
Significant adverse impact	Substantial lowering of in-stream water quality	New exceedences to water quality standards	Contributes a substantial change (>25%)

^a Based upon expected water quality from historical wastewater treatment performance and draft permit limits. Where existing water quality exceedences occur, the receiving water quality will improve or stay the same with the discharge.

For water quality impacts in inland waterways, a discussion of relative impact for the various alternatives is included in Table 6-28. The comparison for water quality impacts for Lake Michigan is included in Section 6.4.1.2.3, Environmental Effects Comparison: Lake Michigan Water Quality.

Deep and Shallow Aquifers Water Supply

This alternative would maintain WWTP discharge to the Fox River as currently occurs. Discharge permit requirements are currently met and would be met under this future groundwater supply alternative. The existing WDNR discharge permit includes a variance for

chloride. This allowance is expected to continue under this water supply source. Consequently, the water quality impacts to the Fox River are expected to be minor adverse impacts.

TABLE 6-28

Water Supply and Return Flow Alternative Environmental Impact Comparison Summary: Inland Waterways Water Quality

Alternative	Water Quality
Water Supply	
Deep and Shallow Aquifers	Minor adverse impact
Shallow Aquifer and Fox River Alluvium	No adverse impact
Lake Michigan (City of Milwaukee)	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 1	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 2	No adverse impact
Lake Michigan (City of Racine)	No adverse impact
Return Flow Alternatives for Lake Michigan Water Supplies	
Underwood Creek to Lake Michigan	No adverse impact
Root River to Lake Michigan Alignment 1	No adverse impact
Root River to Lake Michigan Alignment 2	No adverse impact
Direct to Lake Michigan	No adverse impact

The small cold water streams Pebble Brook, Pebble Creek, and Mill Brook would experience baseflow reduction from groundwater pumping, with Mill Brook experiencing a baseflow reduction of 85 percent on average, with an even greater reduction during low flow conditions. Lower baseflows in these cold water streams would lead to warmer temperatures and potential temperature impairment. Mill Creek's water temperature would be expected to worsen. The water quality impacts to the cold water streams from reductions in baseflow are expected to be captured in the aquatic habitat impact analysis.

Shallow Aquifer and Fox River Alluvium Water Supply

This alternative would maintain WWTP discharge to the Fox River as currently occurs. The existing WDNR discharge permit includes a variance for chloride. This allowance is expected to potentially no longer be needed with this alternative because lime softening would be able to make private water softening no longer necessary. The alternative otherwise has similar water quality to the Deep and Shallow Aquifers alternative. Consequently, the water quality impacts to the Fox River are expected to be no adverse impacts.

The small cold water streams Pebble Brook, Pebble Creek, and Mill Brook would experience baseflow reduction from groundwater pumping, with Pebble Brook experiencing a baseflow reduction of 34 percent on average, with an even greater reduction during low flow conditions. Lower baseflows in these cold water streams would lead to warmer temperatures and potential temperature impairment. Pebble Creek's water temperature

already fluctuates, and this would be expected to worsen. The water quality impacts to the cold water streams from reductions in baseflow are expected to be captured in the aquatic habitat impact analysis.

Lake Michigan Water Supply (Cities of Milwaukee, Oak Creek Alignments 1 and 2, and Racine)

A Lake Michigan water supply would not change water quality in Lake Michigan and have no adverse impact to other surface water resources. A Lake Michigan water supply source would eliminate the need for water softening, which would be necessary under the Deep and Shallow Aquifers groundwater supply alternative. Consequently, discharge of chlorides in the WWTP from water softener salts would be eliminated from discharge to the environment over time. The Lake Michigan water supply consequently would produce no adverse impact on water quality.

Underwood Creek to Lake Michigan Return Flow

Return flow to Underwood Creek would take flow discharged to the Fox River and send it to Underwood Creek instead. The Fox River discharge includes a variance for chloride, which would no longer be discharged daily to the Fox River. Consequently, changes to Fox River water quality would occur, but because WDNR discharge permits are designed to protect receiving waters, no significant change in impacts to the Fox River is expected.

Potential discharge permit requirements provided by the WDNR for return flow discharge have been reviewed, and the WWTP can meet these requirements either based upon historical performance or from more recent analysis for chloride and thermal discharge. No variance for chloride would be expected and phosphorus concentration in the stream is expected to improve.

The phosphorus TMDL currently underway, which the City of Waukesha is a stakeholder in, may lead to reduced phosphorus discharge concentration in the return flow. However, it is not expected to be lower than the 0.075 mg/L water quality standard in Underwood Creek. The 0.075 mg/L is also the phosphorus water quality standard in the Fox River. The City of Waukesha will provide return flow with water quality that meets effluent requirements, regardless of the discharge location. If a discharge were to occur to Underwood Creek, it would have to be in compliance with the TMDL which is protective of water quality. Consequently, the allowance of a discharge meeting the TMDL phosphorus requirements would have no adverse impact.

Water quality loading to Lake Michigan from the watersheds around greater Milwaukee was reviewed and return flow was found to be only 0.18 percent of all fecal coliform loading and only 0.19 percent of all total suspended solids loading under conservative, worst-case conditions. Phosphorus loading was found to be only 0.35 percent of all phosphorous loading under worst-case conditions. Consequently, the water quality impacts to Lake Michigan would be expected to have no adverse impacts.

Root River to Lake Michigan Return Flow

Return flow to the Root River would have the same impacts to the Fox River as described for return flow to Underwood Creek.

Potential discharge permit requirements provided by the WDNR for return flow discharge have been reviewed, and the WWTP can meet these requirements either based upon historical performance or from more recent analysis for chloride and thermal discharge. No

variance for chloride would be expected and phosphorus concentration in the stream is expected to improve.

Water quality impacts to Lake Michigan would be the same as those described for return flow to Underwood Creek: no adverse impacts.

Direct to Lake Michigan Return Flow

Return flow directly to Lake Michigan would have the same impacts to the Fox River as described for return flow to Underwood Creek. Water quality impacts to Lake Michigan are listed in Section 6.4.1.2, Lake Michigan Water Quality.

6.4.2.4 Geomorphology and Sediments

6.4.2.4.1 Affected Environment

Fox River

In the vicinity of the City of Waukesha, the Fox River has reaches that are natural channel with minimal modifications, while other reaches are significantly altered by development. Within the City center upstream of the WWTP, the Fox River has been dammed to create the Barstow Impoundment, where the river banks consist of sheetpile, concrete, rock reinforcements, and vegetation. Upstream of the dam, large sediment depositions are reported to include pollutants that may cause human and aquatic health concern (WDNR, 01/2012b). Farther upstream, the Fox River meanders through developed landscapes including residential, golf course, commercial and transportation development. The river has mostly vegetated banks, with erosion and bank failures common in urban areas. The river generally has a wide floodplain with connected wetlands and some encroachments from development. The river is generally low gradient and primarily consists of glides and pools. The sediments are primarily silts and sands in the pools and sand and gravel in glides.

Downstream of the Barstow Impoundment, the river is confined by development. The river banks are primarily placed rock and concrete retaining walls. The river is fairly narrow and higher gradient than upstream reaches, where the river is primarily riffles with gravel and cobble. Farther downstream of the City near the WWTP, the river returns to a low gradient meandering river. Similar to the upstream reaches, the banks are mostly vegetated with some erosion and bank failures typical of a developing watershed. Farther downstream, the river has a fairly low gradient river, with sediments consisting primarily of silt and sand in pools, and sand in the glides. Occasional areas of gravel are also present. In the downstream reaches, sediment point bars, primarily consisting of sand have formed due to natural sediment transport dynamics and likely from agricultural land runoff.

Pebble Creek

The 18-square mile Pebble Creek watershed contains three main reaches – Brandy Brook and Upper and Lower Pebble Creek. The Brandy Brook and Upper Pebble Creek subwatersheds lie west of the City of Waukesha. The confluence of Upper Pebble Creek and Brandy Brook form Lower Pebble Creek, which then flows into the Fox River within the Fox River Parkway in the southwestern part of the City of Waukesha.

Over half of the reaches within the watershed show evidence of historical channelization, some of which were overwidened. Most channelization occurred between the 1940s and 1970s as part of the accepted agricultural practices of the time. Within the Pebble Creek

watershed, bank erosion is more common on channelized reaches than natural reaches. Upper Pebble Creek is the most urbanized watershed, the most channelized, and has the most notable amount of eroding banks (Waukesha County and SEWRPC, 2008, p. 82).

Lower Pebble Creek is a nonchannelized stream. Its meandering, highly sinuous pattern is indicative of low gradient (less than 1 percent) natural streams in the area. Most of the Pebble Creek streams are low gradient sand and gravel systems. High quality gravel and cobble riffles occur frequently in Lower Pebble. Brandy Brook's headwaters, which are moderately sloped (1.4 percent) systems, and Upper Pebble Creek's 2.2 percent sloped headwater stream, are exceptions to the low gradient prevalence within the watershed (Waukesha County and SEWRPC, 2008, p. 78). These higher gradient reaches have predominantly gravel, cobble, and boulder substrates.

All streams within the watershed are dominated by pool and riffle habitat. Brandy Brook and Pebble Creek upstream of County Trunk Highway (CTH) D are assigned coldwater sport fish and partial water recreation use objectives. Pebble Creek downstream of CTH D is assigned a warm water sport fish use objective (Waukesha County and SEWRPC, 2008, p. 50). Most of the streams within Pebble Creek watershed have riparian buffers that exceed 75 feet (Waukesha County and SEWRPC, 2008, p. 130). Many reaches are within forested riparian corridors, with a good amount of in-stream cover including large woody debris and undercut banks. Occasionally, the abundant woody debris jams (sometimes with the help from beavers), form obstructions to flow. Within channelized and incised reaches, these jams exacerbate bank erosion and cause blowouts during storm events.

Pebble Brook and Mill Brook

The Pebble Brook and Mill Brook watersheds are relatively undeveloped, with residential and some agricultural, commercial, and industrial land uses. They mostly are undeveloped where Pebble and Mill Brook have wide floodplains with large wetland areas bordering the channels. The channels have been straightened in some areas to accommodate road crossings, a railroad, and agricultural developments, but the vast majority of the channel length is natural and highly sinuous with many compound and tortuous bends. The channels are low energy systems that include pool-riffle and pool-glide sequences, with few areas of point bar formations. The pools are generally sandy with some silt and organics. The glides and riffles are generally sand and gravel and the point bars are generally gravel.

The channel banks are nearly all earthen with dense vegetation that provides bank stability. Some erosion and bank failures are present that are typical of developing watersheds, but the channel banks are low and the channels have access to their floodplain during high flow events. The banks are undercut in many areas, with exposed root masses and overhanging vegetation, however these portions of the channels are still very stable because of the accessible floodplain and because the channels are low energy and the roots provide adequate bank strength.

Underwood Creek and Menomonee River

Downstream of the Underwood Creek return flow location, the creek flows about 2.6 miles to its confluence with the Menomonee River. This section of creek includes mostly concrete-lined channels with a 2,400-foot section that was recently rehabilitated (MMSD, 2008a). The downstream 4,400 feet of creek (immediately downstream of the rehabilitated reach) to the confluence with Menomonee River is mostly concrete-lined, with a short segment that has a

concrete low-flow channel and vegetated floodplain and a natural 300-foot segment at the end of the reach. That reach is expected to be rehabilitated in the future, but final design has not yet been completed (SHE, 2009, p. 2). With the exception of the 2,400-foot section of rehabilitated reach, the creek has been straightened and there are no significant natural geomorphic features. There are also no sediments within the concrete lined portions of the creek. Within the rehabilitated reach, however, the creek meanders through constructed pools and riffles that include a gravel and cobble bed and a cobbled lower creek bank. The banks are low, and the creek has been reconnected with its floodplain. A similar channel is likely in the downstream section, when rehabilitation design and construction of the 4,400-foot section is completed in the future.

Downstream of the confluence of Underwood Creek and the Menomonee River, the river flows about 10 miles to Lake Michigan in the City of Milwaukee. Over that distance, the river is confined on both banks between commercial, parkland, parking lot, and industrial land uses. The sediments range from sands and silts in pool areas, to cobble, gravel, and bedrock in riffle areas. The bank materials range from steel sheetpile in the lower sections of the reach in the City of Milwaukee, to rock, earthen, and some concrete retaining walls in the middle section. The banks are generally earthen or rock in the sections in Wauwatosa nearest the confluence with Underwood Creek. In these sections with earthen banks, grasses, shrubs, and trees provide bank stability, however there are erosion and bank failures in some areas, as is typical of urban waterways.

Root River

The Root River flows through parts of Milwaukee and Racine counties, and into Lake Michigan at Racine. The river has a more natural channel (that is, natural bottom substrate and vegetated river banks) than does Underwood Creek, and it has a mixture of land uses between its headwaters and Lake Michigan. The headwaters of the Root River are heavily urbanized, the middle reaches are primarily agriculture and lower density development, and the lower parts of the watershed near Lake Michigan are heavily urbanized. Throughout the many areas of the river, primarily at the upstream and downstream reaches, the river has been straightened or confined within a relatively narrow corridor with transportation, residential, and commercial land uses bordering the river and its floodplain. The middle reaches were straightened through agricultural fields.

The MMSD completed a comprehensive study of the Root River within their jurisdiction in 2007. The purpose of the study was to baseline the existing channel stability in the North Branch of the river and to provide hydrologic, hydraulic and sediment transport predictions on the vertical and lateral stability of the river and tributary channels (MMSD, 2007). The river has a mixture of gradients, with low-gradient reaches dominated by pools and glides with sand, silt, organic and glacial till bottom and bank sediments. Other reaches are higher-gradient with pool and riffle sequences with gravel, cobble and bedrock substrates. The banks of the river are mostly earthen, with vegetation providing bank stability, but there are some areas of erosion and bank failures typical of urbanizing watersheds. The lower reaches of the river in the highly urbanized area of the City of Racine have sheetpile banks.

6.4.2.4.2 Environmental Effects

Geomorphology impacts to the surface waters potentially affected by the water supply and return flow alternatives are discussed below. The geomorphology of the surface waters are assessed based on the impact to the surface water geomorphic stability, change in erosion potential, or change in vertical or lateral stability.

Fox River

Impacts to the Fox River for each water supply and return flow alternative are discussed below. As described in the background information on the Fox River, the average annual stream flow is 110 cfs (71 mgd) over the period of record.

Deep and Shallow Aquifers Water Supply

The shallow groundwater pumping with this alternative causes a drawdown in the aquifer and intercepts groundwater flow to surface waters. The potential change in surface water flow from pumping the shallow aquifer is documented in previous studies and through groundwater modeling for this specific alternative (RJN Environmental Services, 2010, 2013). The expected changes are detailed in Section 6.4.2.2.2, Inland Waterways, Size, Flow, and Floodplain. A change of 2.3 mgd is expected downstream of Vernon Marsh.

Geomorphic changes with reduced baseflows could result in a smaller channel over time, but because channel stability is associated less with baseflow and is influenced more by larger channel-forming flows generally in the 1- to 2-year return period flow range, baseflow reduction is not expected to cause a significant change in channel stability from existing conditions. The 2.3 mgd is approximately 5 percent of the baseflow in the river at the Vernon Wildlife Area, and even less of the channel-forming flow rate. The reduction in baseflow from groundwater pumping will reduce flow in the river, but it is not expected to have a significant adverse impact on flow because the baseflow is small compared to the river flow, and flow in the Fox River includes baseflow along upstream segments of the river, other tributaries, and two WWTPs upstream of Waukesha.

Shallow Aquifer and Fox River Alluvium Water Supply

Shallow groundwater pumping under this alternative would draw down the aquifer and intercept groundwater flow to the Fox River. The habitat impact from pumping the shallow aquifer is documented in previous studies and through groundwater modeling for this specific alternative (RJN Environmental Services, 2010, 2013). The expected changes are detailed in Section 6.4.2.2.2, Inland Waterways, Size, Flow, and Floodplain. A change of 4.8 mgd is expected downstream of Vernon Marsh.

Geomorphic changes with reduced baseflows could result in a smaller channel over time, but because channel stability is associated less with baseflow and is influenced more by larger channel-forming flows, generally in the 1- to 2-year return period flow range, baseflow reduction is not expected to cause a significant change in channel stability from existing conditions. The 4.8 mgd is about 11 percent of the baseflow in the river at the Vernon Wildlife Area, and even less of the channel-forming flow rate. Baseflow reductions from groundwater pumping would reduce flow in the river, but they would not have a significant adverse impact to the flow in the river because the baseflow is small compared to the river flow, and flow in the Fox River includes baseflow along upstream segments of the river, other tributaries, and two WWTPs upstream of Waukesha.

Lake Michigan Water Supply (Cities of Milwaukee, Oak Creek Alignments 1 and 2, and Racine)

A Lake Michigan water supply, regardless of supply location, would not adversely affect the Fox River with respect to geomorphology because groundwater pumping would cease. A Lake Michigan supply and cessation of shallow groundwater pumping would improve the subsurface flow to the Fox River and allow the baseflow from groundwater to be restored at least partially to conditions similar to pre-well conditions, by allowing the groundwater to contribute more baseflow to the river. This would improve the baseflow under current shallow groundwater pumping conditions and have the greatest benefit in the future when projected water demands are greater. The Lake Michigan supply would affect the Fox River the same, regardless of the return flow location.

The Compact requires that the minimum return flow be at least the water withdrawn less an allowance for consumptive use. It also requires that the return flow minimize out-of-basin water sent into the Great Lakes basin. These two requirements established minimum and maximum return flow rates to provide the water balance between the withdrawal and return, as described the Return Flow Plan (Volume 4 of the Application). As a result, WWTP flow to the Fox River under any Lake Michigan water supply alternative would still occur at times.

A study by the USGS and University of Wisconsin Milwaukee reports that wastewater flows from Sussex, Brookfield, and Waukesha contribute 40 percent of the total Fox River flow during annual low flows (Cherkauer et al., 2010). The City of Waukesha's average annual WWTP flow is about 10 mgd, or 50 percent of the WWTP flow from the 3 communities. Using this percentage, the City of Waukesha WWTP contributes about 25 percent of the Fox River flow during annual low flow conditions. Thus, during low flow periods, Fox River annual low flow would be reduced by roughly 25 percent. Lower flows change the amount of aquatic habitat available, however as described in the Return Flow Plan (Volume 4 of the Application), water depth change is expected to be approximately 2 inches or less. Consequently, significant habitat change is not expected. The reduction in flow, and thus in aquatic habitat, would have an impact. The baseflow change of the Fox River flow at the Vernon Wildlife Area was estimated at 23 percent. Consequently a minor adverse impact designation is given for impacts to the river during annual low flow conditions.

During higher river flows, the Waukesha WWTP discharge is even a smaller fraction of the total river flow. For example, over the period of record for the USGS stream gage near the Waukesha WWTP (Gage ID 05543830 for water years 1964–2008), the average annual river flow was 71 mgd and the average annual peak river flow 644 mgd. With an average annual Waukesha WWTP discharge of 10 mgd, the WWTP discharge represents 14 percent of the annual average river flow and only 1.6 percent of the average annual peak river flow. This small amount of flow reduction in the river would not have a significant adverse affect on the flow or geomorphic conditions in the river.

Return Flow Alternatives

Because a Lake Michigan supply would require return flow, impacts to the Fox River are assigned to the Lake Michigan water supply alternatives. Impacts with return flow alternatives are compared to Lake Michigan tributaries and are described below.

Pebble Brook, Pebble Creek, and Mill Brook

Deep and Shallow Aquifers Water Supply

The shallow groundwater pumping in this alternative causes a drawdown in the aquifer and intercepts groundwater flow to these cold water streams. Detailed groundwater

modeling of this alternative found that average groundwater baseflows to the cold water streams could decrease significantly (RJN Environmental Services, 2010, 2013). For example, groundwater baseflow to Pebble Brook would be reduced by 34 percent, to Pebble Creek by 0 percent, and to Mill Brook by 85 percent. Geomorphic changes with reduced baseflows could result in a smaller channel over time. Because channel stability is associated less with baseflow and is influenced more by larger channel-forming flows, generally in the 1- to 2-year return period flow range, baseflow reduction is not expected to cause a significant change in channel stability.

Shallow Aquifer and Fox River Alluvium Water Supply

Under this alternative, pumping of the shallow groundwater would draw down the aquifer and intercept groundwater flow to the cold water streams. Detailed groundwater modeling of this alternative found that average groundwater baseflows to the cold water streams could decrease significantly, and greater than the Deep and Shallow Aquifer alternative (RJN Environmental Services, 2010, 2013). For example, groundwater baseflow to Pebble Brook would be reduced by 34 percent, Pebble Creek would be reduced by 13 percent, and Mill Brook would be reduced by 77 percent. Geomorphic changes with reduced baseflows could result in a smaller channel over time. Because channel stability is associated less with baseflow and is influenced more by larger channel forming flows, generally in the 1- to 2-year return period flow range, baseflow reduction is not expected to cause a significant change in channel stability from what exists.

Lake Michigan Water Supply and Return Flow

There would be no shallow groundwater pumping under this alternative, and so the cold water streams would not be affected.

Underwood Creek and Menomonee River

Deep and Shallow Aquifers, and Shallow Aquifer and Fox River Alluvium Water Supplies

These alternatives would not affect flow in Underwood Creek or the Menomonee River.

Lake Michigan Water Supply (Cities of Milwaukee, Oak Creek Alignments 1 and 2, and Racine)

Impacts of a Lake Michigan water supply, regardless of supply location, are described below under return flow alternatives.

Underwood Creek to Lake Michigan Return Flow

The average annual stream flow is 15.1 cfs (9.8 mgd) over the period of record for Underwood Creek and 108 cfs (69 mgd) for the Menomonee River over the period of record.

A detailed analysis of the flow and geomorphic conditions is included in the Return Flow Plan (Volume 4 of the Application). The purpose of the geomorphic analysis was to evaluate the hydraulic and geomorphic effects that a return flow would have on the rehabilitated portions of Underwood Creek and to determine if adding additional flow (i.e. return flow) would adversely affect the 2,400-foot reach of the creek recently rehabilitated by MMSD. The study determined that the return flow would not contribute significantly to sediment transport. That conclusion was made based on this study evaluating the hydraulic, geomorphic and fisheries impacts of adding return flow.

The purpose of the Underwood Creek habitat and fisheries evaluation (see the Return Flow Plan – Volume 4 of the Application) was to document habitat impacts. The analysis was performed after additional surveying and analysis of fisheries data for Underwood Creek were completed as part of the return flow evaluation. The purpose of the evaluation was to

determine if the return flow would affect the habitat in the parts of the creek downstream of the proposed return flow discharge location. Hydraulic modeling of the return flow showed increases in average velocity and shear stress, which can reduce embeddedness. From the perspective of habitat, reduced embeddedness is beneficial for organisms that prefer coarser substrate. Return flow to Underwood Creek provides this habitat benefit with an increase in flow in the creek through relatively constant return flow. The velocity and shear stress increases calculated as part of the habitat analysis are very small and, as concluded in the geomorphic analysis, the increases will have a negligible effect on the hydraulic and geomorphic conditions in the creek. (That is, the small increases will have a negligible effect on the geomorphic stability of the creek.)

Underwood Creek experiences periods of no flow, and so a return flow could constitute 100 percent of the creek flow at those times. During less frequent high flow events, such as a 2-year flow, a return flow is less than 2 percent of the creek flow and a lower percentage of the Menomonee River flow. Because of the small percentage of return flow in the creek and river during channel forming flows, a return flow would not affect geomorphic conditions adversely. Instead, the return flow would benefit Underwood Creek habitat during low and no-flow periods, because the return flow would provide a baseflow in the creek at all times.

Root River and Direct to Lake Michigan Return Flow

These alternatives would not affect flow in Underwood Creek and thus have no significant adverse affects on its geomorphology.

Root River

Deep and Shallow Aquifers, and Shallow Aquifer and Fox River Alluvium Water Supplies

These alternatives would not affect flow in Underwood Creek.

Lake Michigan Water Supply (Cities of Milwaukee, Oak Creek Alignments 1 and 2, and Racine)

The impacts of a Lake Michigan water supply, regardless of supply location, are discussed below under the return flow alternatives.

Underwood Creek and Lake Michigan Direct Return Flow

These alternatives would not affect flow in the Root River and thus have no significant adverse affects on its geomorphology.

Root River Alignments 1 and 2 to Lake Michigan Return Flow

Return flow to the Root River is expected to have an insignificant impact on geomorphology. Flow in the Root River sometimes is very low, and the functional habitat in the river is limited by the river flow. Augmentation of the return flow would eliminate the very low flow periods. Because the return flow rate is small compared to the higher flows in the river, return flow is not expected to affect the geomorphic stability of the river.

Root River flow rates at the discharge location for the 2-year through 100-year profiles were obtain from MMSD (MMSD, 2007, Table 3, p. 9). This location is nearest the discharge location, slightly downstream of the Franklin gage but upstream of the confluence with the Root River Canal. The watershed area at this location is 59.2 square miles which is still significantly less than the watershed area at the discharge location (126.2 square miles). These flow rates were used as a conservative estimate of flow impacts from a return flow. Based upon this conservative assumption, during less frequent high flow events, such as a 2-year flow, a return flow is less than 3% of the river flow (MMSD, 2007).

These are similar to the Underwood Creek return flow findings, for which a detailed evaluation concluded that the return flow would not affect the geomorphic stability of the rehabilitated parts of the creek. The Return Flow Plan (Volume 4 of the Application) contains a detailed discussion of the geomorphic conditions.

A recent sediment transport study of the Root River concluded that the river stability is relatively insensitive to changes in flow because of the erosion resistance of the channel boundary materials, the relatively flat channel gradient, and the presence of a functional floodplain (MMSD, 2007). For these reasons, a return flow would not adversely affect the geomorphic conditions in the river. Instead, the return flow would benefit Root River habitat during low-flow periods, because the return flow would provide additional baseflow in the river. Refer to Section 6.4.2.5, Flora and Fauna, for a full description of habitat benefits to the Root River.

6.4.2.4.3 Environmental Effects Comparison: Inland Waterway Geomorphology and Sediments

Adverse impacts from changes in inland waterway geomorphology and sediments are compared based upon Table 6-29.

TABLE 6-29

Environmental Impact Category Description: Inland Waterways Geomorphology and Sediments

Category	Channel Stability with Return Flow	Substrate Change to Lake Michigan
No adverse impact	Channel is stable for flows up to 2-year return where channel is currently stable	No substrate change
Minor adverse impact	Channel has some instability for flows up to 2-year return where channel is currently stable	Fewer than 10 acres
Moderate adverse impact	Channel has frequent instability for flows up to 2-year return where channel is currently stable	Greater than 10 acres, but less than 20 acres
Significant adverse impact	Channel is unstable at most flows where the channel is currently stable	Greater than 20 acres

Table 6-30 summarizes the impacts of the various alternatives on geomorphology and sediments on inland waterways. Section 6.4.1.3, Geomorphology and Sediments, contains a comparison of geomorphology impacts for Lake Michigan.

Deep and Shallow Aquifers Water Supply

Impacts to the geomorphology of surface water resources would occur from shallow groundwater pumping under this water supply alternative. Groundwater modeling of the

TABLE 6-30

Water Supply and Return Flow Alternative Environmental Impact Comparison Summary: Inland Waterways Geomorphology and Sediments

Alternative	Geomorphology and Sediments
Water Supply	
Deep and Shallow Aquifers	No adverse impact
Shallow Aquifer and Fox River Alluvium	No adverse impact
Lake Michigan (City of Milwaukee)	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 1	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 2	No adverse impact
Lake Michigan (City of Racine)	No adverse impact
Return Flow Alternatives for Lake Michigan Water Supplies	
Underwood Creek to Lake Michigan	No adverse impact
Root River to Lake Michigan Alignment 1	No adverse impact
Root River to Lake Michigan Alignment 2	No adverse impact
Direct to Lake Michigan	No adverse impact

alternative indicates that the Fox River would receive 2.3 mgd less flow (RJN Environmental Services, 2010, 2013). The small cold water streams Pebble Brook, Pebble Creek, and Mill Brook would also experience baseflow reduction from groundwater pumping, with Mill Brook experiencing a baseflow reduction of 85 percent on average and an even more during low flow conditions. Geomorphic changes with reduced baseflows could result in a smaller channel over time, but because channel stability is associated less with baseflow and influenced more by larger channel-forming flows, baseflow reduction is not expected to cause a significant change in channel stability from existing conditions. The baseflow reduction to surface waters from groundwater pumping would have no adverse impact to geomorphology.

Shallow Aquifer and Fox River Alluvium

Impacts to the geomorphology of surface water resources would occur from shallow groundwater pumping with this water supply alternative. Groundwater modeling of this alternative indicates the Fox River would experience 4.8 mgd less flow (RJN Environmental Services, 2010, 2013). The small cold water streams Pebble Brook, Pebble Creek, and Mill Brook would also experience baseflow reduction from groundwater pumping, with Mill Brook experiencing a baseflow reduction of 77 percent on average and an even greater reduction during low flow conditions. Geomorphic changes with reduced baseflows could result in a smaller channel over time, but because channel stability is associated less with baseflow and influenced more by larger channel-forming flows, baseflow reduction is not expected to cause a significant change in channel stability from existing conditions. The baseflow reduction to surface waters from groundwater pumping would produce no adverse impact to geomorphology.

Lake Michigan Water Supply (Cities of Milwaukee, Oak Creek Alignments 1 and 2, and Racine)

The Lake Michigan water supply alternatives would prevent baseflow reduction from groundwater pumping. Because geomorphology changes to the environment would depend only on the return flow location, the Lake Michigan water supply would have no adverse impacts on geomorphology.

Underwood Creek to Lake Michigan Return Flow

Impacts to the geomorphology of surface water resources occur under this alternative. Return flow to Underwood Creek would reduce the baseflow in the Fox River by roughly 10 mgd, based upon historical WWTP operation. Geomorphic changes with reduced baseflows could result in channel change over time, but because channel stability is associated less with baseflow and is influenced more by larger channel-forming flows, baseflow reduction is not expected to cause a significant change in channel stability from existing conditions. Consequently, geomorphology changes to the Fox River would have no adverse impact.

Flow that formerly had been discharged to the Fox River would instead increase baseflow in Underwood Creek and the Menomonee River. A geomorphic study analyzing channel stability with return flow to Underwood Creek found that the increased baseflows would not adversely impact the channel stability. Therefore, return flow to Underwood Creek would have no adverse impact on geomorphology.

Root River to Lake Michigan Return Flow

Impacts to the geomorphology of surface water resources occur under this alternative. Changes to the Fox River would be the same as those for the Underwood Creek return flow alternative. Flow formerly discharged to the Fox River would instead increase baseflow in the Root

River. A recent sediment transport study of the Root River concluded that the river stability is relatively insensitive to changes in flow, because of the erosion resistance of the channel boundary materials, the relatively flat channel gradient, and the presence of a functional floodplain. Therefore, return flow to Root River would have no adverse impact on geomorphology.

Direct to Lake Michigan Return Flow

Impacts to the geomorphology of surface water resources occur with this alternative. The changes to the Fox River would be the same as those listed for the Underwood Creek return flow alternative. The flow that used to discharge to the Fox River instead would discharge directly to Lake Michigan.

6.4.2.5 Flora and Fauna

6.4.2.5.1 Affected Environment

Wildlife species require adequate food, water, cover, and living space for the survival of individuals and to maintain population viability. Aquatic resources affected by the proposed project consist generally of streams and wetlands, which include all inland waterways (Fox River, Pebble Creek, Underwood Creek, Root River, and others). Aquatic areas can provide habitat to a diverse wildlife population, some common species (beaver, muskrat, herons) are dependent on aquatic habitats for food and shelter. Others (e.g., raccoon) are less restricted, but prefer to be close to water. Amphibians and many reptiles favor aquatic habitats; representative species include bullfrog and northern water snake.

Many of the Wisconsin's richest and most diverse streams and rivers were in the southeastern part of the state, but many have been degraded from nonpoint pollution sources from agriculture and urbanization. Most streambeds, banks, and channels within the project area have been modified by changes in land cover and have lost varying degrees of their biological productivity and diversity (WDNR, 12/2011e).

The rivers and streams within the project area are a combination of cold water communities and warm water communities. Cold water streams are capable of supporting cold water sport fish, such as trout, and other aquatic life, or serving as a spawning area for cold water fish species. Cold water streams, such as Pebble Creek and Mill Brook, contain relatively few fish species and are dominated by trout and sculpins. Warm water fisheries are capable of supporting sport fish such as bass, walleye, and northern pike, and forage fish such as, suckers, minnows, and darters. Warm water rivers include large rivers such as the Fox River, as well as smaller streams such as Underwood Creek and the Root River.

Most of the warm water streams and rivers within the project area are on the 303(d) list for impairments, such as, PCBs, fecal coliform, *E. coli* bacteria, phosphorous for low dissolved oxygen concentration, construction erosion, non-point-source contamination, sedimentation, beaver dams, and unspecified metals for chronic aquatic toxicity (WDNR, 01/2010). These impairments result in a loss of habitat within the waterway and water temperature fluctuations (WDNR, 2002a).

The USFWS and the WDNR were contacted to determine where federal- or state-listed species occur along the project corridor in Lake Michigan. The species identified by these agencies as potentially occurring within the project corridors are summarized for all

alternatives in Section 6.4.3, Wetlands, since most of the potential impacts involve federal- or state-listed species associated with wetlands.

Background information for inland waterways affected by the project or alternatives to the project is given below.

Fox River

Fisheries information for the Fox River downstream of the WWTP was obtained from the WDNR (2011b). The data were collected along roughly 2 miles of the Fox River between County Highway I and the confluence of Genesee Creek, about 6 miles downstream of the Waukesha WWTP discharge (Table 6-31). Figure 6-9 shows the sampling locations relative to the WWTP. Fishery surveys were conducted in 1999, 2000, 2003, 2004, and 2006 (Table 6-32).

TABLE 6-31

Location of WDNR Fox River Fishery Survey Site Numbers and Year of Survey

WDNR Site Number	Survey Number	Year	Location
62121	2664	1999	At confluence with Genesee Creek.
62129	2663	1999	0.6 river mile east of Site #62121.
62245	2608	1999	Upstream of County Hwy I.
62605	2609	2000	
	52059	2003	
	92051	2004	
	92253	2006	

Note: The WDNR lists Genesee Creek as an exceptional resource water and cold water fishery (WDNR, 2002a).

The surveys identified 35 species of fish (Table 6-32). The most abundant species collected were golden redhorse, common carp, bluegill, channel catfish, largemouth bass, white bass, northern pike, rock bass, common shiner, sand shiner, bluntnose minnow, emerald shiner, longnose gar, white sucker, and creek chub. Most are considered warm water species, although they may also be found in cool water habitats. The greater redhorse, a designated threatened species, also was collected in this stream reach. Several coldwater species (brook and brown trout) were noted at the confluence of Genesee Creek (a cold water fishery) and Fox River but were only present in small numbers.

A separate fish survey was conducted at the confluence of the Fox River and Pebble Creek, 1.65 miles downstream of the Waukesha WWTP (Waukesha County and SEWRPC, 2008). Many species were the same as those collected in the WDNR surveys, but species not found farther downstream in the Fox River were collected. These were brook stickleback, spottail shiner, banded killifish, golden shiner, longear sunfish, orange-spotted sunfish, starhead topminnow, and tadpole madtom, all warm water species except for the brook stickleback, a cool water species. The longear sunfish is a designated threatened species in Wisconsin. The starhead topminnow and banded killifish are special species of concern.

Pebble Brook

Pebble Brook is a 9-mile-long perennial trout stream in southeastern Waukesha County. It is tributary to the Fox River south of the City of Waukesha. The WDNR classifies Pebble Brook a cold water fishery (NR 102.04(3)). Cold water fisheries are surface waters capable of supporting a community of cold water fish and other aquatic life or serving as a spawning area for cold water fish species. Cold water streams receive much of their flow from

groundwater entering the stream, enabling their temperature to remain cold. Pebble Brook is not listed for use impairments (WDNR, 2002a).

FIGURE 6-9
Approximate Fish Sampling Locations Relative to the Waukesha WWTP

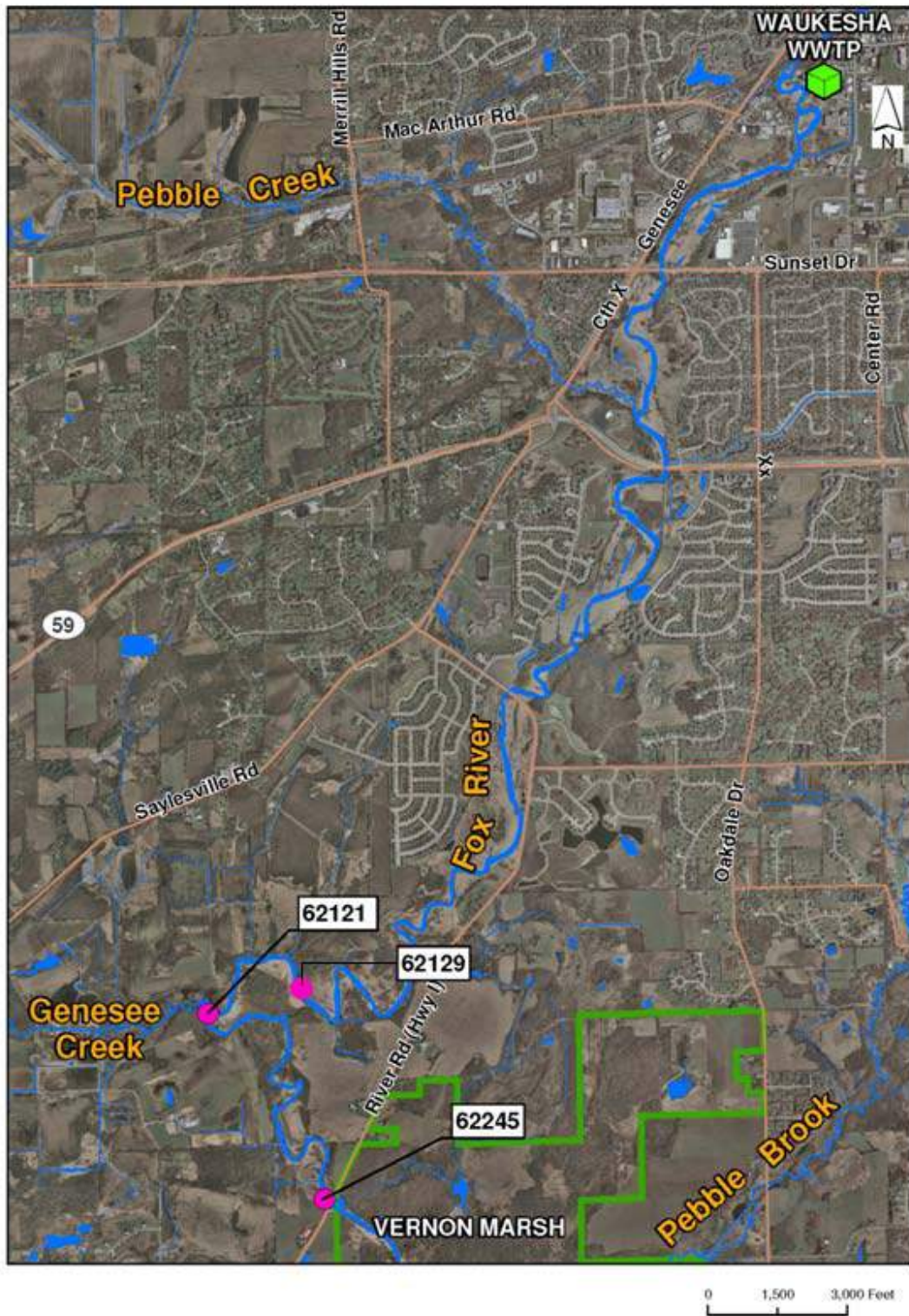


TABLE 6-32
Fisheries Data from WDNR Surveys in the Fox River Downstream of the Waukesha WWTP

Species	WDNR Site Numbers			
	62121	62129	62245	62605
Bigmouth shiner				X
Black bullhead			X	
Black crappie			X	
Blackstripe topminnow				X
Bluegill			X	X
Bluntnose minnow				X
Bowfin				X
Brook silverside				X
Brook trout	X	X		
Brown trout	X	X		
Central mudminnow	X	X		X
Central stoneroller				X
Channel catfish			X	X
Common carp			X	X
Creek chub	X	X		X
Emerald shiner				X
Golden redhorse			X	X
Grass pickerel	X			X
Greater redhorse			X	X
Green sunfish				X
Johnny darter				X
Largemouth bass	X			X
Longnose gar				X
Mottled sculpin	X	X		
Northern pike			X	X
Pumpkinseed			X	X
Quilback				X
Rock bass			X	X
Sand shiner				X
Spotfin shiner				X
Walleye				X
White bass				X
White sucker	X	X		X
Yellow bass				X
Yellow perch				X

Pebble Creek

Pebble Creek is a 6-mile-long perennial trout stream in southeastern Waukesha County (WDNR, 2002a). It is tributary to the Fox River south of the City of Waukesha. The WDNR classifies Pebble Creek as a cold water fishery (NR 102.04(3)). Cold water fisheries are surface waters capable of supporting a community of cold water fish and other aquatic life or serving as a spawning area for cold water species. Cold water streams receive much of their flow from groundwater entering the stream which enables the temperature to remain cold.

SEWRPC's report, Community Assistance Planning Report No. 284, Pebble Creek Watershed Protection Plan (2008), documents the presence of the state threatened longear sunfish (*Lepomis megalotis*) and the cold water brown trout (*Salmo trutta*) and mottled sculpin (*Cottus bairdi*) in 1999–2005 surveys in Pebble Creek. Other species were found in Pebble Creek or at the confluence with the Fox River that are species of special concern in Wisconsin.

Mill Brook

Mill Brook is a narrow, 5-mile-long perennial trout stream in southeastern Waukesha County (WDNR, 2002). It is a tributary to the Fox River south of the City of Waukesha. The WDNR has classified Mill Brook as a cold water fishery (NR 102.04(3)). Cold water fisheries are surface waters capable of supporting a community of cold water fish and other aquatic life or serving as a spawning area for cold water fish species. Cold water streams receive much of their flow from groundwater entering the stream that enables the temperature to remain cold.

Underwood Creek and Menomonee River

Fisheries and habitat information for Underwood Creek and the Menomonee River is summarized in the Return Flow Plan (Volume 4 of the Application) and below.

Underwood Creek, along with the Menomonee River, is a WWSF. The imbalance in number and type of species is indicative of a poor-quality fishery. Although macroinvertebrate communities within the watershed have improved substantially since 1993, the USGS macroinvertebrate data collected in 2007 concluded that Underwood Creek and the Menomonee River range from fairly poor to fair-to-good, based on the presence of specific macroinvertebrates. Fish and macroinvertebrate communities are listed in the Return Flow Plan (Volume 4 of the Application). Table 6-33 lists the dominant fish species.

Fisheries data for the Menomonee River watershed show an apparent net gain of fish species within the watershed. For example, 10 new species have been identified since 1986, and the most recent fishery surveys conducted by the USGS in 2004 and 2007 noted that 12 of the 20 species found in the Menomonee River watershed occurred within Underwood Creek (SEWRPC, 2007, pp. 100–14). Underwood Creek is predominantly a concrete channel with little habitat for fish, but the creek provides minimal substrate for macroinvertebrates. The part of the concrete channel removed in 2009 and rehabilitated to a meandering stream channel has numerous pools and riffles, and a substrate composed of gravel, sand, and silt.

TABLE 6-33
Summary of Preferred Habitat Characteristics for Dominant Fish Species in the Menomonee River Watershed

Dominant Fish Species	Found in Underwood Creek 2004 or 2007	Preferred Current Velocity Range	Stream Gradient	General Habitat Characteristics	Dominant Substrate Preference
Pearl dace	X			Pools	Sand, gravel
Creek chub	X	< 0.98 ft/sec	3–23 m/km	Pools	Sand, gravel
White sucker	X	1.31 ft/sec	Wide range	Wide range	Gravel, sand
Long nose dace	X	> 1.48 ft/sec	1.9–18.7 m/km	Riffles	Gravel, rubble
Blunt nose minnow	X			Wide range	Gravel, sand
Black nose dace	X	0.49–1.48 ft/sec	11.4–23.3 m/km	Rocky runs and pools	Gravel, sand
Central stoneroller	X			Rocky riffles, runs, and pools	Gravel, sand, rubble
Common shiner	X			Rocky pools near riffles	Hard bottom, gravel, sand, rubble
Fathead minnow	X			Muddy pools	Sand, rubble, gravel
Largemouth bass	X	> 0.33 ft/sec			Vegetated areas, sand, gravel, mud
Green sunfish	X	< 0.33 ft/sec	0.2–5.7 m/km	50% pools	Vegetated cover
Johnny darter				Pools	Sand/mud
Bluegill	X	< 0.33 ft/sec	≤ 0.5 m/km	60% pool areas	Submerged vegetation, logs, brush
Central mud minnow				Quiet areas	Soft mud bottom, dense vegetation

With the potential presence of two state-listed threatened fish species in the Menomonee River watershed, there appear to be areas of good river quality within limited parts of the watershed. The poor quality of the fish communities in the watershed is caused mostly by habitat loss. The rehabilitated channel of Underwood Creek contains habitat features that fish and macroinvertebrates can use. Although habitat conditions in Underwood Creek are limiting for the fish and benthic communities, those conditions could be improved by providing more or higher quality habitat.

Root River

Fisheries and habitat information for the Root River is summarized in the Return Flow Plan (Volume 4 of the Application) and here.

Fishery data for in the Root River watershed shows that 10 new species have been identified, but 10 of 64 recorded species have not been observed since 1986 (SEWRPC, 2007, pp. 100–14).. The most recent fishery surveys, conducted in 2004, 2007 and 2010 by the USGS, identified 19 species in the Root River near the proposed return flow location (USGS, 01/2013). None of the fish species observed are state-listed species. Table 6-34 lists the fish species found at the USGS locations upstream of the proposed return flow location for Alignment 2.

TABLE 6-34
Fisheries Data from USGS Fish Surveys in the Root River

Species	Found in the Root River		
	2004	2007	2010
Black bullhead		X	
Blacknose dace	X		X
Blackside darter	X		X
Bluegill	X		X
Bluntnose minnow	X		
Brook stickleback	X		X
Central mudminnow	X		X
Creek chub	X	X	X
Fathead minnow	X		
Green sunfish	X	X	X
Johnny darter	X	X	X
Largemouth bass	X		X
Longnose dace		X	
Northern pike	X		
Orangespotted sunfish			
Pumpkinseed	X	X	X
Sand shiner	X		
White sucker	X	X	X
Yellow perch	X		

Note: Fish surveys taken October 4, 2004, September 5, 2007, and September 14, 2010 at USGS Stream Gauge 04087214 in Greenfield, WI and USGS Stream Gauge 04087220 near Franklin

Some of the new species were observed in reaches of the Root River between the confluence with Lake Michigan and the first dam, suggesting that Lake Michigan's fish community may be influencing the fish community of the lower reaches of the watershed. The Root River is a warm-water habitat, where the balance of fish species indicates a fair quality fishery overall in the watershed that is higher in quality than.

Several biological indices have been developed for three stream reaches along the Root River (WDNR, 2012c). These indices use benthic macroinvertebrates and fish as indicators of water quality and physical conditions present within the stream. The MIBI (benthic macroinvertebrate index) and IBI (fish index) were developed within each of three stream reaches of the Root River. In general the MIBI and IBI for the lower reach of the Root River (river miles 0 to 5.82) suggests fair to good water quality and physical habitat condition. The middle reach (river miles 5.82 to 20.48) ranges from poor to good, with most of the data suggesting fair conditions. The upper reach (river miles 20.48 to 43.95) also ranges from poor to good. This data suggests some limitation in water quality or physical habitat in the middle and upper reaches.

With the potential presence of one state-listed endangered and three state-listed threatened fish species, there appears to be areas of good quality within parts of the watershed, but there is also impairment because of agricultural and urban development. The Root River watershed has relatively few streambed and bank modifications, with less than 1 percent of the stream channel being in conduit and none lined with concrete. Although habitat conditions in the Root River are fair to good, habitat could be improved by providing more or higher quality habitat.

6.4.2.5.2 Environmental Effects

Environmental effects of the proposed project on the flora and fauna of inland waterways consist of impacts from construction and operational impacts from flow changes, including from groundwater drawdown.

The primary temporary construction impact can be associated with elevated loads of suspended sediment resulting from in-stream trenching activities and erosion of cleared streambanks and rights-of-way from pipeline construction. The severity of impact would be a function of sediment load, particle size, streambank and streambed composition, flow velocity, turbulence, and duration of construction activities. Turbidity and erosion created by construction would be minimal, because the construction period will be brief and BMPs will be employed to reduce the impact.

Without mitigation by implementing BMPs, temporary construction impacts can also elevate suspended sediment levels that increase turbidity and consequently reduce primary photosynthetic production, flocculate plankton, decrease visibility and food availability, and produce effects that are aesthetically displeasing (USFWS, 1982). However, Long (1975) concluded that most fish avoid turbid water and can survive for several days in waters where construction in a stream has caused turbidity. Since the construction impacts will be temporary and river crossings will use BMPs designed to reduce the impact, turbidity and erosion created by construction will be minimal.

Because these impacts are expected to be temporary and the crossings will be restored following construction, temporary impacts to flora and fauna are not discussed further.

It is not anticipated that any of the Lake Michigan supply or return alternatives will have a significant impact on mammals and birds in the various inland waterways discussed in this document. Mammals and birds that normally live in areas undergoing pipeline construction may be temporarily displaced during construction. However, habitat alteration will be relatively insignificant because of the small area affected and post-construction restoration efforts used to promote habitat recovery. Operational changes in water levels are anticipated to be approximately 2 inches or less in the Fox River and also minimal in the Root River and Underwood Creek. Because potential habitat affected by these small water depths is immediately adjacent to the ordinary high water mark, mammal, vegetative, and bird species associated with inland waterways are well adapted to withstand minor fluctuations in water elevation resulting from typical seasonal conditions, flood events, or drought. Consequently, the operational impacts to these species are expected to be insignificant.

Alternatives with significant groundwater drawdown like the Deep and Shallow Aquifers and Shallow Aquifer and Fox River Alluvium water supply alternatives will have significant

impacts on wetland habitat. Impacts to species that depend upon wetland habitat are discussed in detail in Wetlands Section 6.4.3.

Operational impacts to inland waterway flora and fauna occur from flow conditions in the waterways that can affect flora and fauna. Operational impacts would be ongoing and permanent. Consequently, the remainder of this impact evaluation focuses upon operational impacts due to flow changes.

Evaluation of impacts to wildlife, endangered resources, and natural communities in inland waterway is part of the comprehensive evaluation for all affected environments. It is included under Wetlands (Section 6.4.3) because project alternatives would affect them most. Impacts to individual inland waterways are summarized below.

Fox River

Deep and Shallow Aquifers, and Shallow Aquifer and Fox River Alluvium Water Supplies

The groundwater supply alternatives would change the flow in the Fox River, as described in Section 6.4.2.2, Size, Flows, and Floodplain. This flow change is small compared to a cessation of WWTP discharge to the Fox River under the Lake Michigan water supply alternatives. The Lake Michigan water supply alternatives would have no significant adverse impact on fisheries (see below). Consequently, the affect upon Fox River fisheries with the groundwater supply alternatives is also expected to have no significant adverse impact.

Lake Michigan Supply (Cities of Milwaukee, Oak Creek Alignments 1 and 2, and Racine)

A Lake Michigan supply, regardless of the return flow location, would have its primary discharge location in the Lake Michigan basin instead of to the Fox River. Consequently, these impacts are listed under the return flow alternatives.

Underwood Creek, Root River Alignments 1 and 2, and Direct to Lake Michigan Return Flow

A Lake Michigan supply, regardless of return flow location, would not have its primary discharge location on the Fox River at the Waukesha WWTP. Consequently, these alternatives would change the flow in the Fox River (see Section 6.4.2.2, Size, Flows, and Floodplain). The return flow requirement would change discharge to the Fox River for all Lake Michigan water supply alternatives.

Change in water depth and habitat available for fisheries is discussed in the Return Flow Plan (Volume 4 of the Application). Flow in the Fox River for 2005, a dry year, and 2008, a wet year, was analyzed to determine the change in flow in the Fox River and to estimate water depth change. The water depth change in both years was approximately 2 inches or less at the USGS flow gage in Waukesha.

The small reduction in depth is not expected to have a significant impact on the fishery. The individual fish habitat requirements for dominant species (Table 6-35) and threatened and endangered species (Tables 6-36 and 6-37) generally would still be met. Table 6-36 includes cold water and threatened and endangered species found during surveys used for this analysis. Table 6-37 includes threatened and endangered species not found during the surveys but included in the NHI list of species potentially in the vicinity. With such a small change in flow depth, aquatic vegetation and macroinvertebrate habitat would not be expected to change significantly. No significant adverse impacts to these species or the Fox River fishery are expected.

TABLE 6-35
Summary of Return Flow Effects on Habitat Characteristics for Dominant Fish Species in the Fox River

Dominant Fish Species	Preferred Current Velocity Range ^a	Stream Gradient	General Habitat Characteristics	Dominant Substrate Preference	Potential Changes to Habitat with Return Flow
Channel catfish	Wide range	Not documented in reviewed literature	Wide range	Mud, sand, clay, gravel	With the wide range of preferred velocities, habitat characteristics, and substrate preference, no significant changes are expected.
Creek chub	< 0.98 ft/sec	3–23 m/km	Pools	Sand, gravel	Slightly less pool depth, but because pools are by definition deeper areas no significant changes expected. No significant changes expected to preferred substrate.
White sucker	1.31 ft/sec	Wide Range	Wide range	Gravel, sand	With the wide range of preferred habitat characteristics and substrate preference, no significant changes are expected.
Golden redbreast	Not documented in reviewed literature	Not documented in reviewed literature	Pools in river bends	Sand, gravel	Slightly less pool depth, but because pools are by definition deeper areas no significant changes expected. No significant changes expected to preferred substrate.
Bluntnose minnow	Not documented in reviewed literature	Not documented in reviewed literature	Wide range	Gravel, sand	With the wide range of preferred habitat characteristics and substrate preference, no significant changes are expected.
Common carp	Not documented in reviewed literature	Not documented in reviewed literature	Wide range	Sand, gravel, clay	With the wide range of preferred habitat characteristics and substrate preference, no significant changes are expected.
White bass	Moderate currents	Not documented in reviewed literature	Generally occurs in waters 6m in depth or less	Sand, mud, rubble, gravel	With the wide range of preferred habitat characteristics and variety of substrate preference, no significant changes are expected.
Common shiner	Not documented in reviewed literature	Not documented in reviewed literature	Rocky pools near riffles	Hard bottom, gravel, sand, rubble	Slightly less pool depth, but because pools are by definition deeper areas no significant changes expected. No significant changes expected to preferred substrate.
Northern pike	Not documented in reviewed literature	Not documented in reviewed literature	Shallow vegetated areas	Vegetated areas	Shallow areas will become shallower on average, but less than 2 inches water depth change would occur. With critical spawning times for northern pike during early spring when flows are high, water depth change would be even less. Consequently, no significant changes are expected.

TABLE 6-35
Summary of Return Flow Effects on Habitat Characteristics for Dominant Fish Species in the Fox River

Dominant Fish Species	Preferred Current Velocity Range ^a	Stream Gradient	General Habitat Characteristics	Dominant Substrate Preference	Potential Changes to Habitat with Return Flow
Largemouth bass	> 0.33 ft/sec	Not documented in reviewed literature	Not documented in reviewed literature	Vegetated areas, sand, gravel, mud	With the wide range of preferred substrate preference, no significant changes are expected.
Rock bass	Not documented in reviewed literature	Not documented in reviewed literature	Preference for clear cool to warm water	Sand, gravel	No significant changes expected to general habitat characteristics or preferred substrate.
Emerald shiner	Not documented in reviewed literature	Not documented in reviewed literature	Wide range	Sand, gravel	With the wide range of preferred habitat characteristics and substrate preference, no significant changes are expected.
Bluegill	< 0.33 ft/sec	≤ 0.5 m/km	60% pool areas	Submerged vegetation/ logs, brush	Slightly less pool depth, but because pools are by definition deeper areas no significant changes expected. No significant changes expected to preferred substrate.
Longnose gar	Not documented in reviewed literature	Not documented in reviewed literature	Backwaters, quiet currents	Gravel, sand	No significant changes expected to general habitat characteristics or preferred substrate.

TABLE 6-36

Return Flow Effects on Preferred Habitat for State Threatened, Endangered, Special Concern, and Cold Water Species Recorded Since 1999 within the Fox River

Fish Species	Preferred Current Velocity Range ^a	Stream Gradient ^a	General Habitat Characteristics	Dominant Substrate Preference	Potential Changes to Habitat with Return Flow
Greater redhorse (threatened)	Not documented in reviewed literature	Not documented in reviewed literature	Pools and runs of medium to large rivers	Sandy to rocky pools	Slightly less pool depth, but because pools are by definition deeper areas no significant changes expected. No significant changes expected to preferred substrate.
Longear sunfish (threatened)	Not documented in reviewed literature	Not documented in reviewed literature	Slow moving rivers and streams	Shallow dense vegetation	Shallow areas will become shallower on average, but less than 2 inches water depth change would occur. Consequently, no significant changes are expected.
Banded killifish (special concern)	Not documented in reviewed literature	Not documented in reviewed literature	Shallow sluggish streams	Sand/mud/near vegetation.	Shallow areas will become shallower on average, but less than 2 inches water depth change would occur. No significant changes are expected to the preferred substrate. Consequently, no significant changes are expected.
Starhead topminnow (special concern)	Not documented in reviewed literature	Not documented in reviewed literature	Quiet pools and backwaters	Vegetated areas	Slightly less pool depth, but because pools are by definition deeper areas no significant changes expected. No significant changes expected to preferred substrate.
Brook trout (cold water species)	Not documented in reviewed literature	Not documented in reviewed literature	Clear, cool, well oxygenated streams	Sand/ gravel/rubble	Lower flow in the Fox River could extend cool water influence from Genesee Creek. No significant changes are expected to the preferred substrate. Consequently, no significant changes expected.
Brown trout (cold water species)	Not documented in reviewed literature	Not documented in reviewed literature	Cold, well oxygenated waters	Submerged rocks, undercut banks, overhanging vegetation	Lower flow in the Fox River could extend cool water influence from Genesee Creek. No significant changes are expected to the preferred substrate. Consequently, no significant changes expected.

TABLE 6-37

Return Flow Effects on Habitat Characteristic for Fish Species Identified in the WDNR Online NHI Database as State Threatened, Endangered, and Species of Special Concern in the Vicinity of the Fox River, but not Documented as Present in Recent Fish Surveys

Fish Species ^a	Preferred Current Velocity	Stream Gradient	General Habitat Characteristics	Dominant Substrate Preference	Potential Changes to Habitat with Return Flow
Striped shiner (endangered)	Not documented in reviewed literature.	Not documented in reviewed literature.	Clear to slightly turbid waters of runs and shallow pools, with dense aquatic vegetation.	Cobble, boulders, silt, sand, mud or bedrock	Slightly less pool depth, but because pools are by definition deeper areas no significant changes expected. No significant changes expected to preferred substrate.
Slender madtom (endangered)	Not documented in reviewed literature.	Not documented in reviewed literature.	Prefers clear, moderate to swift currents of streams and wide rivers.	Gravel and boulders interspersed with fine sand	Reduction in current velocity could occur during low periods, but no significant changes are expected. No significant changes expected to preferred substrate.
River redbhorse (threatened)	Not documented in reviewed literature.	Not documented in reviewed literature.	Prefers moderate to swift currents in large rivers systems, including impoundments and pools.	River bottoms of clean gravel.	The preferred habitat for this species likely does not exist in the Fox River because it is not a large river.
Pugnose shiner (threatened)	Not documented in reviewed literature	Not documented in reviewed literature	Prefers weedy shoals of glacial lakes and low-gradient streams	Mud, sand, cobble, silt, and clay	Some weedy areas may be exposed under low flow conditions, however no significant changes are expected. No significant changes expected to preferred substrate.
Lake chubsucker (special concern)	Not documented in reviewed literature.	Not documented in reviewed literature.	Prefers moderately clear lakes, oxbow lakes, sloughs of weedy lakes and their associated marshy streams.	Organic debris over bottoms of cobble, sand, boulders, mud or silt.	The preferred habitat for this species likely does not exist in the Fox River because it is not a lake.
Least darter (special concern)	Not documented in reviewed literature	Not documented in reviewed literature	Prefers clear, warm, quiet waters of overflow ponds, pools, lakes and streams.	Gravel, silt, sand, boulders, mud or clay with dense vegetation or filamentous algal beds	Slightly less pool depth, but because pools are by definition deeper areas no significant changes expected. No significant changes expected to preferred substrate.
Weed shiner (special concern)	Not documented in reviewed literature	Not documented in reviewed literature	Prefers sloughs, lakes, and still to sluggish sections of medium streams to large rivers	Sand, mud, clay, silt, detritus, gravel or boulders	Some slough areas may have less water in them under low flow conditions. No significant changes expected. No significant changes expected to preferred substrate.

^a WDNR. Online Natural Heritage Inventory Database: <http://dnr.wi.gov/org/land/er/nhi/CountyElements/>

Pebble Brook, Pebble Creek, and Mill Brook

Planning Report No. 284, Pebble Creek Watershed Protection Plan documents the presence of the state threatened longear sunfish (*Lepomis megalotis*) and cold water brown trout (*Salmo trutta*) and mottled sculpin (*Cottus bairdi*) in 1999–2005 surveys in Pebble Creek.

Baseflow reduction, which reduces habitat and increases temperature, stresses cold water species. Baseflow reduction would consequently adversely affect the flora and fauna in Pebble Brook, Pebble Creek, and Mill Brook. The three streams are all cold water fisheries tributary to the Fox River that are near each other and all affected by reduced baseflow from groundwater supply alternatives. Consequently, they are considered together. Increased water temperature occurs because cold groundwater seeping into the waterways as baseflow is reduced by shallow aquifer pumping. The temperature in the lower flow remaining in the waterway then further increases from solar radiation. The coldwater species brown trout, mottled sculpin as well as state threatened species longear sunfish would be affected by reduced flows and increased water temperature.

Impacts to flora and fauna are closely associated with baseflow changes. Consequently, the information below is consistent with that found in Section 6.4.2.2 discussing the size, flow, and floodplain of inland waterways.

Deep and Shallow Aquifers Water Supply

Shallow groundwater pumping under this alternative would draw down the aquifer and intercept groundwater flow to these cold water streams. Detailed groundwater modeling of this alternative found that average groundwater baseflows to these cold water streams could decrease significantly (RJN Environmental Services, 2010, 2013). For example, groundwater baseflow to Pebble Brook would be reduced by 34 percent, to Pebble Creek by 0 percent, and to Mill Brook by 85 percent. The baseflow reductions could have a significant adverse impact to the flow in the channels (especially Mill Brook) during low flow periods, when groundwater baseflow accounts for most of the flow in the channels. Increases in water temperature would in turn affect the cold water species in the waterways.

Shallow Aquifer and Fox River Alluvium Water Supply

Shallow groundwater pumping under this alternative would draw down the aquifer and intercept groundwater flow to these cold water streams. Detailed groundwater modeling of this alternative found that average groundwater baseflows to these cold water streams could decrease significantly, more than under the Deep and Shallow Aquifer alternative (RJN Environmental Services, 2010, 2013). For example, groundwater baseflow to Pebble Brook would be reduced by 34 percent, to Pebble Creek by 13 percent, and to Mill Brook by 77 percent. Geomorphic changes with reduced baseflows could result in a smaller channel over time. The baseflow reductions could have a significant adverse impact to the flow in the channels (especially Mill Brook) during low flow periods, when groundwater baseflow accounts for most of the flow in the channels. Increases in water temperature would in turn affect the cold water species in the waterways.

Lake Michigan Water Supply and Return Flow

There would be no groundwater pumping under this alternative, and consequently the cold water streams would not be affected.

Underwood Creek and Menomonee River

Deep and Shallow Aquifers, and Shallow Aquifer and Fox River Alluvium Water Supplies

The groundwater supply alternatives would not cause a change in Underwood Creek. Consequently, the affect upon Underwood Creek and Menomonee River fisheries with the groundwater supply alternatives will have no significant adverse impact.

Lake Michigan Water Supply (Cities of Milwaukee, Oak Creek, and Racine)

No Lake Michigan supply alternative itself would affect Underwood Creek or the Menomonee River.

Underwood Creek to Lake Michigan Return Flow

An analysis of potential Underwood Creek habitat changes from an increase in flow from return flow was documented in the Return Flow Plan (Volume 4 of the Application). The analysis found that the estimated increase in water surface elevation with a return flow of 20 cubic feet per second (ft³/sec) (12.9 mgd) was 0.78 foot at 2 cross section survey sites. The estimated average velocity at baseflow for these locations was 0.85 ft/sec. With a return flow range of 11.6 to 20 ft³/sec, the estimated velocities increase to 1.11 to 1.32 ft/sec. The flow difference in Underwood Creek with and without return flow in 2005 (a dry year in the recent past) and 2008 (a wet year in the recent past) is shown in graphical and tabular format in the Return Flow Plan (Volume 4 of the Application).

According to the literature, the slightly higher velocity generally still would be within the preferred velocity range for the dominant fish species in Underwood Creek. Consequently, the slightly higher velocity is not expected to adversely affect the dominant fish species in Underwood Creek. Table 6-38 summarizes the habitat preferences and potential changes to habitat with return flow for the dominant fish species in Underwood Creek.

A search of the Wisconsin Natural Heritage Working List (WDNR, 2009) and the WDNR Animals, Plants, and Natural Communities Database identified several threatened, endangered, or species of special concern in the Underwood Creek area (Table 6-39). Because of the physical habitat limitation within Underwood Creek noted in Section 6.4.2.2, Size, Flows, and Floodplain, it is unlikely any of these species would be present.

Return flow will increase the baseflow, which will have positive effects on water availability, amount of habitat, and also the fish species that depend upon Underwood Creek. These anticipated positive effects are summarized in the Return Flow Plan (Volume 4 of the Application) and as follows:

- The habitat for fish could be improved with additional flow, especially in the rehabilitated segment of the creek and during periods when with current conditions low baseflows limit habitat availability.
- Underwood Creek often experiences extended periods when there is little precipitation and thus no flow in the creek because of ice or dry conditions. At those times, return flow would provide the greatest habitat improvement because periods of no flow could be eliminated, allowing aquatic habitat to always be available instead of having intermittent periods when habitat features provide no function because of lack of water.

TABLE 6-38
Habitat Characteristic for Dominant Fish Species in Underwood Creek and Menomonee River Near Underwood Creek

Dominant Fish Species	Preferred Current Velocity ^a	Stream Gradient ^a	General Habitat Characteristics ^a	Dominant Substrate Preference ^a	Potential Changes to Habitat with Return Flow
Pearl dace	Not documented in reviewed literature	Not documented in reviewed literature	Pools	Sand, gravel	Improved pool depth, especially during low-flow periods. Additional substrate habitat could become available.
Creek chub	Less than 0.98 ft/sec	3 to 23 meters per kilometer (m/km)	Pools	Sand, gravel	Improved pool depth, especially during low-flow periods. Preferred velocity is out of range, but larger pools should offer more refuge. More substrate habitat could become available.
White sucker	1.31 ft/sec	Wide range	Wide range	Gravel, sand	Improved preferred current velocity. More substrate habitat could become available.
Long nose dace	More than 1.48 ft/sec	1.9 to 18.7 m/km	Riffles	Gravel, rubble	Improved preferred current velocity. More substrate habitat could become available.
Blunt nose minnow	Not documented in reviewed literature	Not documented in reviewed literature	Wide range	Gravel, sand	More substrate habitat could become available.
Black nose dace	0.49 to 1.48 ft/sec	11.4 to 23.3 m/km	Rocky runs and pools	Gravel, sand	Improved pool depth, especially during low-flow periods. Improvement in preferred current velocity. More substrate habitat could become available.
Central stoneroller	Not documented in reviewed literature	Not documented in reviewed literature	Rocky riffles, runs, pools	Gravel, sand, rubble	Improved pool depth, especially during low-flow periods. More substrate habitat could become available.
Common shiner	Not documented in reviewed literature	Not documented in reviewed literature	Rocky pools near riffles	Hard bottom, gravel, sand, rubble	Improved pool depth, especially during low-flow periods. More substrate habitat could become available.
Fathead minnow	Not documented in reviewed literature	Not documented in reviewed literature	Muddy pools	Sand, rubble, gravel	Improved pool depth, especially during low-flow periods. More substrate habitat could become available.
Largemouth bass	More than 0.33 ft/sec	Not documented in reviewed literature	Not documented in reviewed literature	Vegetated areas, sand, gravel, mud	Improved preferred current velocity. More substrate habitat could become available.

TABLE 6-38
Habitat Characteristic for Dominant Fish Species in Underwood Creek and Menomonee River Near Underwood Creek

Dominant Fish Species	Preferred Current Velocity ^a	Stream Gradient ^a	General Habitat Characteristics ^a	Dominant Substrate Preference ^a	Potential Changes to Habitat with Return Flow
Green sunfish	Less than 0.33 ft/sec	0.2 to 5.7 m/km	50 percent pool areas	Vegetated cover	Improved pool depth, especially during low-flow periods. Preferred velocity is out of range, but larger pools should offer more refuge. No change in vegetated cover habitat expected.
Johnny darter	Not documented in reviewed literature	Not documented in reviewed literature	Pools	Sand, mud	Improvement pool depth, especially during low-flow periods. More substrate habitat could become available.
Bluegill	Less than 0.33 ft/sec	≤ 0.5 m/km	60 percent pool areas	Submerged vegetation, logs, brush	Improved pool depth, especially during low-flow periods. Preferred velocity is out of range; however, larger pools should offer more refuge. No change in vegetated cover habitat expected.
Central mud minnow	Not documented in reviewed literature	Not documented in reviewed literature	Quiet areas	Soft mud bottom/dense vegetation	More substrate habitat could become available.

^a Main sources of information are from “Desktop Fisheries Analysis Assessment for Underwood Creek and Menomonee River Return Flow”, included as an attachment to the Return Flow Plan (Volume 4 of the Application).

TABLE 6-39

Summary of Return Flow Effects on Habitat Characteristic for Fish Species Identified in WDNR Online Database as State Threatened, Endangered, and Species of Special Concern near Underwood Creek, but not Documented as Present in Recent Fish Surveys

Fish Species ^a	Preferred Current Velocity	Stream Gradient	General Habitat Characteristics	Dominant Substrate Preference	Potential Changes to Habitat with Return Flow
Striped shiner (endangered)	Not documented in reviewed literature.	Not documented in reviewed literature.	Clear to slightly turbid waters of runs and shallow pools, with dense aquatic vegetation.	Cobble, boulders, silt, sand, mud or bedrock	Preferred habitat for this species is unlikely in this reach of Underwood Creek; therefore no change expected.
Redfin shiner (threatened)	Not documented in reviewed literature.	Not documented in reviewed literature.	Prefers turbid waters of pools in low-gradient streams.	Boulders, cobble, sand, silt or detritus	Preferred habitat for this species is unlikely in this reach of Underwood Creek; therefore no change expected.
Redside dace (special concern)	Not documented in reviewed literature.	Not documented in reviewed literature.	Prefers cool water pools and quiet riffles of small streams (usually adjacent to meadows or pastures).	Cobble, sand, clay silt or bedrock	Preferred habitat for this species is unlikely in this reach of Underwood Creek; therefore no change expected.
Lake chubsucker (special concern)	Not documented in reviewed literature.	Not documented in reviewed literature.	Prefers moderately clear lakes, oxbow lakes, sloughs of weedy lakes and their associated marshy streams.	Organic debris over bottoms of cobble, sand, boulders, mud or silt.	Preferred habitat for this species does not exist in this reach of Underwood Creek; therefore no change expected.
Least darter (special concern)	Not documented in reviewed literature.	Not documented in reviewed literature.	Prefers clear, warm, quiet waters of overflow ponds, pools, lakes and streams.	Gravel, silt, sand, boulders, mud or clay with dense vegetation or filamentous algal beds	Preferred habitat for this species is unlikely in this reach of Underwood Creek; therefore no change expected.

^a WDNR. Online Natural Heritage Inventory Database: <http://dnr.wi.gov/org/land/er/nhi/CountyElements/>.

- Under baseflow and low-flow conditions, return flow would provide additional water depth to improve fish passage through the riffle and concrete parts of the creek, to deepen pools within the restored reach, and to provide more wetted perimeter habitat near the creek banks and overhanging vegetation.
- Return flow is expected to slightly increase shear stresses in the creek, which are insignificant to the geomorphic stability of the creek, but could improve the bottom substrate habitat by reducing embeddedness (fine sediment accumulation in coarse substrates) to support coarse sediment habitat, such as gravel.
- An increase in wetted perimeter would provide additional substrate for the production of macroinvertebrates, thus improving the quantity of the food base for fish. Where suitable habitat is available, the macroinvertebrate community in Underwood Creek might change with return flow, but it would change to one that is more sustainable and adapted to the increased flows. The macroinvertebrate community with return flow would likely be more diverse since periods of no flow would no longer occur.
- As a result of this analysis, return flow to Underwood Creek is expected to have a positive impact to fisheries in Underwood Creek.

Return flow is not expected to have a significant adverse effect upon natural communities or wetlands adjacent to the waterway downstream of the return flow location. Because floodplain forest and emergent marsh habitats or similar habitats that may exist near return flow locations are immediately adjacent to the ordinary high water mark, mammal, vegetative, and bird species associated with floodplain forest and emergent marsh are well adapted to withstand minor fluctuations in water elevation resulting from typical seasonal conditions, flood events, or drought. Based upon the small water level changes expected to occur with return flow, no significant adverse impacts to emergent marsh, riparian species, or floodplain forests or the species that depend upon these habitats is expected.

Root River Alignments 1 and 2 and Direct-to-Lake Michigan Return Flow

These return flow alternatives do not change flow in Underwood Creek and will consequently cause no significant adverse impacts to Underwood Creek fisheries.

Root River

Deep and Shallow Aquifers, and Shallow Aquifer and Fox River Alluvium Water Supplies

The groundwater supply alternatives do not cause a change in the Root River. Consequently, the affect upon Root River fisheries with the groundwater supply alternatives will be no significant adverse impact.

Lake Michigan Water Supply (Cities of Milwaukee, Oak Creek, and Racine)

A Lake Michigan supply itself will have no impact upon the Root River. The impacts of various return flow alternatives are described below.

Underwood Creek to Lake Michigan Return Flow

The Underwood Creek return flow alternative will have no affect on the Root River. Consequently, the affect upon Root River fisheries with Underwood Creek return flow will be no significant adverse impact.

Root River Alignments 1 and 2 to Lake Michigan Return Flow

An analysis of potential Root River habitat changes from an increase in flow from return flow was performed. The baseflow rate near the potential return flow location was 3 cfs and velocity was 0.11 ft/sec. The analysis found that the estimated increase in water surface elevation at baseflow conditions with a maximum return flow of 28.6 ft³/sec (18.5 mgd) was 0.91 foot and an increase in river velocity to 0.51 ft/sec during low-flow periods.

According to the literature, the slightly higher velocity generally still would be within the preferred velocity range for the dominant fish species in the Root River. Consequently, the slightly higher velocity is not expected to adversely affect the dominant fish species in the Root River. Table 6-40 summarizes the habitat preferences and potential changes to habitat with return flow for the dominant fish species in the Root River.

A search of the Wisconsin Natural Heritage Working List (WDNR, 2012b) and the WDNR Animals, Plants, and Natural Communities Database identified several threatened, endangered, or species of special concern in Root River area (Table 6-41).

Return flow will increase the baseflow, which will have positive effects on water availability, amount of habitat, and also the fish species that depend upon Root River. This is consistent with baseflow augmentation recommendations in prior Root River watershed reports. These anticipated positive effects are summarized below:

- The habitat for fish could be improved with additional flow, especially during periods when with current conditions low baseflows limit habitat availability.
- The WDNR's Root River Steelhead Facility could benefit from additional flow in the Root River. Since natural reproduction of trout and salmon does not occur in Wisconsin waters, the Lake Michigan's trout and salmon fishery is entirely dependent upon hatchery-raised fish. The Root River Steelhead Facility is Wisconsin's main source of rainbow trout (steelhead) eggs and brood (parent) stock and is the backup facility for the collection of eggs of other trout and salmon species. During some years when flow on the Root River is low, the WDNR has not met fish egg collection quotas. The WDNR has evaluated flow augmentation of the Root River to improve fish migration for egg collection, but determined it was cost prohibitive. Return flow provides the flow augmentation considered by the WDNR to allow more fish to reach the Steelhead Facility, meet egg collection quotas, and fish stocking goals (WDNR, 01/2013a).
- Under baseflow and low-flow conditions, return flow would provide additional water depth to improve fish passage through the riffle and shallow parts of the river, to deepen pools, and to provide more wetted perimeter habitat near the river banks and overhanging vegetation.
- Return flow is expected to slightly increase shear stresses in the river, which are insignificant to the geomorphic stability, but could improve the bottom substrate habitat by reducing embeddedness (fine sediment accumulation in coarse substrates) to support coarse sediment habitat, such as gravel.

TABLE 6-40
Habitat Characteristic for Dominant Fish Species in the Root River

Dominant Fish Species	Preferred Current Velocity ^a	Stream Gradient ^a	General Habitat Characteristics ^a	Dominant Substrate Preference ^a	Potential Changes to Habitat with Return Flow
Creek chub	Less than 0.98 ft/sec	3 to 23 meters per kilometer (m/km)	Pools	Sand, gravel	Improved pool depth, especially during low-flow periods. Preferred velocity is out of range, but larger pools should offer more refuge. More substrate habitat could become available.
White sucker	1.31 ft/sec	Wide range	Wide range	Gravel, sand	Improved preferred current velocity. More substrate habitat could become available.
Long nose dace	More than 1.48 ft/sec	1.9 to 18.7 m/km	Riffles	Gravel, rubble	Improved preferred current velocity. More substrate habitat could become available.
Blunt nose minnow	Not documented in reviewed literature	Not documented in reviewed literature	Wide range	Gravel, sand	More substrate habitat could become available.
Black nose dace	0.49 to 1.48 ft/sec	11.4 to 23.3 m/km	Rocky runs and pools	Gravel, sand	Improved pool depth, especially during low-flow periods. Improvement in preferred current velocity. More substrate habitat could become available.
Green sunfish	Less than 0.33 ft/sec	0.2 to 5.7 m/km	50 percent pool areas	Vegetated cover	Improved pool depth, especially during low-flow periods. Preferred velocity is out of range, but larger pools should offer more refuge. No change in vegetated cover habitat expected.
Johnny darter	Not documented in reviewed literature	Not documented in reviewed literature	Pools	Sand, mud	Improvement pool depth, especially during low-flow periods. More substrate habitat could become available.
Central mud minnow	Not documented in reviewed literature	Not documented in reviewed literature	Quiet areas	Soft mud bottom/dense vegetation	More substrate habitat could become available.

TABLE 6-40
Habitat Characteristic for Dominant Fish Species in the Root River

Dominant Fish Species	Preferred Current Velocity ^a	Stream Gradient ^a	General Habitat Characteristics ^a	Dominant Substrate Preference ^a	Potential Changes to Habitat with Return Flow
Brook stickleback	Not documented in reviewed literature	Not documented in reviewed literature	Clear to slightly turbid waters of moderate currents	Sand, gravel and mud	More substrate habitat could become available.
Sand Shiner	0.33 to 0.98 ft/sec	Wide Range	Prefers moderate currents and depths less than 0.33 ft	Sand, gravel-rubble/no aquatic vegetation	Improved preferred current velocity.

^a Main sources of information are from “Desktop Fisheries Analysis Assessment for Underwood Creek and Menomonee River Return Flow”, included as an attachment to the Return Flow Plan (Volume 4 of the Application), and Edwards et al (1988).

TABLE 6-41

Summary of Return Flow Effects on Habitat Characteristic for Fish Species Identified in WDNR Online Database as State Threatened, Endangered, and Species of Special Concern near Root River Return Flow Alignment 2 Discharge Location, but not Documented as Present in Recent Fish Surveys

Fish Species ^a	Preferred Current Velocity	Stream Gradient	General Habitat Characteristics	Dominant Substrate Preference	Potential Changes to Habitat with Return Flow
Longgear Sunfish (threatened)	Not documented in reviewed literature.	Not documented in reviewed literature.	Slow moving rivers and streams.	Shallow dense vegetation	More substrate habitat could become available.
Redfin shiner (threatened)	Not documented in reviewed literature.	Not documented in reviewed literature.	Prefers turbid waters of pools in low-gradient streams.	Boulders, cobble, sand, silt or detritus	Improved pool depth, especially during low-flow periods.
Lake chubsucker (special concern)	Not documented in reviewed literature.	Not documented in reviewed literature.	Prefers moderately clear lakes, oxbow lakes, sloughs of weedy lakes and their associated marshy streams.	Organic debris over bottoms of cobble, sand, boulders, mud or silt.	Preferred habitat for this species is unlikely in this reach of the Root River; therefore no change expected.
Least darter (special concern)	Not documented in reviewed literature.	Not documented in reviewed literature.	Prefers clear, warm, quiet waters of overflow ponds, pools, lakes and streams.	Gravel, silt, sand, boulders, mud or clay with dense vegetation or filamentous algal beds	Improved pool depth, especially during low-flow periods.

^a WDNR. Online Natural Heritage Inventory Database: <http://dnr.wi.gov/org/land/er/nhi/CountyElements/>.

- An increase in wetted perimeter would provide additional substrate for the production of macroinvertebrates, thus improving the quantity of the food base for fish. Where suitable habitat is available, the macroinvertebrate community in the Root River might change with return flow, but it would change to one that is more sustainable and adapted to the increased flows. The macroinvertebrate community with return flow would likely be more diverse since periods of low flow would no longer occur.
- As a result of this analysis, return flow to the Root River is expected to have a positive impact to fisheries in the Root River.

Return flow is not expected to have a significant adverse effect upon natural communities or wetlands adjacent to the waterway downstream of the return flow location. Because floodplain forest and emergent marsh habitats or similar habitats that may exist near return flow locations are immediately adjacent to the ordinary high water mark, mammal, vegetative, and bird species associated with floodplain forest and emergent marsh are well adapted to withstand minor fluctuations in water elevation resulting from typical seasonal conditions, flood events, or drought. Based upon the small water level changes expected to occur with return flow, no significant adverse impacts to emergent marsh, riparian species, or floodplain forests or the species that depend upon these habitats is expected.

Direct to Lake Michigan Return Flow

The direct to Lake Michigan return flow alternative will have no affect on the Root River. Consequently, the affect upon Root River fisheries with direct to Lake Michigan return flow will be no significant adverse impact.

Potential For Invasive Species

The City of Waukesha will use practices to reduce the potential of introducing or spreading invasive species and viruses (e.g. VHS) through the use of construction best management practices and ongoing operation practices.

During the construction phase of the water supply and return flow pipelines, best management practices will be used to reduce the potential introduction or spread of invasive species. The recently developed NR 40 *Invasive Species Identification, Classification and Control*, will be consulted and followed where applicable to implement best practices to control the spread of invasive species. Example practices that will be considered include washing equipment and timber mats before entering wetlands/water bodies, removing aquatic vegetation from equipment leaving waterways, steam cleaning and disinfecting equipment used in waterways where invasive species may exist, utilizing non-invasive construction techniques, and others. Post construction restoration methods will only use native species and it will consider methods to encourage existing native species to thrive to reduce the potential of the invasive species establishing a foothold. Using these approaches will reduce the potential for spreading invasive species during construction.

During the operation phase of the water supply and return flow pipelines, a Lake Michigan water supply source would have multiple barriers that would prevent the spread of invasive species through water delivered to the City of Waukesha. Drinking water treatment at any of the three potential Lake Michigan suppliers includes filters and disinfection procedures to remove and inactivate viruses. This level of treatment will not allow transfer of invasive species through the water distribution system. Once the water is

distributed in pipelines, an on-going disinfectant residual will be maintained, as required, to prevent microbial growth within the pipelines.

Once the drinking water is used and is collected in the sanitary sewer collection system, the City of Waukesha WWTP provides treatment before being discharged to the Fox River or as return flow. The WWTP is an advanced facility with settling and biological treatment systems, dual media sand filters, and ultraviolet light disinfection designed to meet WDNR water quality requirements. The treated wastewater is contained within the WWTP before being discharged as return flow. Consequently, there are no opportunities for invasive species or VHS from the Mississippi Basin to be introduced to the Lake Michigan basin from the return flow discharge.

6.4.2.5.3 Environmental Effects Comparison: Inland Waterways Flora and Fauna

Adverse impacts from changes in inland waterways flora and fauna are captured by impacts to aquatic habitat from baseflow changes. Baseflow changes have been previously documented in the Section 6.4.2.2 documenting baseflow changes. The threatened and endangered species identified by regulatory agencies as potentially occurring within the project corridors are summarized for all alternatives in Section 6.4.3, Wetlands, since most of the potential impacts involve federal- or state-listed species associated with wetlands.

6.4.3 Wetlands

Federally jurisdictional wetlands are classified as “waters of the United States” and are protected under Section 404 of the Clean Water Act (34 USC 1344). The term “waters of the United States” covers both deepwater aquatic habitats and six categories of special aquatic sites (of which wetlands are one category) designated by the EPA in its Section 404(b)(1) guidelines (EPA, 2010b). The USACE and EPA jointly define wetlands as “areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that in normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.” Wetlands generally include swamps, marshes, bogs, and similar areas.

Wetland quality is decreased by various disturbances, including agricultural activities, silviculture, residential development, transportation and utility easements, drainage modifications (ditches, dams, drain tiles, stream channelization, etc.), and the invasion of exotic or nuisance plants. These disturbances usually alter the plant species composition or hydrological regime of an area, which in turn alter wetland quality.

For an area to be defined as a jurisdictional wetland, it must, under normal circumstances, possess positive indicators of each of three parameters: hydrophytic vegetation, hydric soils, and wetland hydrology.

- *Hydrophytic vegetation.* The prevalent vegetation must consist of plants adapted to life in hydric soils. These species, because of morphological, physiological, or reproductive adaptations, can and do persist in anaerobic soil conditions.
- *Hydric soils.* Soils in wetlands must be classified as hydric, or they must possess characteristics that are associated with reducing soil conditions. Hydric soils are soils that are “saturated, flooded, or ponded long enough during the growing season to

develop anaerobic conditions that favor the growth and regeneration of hydrophytic vegetation” (USACE, 1987).

- *Wetland hydrology.* The area must be permanently or periodically inundated or have soils that are saturated to the surface for some time during the growing season.

6.4.3.1 Location, Type, Size

6.4.3.1.1 Affected Environment

Wetlands crossed by the supply and return flow alternatives, at the proposed aboveground structures (including well houses and WTP), and affected by groundwater drawdown were identified from the 2005 Wetlands Inventory provided by SEWRPC and WDNR (2005) to produce an accurate and comprehensive desktop wetlands inventory.

Table 6-42 lists the wetlands crossed by the supply and return flow alternatives. Refer to the maps found in Appendix 3-1 of Section 3 and to Appendix 6-1 at the end of this section for maps associated with the proposed project and alternatives to the proposed project. There is some overlap between wetlands potentially affected by groundwater drawdown and wetlands affected only by groundwater supply pipelines or aboveground structure construction for the groundwater alternatives. Table 6-43 lists wetlands that would be affected by the pipeline or aboveground structure construction.

Wetlands affected by groundwater pumping were determined from groundwater modeling results (RJN Environmental Services, 2010). The wetlands affected by 5 foot or greater or 1 foot or greater groundwater drawdown are shown in Appendix 6-3 at the end of this section. Because a wetland is designated by the type of plants, hydrology, and soil type, groundwater drawdown in wetlands can reduce or eliminate the hydrology element required to sustain wetland conditions. Consequently, wetlands susceptible to groundwater drawdown from shallow aquifer water supply alternatives are included in the affected environment.

6.4.3.1.2 Environmental Effects

Wetland effects caused by the proposed project or alternatives to the proposed project fall into two categories: impacts from construction, and impacts from groundwater drawdown. Impacts from construction may be temporary construction impacts or operational impacts from new facilities, such as buildings or roads. Groundwater drawdown impacts are operational impacts caused by lowering water tables when aquifers are pumped. Wetland loss from pipeline construction impacts are expected to be temporary in nature, whereas operational impacts will be ongoing permanent impacts. Some changes in wetland type from pipeline corridor maintenance are expected only where the pipeline corridor is not already maintained.

Aboveground structures associated with the various alternatives represent potential permanent impacts to wetland resources. Depending on the alternative, permanent structures may include pump houses, access roads, and WTPs. Preliminary siting of aboveground resources has been completed and is associated primarily with the Deep and Shallow Aquifers alternative and the Shallow Aquifer and Fox River Alluvium alternative. Potential permanent impacts to wetland resources under these two alternatives are described below. The pipeline alignments for other alternatives have few aboveground structures.

TABLE 6-42
Wetland Crossings

Alternative	Wetland No.	Wetland Type	Crossing Width (ft)	Crossing Area (acres)
Supply				
Deep and Shallow Aquifers	7963	Emergent/wet meadow	556.9	1.60
	7982	Emergent/wet meadow	597.2	1.83
	8111	Flats/unvegetated wet soil	—	0.01
	8122	Scrub/shrub	—	0.13
	8129	Scrub/shrub	474.7	1.34
	8146	Scrub/shrub	872.4	1.50
	8178	Scrub/shrub	480.3	0.83
	8197	Scrub/shrub	526.8	0.71
	8246	Scrub/shrub	—	0.07
	8263	Scrub/shrub	283.3	0.58
	8315	Forested	—	0.02
	8325	Forested	—	0.02
	8392	Forested	—	0.84
	8395	Forested	235.7	0.40
	8399	Forested	611.9	0.95
	8401	Forested	—	0.01
Shallow Aquifer and Fox River Alluvium	7963	Emergent/wet meadow	556.9	1.60
	7982	Emergent/wet meadow	597.2	1.83
	8044	Emergent/wet meadow	—	0.52
	8089	Emergent/wet meadow	58.6	0.28
	8111	Flats/unvegetated wet soil	—	0.01
	8122	Scrub/shrub	—	0.13
	8129	Scrub/shrub	474.7	1.34
	8146	Scrub/shrub	872.4	1.50
	8178	Scrub/shrub	480.3	0.83
	8179	Scrub/shrub	45.8	0.31
	8184	Scrub/shrub	220.8	1.09
	8197	Scrub/shrub	526.8	0.71
	8246	Scrub/shrub	—	0.07
	8249	Scrub/shrub	—	0.11
	8263	Scrub/shrub	283.3	0.58
	8266	Scrub/shrub	—	0.15
	8303	Forested	782.9	1.34
	8315	Forested	—	0.02

TABLE 6-42
Wetland Crossings

Alternative	Wetland No.	Wetland Type	Crossing Width (ft)	Crossing Area (acres)
	8324	Forested	—	1.23
	8325	Forested	902.8	2.06
	8392	Forested	—	0.84
	8395	Forested	235.7	0.40
	8399	Forested	611.9	0.95
	8401	Forested	248.5	1.59
	8402	Forested	213.5	2.42
Lake Michigan (City of Milwaukee)	4965	Scrub/shrub	216.7	0.38
	7962	Emergent/wet meadow	—	0.37
	8145	Scrub/shrub	—	0.16
	8239	Scrub/shrub	—	0.13
	8290	Scrub/shrub	—	0.49
	8465	Forested	—	0.12
	8723	Emergent/wet meadow	—	0.08
	8909	Scrub/shrub	—	0.30
	8911	Scrub/shrub	—	0.17
	8915	Scrub/shrub	—	0.001
	8920	Scrub/shrub	—	0.11
	8921	Scrub/shrub	—	0.14
	8923	Scrub/shrub	—	0.07
	9184	Forested	—	0.01
	9306	Open water	—	0.01
	10454	Emergent/wet meadow	—	0.02
	11047	Emergent/wet meadow	313.4	0.50
	11672	Scrub/shrub	—	0.02
	11796	Forested	637.4	1.08
	11799	Forested	1,286.9	2.53
	11973	Forested	—	0.002
	12645	Forested	—	0.02
	12650	Forested	—	0.15
	12660	Forested	—	0.01
Lake Michigan (City of Oak Creek) Alignment 1	4965	Scrub/shrub	—	0.38
	7962	Emergent/wet meadow	—	0.37
	8145	Scrub/shrub	—	0.16
	8239	Scrub/shrub	—	0.13

TABLE 6-42
Wetland Crossings

Alternative	Wetland No.	Wetland Type	Crossing Width (ft)	Crossing Area (acres)
	8290	Scrub/shrub	—	0.49
	8465	Forested	—	0.12
	8723	Emergent/wet meadow	—	0.08
	8909	Scrub/shrub	—	0.30
	8911	Scrub/shrub	—	0.17
	8915	Scrub/shrub	—	0.001
	8920	Scrub/shrub	—	0.11
	8921	Scrub/shrub	—	0.14
	8923	Scrub/shrub	—	0.07
	9184	Forested	—	0.01
	9306	Open water	—	0.01
	10454	Emergent/wet meadow	—	0.02
	10748	Emergent/wet meadow	—	0.03
	10753	Emergent/wet meadow	—	0.52
	10810	Emergent/wet meadow	—	0.17
	10822	Emergent/wet meadow	—	0.13
	10931	Emergent/wet meadow	—	0.72
	11026	Emergent/wet meadow	—	0.04
	11030	Emergent/wet meadow	—	0.07
	11031	Emergent/wet meadow	—	0.28
	11047	Emergent/wet meadow	—	0.50
	11273	Scrub/shrub	—	0.01
	11346	Scrub/shrub	—	0.09
	11363	Scrub/shrub	—	0.10
	11381	Scrub/shrub	—	0.04
	11433	Scrub/shrub	—	0.15
	11437	Scrub/shrub	—	0.001
	11548	Scrub/shrub	—	0.19
	11564	Scrub/shrub	—	1.82
	11586	Scrub/shrub	—	0.02
	11638	Scrub/shrub	—	0.01
	11672	Scrub/shrub	—	0.02
	11772	Forested	—	0.40
	11796	Forested	—	0.01
	11799	Forested	—	2.49

TABLE 6-42
Wetland Crossings

Alternative	Wetland No.	Wetland Type	Crossing Width (ft)	Crossing Area (acres)
	11970	Forested	—	0.16
	11972	Forested	—	1.14
	11973	Forested	—	0.002
	12265	Forested	—	0.09
	12285	Forested	—	0.04
	12294	Forested	—	0.47
	12299	Forested	—	0.26
	12384	Forested	—	0.43
	12505	Forested	—	0.09
	12645	Forested	—	0.02
	12650	Forested	—	0.15
	12660	Forested	—	0.01
	13168	Open water	—	0.03
	13185	Open water	—	0.02
Lake Michigan (City of Oak Creek) Alignment 2	8714	Emergent/wet meadow	—	0.07
	9020	Forested	—	0.02
	9026	Forested	—	0.07
	9028	Forested	—	0.01
	10401	Emergent/wet meadow	—	<0.01
	10573	Emergent/wet meadow	—	<0.01
	11286	Scrub/shrub	—	0.01
	11290	Scrub/shrub	—	0.02
	11369	Scrub/shrub	—	0.02
	11376	Scrub/shrub	—	0.05
	11539	Scrub/shrub	—	<0.01
	11896	Forested	—	0.07
	11897	Forested	—	<0.01
	11900	Forested	—	0.13
	11906	Forested	—	0.03
	11914	Forested	—	<0.01
	12293	Forested	—	0.01
	12301	Forested	—	0.01
	12314	Forested	—	<0.01
	12392	Forested	—	0.01
	12399	Forested	—	<0.01

TABLE 6-42
Wetland Crossings

Alternative	Wetland No.	Wetland Type	Crossing Width (ft)	Crossing Area (acres)
Lake Michigan (City of Racine)	3	Emergent/wet meadow	—	0.61
	4965	Scrub/shrub	—	0.38
	7512	Scrub/shrub	—	0.02
	7895	Open water	—	0.39
	7962	Emergent/wet meadow	—	0.37
	8050	Emergent/wet meadow	—	1.94
	8126	Scrub/shrub	—	0.51
	8139	Scrub/shrub	—	0.09
	8145	Scrub/shrub	—	0.16
	8168	Scrub/shrub	—	0.43
	8183	Scrub/shrub	—	0.96
	8188	Scrub/shrub	—	0.54
	8192	Scrub/shrub	—	0.70
	8239	Scrub/shrub	—	0.13
	8290	Scrub/shrub	—	0.49
	8338	Forested	—	1.14
	8382	Forested	—	0.03
	8383	Forested	—	0.05
	8436	Forested	—	0.20
	8465	Forested	—	0.12
	8625	Filled/drained wetland	—	0.17
	8632	Filled/drained wetland	—	0.37
	8766	Emergent/wet meadow	—	3.23
	8872	Scrub/shrub	—	3.46
	8873	Scrub/shrub	—	2.72
	8901	Scrub/shrub	—	0.47
	9139	Forested	—	0.06
	9184	Forested	—	0.01
	9309	Scrub/shrub	—	2.25
	9336	Emergent/wet meadow	—	0.22
	9337	Emergent/wet meadow	—	0.36
	9345	Emergent/wet meadow	—	0.40
	9353	Emergent/wet meadow	—	0.81
	9358	Emergent/wet meadow	—	0.001
	9366	Emergent/wet meadow	—	0.43

TABLE 6-42
Wetland Crossings

Alternative	Wetland No.	Wetland Type	Crossing Width (ft)	Crossing Area (acres)
	9378	Emergent/wet meadow	—	1.85
	9381	Emergent/wet meadow	—	0.12
	9382	Emergent/wet meadow	—	0.10
	9395	Emergent/wet meadow	—	0.26
	9396	Emergent/wet meadow	—	0.55
	9406	Emergent/wet meadow	—	0.45
	9408	Emergent/wet meadow	—	0.15
	9423	Flats/unvegetated wet soil	—	0.21
	9432	Flats/unvegetated wet soil	—	0.61
	9434	Flats/unvegetated wet soil	—	0.44
	9450	Flats/unvegetated wet soil	—	1.84
	9451	Flats/unvegetated wet soil	—	0.63
	9457	Scrub/shrub	—	1.26
	9459	Scrub/shrub	—	0.54
	9461	Scrub/shrub	—	0.42
	9464	Scrub/shrub	—	1.22
	9477	Scrub/shrub	—	0.75
	9503	Forested	—	0.51
	9531	Forested	—	0.03
	9552	Open water	—	0.20
	9556	Open water	—	0.50
	9559	Open water	—	0.22
	9561	Open water	—	0.05
	9592	Emergent/wet meadow	—	0.46
	9597	Emergent/wet meadow	—	0.26
	10058	Emergent/wet meadow	—	0.72
	10090	Emergent/wet meadow	—	0.26
	10164	Scrub/shrub	—	0.02
	10195	Forested	—	1.31
	13701	Filled/drained wetland	—	0.05
	13719	Filled/drained wetland	—	0.07
	14241	Emergent/wet meadow	—	0.02
	14301	Emergent/wet meadow	—	0.23
	14655	Flats/unvegetated wet soil	—	0.12
	15492	Emergent/wet meadow	—	0.21

TABLE 6-42
Wetland Crossings

Alternative	Wetland No.	Wetland Type	Crossing Width (ft)	Crossing Area (acres)
	15519	Emergent/wet meadow	—	0.32
	15593	Emergent/wet meadow	—	0.12
	15606	Emergent/wet meadow	—	0.26
	15748	Emergent/wet meadow	—	0.36
	15821	Emergent/wet meadow	—	0.73
	16339	Flats/unvegetated wet soil	—	0.05
	16468	Flats/unvegetated wet soil	—	0.66
	16601	Scrub/shrub	—	2.03
	16870	Scrub/shrub	—	0.68
	16945	Scrub/shrub	—	0.86
	16956	Scrub/shrub	—	0.001
	16957	Scrub/shrub	—	0.26
	16973	Scrub/shrub	—	0.14
	17124	Scrub/shrub	—	0.72
	17253	Scrub/shrub	—	0.18
	17860	Forested	—	0.85
	18252	Forested	—	0.30
	18661	Forested	—	0.02
	18669	Forested	—	0.75
	18679	Forested	—	1.47
	20167	Open water	—	0.26
Return Flow Alternatives				
Underwood Creek to Lake Michigan	6807	Emergent/wet meadow	187.0	0.30
	6934	Forested	20.0	0.04
	6937	Forested	1,380.9	2.52
	7003	Forested	—	0.05
	7962	Emergent/wet meadow	—	1.38
	7970	Emergent/wet meadow	—	0.00
	8015	Emergent/wet meadow	—	0.17
	8125	Scrub/shrub	—	0.75
	8145	Scrub/shrub	—	0.16
	8239	Scrub/shrub	—	0.13
	8290	Scrub/shrub	—	0.49
	8463	Forested	—	0.11

TABLE 6-42
Wetland Crossings

Alternative	Wetland No.	Wetland Type	Crossing Width (ft)	Crossing Area (acres)
	8723	Emergent/wet meadow	—	0.08
	8909	Scrub/shrub	—	0.30
	8911	Scrub/shrub	—	0.17
	8915	Scrub/shrub	—	0.00
	8920	Scrub/shrub	—	0.11
	8921	Scrub/shrub	—	0.14
	8923	Scrub/shrub	—	0.07
	9184	Forested	—	0.01
	9306	Open water	—	0.01
	12683	Forested	1,454.2	2.38
Root River to Lake Michigan Alignment 1	7962	Emergent/wet meadow	—	1.38
	7970	Emergent/wet meadow	—	0.00
	8015	Emergent/wet meadow	—	0.17
	8125	Scrub/shrub	—	0.75
	8145	Scrub/shrub	—	0.16
	8239	Scrub/shrub	—	0.13
	8290	Scrub/shrub	—	0.49
	8463	Forested	—	0.11
	8723	Emergent/wet meadow	—	0.08
	8909	Scrub/shrub	—	0.30
	8911	Scrub/shrub	—	0.17
	8915	Scrub/shrub	—	0.00
	8920	Scrub/shrub	—	0.11
	8921	Scrub/shrub	—	0.14
	8923	Scrub/shrub	—	0.07
	9184	Forested	—	0.01
	9306	Open water	—	0.01
	11029	Emergent/wet meadow	—	0.01
	11030	Emergent/wet meadow	90.5	0.11
	11031	Emergent/wet meadow	175.3	0.30
	11047	Emergent/wet meadow	—	0.18
	11433	Scrub/shrub	114.5	0.20
	11638	Scrub/shrub	14.5	0.04
	11672	Scrub/shrub	—	0.10

TABLE 6-42
Wetland Crossings

Alternative	Wetland No.	Wetland Type	Crossing Width (ft)	Crossing Area (acres)
	11794	Forested	—	0.00
	11796	Forested	15.3	0.03
	11799	Forested	2,261.4	3.58
	11970	Forested	—	0.01
	11972	Forested	503.7	0.92
	12578	Forested	304.8	0.52
	12581	Forested	—	0.22
	12585	Forested	82.7	0.13
	12587	Forested	—	0.00
	12645	Forested	—	0.72
	12650	Forested	284.7	0.69
	12656	Forested	—	0.25
	12660	Forested	—	0.28
Root River to Lake Michigan Alignment 2	8714	Emergent/wet meadow	—	0.07
	9020	Forested	—	0.02
	9026	Forested	—	0.07
	9028	Forested	—	0.01
	10573	Emergent/wet meadow	—	<0.01
	11209	Flats/unvegetated wet ^a soil	12.96	0.04
	11286	Scrub/shrub	—	0.01
	11290	Scrub/shrub	—	0.02
	11369	Scrub/shrub	—	0.02
	11376	Scrub/shrub	—	0.05
	11777	Forested	37.48	0.07
	11890	Forested	—	0.01
	11896	Forested	—	0.07
	11914	Forested	—	<0.01
	12263	Forested	—	0.11
	12314	Forested	—	<0.01
	12392	Forested	—	0.01
	12399	Forested	—	<0.01
Direct to Lake Michigan	7962	Emergent/wet meadow	—	1.38
	7970	Emergent/wet meadow	—	0.00
	8015	Emergent/wet meadow	—	0.17

TABLE 6-42
Wetland Crossings

Alternative	Wetland No.	Wetland Type	Crossing Width (ft)	Crossing Area (acres)
	8125	Scrub/shrub	—	0.75
	8145	Scrub/shrub	—	0.16
	8239	Scrub/shrub	—	0.13
	8290	Scrub/shrub	—	0.49
	8463	Forested	—	0.11
	8723	Emergent/wet meadow	—	0.08
	8909	Scrub/shrub	—	0.30
	8911	Scrub/shrub	—	0.17
	8915	Scrub/shrub	—	0.00
	8920	Scrub/shrub	—	0.11
	8921	Scrub/shrub	—	0.14
	8923	Scrub/shrub	—	0.07
	9184	Forested	—	0.01
	9306	Open water	—	0.01
	10321	Filled/drained wetland	121.6	0.13
	11046	Emergent/wet meadow	270.9	0.45
	11053	Emergent/wet meadow	—	0.19
	11054	Emergent/wet meadow	—	0.10
	11676	Scrub/shrub	—	0.01
	12613	Forested	—	0.08
	12627	Forested	—	0.08
	12628	Forested	—	0.01
	12643	Forested	193.6	0.32

^a Included in PEM summary because open flats will likely first transition to emergent vegetation.

Wetland crossing acreages associated with each of the alternatives are noted in Table 6-42, discussed below, and summarized in Table 6-43. A pipeline crossing a forested or scrub/shrub wetland would have a permanent wetland type change across the pipeline maintenance width. Maintenance would include managing woody vegetation. Consequently, pipeline maintenance would cause a shift from forested or scrub/shrub wetland to emergent marsh or wet meadow wetland type. Additional analysis on the significance of wetland acreages affected under each alternative as compared to other land use types can be found in Section 6.5.1.2, "Land Use."

Before the City of Waukesha obtains a construction permit for the proposed project, the City will coordinate with the WDNR pursuant to the requirement of NR 103 to seek ways to reduce wetland impacts, whether temporary construction or long-term operational impacts.

Such an analysis will look for ways to further reduce impacts, including adjustments to pipeline routes or construction methods to further minimize impacts.

Impacts to wetlands from permanent groundwater drawdown under the groundwater supply alternatives are discussed in Appendix 6-4, Vernon Marsh Wildlife Area Wetland Habitat Impact Analysis. Table 6-43 also documents the wetland acreages affected by groundwater drawdown.

Effects of Groundwater Drawdown on Wetlands

Estimated wetland impacts from groundwater drawdown were made for the greater-than-1-foot and the greater-than-5-foot drawdown extents. The degree of impact from groundwater drawdown will vary depending upon the wetland type, proximity to the zone of drawdown, severity of the depressed water table, frequency and amount of rainfall, and so on. The impacts will vary from one extreme, such as total loss of all wetland functions, to a shift from one wetland type to another. Impacts from groundwater drawdown are discussed in Appendix 6-4, Vernon Marsh Wildlife Area Wetland Habitat Impact Analysis, and summarized by wetland type as follows.

Calcareous Fen

Calcareous fen is a rare wet meadow type that is sustained by natural springs or groundwater seeps that make it to the surface. These springs and seeps bring specific water chemistry and hydrologic conditions that sustain some rare and specialized plant species (WDNR, 2006). The groundwater that reaches the surface is rich with calcium and magnesium bicarbonates (or sulfates), which creates a strong alkaline soil condition, in which only a few, rare calcium-tolerant plants can thrive (Miner and Ketterling, 2003). Prolonged interruption of this hydrologic process sustained by consistent groundwater expression may result in loss of certain rare resources. Calcareous fen occurs in the southern end of the Vernon Marsh Wildlife Area, in an area not included in the predicted area of groundwater drawdown. Consequently, no known calcareous fens will be impacted by the drawdown. However, plant species that require calcareous fen habitat or similar conditions were retained in the threatened and endangered species evaluation for the groundwater alternatives that have the potential to affect the Vernon Marsh Wildlife Area, since similar groundwater seepage conditions, even though they might not be a calcareous fen, could exist in the groundwater drawdown influence area.

Shallow Wetlands

Shallow wetland types, such as the emergent or wet meadow, flats or unvegetated wet soil, forested swamps or alluvium, seeps, and scrub shrub are wet only part of the year, as these wetland types have short and shallow hydroperiods. A prolonged or permanent decrease in groundwater levels of 1 foot or greater could lower the surface water level and soil saturation within these wetland types to such a degree that detrimental impacts to wildlife, endangered resources, and vegetative cover may occur. Impacts might include loss of habitat for invertebrates, fish, amphibians, or wading birds. Other impacts might be seen as a change in wildlife species that use the wetland, that is, with fewer wetland-dependent species present, more terrestrial species move in. Changes in herbaceous groundcover species would be observed first, followed by growth of a shrub layer.

Changes in groundcover could include a shift toward upland species, and upland shrubs could invade, resulting in a shift from herbaceous wetland to herbaceous/shrubby upland.

In many stressed wetlands, invasive plants become established and out-compete native vegetation. Invasive exotics can include reed canary grass (*Phalaris arundinacea*), giant reed (*Phragmites communis*), and purple loosestrife (*Lythrum salicaria*).

A permanent loss of surface water would most certainly preclude fish habitat and amphibian habitat, which likely would degrade the potential for the wetland to support other wildlife that feed on fish or amphibians.

Forested Wetlands

Wetland trees have a morphological adaptation to survive in wet soil conditions. When wet soils are exposed to air for several years, the result can be a loss of hydric indicators in the soil through oxidation, and subsidence can occur. The tree subcanopy and canopy would show signs of stress, the soil can subside, and trees topple as a result of reduced soil strength. With the loss of trees, the habitat is less suitable for nesting and denning, and food sources change (different plant seeds/berries), which may result in a loss of habitat for mammals, birds, or reptiles.

Drained or Filled Wetlands

Previously impacted (drained or filled) wetlands are likely to have diminished wetland functions and characteristics. Further and prolonged reductions in surface hydrology would in most situations result in complete loss of remaining functions.

Open Water Wetlands

Open water and aquatic bed wetland systems, which have much deeper water and are typically a permanent year-round flooded wetland type, can retain many of the functions associated with wetlands depending on the severity with which the hydrology has been affected. Aquatic beds along open-water areas could adapt to lowered water levels by extending runners and rhizomes farther into the deeper water zones as they drain or by a change in vegetation composition, where more drought-tolerant wetland plants become established. Within the predicted 1-to-5-foot drawdown range, the deeper systems might lose some deep-water wetland characteristics, such as waterfowl habitat, but may transition to a wet meadow or marsh habitat, which is more suitable to wading birds.

Impacts by Water Supply and Return Flow Alternative

The impacts to wetlands from water supply and return flow alternatives are described below.

Deep and Shallow Aquifers Water Supply

Two palustrine emergent (PEM) wetlands, seven palustrine scrub-shrub (PSS) wetlands, six palustrine forested (PFO) wetlands, and one flat/unvegetated wetland located along this alternative would be affected by the pipeline construction or aboveground structures. As shown in Table 6-43, the supply route may temporarily affect 12 acres of wetlands and permanently affect 4 acres of wetlands.

The groundwater drawdown from pumping would have significant operational impacts as shown in Table 6-43. Nearly 1,000 acres of wetlands would experience a 5-foot or greater groundwater drawdown. A 1-foot or greater groundwater drawdown would occur for more than 3,000 wetland acres.

TABLE 6-43
Wetlands Crossed by the Alternatives (Acres)

Alternative Name	Wetlands (ac)										Total	
	Emergent/Wet Meadow		Scrub/Shrub		Forested		Open Water		Other ^c			
	Temporary Land Affected ^a	Permanent Land Affected ^b	Temporary Land Affected ^a	Permanent Land Affected ^b	Temporary Land Affected ^a	Permanent Land Affected ^b	Temporary Land Affected ^a	Permanent Land Affected ^b	Temporary Land Affected ^a	Permanent Land Affected ^b	Temporary Wetlands Affected ^a	Permanent Wetland Affected ^b
Water Supply Alternatives												
Deep and Shallow Wells												
Pipeline & Aboveground Structures ^d	4	2	5	1	2	1	0	0	<1	0	12	4
Areas of 1-Foot or Greater Groundwater Drawdown	710	710	1,294	1,294	932	932	89	89	62	62	3,087	3,087
Areas of 5-Foot or Greater Groundwater Drawdown ^e	241	241	419	419	307	307	11	11	14	14	992	992
Deep and Shallow Wells Total ^f	714	712	1,299	1,295	934	933	89	89	63	62	3,099	3,091
Shallow Aquifer and Fox River Alluvium												
Pipeline & Aboveground Structures ^d	4	2	7	2	11	3	0	0	<1	0	23	7
Areas of 1-Foot or Greater Groundwater Drawdown	1,079	1,079	1,558	1,558	1,279	1,279	103	103	87	87	4,106	4,106
Areas of 5-Foot or Greater Groundwater Drawdown ^e	475	475	871	871	548	548	37	37	33	33	1,964	1,964
Shallow Aquifer and Fox River Alluvium Total ^f	1,083	1,081	1,565	1,560	1,290	1,282	103	103	88	87	4,129	4,113
Lake Michigan Supply Alternatives												
Lake Michigan (City of Milwaukee) ^g	1	0	2	<1	4	1	<1	0	0	0	8	1
Lake Michigan (City of Oak Creek) Alignment 1 ^g	3	0	4	1	6	1	<1	0	0	0	13	1
Lake Michigan (City of Oak Creek) Alignment 2 ^g	0.08	0	0.10	0	0.36	0	0	0	0	0	0.54	0
Lake Michigan (City of Racine) ^g	16	0	22	4	7	1	2	0	6	0	52	6
Return Flow Alternatives												
Underwood Creek to Lake Michigan ^g	2	0	2	0	5	1	<1	0	0	0	9	1
Root River to Lake Michigan Alignment 1 ^g	2	0	3	<0.1	7	1	<1	0	0	0	12	1
Root River to Lake Michigan Alignment 2 ^g	0.07	0	0.10	0	0.36	0.01	0	0	0.04	0	0.58	0.01
Direct to Lake Michigan ^g	2	0	2	0	1	<1	<1	0	<1	0	5	<1

Source: WWI

^a Includes all areas being temporarily impacted by the construction of the supply and return flow alternatives. Total values are slightly different due to rounding.

^b Includes all land being disturbed permanently for groundwater drawdowns and the operation of the alternatives, which includes new access roads, new aboveground structures, and pipeline maintenance corridors, where applicable. Total values are slightly different due to rounding.

^c Includes filled/drained wetlands, and flats/unvegetated wet soil areas.

^d Includes pipeline alignment, new access roads (15 feet wide), well houses, and WTP.

^e The Areas of the 5-Foot or Greater Groundwater Drawdown is contained within the Areas of the 1-Foot or Greater Groundwater Drawdown.

^f Includes Pipeline & Aboveground Structures and Areas of 1-Foot or Greater Groundwater Drawdown.

^g The majority of pipeline alignments follow previously disturbed areas and maintained utility corridors. Forested wetlands are generally not present in maintained utility corridors. Potential permanent wetland impacts are consequently conservative. Permanent wetland impacts incorporated in the Environmental Report are consequently estimated to be less than 5 acres, minor adverse impact.

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Because a wetland is designated by plant type, hydrology, and soil type, groundwater drawdown in wetlands can reduce or eliminate the hydrology element required to sustain wetland conditions. Species change, habitat change, or destruction of habitat could occur when the groundwater level is lowered below that needed for plant species that have colonized areas based upon current groundwater levels. Vernal pool habitat is also very susceptible to changes in water depth, and lowered groundwater levels could reduce the occurrence or duration of this seasonal habitat where it exists within the groundwater drawdown zone.

Shallow Aquifer and Fox River Alluvium Water Supply

Four PEM, 11 PSS, and 9 PFO wetlands are located along this alternative and affected by the pipeline construction or aboveground structures. As shown in Table 6-43, this supply route may temporarily affect 23 acres of wetlands and permanently affect 7 acres of wetlands.

The groundwater drawdown would have significant additional operational impacts, as shown in Table 6-43. Nearly 2,000 acres of wetlands would experience a 5-foot or greater groundwater drawdown. A 1-foot or greater groundwater drawdown would occur for over 4,000 wetland acres. The potential habitat changes described for the Deep and Shallow Aquifer alternative also apply to this alternative.

Lake Michigan Water Supply (City of Milwaukee)

Four PEM, 11 PSS, and 11 PFO wetlands are located along this alternative and affected by the pipeline construction. As shown in Table 6-43, this supply route may temporarily affect 8 acres of wetlands; additionally 1 acre of permanent impact in the form of a wetland type change is anticipated.

Lake Michigan Water Supply (City of Oak Creek) Alignment 1

Twelve PEM, 21 PSS, 20 PFO, and 3 open-water wetlands along this alternative could be affected by pipeline construction. As shown in Table 6-43, the supply route could affect 13 acres of wetlands. Additionally, 1 acre of permanent impact in the form of a wetland type change is anticipated.

Lake Michigan Water Supply (City of Oak Creek) Alignment 2

Three PEM, 5 PSS, and 13 PFO wetlands along this route could be affected by pipeline construction. As shown in Table 6-43, the supply route could affect less than 1 acre of wetlands additionally less than 0.1 acre of permanent impact in the form of a wetland type change is anticipated.

Lake Michigan Water Supply (City of Racine)

Twenty-nine PEM, 29 PSS, 16 PFO, 4 filled/draind, 8 flat/unvegetated soil, and 6 open-water wetlands along this alternative could be affected by pipeline construction. As shown in Table 6-43, the supply route could affect 52 acres of wetlands, additionally 6 acres of permanent impacts in the form of a wetland type change are anticipated.

Underwood Creek to Lake Michigan Return Flow

Five PEM, 10 PSS, and 6 PFO wetlands along this alternative could be affected by pipeline construction. As shown in Table 6-43, the return flow alternative could affect 9 acres of wetlands, additionally 1 acre of permanent impact in the form of a wetland type change is anticipated.

Root River to Lake Michigan Return Flow Alignment 1

Eight PEM, 13 PSS, 15 PFO, and 1 open-water wetland along this alternative could be affected by pipeline construction. As shown in Table 6-43, the return flow alternative could affect 12 acres of wetlands, additionally 1 acre of permanent impact in the form of a wetland type change is anticipated.

Root River to Lake Michigan Return Flow Alignment 2

Three PEM, 3 PSS, and 11 PFO wetlands along this route could be affected by pipeline construction. As shown in Table 6-43, the return flow route could affect less than 1 acre of wetlands, additionally less than 0.1 acre of permanent impact in the form of a wetland type change is anticipated.

Direct to Lake Michigan Return Flow

Seven PEM, 11 PSS, 6 PFO, 1 open-water, and 1 filled/draind wetland along this alternative could be affected by pipeline construction. As shown in Table 6-43, the return flow alternative could affect 5 acres of wetlands, additionally less than 1 acre of permanent impact in the form of a wetland type change is anticipated.

Avoidance and Minimization

Based on the results of the groundwater modeling study completed (RJN Environmental Services, 2010, 2013), approximately 1,000 to 2,000 acres of wetlands could be affected by a 5-foot groundwater drawdown, depending upon the groundwater water supply alternative. For 1 foot of drawdown, approximately 3,000 to 4,000 wetland acres could be affected. As described by groundwater modeling (RJN Environmental Services, 2010, 2013), an alternative groundwater well location option that altered and added well locations to spread them farther apart so as to reduce potential environmental impacts, was analyzed for the Shallow Aquifer and Fox River Alluvium alternative. A review of the modeling drawdown for that alternative (see the Water Supply Service Area Plan and the groundwater drawdown maps in Appendix 6-3 at the end of this Section) indicated the 5-foot drawdown would reduce the wetland impact to 1,783 acres and the 1-foot drawdown would reduce the wetland impact to 4,063 acres. The wetland impacts from this variation only reduced the impacts from the base case 1 to 9 percent. As a result, it appears that any shallow groundwater supply alternative in the Troy Bedrock aquifer near the City of Waukesha will result in potentially significant impacts.

Wetland avoidance and minimization measures to counteract the impact of groundwater drawdown in the Vernon Marsh Wildlife Area are described in Appendix 6-4, Vernon Marsh Wildlife Area Wetland Habitat Impact Analysis, and summarized by wetland type as follows. Activities or actions that could partially minimize, restore, reduce, or reverse the adverse effects of groundwater drawdown were evaluated, including:

- Flow augmentation with groundwater
- Control of surface water outfall
- Well field pump rotation
- Wetland bank credit purchase

The first three methods could be targeted to reduce impacts on selected wetlands if particularly rare or locally important resources were threatened. However, each of the strategies is impractical to address all impacts. Wetland bank credit purchase has limitations in that there are insufficient credits available at approved banks to offset wetland impacts

and the banks are over 100 miles away from the project area making wetland banking inadequate to compensate for the predicted impacts at the Vernon Marsh Wildlife Area.

The construction areas for supply and return flow pipeline alternatives are co-located with existing infrastructure to the greatest extent feasible to minimize wetland impacts by using previously disturbed land and reducing habitat fragmentation. The Deep and Shallow Aquifers and Shallow and Fox River Alluvium alternatives will affect previously undisturbed wetland areas because of the need to drill wells in rural, undeveloped locations. Except for the proposed aboveground structures and groundwater drawdown, construction impacts would be temporary.

Temporary construction impacts in wetlands may include loss of herbaceous and scrub-shrub vegetation, wildlife habitat disruption, soil disturbance associated with grading, trenching, and stump removal, sedimentation and turbidity increases, and hydrological profile changes. Impacts will be minimized by adherence to BMPs developed by coordination among the City and agency stakeholders, and state and local permit requirements.

6.4.3.1.3 Environmental Effects Comparison: Wetlands—Location, Type, and Size

Adverse impacts from changes to wetlands are summarized below. Level of relative impact was developed to compare one alternative to another. Impacts were compared based upon Table 6-44. Table 6-45 summarizes the impacts to wetlands. Temporary construction-related impacts to wetlands are associated with all alternatives. The summaries below focus upon operational impacts to wetlands that occur from aboveground structures and groundwater drawdown under each alternative.

TABLE 6-44
Environmental Impact Category Description: Wetlands

Category	Temporary Construction Impacts	Operational Impacts
No adverse impact	Less than 0.1 acre	Less than 0.1 acre
Minor adverse impact	Greater than 0.1 acre	Greater than 0.1 acre, but less than 5 acres
Moderate adverse impact	Not applicable	Greater than 5 acres, but less than 10 acres
Significant adverse impact	Not applicable	Greater than 10 acres

Deep and Shallow Aquifers Water Supply

A total of 4 acres of wetlands could be impacted by operational impacts associated with aboveground structures. This alternative would have a minor adverse impact on wetlands from aboveground structures. The pumping operation would reduce the groundwater level by 5 feet or more for nearly 1,000 wetland acres. A 1-foot or greater groundwater drawdown would occur over more than 3,000 wetland acres. Because a wetland is designated by the type of plants, hydrology, and soil, groundwater drawdown in wetlands can reduce or eliminate the hydrology element required to sustain wetland conditions. The groundwater drawdown to wetlands from groundwater pumping would be a significant adverse impact.

Shallow Aquifer and Fox River Alluvium Water Supply

A total of 7 acres of wetlands could be affected by operation of aboveground structures. Thus, construction would have a moderate adverse impact on wetlands. Pumping would reduce the groundwater level by 5 feet or more for nearly 2,000 wetland acres. A 1-foot or

greater groundwater drawdown would occur over more than 4,000 wetland acres. Because a wetland is designated by plant type, hydrology, and soil type, groundwater drawdown in wetlands can reduce or eliminate the hydrology element required to sustain certain wetland conditions. The drawdown in wetlands from groundwater pumping would be a significant adverse impact.

Lake Michigan Water Supply (Cities of Milwaukee and Oak Creek Alignment 1)

There would be approximately 1 acre of permanent wetland impacts in the form of wetland type changes (i.e. forested to emergent) associated with these alternatives. This would be a minor adverse impact.

Lake Michigan Water Supply (City of Oak Creek) Alignment 2

There would be less than one acre of temporary and permanent wetland impacts associated with this route. Since the alignment requires temporary impacts to wetlands, this would be a minor adverse impact.

Lake Michigan Water Supply (City of Racine)

There would be approximately 6 acres of permanent wetland impacts in the form of wetland type changes (i.e. forested to emergent) associated with this alternative. This would be a moderate adverse impact.

Return Flow to Lake Michigan

For any return flow alternative, there would be approximately 1 acre or less of permanent wetland impacts in the form of wetland type changes. This would be a minor adverse impact.

6.4.3.2 Flora and Fauna

6.4.3.2.1 Affected Environment

The regional landscape around the project originally was a combination of hardwood forest, prairie, savanna, and wetlands. Only parts of the hardwood forests and wetlands remain, because most of the project area has been converted to urban, suburban, and agricultural land. Wet prairies, southern sedge meadows, emergent marshes, calcareous fens, shrub-carr, northern wet forests, and floodplain forests might be found within the project area. Sedge

TABLE 6-45
Water Supply and Return Flow Alternative Environmental Impact Comparison
Summary: Wetlands

Alternative	Wetlands
Water Supply	
Deep and Shallow Aquifers	Significant adverse impact
Shallow Aquifer and Fox River Alluvium	Significant adverse impact
Lake Michigan (City of Milwaukee)	Minor adverse impact
Lake Michigan (City of Oak Creek) Alignment 1	Minor adverse impact
Lake Michigan (City of Oak Creek) Alignment 2	Minor adverse impact
Lake Michigan (City of Racine)	Moderate adverse impact
Return Flow Alternatives for Lake Michigan Water Supplies	
Underwood Creek to Lake Michigan	Minor adverse impact
Root River to Lake Michigan Alignment 1	Minor adverse impact
Root River to Lake Michigan Alignment 2	Minor adverse impact
Direct to Lake Michigan	Minor adverse impact

meadows and wet prairies are dominated by grasses and sedges. Fens support grasses, sedges, and a diversity of other herbaceous plants. Emergent marshes occur along the edges of lakes and streams, and consist of emergent and submergent vegetation. Shrub swamps are dominated by various wet shrubs, but they also may occur as a successional stage that follows herbaceous vegetation found in sedge meadows, fens or floodplains. Forested wetlands may be dominated by conifers or hardwoods (WDNR, 12/2011_).

The spatial arrangement of wetlands can provide essential habitat for wildlife. Wetlands form links between aquatic and upland areas, and can be a connection among upland communities. They provide water, food, and shelter for wildlife, and supply unique habitat conditions for many plant species. Wetlands have a higher rate of biological productivity than other types of ecosystems, partly because of the natural functions they provide. This allows them to support abundant plant and animal life and also rare species. Almost half of all federal-listed threatened and endangered species use wetlands at some point in their life cycles. In Wisconsin, about 32 percent of the state's listed species are wetland dependent (WDNR, 12/2011b).

Many bird and mammal species rely on wetlands, especially during migration and breeding. The large marshes throughout southeastern Wisconsin provide critical feeding, nesting, and resting habitat for numerous waterfowl. Natural, periodic flood flows, usually spurred by spring snowmelt and heavy rains, are important to the health of floodplain forests and wetlands, and to the maintenance of self-sustaining populations of wetland-spawning fish, such as walleye and northern pike. Aquatic life that is dependent upon rivers and floodwaters supports a variety of mammal and avian species. Unfortunately, most wetlands within the area have experienced widespread draining, ditching, grazing, and infestation by invasive plants, such as reed canary grass.

Natural Communities

According to correspondence from the USFWS (2010, 2013), no vegetation communities of special concern or critical habitat occur within the construction workspaces associated with the supply and return flow alternatives.

WDNR (2010c, 2011c, 2013c) identified vegetation communities of special concern (referred to as "natural communities") that may occur within the Lake Michigan supply and return flow corridors. The pipeline alignments follow streets, alleys, bike paths, active and abandoned railroad corridors, utility corridors, city and county lands, and previously disturbed areas, so few impacts to natural communities are expected. Impacts to natural communities will be coordinated with the appropriate state and federal agencies, avoided, and minimized.

Natural communities include Lake Michigan, inland waterways, wetlands, and terrestrial habitats. However, discussion of all natural communities is included under "wetlands" because most of the natural community types are wetland communities.

The WDNR identified the following natural communities that could exist along the alternative corridors in response to the Natural Heritage Inventory Environmental Review Request submitted by the Waukesha Water Utility (WDNR, 2010c):

- Southern dry mesic forest
- Southern mesic forest
- Southern dry forest
- Mesic prairie
- Wet prairie
- Emergent marsh
- Southern sedge meadow
- Oxbow lake
- Oak Opening
- Calcareous fen
- Shrub-carr
- Southern tamarack swamp
- Northern wet forest
- Floodplain forest
- Springs and spring runs
- Warm-water stream
- Bird rookery
- Wet-mesic prairie

A habitat assessment was completed in July 2010 (Appendix 6-7) along the pipeline corridors which provided field verification of potential habitat types. Oak opening and wet-mesic prairie natural community were identified by the WDNR in the most recent response to the Natural Heritage Inventory Environmental Review Request for the proposed project submitted by the Waukesha Water Utility (WDNR, 2013c). The field observations noted specific natural communities at or immediately downstream of discharge locations are limited to floodplain forests, emergent marsh, and warm-water streams. Evaluations of the oak opening and wet mesic prairie natural communities were added to the exhibits in Appendix 6-5 and the following analysis. Impacts to natural communities were evaluated using the results of the field work and available spatial data. Descriptions of the communities affected and how they were evaluated include:

Bird Rookery

Bird rookeries require trees in or adjacent to open water or wetlands. Consequently, the relative potential occurrence of bird rookery habitat was compared by determining the total of all wetlands and all woodlands adjacent to bodies of water affected by the alternative. With the absence of a GIS data set specific to bird rookeries, the relative ranking of low, moderate, or high potential suitability was used. There has been no confirmed presence of a bird rookery for any of the alternatives. Appendix 6-5, Exhibit 2 compares potential bird rookery impacts.

Wet Prairie

Wet prairie shares characteristics with emergent aquatic communities. Thus, the relative occurrence of potential wet prairie impacts utilized the WWI emergent marsh GIS data set to evaluate potential wet prairie impacts. With the absence of a GIS data set specific to a wet prairie, the relative ranking of low, moderate, or high potential suitability was used. There has been no confirmed presence of wet prairie for any of the alternatives. Appendix 6-5, Exhibit 2 compares potential wet prairie impacts.

Springs and Spring Runs

The Wisconsin Geological and Natural History Survey (WGNHS) maintains an inventory of springs that was consulted to determine potential impacts to them. Several springs exist near the groundwater alternative areas (shallow wells in the Deep and Shallow Wells alternative, and all wells in the Shallow Aquifer and Fox River Alluvium alternative) (WGNHS, 2010), but none was found within the construction footprint of the Lake Michigan water supply alternatives or the return flow alternatives. An analysis of springs potentially

affected by groundwater drawdown had been done previously (see maps in Appendix 6-3 at the end of this Section). Another analysis was conducted to determine the number of WGNHS-documented springs within the project area for all alternatives. With the availability of a specific GIS data set addressing springs, a comparison to the WGNHS data set was conducted. A ranking of low, moderate, or high suitability was developed using the number of springs, instead of the number of acres, affected. Springs and spring runs have been confirmed based upon literature documentation for the groundwater supply alternatives within the groundwater drawdown areas. Appendix 6-5, Exhibit 2 compares potential springs and spring run impacts.

Streams

Stream data are available through GIS data sets. A comparison was conducted using the data, and the relative ranking of low, moderate, or high potential suitability based upon acres impacted was used to evaluate impacts to streams listed as (slow, hard warm) by the WDNR. There has been no confirmed presence of a slow, hard warm stream within any of the alternatives. Appendix 6-5, Exhibit 2 compares potential stream impacts.

Oxbow Lake

No GIS data were available for oxbow lakes. The analysis for the potential of an oxbow lake was conducted by observing the location of bodies of water on aerial maps and through the habitat field survey conducted in 2010. There has been no confirmed presence of an oxbow lake within any of the alternatives. Appendix 6-5, Exhibit 2 compares potential oxbow lake impacts.

Emergent Marsh

Information on the presence and extent of emergent marshes was available through the WWI. The relative comparison of the potential for an alternative to impact emergent marsh habitat was conducted using GIS analysis. With the availability of a specific GIS data set, a numeric comparison of acres was made. Appendix 6-5, Exhibit 3 compares potential emergent marsh impacts.

Shrub-Carr Wetlands

Information on the presence and extent of the shrub-carr natural community is available through the WWI which identifies shrub-carr as “scrub-shrub” wetland. The relative comparison of the potential for an alternative to impact shrub-carr wetlands was conducted using GIS analysis. With the availability of a GIS data set specific to shrub-carr communities, a numeric comparison of acres impacted was made to conduct the relative comparison. Appendix 6-5, Exhibit 3 compares potential shrub-carr impacts.

Forested Floodplain

Information on the potential location of the forested floodplain natural community was analyzed using available GIS data sets for SEWRPC woodlands, WWI forested wetlands, and Federal Emergency Management Agency (FEMA) floodplains. All areas of woodlands and forested wetlands located within the mapped 100-year floodplain were assumed to represent forested floodplain. The calculated numeric acreages were used as the basis determining whether an alternative could affect a forested floodplain. Appendix 6-5, Exhibit 3 compares potential forested floodplain impacts.

Mesic Prairie

A mesic prairie is an open grassland habitat. Because a mesic prairie GIS data set was unavailable, information on the potential location of the mesic prairie natural community was analyzed using available GIS data sets for the SEWRPC open lands and observations made during the summer 2010 habitat assessment. The presence of open lands does not necessarily mean mesic prairie would exist but using the SEWRPC open lands data set provides insight into the potential existence for this habitat type. With the absence of a GIS data set specific to the mesic prairie, the relative ranking of low, moderate, or high potential suitability based on open lands acreage and field observations was used. There has been no confirmed presence of a mesic prairie for any of the alternatives. Appendix 6-5, Exhibit 2 contains the relative comparison of potential mesic prairie impacts.

Southern Sedge Meadow

A southern sedge meadow is an open wetland community. Because a southern sedge meadow GIS data set was unavailable, information on the potential location of the southern sedge meadow natural community was analyzed using available GIS data sets for WWI emergent marsh. Southern sedge meadow is often found adjacent to emergent marsh; thus, emergent marsh is a good indicator of the potential presence of southern sedge meadow. With the absence of a GIS data set specific to southern sedge meadow, the relative ranking of low, moderate, or high potential suitability based on emergent marsh acreage was used. There has been no confirmed presence of a southern sedge meadow for any of the alternatives. Appendix 6-5, Exhibit 4 compares potential southern sedge meadow impacts.

Calcareous Fen

Calcareous fens occur in areas receiving carbonate-enriched groundwater. Because a GIS data set for calcareous fen was unavailable, information on the potential location of the calcareous fen natural community was analyzed using available GIS data sets for WWI emergent marsh supplemented with 2010 field observations and communication with the Vernon Marsh Wildlife Area manager, who is aware of known calcareous fen locations in the Vernon Marsh Wildlife Area. Calcareous fens are often found adjacent to emergent marshes; consequently, emergent marsh is a good indicator of potential presence of calcareous fen. With the absence of a GIS data set specific to calcareous fen, the relative ranking of low, moderate, or high potential suitability based on emergent marsh acreage and field observations was used. There has been no confirmed presence of a calcareous fen for any of the alternatives. Appendix 6-5, Exhibit 4 compares potential calcareous fen impacts.

Northern Wet Forest

The potential presence of northern wet forest was analyzed using WWI forested wetlands, because a GIS data set specific to northern wet forest was unavailable. The presence of forested wetlands does not necessarily mean a northern wet forest would exist but using the WWI forested wetlands data set provides insight into the potential existence of this habitat type. With the absence of a community-specific specific GIS data set, the relative ranking of low, moderate, or high potential suitability based on forested wetlands acreage was used. There has been no confirmed presence of a northern wet forest for any of the alternatives. Appendix 6-5, Exhibit 5 compares potential northern wet forest impacts.

Southern Dry Forest

The potential presence of southern dry forest was analyzed using SEWRPC woodlands, because a GIS data set specific to southern dry forest was unavailable. The presence of

woodlands does not necessarily mean a southern dry forest would exist but using the SEWRPC woodlands data set provides insight into the potential existence for this habitat type. With the absence of a GIS data set specific to southern dry forest, the relative ranking of low, moderate, or high potential suitability based on woodlands acreage was used. There has been no confirmed presence of a southern dry forest for any of the alternatives. Appendix 6-5, Exhibit 5 compares potential southern dry forest impacts.

Southern Dry Mesic Forest

The potential presence of southern dry mesic forest was analyzed using SEWRPC woodlands, because a GIS data set specific to southern dry mesic forest was unavailable. The presence of woodlands does not necessarily mean a southern dry mesic forest would exist but using the SEWRPC woodlands data set provides insight into the potential existence of this habitat type. With the absence of a GIS data set specific to southern dry mesic forest, the relative ranking of low, moderate, or high potential suitability based on woodlands acreage was used. There has been no confirmed presence of a southern dry mesic forest for any of the alternatives. Appendix 6-5, Exhibit 5 compares potential southern dry mesic forest impacts.

Southern Mesic Forest

The potential presence of southern mesic forest was analyzed using SEWRPC woodlands, because a GIS data set specific to a southern mesic forest was unavailable. The presence of woodlands does not necessarily mean a southern mesic forest would exist but using the SEWRPC woodlands data set provides insight into the potential existence for this habitat type. With the absence of a GIS data set specific to southern mesic forest, relative ranking of low, moderate, or high potential suitability based on woodland acreage was used. There has been no confirmed presence of a southern mesic forest for any of the alternatives. Appendix 6-5, Exhibit 5 compares potential southern mesic forest impacts.

Southern Tamarack Swamp

The potential presence of southern tamarack swamp was analyzed using WWI forested wetlands, because a GIS data set specific to southern tamarack swamp was unavailable. The presence of forested wetlands does not necessarily mean a southern tamarack swamp would be present but using the WWI forested wetlands data set provides insight into the potential existence of this habitat type. With the absence of a community-specific GIS data set, the relative ranking of low, moderate, or high potential suitability based on forested wetland acreage was used. There has been no confirmed presence of a southern tamarack swamp for any of the alternatives. Appendix 6-5, Exhibit 5 contains the relative comparison of potential southern tamarack swamp impacts.

Oak Opening

An oak opening is an oak dominated savanna community in which there is less than 50 percent tree canopy. The potential presence of an oak opening community was analyzed using SEWRPC open lands, because a GIS data set specific to an oak opening was unavailable. The presence of open lands does not necessarily mean an oak opening would exist but using the SEWRPC open lands data set provides insight into the potential existence for this habitat type. With the absence of a GIS data set specific to oak opening, relative ranking of low, moderate, or high potential suitability based on open lands acreage was used. There has been no confirmed presence of an oak opening for any of the alternatives. Appendix 6-5, Exhibit 5 compares potential oak opening impacts.

Wet-Mesic Prairie

Wet-mesic prairie shares characteristics with emergent aquatic communities. Thus, the relative occurrence of potential wet-mesic prairie impacts utilized the WWI emergent marsh GIS data set to evaluate potential wet-mesic prairie impacts. With the absence of a GIS data set specific to a wet-mesic prairie, the relative ranking of low, moderate, or high potential suitability was used. There has been no confirmed presence of wet-mesic prairie for any of the alternatives. Appendix 6-5, Exhibit 2 compares potential wet-mesic prairie impacts.

Natural Communities Near Return Flow Discharge Locations

At the Underwood Creek discharge location, the stream is contained within a concrete-lined channel designed to restrict the flow of water to adjacent areas and its floodplain. As a result, the only natural community directly affected at the outfall is warm-water stream. Floodplain forest areas are present in the downstream reaches of Underwood Creek and below its confluence with the Menomonee River.

At the Root River Alignment 1 discharge location, natural communities potentially affected by the return flow include emergent marsh, floodplain forest, and warm-water stream. The same community types could be affected in the Fox River, when return flow is conveyed to the Lake Michigan basin. Because these communities are adapted to water level fluctuations, small changes in water level caused by return flow are not expected to affect these communities significantly.

At the Root River Alignment 2 discharge location, natural communities potentially affected by the return flow include mesic prairie, southern dry-mesic forest, emergent marsh, shrub-carr, southern sedge meadow, and wet prairie (WDNR, 2013c). For those communities potentially located immediately adjacent to the Root River, they would be adapted to water level fluctuations and small changes in water level caused by return flow are not expected to affect these communities significantly.

The proposed return flow direct to Lake Michigan would be discharged in the open waters of Lake Michigan. As a result, none of the natural communities listed above would be affected.

Natural communities other than those adapted to live immediately adjacent to waterways may exist along the various alternatives and near the proposed return flow outfall locations, but because of their topographical location within the southeastern Wisconsin landscape and distance from the discharge location, they are not likely to be affected by minor changes in water elevations and flow. They could, however, be affected by pipeline construction or groundwater drawdown, the impacts of which are described in Appendix 6-5 with a relative comparison summary in Table 6-46.

Endangered and Threatened Species

Endangered and threatened species are described for all habitat types (Lake Michigan, inland waterways, wetlands, and terrestrial habitats) under "Wetlands," because the project or alternatives would have the greatest environmental impact on the wetland habitat type.

The Endangered Species Act of 1973 (16 U.S. Code (USC) 1531-1543, Public Law 93-205) states that threatened and endangered plant and animal species are of aesthetic, ecological, educational, historic, and scientific value to the U.S., and that those species and their

habitats must be protected. The Act protects fish, wildlife, plants, and invertebrates that are federally listed as endangered or threatened.

A federally endangered species is one that is in danger of extinction throughout all or a significant part of its range, with the exception of certain insect pests. A federally threatened species is one that is likely to become endangered in the foreseeable future throughout all or a significant part of its range. Species likely to become endangered or threatened in the foreseeable future may be listed as proposed endangered or threatened, or of special concern. Federal regulatory protection is also afforded to certain rare, natural vegetation communities, or critical habitats.

In Wisconsin, WDNR describes threatened and endangered species as one of three categories. An “endangered” species is one whose continued existence as a viable component of the state’s wild animals or wild plants is determined by WDNR to be in jeopardy on the basis of scientific evidence. A “threatened” species is one that appears likely, within the foreseeable future and on the basis of scientific evidence, to become endangered. A “special concern” species is one for which some problem of abundance or distribution is suspected but not yet proved. The main purpose of the last category is to focus attention on certain species before they become endangered or threatened.

Endangered and threatened species are characteristically in jeopardy because of ecosystem disruptions, including destruction, alteration, or curtailment of habitats; overexploitation; and the effects of disease, pollution, and predation. An individual species may be both state and federally listed.

The USFWS and the WDNR were contacted to determine federal- or state-listed species known to occur within the project corridor.

Federal-Listed Species

According to correspondence from the USFWS (2010, 2013), no federally listed threatened or endangered species occur near all the supply and return flow alternatives being evaluated, except for the Lake Michigan (City of Oak Creek) Alignment 2. According to correspondence from the USFWS (2013), one federally listed threatened species occurred near the Lake Michigan (City of Oak Creek) Supply Alignment 2. The federally listed species is the Prairie White-fringed Orchid. Since the occurrence is historical, the prairie white-fringed orchid is not expected to be near the project vicinity. The City plans to consult with the USFWS before construction to verify that no new federal-listed species have been identified within the selected construction workspace.

State-Listed Species

The City initiated consultation with WDNR Office of Energy, which assumes responsibility for the review of endangered resources for utility projects and works closely with the Bureau of Endangered Resources to implement the WDNR’s policies and regulations regarding protection of endangered resources. WDNR (2010c, 2011c) identified several State listed species as potentially occurring near the proposed supply and return flow alternatives. In 2013, WDNR (2013c) also identified several State listed species as potentially intersecting the alignments and occurring within a mile of the proposed Lake Michigan supply and return flow. Due to the pipeline alignments following previously disturbed street and utility rights-of-ways, few impacts to listed species are expected.

The City also consulted SEWRPC at the WDNR's request to inquire about threatened or endangered species or species of concern. The information obtained from SEWRPC is available in several reports, by watershed, and is consistent with information on listed species received from the WDNR. However, a recent SEWRPC report, Community Assistance Planning Report No. 284, Pebble Creek Watershed Protection Plan documented the presence of a state threatened species, the longear sunfish (*Lepomis megalotis*) in surveys of Pebble Creek in 1999–2005. As discussed in Section 6.4.2.2.2, the Deep and Shallow Aquifer and Shallow Aquifer and Fox River Alluvium alternatives could affect base groundwater flows to Pebble Creek significantly, and as a result, they could adversely affect habitats for documented listed species. Other species found in Pebble Creek or at the confluence with the Fox River are species of special concern in Wisconsin. Section 6.4.2.5.2, discusses fish species in the Fox River.

Once a regional approval has been received, field surveys will be completed along the selected route to confirm the presence or absence of the species listed by the WDNR.

The tables in Appendix 6-6 summarize the listed species associated with the supply and return flow alternatives. The attachment also documents correspondence with the WDNR and USFWS in regards to threatened and endangered species.

Significant Habitat: Vernon Wildlife Area

Significant wildlife habitats typically include state game refuges, wildlife management areas, National Wildlife Refuges, and other unique or sensitive areas. A single state wildlife management area, Vernon Wildlife Area (VWA), is within the proposed construction workspace for the Deep and Shallow Aquifers and the Shallow Aquifer and Fox River Alluvium supply alternatives. VWA is a 4,655-acre property in eastern Waukesha County consisting of wetlands and flowages associated with the Fox River and including a calcareous fen in the southern part of the property. Adjacent uplands are dominated by grassland habitats with interspersed areas of limited hardwoods. The VWA provides significant wildlife habitat, especially for migrating and nesting waterfowl (WDNR, 2010b).

6.4.3.2.2 Environmental Effects

Potential impacts to wildlife, natural community, and endangered resources fall into three categories:

- **Temporary** – Temporary impacts are those that result only from construction. Use of construction techniques that minimize impacts and that restore the construction area is expected to limit temporary impacts to the duration of the construction period (typically less than a year). Areas temporarily disturbed by pipeline construction would be restored to the same or better condition than what had existed initially. Temporary impacts would occur for all water supply and return flow alternatives.
- **Permanent, associated with long-term groundwater drawdown that results in habitat-type changes** – An example of such an impact is groundwater drawdown in an emergent marsh that causes the marsh habitat to decrease in areal extent and at least partially transition to upland habitat. Groundwater drawdown impacts are applicable only to the Deep and Shallow Well and the Shallow Aquifer and Fox River Alluvium water supply alternatives.

- **Permanent, associated with new aboveground infrastructure or aboveground pipeline maintenance** — Aboveground infrastructure includes access roads and other aboveground structures. Pipeline corridor maintenance is a long-term impact in areas where routine mowing may result in a permanent habitat type change. Habitat type changes could occur in areas of natural vegetation where active maintenance is not currently performed. Other than small less than a quarter acre pump stations associated with the Lake Michigan water supply and return flow, aboveground structures having new impacts to undisturbed area are associated only with the Deep and Shallow Well and the Shallow Aquifer and Fox River Alluvium water supply alternatives

Impacts to Natural Communities

A natural community is an assemblage of different plants and animal species within a specific habitat. Appendix 6-5, Exhibit 1 contains the WDNR's description of each natural community identified by the NHI inventory potentially near the project and therefore potentially affected by the water supply and return flow alternatives. Exhibit 1 is provided separately because of the sensitive nature of potential habitat locations for threatened and endangered species.

An analysis of the NHI data received from the WDNR, supplemented by the findings from the 2010 field observations and aerial imagery, was conducted for each natural community to produce a relative comparison of impacts for the water supply and return flow alternatives. Impacts were evaluated based on the assumption of a conventional excavation installation technique without considering construction BMPs that could minimize impacts, such as directional drilling for pipelines. The City of Waukesha will work with the WDNR and other resource agencies to minimize natural community impacts with the approved alternative. The process for evaluating the natural communities is described below, with the relative comparison for each alternative presented in Appendix 6-5, Exhibits 2 through 5. The exhibits are summarized below.

Relative Comparison Method

Because natural community-specific data in acres were not directly available in GIS data sets for all natural communities, general habitat information was used to generate a relative comparison of the potential impact of an alternative. For example, no GIS layer specific for the bird rookery is available, so a relative comparison was conducted using other habitat-type information. Conversely, the estimated acreage impact to the emergent marsh natural community is available from the WWI GIS layer, and so the specific data were used for the analysis. The procedure for evaluating each natural community is described below.

The following suitability rating scale is meant to provide a measure of the potential of a given route to contain the natural communities listed by the WDNR:

- Absent — habitat is not present
- Low potential suitability — Up to 10 acres
- Moderate potential suitability — 10 to 20 acres
- High potential suitability — More than 20 acres

Summary of Natural Community Relative Comparisons

Evaluation of Appendix 6-5, Exhibits 2 through 5, indicated that the groundwater supply alternatives have the highest overall potential impact to natural communities. The most

significant impacts to natural communities are the potential permanent habitat type changes to wetland areas that may result from the groundwater drawdown associated with the groundwater supply alternatives. Impacts to wetland areas and other natural communities from the Lake Michigan water supply and return flow alternatives are largely temporary or several orders of magnitude less than those associated with the groundwater supply alternatives. Table 6-46 summarizes the relative impact ratings ranked “high,” whereby impacts would occur for each water supply and return flow alternative.

TABLE 6-46
Summary of Natural Community High Suitability Ratings

Alternative	High Suitability Ratings (Out of 18 Natural Communities)
Water Supply	
Deep and Shallow Aquifers	7
Shallow Aquifer and Fox River Alluvium	7
Lake Michigan Supply	
Lake Michigan (City of Milwaukee)	0
Lake Michigan (City of Oak Creek) Alignment 1	1
Lake Michigan (City of Oak Creek) Alignment 2	0
Lake Michigan (City of Racine)	3
Return Flow Alternatives for Lake Michigan Water Supplies	
Underwood Creek to Lake Michigan	0
Root River to Lake Michigan Alignment 1	0
Root River to Lake Michigan Alignment 2	0
Direct to Lake Michigan	0

The alternatives which have the highest potential habitat suitability for threatened and endangered species are the groundwater supply alternatives. When this information is combined with the amount of land potentially affected by the alternative (see Table 6-47), the most significant impacts would be from groundwater supply alternatives.

The comparison of impacts to natural communities was not carried forward because the analysis was similar to that for the wetland and aquatic habitat categories already documented. The largest impacts to natural communities are to wetland natural community types from groundwater drawdown for the groundwater supply alternatives. These impacts are documented under Wetlands (see Section 6.4.3). Impacts also occur to cold water streams from groundwater drawdown and this is documented under (see Section 6.4.2.2, Inland Waterways, Size, Flows, and Floodplain).

All other impacts to natural communities are only temporary during construction or are much smaller than the wetland impacts. The actual impacts to natural communities may vary from those presented here, depending upon the final selected alternative, field verification of natural resources, and efforts to avoid, minimize, and mitigate impacts to natural communities, but the analysis conducted accurately depicts the relative impacts of

the alternatives. The City of Waukesha will work with the WDNR and resource agencies to avoid, minimize, and mitigate impacts resulting from the final selected alternative.

Impacts to Endangered and Threatened Species

Based on the consultation response from USFWS (2010, 2013), no federally listed species or critical habitat are expected. One federally-listed species was historically reported within a mile of the Lake Michigan (City of Oak Creek) Supply Alignment 2. The federally listed species is the Prairie White-fringed Orchid. USFWS stated that the prairie white-fringed orchid would not be expected within the projected area due to the historical nature of the occurrence (USFWS, 2013). Once the project receives regional approval, field surveys will be completed along the selected route to confirm the presence or absence of the listed species by the WDNR. USFWS stated that “if there is a lag between plan completion and construction this office should be contacted for updated species and critical habitat information [which is] updated every 6 months.” The City will resume consultation with the USFWS before construction to comply with its request and to meet requirements to protect federal-listed species or critical habitat.

The City selected pipeline routes through areas already developed or disturbed to minimize impacts to endangered and threatened species. The City will work with regulatory agencies to identify locations where such species could be affected and take measures to minimize impacts. Most of the project footprint for all alternatives is associated with pipeline construction, and the impacts of construction will be temporary.

Operational impacts are associated with the aboveground structures and with groundwater drawdown under the Deep and Shallow Aquifers and the Shallow Aquifer and Fox River Alluvium supply alternatives. The Lake Michigan water supply and return flow alternatives have insignificant operational surface impacts. Land Use Section 6.5.1.2, Table 6-51, summarizes the temporary construction and operational surface impacts.

The City coordinated with the WDNR to conduct a habitat assessment at locations along alternative infrastructure alignments in the summer of 2010. The information obtained was incorporated into identifying natural communities at locations along the alternative alignments and incorporated qualitatively in the analysis below. The proposed project which follows previously disturbed street right-of-ways was qualitatively reviewed using aerial imagery. The habitat assessment report is included as Appendix 6-7.

Relative Comparison of Endangered Species Impacts

The water supply and return flow alternatives were analyzed for the impacts they could have on preferred habitat for threatened, endangered, or species of special concern.

Habitat Comparison

The preferred habitat for threatened species, endangered species, and species of special concern affected by each alternative was summarized, including temporary impacts that would occur during construction and permanent impacts associated with pipeline maintenance, aboveground structures, access roads, and groundwater drawdown. SEWRPC land use data were used to document habitat affected by each alternative. A 15 foot wide permanent pipeline maintenance corridor was assumed to calculate permanent impacts where land was not already developed or within existing utility or transportation right-of-ways.

Temporary impacts for pipelines assumed a larger impact area to compensate for machinery and material staging for installing the pipeline. A 75 foot wide temporary pipeline construction easement was assumed to calculate temporary impacts. After the pipeline is constructed, the construction area will be restored to a condition similar to or better than what existed prior to construction in accordance with recommendations from the WDNR and applicable resource agencies. Permanent impacts for pipelines exist only where long-term pipeline maintenance requires a change in land use. For example, existing transportation and utility corridors are already routinely maintained, so no additional maintenance of those areas would be needed. Long-term impacts from pipeline corridors are associated mainly with forest and scrub-shrub habitat areas, where new tree growth would conflict with maintenance goals.

Appendix 6-5, Exhibit 6, summarizes the temporary and permanent impacts of each alternative. The tabulated data indicate that the dominant land uses affected by the Lake Michigan water supply and return flow alternatives are utility corridors, transportation, agriculture, and in some cases residential. The dominant land uses affected by the groundwater alternatives, including the groundwater drawdown area, are agricultural, residential, and wetlands.

Table 6-47 summarizes the permanently affected acres of wetlands and all land uses.

Endangered Resource Inventory

The endangered resources are reviewed together in this wetlands section for all habitat types (wetland, aquatic, and terrestrial) because the species most affected by the proposed project or alternatives to the proposed project are species with wetland habitat preferences.

ABLE 6-47

Summary of Permanent Land Impacts to Wetlands and Total Acreage

Alternative Name	Wetland Impacts ^a (acres)	Total Impacts (acres)
Water Supply		
Deep and Shallow Aquifers	3,091	4,129
Shallow Aquifer and Fox River Alluvium	4,113	5,562
Lake Michigan Supply Alternatives		
Lake Michigan (City of Milwaukee)	1	2
Lake Michigan (City of Oak Creek) Alignment 1	1	2
Lake Michigan (City of Oak Creek) Alignment 2	<1	<1
Lake Michigan (City of Racine)	6	6
Return Flow Alternatives for Lake Michigan Water Supplies		
Underwood Creek to Lake Michigan	1	1
Root River to Lake Michigan Alignment 1	1	2
Root River to Lake Michigan Alignment 2	<1	<1
Direct to Lake Michigan	<1	1

^a Wetland types include emergent/wet meadow, scrub/shrub, forested, open water, other (filled/drained and flats/unvegetated wet soil areas), and no surface water.

Preferred habitat requirements for each of the threatened, endangered, and species of special concern, based upon NHI information, was summarized and correlated with SEWRPC land use types present along the various alternative corridors. For example, species listed by NHI as requiring forest habitat were categorized as woodland species according to the SEWRPC land use designations. It should be noted, that depending upon NHI habitat requirements, a particular species may be associated with multiple SEWRPC land use designations. The list of species, their habitat preferences, and the corresponding SEWRPC land use designation assignments are included in Appendix 6-5, Exhibits 7 and 8. Exhibits 7 and 8 are provided separately due to the sensitive nature of the potential habitat locations for threatened and endangered species. Each water supply and return flow alternative has a separate list of species, except for the two groundwater alternatives that share one list of species because the area they affect overlaps.

Once each listed species was assigned to a SEWRPC land use, the number of occurrences for each land use type was calculated and used to determine which land use types are more likely to represent habitat for listed species. Appendix 6-5, Exhibit 9 compares rare species habitat occurrences by land use type. Individual wetlands types (emergent marsh, forested wetland, etc.) were used to designate habitat requirements for individual species, but all wetlands types were added together to simplify comparison.

Table 6-48 lists the land uses that scored highest for habitat requirements, the relative occurrence of habitat requirements for the top four habitat types (accounting for more than 90 percent of all listed species), and the total number of NHI species by route.

TABLE 6-48

Relative Occurrence of State- and Federal-Listed Species per Land Use for Each Proposed Alternative
Relative Comparison of Wildlife, Natural Community, and Endangered Resources

Alternative Name	Open Lands	Woodlands	Surface Water	Wetlands ^a	Total Listed Species per Route
Deep and Shallow Aquifers ^b	9%	8%	19%	61%	60
Shallow Aquifer and Fox River Alluvium ^b	9%	8%	19%	61%	60
Lake Michigan (City of Milwaukee)	10%	14%	14%	57%	36
Lake Michigan (City of Oak Creek) Alignment 1	11%	14%	14%	57%	53
Lake Michigan (City of Oak Creek) Alignment 2	11%	20%	20%	45%	31
Lake Michigan (City of Racine)	11%	17%	13%	55%	62
Return Flow Alternatives for Lake Michigan Water Supplies					
Underwood Creek to Lake Michigan	12%	15%	14%	52%	38
Root River to Lake Michigan Alignment 1	12%	15%	13%	54%	35
Root River to Lake Michigan Alignment 2	12%	21%	19%	42%	29
Direct to Lake Michigan	13%	13%	13%	52%	43

^a Includes all wetland types, including, emergent/wet meadow, scrub-shrub, forested, open water, and other. See Exhibit 6, Appendix 6-5.

^b Includes pipeline, access roads, wells, and WTP, as well as the areas of 1-foot and greater, and areas of 5-foot and greater groundwater drawdown areas.

Sources: SEWRPC Land Use Data and Wisconsin Dept. of Natural Resources, Natural Heritage Inventory Results

Summary of Potential Listed Species Impacts

Appendix 6-5, Exhibit 9 and Table 6-48 show that wetlands habitat is needed for more than half the listed species habitat requirements along the supply and return flow alternatives. Of all habitats affected by the supply and return flow alternatives, wetlands have the greatest potential to provide habitat for listed species. Comparison of the amount of wetland habitat acres affected by each alternative (shown in Appendix 6-5, Exhibit 6 and summarized in Table 6-43) indicates that the groundwater supply alternatives would result in permanent groundwater drawdown impacts to thousands of acres of wetland habitat. The Lake Michigan water supply and return flow alternatives, however, have only several acres of potential permanent wetland impacts. As such, the groundwater supply alternatives would have significant adverse impacts to listed species whereas the Lake Michigan water supply alternatives would have minor adverse impacts.

The comparison of impacts to listed species was not carried forward, because the listed species impact analysis is similar to the wetland impacts and aquatic habitat impacts and the listed species predominantly require wetland habitats. Once regional approval for the project has been received, further field surveys will be completed to confirm the presence or absence of the species listed by the WDNR. The City will work closely with the WDNR and other resource agencies to avoid, minimize, or mitigate impacts to threatened or endangered species.

Should a threatened or endangered species be positively identified within the construction workspace, the City will:

- Avoid or minimize impacts to the species wherever feasible
- Stage construction to limit disturbance during sensitive time periods
- Conduct temporary removal by an approved scientist following established protocols

Impacts to Vernon Wildlife Area

Deep and Shallow Aquifers Water Supply

The Deep and Shallow Aquifers supply alternative would affect 1.25 acres of the VWA, if constructed as proposed (see Table 6-56). The impacts would be temporary construction impacts. Because of the volume of water to be withdrawn, the water table within the VWA could be drawn down. Groundwater modeling shows groundwater level drawdown associated with this alternative (RJN Environmental Services, 2010, 2013). Drawdown relative to the VWA is shown in the maps in Appendix 6-3.

Groundwater drawdowns were compared for overlap to the VWA. The Deep and Shallow Aquifers alternative has a 5-foot or greater depth of groundwater drawdown, affecting 291 acres, or a 1-foot or greater depth of groundwater drawdown, affecting 609 acres. This level of groundwater drawdown would have a significant impact upon the VWA habitat, because much of the VWA is wetland and drawdown could result in habitat type change. Wetland impacts are described in Section 6.4.3, Wetlands.

Shallow Aquifer and Fox River Alluvium Water Supply

The Shallow Aquifer and Fox River Alluvium supply alternative would affect 1.25 acres of the VWA if it were constructed as proposed (see Table 6-56). The impacts would be temporary construction impacts. Because of the volume of water to be withdrawn, the water table within the VWA could be drawn down. Groundwater modeling shows groundwater level drawdown associated with this alternative (RJN Environmental Services, 2010, 2013). Drawdown relative to the VWA is shown in the maps in Appendix 6-3.

The Shallow Aquifer and Fox River Alluvium alternative has a 5-foot or greater depth of groundwater drawdown, affecting 343 acres, or a 1-foot or greater depth of groundwater drawdown, affecting 1,106 acres. This level of groundwater drawdown is a significant impact upon the VWA habitat, because much of the VWA is wetland and drawdown could result in habitat type change. Wetland impacts are described in Section 6.4.3, Wetlands.

Lake Michigan Water Supply (Cities of Milwaukee, Oak Creek Alignments 1 and 2, and Racine)
There are no impacts to the VWA with a Lake Michigan water supply.

Return Flow to Lake Michigan
There are no impacts to the VWA with the return flow alternatives.

The impacts comparison for the VWA was not carried forward because the impacts are similar to those for wetlands and aquatic habitats, since a significant part of the VWA is wetland habitat.

6.4.3.2.3 Functional Values

Until the latter half of the 20th century, wetlands often were viewed as wastelands, useful only when drained or filled. Wetlands are now known to provide critical habitat for wildlife, water storage to prevent flooding and improve water quality, and recreational opportunities for wildlife watchers, anglers, hunters, and boaters. These are known as “wetland functional values.” Wetlands provide the following different functions:

- Biodiversity of plants for food and shelter for many animal species at critical times during their life cycles
- Creating critical habitat for feeding, breeding, resting, nesting, escape cover, or travel corridors
- Essential habitat for smaller aquatic organisms in the food web, including crustaceans, mollusks, insects, and plankton
- Retention of stormwater to prevent rain and melting snow from rushing toward rivers and lakes, and reducing floodwater from rising streams
- Capacity in plants and soils to store and to filter pollutants, ranging from pesticides to animal wastes
- Protection against erosion by absorbing the force of waves and currents and by anchoring sediments. Roots of wetland plants bind lakeshores and streambanks, providing further protection.
- Wetlands can provide a valuable service of replenishing groundwater supplies.
- Open space in landscapes which are under development pressure, and have rich potential for hunters, anglers, scientists, and students (WDNR, 12/2012a).

Affected Environment

The proposed project and alternatives to the proposed project have impacts upon wetlands. The wetland impacts, summarized in Section 6.4.3 Wetlands, vary from 1 acre for the Lake Michigan–City of Oak Creek Supply Alignment 2 alternative with return flow to Root River Alignment 2 Creek, to over 4,000 acres for the Shallow Aquifer and Fox River Alluvium alternative, which has impacts from groundwater drawdown.

Most of the wetlands are palustrine emergent wetlands consisting predominantly of reed canary grass, phragmites, and cattails. Other wetlands are palustrine scrub/shrub wetlands with box elder, dogwoods, and various willow species. All water supply and return flow alternatives follow utility and transportation corridors to minimize disturbance to wetlands. These existing utility and transportation corridors make use of previously disturbed areas that are developed or actively maintained in order to minimize impacts. Some utility corridors have paved or gravel access roads; unpaved corridors generally are maintained by removing woody vegetation and mowing. Most impacts to wetland functional values will be temporary. Some permanent impacts will occur in association with roads, treatment plants, valve stations, or well house locations, depending upon the alternative.

Environmental Effects

Wetland impacts will be temporary during construction of pipelines. Impacts will be avoided or mitigated by constructing pipeline within previously disturbed areas and employing post-construction restoration techniques. During construction, only the trench line will be excavated, taking care to segregate topsoil from subsoil to the extent possible.

When crossing wetlands, construction techniques will be agreed upon with regulators to minimize impacts. Potential approaches could include building a temporary travel lane using timber mats or other similar materials, unless equipment can be supported without rutting that causes soil mixing. Subsoil and topsoil will be replaced to cover the installed pipeline in the correct order. Seed-free mulch or erosion control matting will be applied with appropriate seeding to meet restoration goals and to minimize the duration of temporary impacts.

Operational or permanent impacts will occur where roads, treatment plants, or well houses are constructed in wetlands. The structures will be left in place for the lifetime of the pipeline to enable operation and maintenance associated with sustaining the reliability and functionality of the line. Aboveground wetland impacts are described in Table 6-43. The groundwater alternatives also have operational impacts to wetlands caused by groundwater drawdown, as described in Table 6-43.

6.4.4 Groundwater

The impact of groundwater withdrawals on surface water is a concern in Wisconsin, and human-induced and natural groundwater shortages occur. Regional aquifers and groundwater resources were identified for the areas underlying the supply and return flow alternatives. Aquifer data from published reports are provided by county. Groundwater quality data are provided by region and should be considered summary data.

The USEPA designates sole-source aquifers as part of its Wellhead Protection Program. There are no designated sole-source aquifers in the State of Wisconsin (EPA, 2010a).

6.4.4.1 Aquifers and Water Use

6.4.4.1.1 Affected Environment

The major aquifers in Waukesha and Milwaukee counties are the Quaternary and Late Tertiary unconsolidated sand and gravel aquifer, and Cambrian-Ordovician sandstone aquifer. Historical use of the aquifers is summarized below and discussed further in the Water Supply Service Area Plan, Volume 2 of the Application.

Shallow Aquifer

The unconsolidated sand-and-gravel aquifer consists of layers and lenses of sand and gravel interspersed with fine-grained or other low-permeability deposits. Well yields vary and are dependent on the permeability and thickness of the sand and gravel at any given location. Recharge occurs through infiltration through surface soils and directly into the aquifer. The shallow aquifer is known locally as the Troy Bedrock Valley Aquifer. The formation contains up to 500 feet of glacial deposits in its deepest parts (SEWRPC, 2010b). It is a source of water supply for the Villages of Mukwonago and East Troy, and the Cities of Waukesha and Muskego. The aquifer is hydraulically connected to sensitive environmental resources, including the VWA, Pebble Brook (a Class II trout stream), and Pebble Creek. The City currently obtains approximately 20 percent of their annual water supply from this aquifer. The Water Supply Service Area Plan (Volume 2 of the Application) provides additional detail on the use of the shallow aquifer for water supply in the City of Waukesha.

Fox River Alluvium

The Fox River Alluvium under and near the Fox River consists of sands, gravels, and clay layers. The geology varies spatially because of past geologic activity and river geomorphic processes. In some locations, the Fox River Alluvium may be connected to the shallow aquifer system. Wells designed to access river alluvium water typically draw water from the river and from adjacent shallow aquifers. Current water supply wells have not been sited to specifically tap the Fox River Alluvium as a water supply source in order to avoid treating to meet surface water regulations. However, the Fox River alluvium is assumed to be under the influence of surface water and will require treatment to surface water standards to serve as a water supply source as described in the Water Supply Service Area Plan.

Deep Aquifer

The sandstone aquifer consists of alternating sequences of Cambrian- and Ordovician-age sandstone and dolomite, along with some shale. The sandstone aquifer underlies a low permeability layer called the Maquoketa shale. Due to the thickness of the sandstone aquifer, large water quantities can be produced from wells within the aquifer. The City's deep aquifer wells are constructed to depths greater than 2,100 feet and withdraw water from 800 to 1,000 feet below ground. Since the nineteenth century (SEWRPC, 2010a, pp. 108–9), the deep aquifer has been drawn down 500 to 600 feet. The deep aquifer supplies approximately 80 percent of annual water supply for the City of Waukesha.

Near Waukesha, recharge of this aquifer occurs further west where the Maquoketa shale does not exist. Figures 6-10 through 6-12 illustrate the constraints limiting recharge of the deep aquifer near the City of Waukesha.

The Precambrian aquifer is present throughout Wisconsin. The Precambrian crystalline bedrock aquifer consists of all rocks of Precambrian age that underlie Wisconsin, primarily granitic and metamorphic rocks. The crystalline bedrock aquifer directly underlies the sandstone aquifer (Deep Aquifer). Groundwater comes from fractures that exist in the crystalline rocks and yield small quantities of water (USGS, 2000, 2010; WDNR, 2010a).

FIGURE 6-10
Flow of Groundwater in the St. Peter Sandstone Deep Aquifer

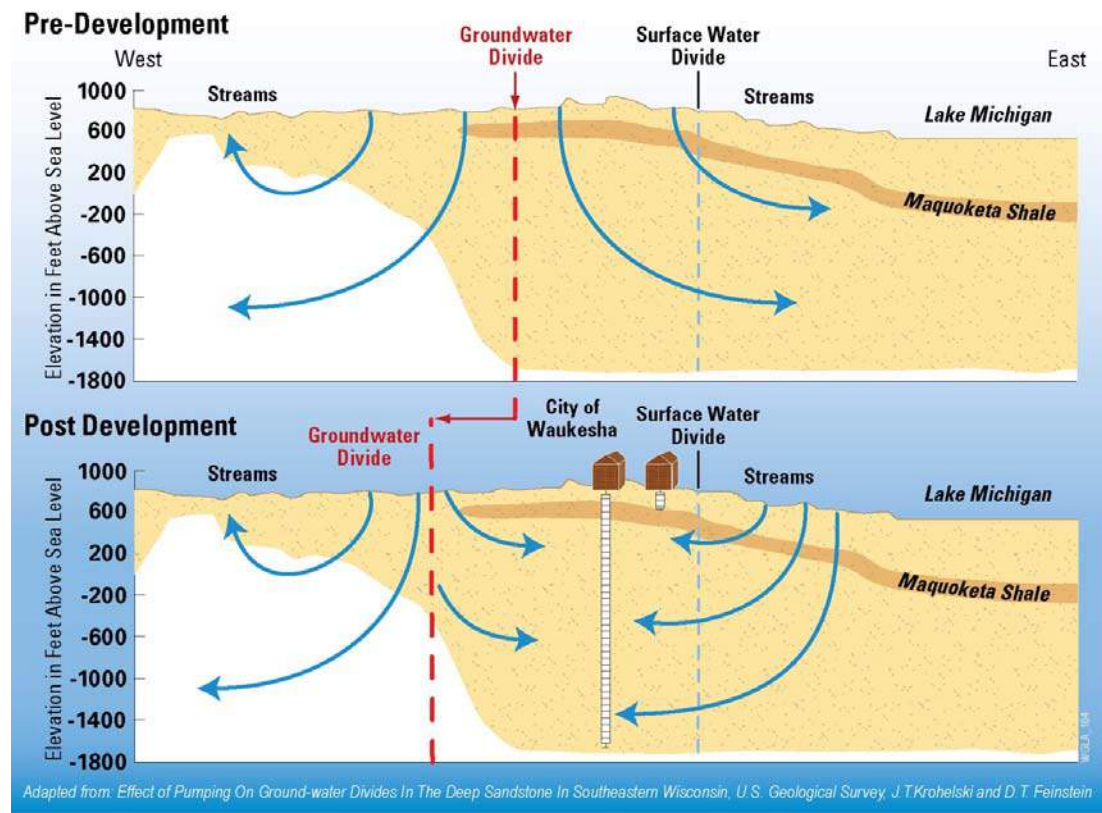
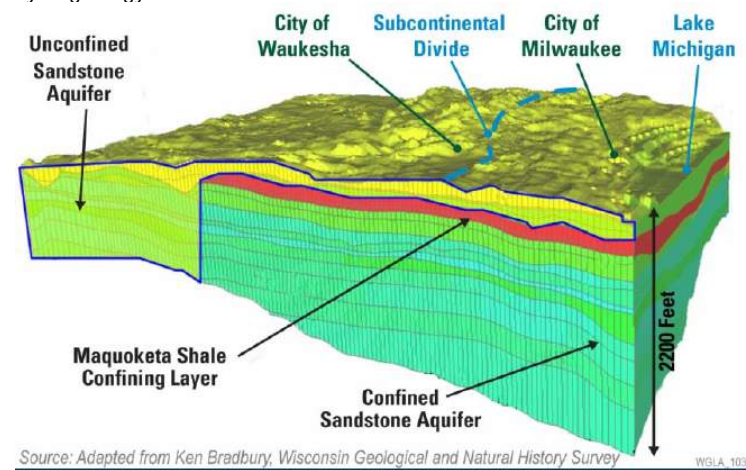


FIGURE 6-11
Hydrogeology of Southeastern Wisconsin



Springs

Springs are known to exist in Waukesha County. The Wisconsin Geological and Natural History Survey maintains an inventory of springs. Multiple springs exist near the groundwater alternatives area (WGNHS, 2010). Wisconsin regulates groundwater pumping that may affect large springs under Act 310. Act 310 requires an environmental review of wells that may have a significant impact on springs that have a flow of at least 1 cubic feet per second at least 80 percent of the time. Potential impacts to springs were evaluated under Natural Communities in Section 6.4.3.2.1.

6.4.4.1.2 Environmental Effects

Potential impacts to the aquifers present near the supply and return flow alternatives being considered can be divided into two categories: temporary construction-related impacts and long-term operational impacts.

Temporary construction impacts to shallow aquifers resulting from construction and placement of a 30-inch water main from new WTPs to the City and of 8- to 20-inch pipelines generally less than 10 feet deep from the well field to the WTPs are not expected to be significant. Temporary impacts may include short-duration trench-dewatering efforts. It is anticipated that the shallow aquifers would return to preconstruction conditions following construction.

Long-term impacts related to the operation of the supply or return flow alternatives may involve long-term water withdrawal from deep and shallow aquifers and from alluvial soils adjacent to the Fox River, or replenishment of the deep aquifer system if a Lake

Michigan water supply source is

approved. Return flow alternatives would result in the discharge of treated water to Underwood Creek or Root River, which drain to Lake Michigan, or discharge directly to Lake Michigan itself.

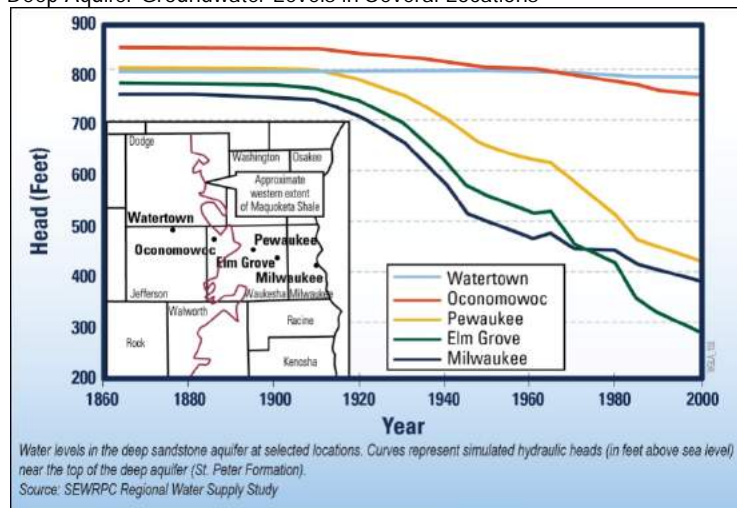
Potential impacts to the aquifers are discussed below. The Shallow Aquifer and the Fox River Alluvium are combined, since the wells for the groundwater alternatives would be close to the Fox River, making impacts to the aquifers indistinguishable.

Shallow Aquifer and Fox River Alluvium

No Action Alternative

The No Action alternative would continue use of the shallow aquifer for approximately 20 percent of the City's water supply needs. Water withdrawal from the shallow aquifer is described in detail in the Water Supply Service Area Plan.

FIGURE 6-12
Deep Aquifer Groundwater Levels in Several Locations



Deep and Shallow Aquifers Water Supply

The Deep and Shallow Aquifers supply alternative is entirely within Waukesha County. The aquifers that would be used for water supply with this alternative include the Quaternary and Late Tertiary unconsolidated sand-and-gravel-aquifer (shallow aquifer) and the Cambrian-Ordovician sandstone aquifer (deep aquifer). As discussed in the Water Supply Service Area Plan, long-term water withdrawal from the deep and shallow aquifers and from alluvial soils adjacent to the Fox River in Waukesha County will result in a continued draw down of the aquifer levels and increased treatment to ensure a safe drinking water supply.

A groundwater model was developed to simulate groundwater flow and capacity of the shallow aquifer (RJN Environmental Services, 2010, 2013). Deep aquifer modeling was not conducted because the City of Waukesha uses the aquifer and the performance is well known. The results indicate a maximum groundwater drawdown of about 50 feet. Groundwater impacts to surface waters and other natural resources are described in Section 6.4.2.2, Size, Flows, and Floodplain.

Groundwater flow to the Fox River would be intercepted and flow from the Fox River reduced, for a total change of 2.3 mgd in this reach of the river. Groundwater flow to three cold water trout streams would be reduced. Groundwater baseflow to Pebble Brook would be reduced by 34 percent, to Pebble Creek by 0 percent, and to Mill Brook by 85 percent. The largest reduction of groundwater flow to a trout stream is 1.2 mgd to Pebble Brook. The extent of groundwater drawdown of 5 feet or greater and of 1 foot or greater is shown in the maps in Appendix 6-3 at the end of this section.

Shallow Aquifer and Fox River Alluvium Water Supply

The Shallow Aquifer and Fox River Alluvium alternative is entirely within Waukesha County. The aquifer used for this water supply alternative is the Quaternary and Late Tertiary unconsolidated sand-and-gravel aquifer (shallow aquifer) and alluvium under and around the Fox River. Water withdrawal from this aquifer is described in detail in the Water Supply Service Area Plan, Volume 2 of the Application. Under this alternative, the deep aquifer would no longer be used. No longer using the deep aquifer will result in a beneficial partial rebound of the deep aquifer groundwater level.

A groundwater model was developed to simulate the groundwater flow and capacity of the shallow aquifer (RJN Environmental Services, 2010, 2013). Under this alternative, more water would be pumped out of the shallow aquifer because the deep aquifer would no longer be used. The results indicate a maximum groundwater drawdown of about 105 feet. Groundwater impacts to surface waters and other natural resources are described in Section 6.4.2.2, Size, Flows, and Floodplain.

Groundwater flows to the Fox River would be intercepted, and flow from the Fox River would be reduced for a total change of 4.8 mgd in this reach of the river. Groundwater reductions to three cold water trout streams would also occur. Groundwater baseflow to Pebble Brook would be reduced by 34 percent, to Pebble Creek by 13 percent, and to Mill Brook by 77 percent. The largest reduction of groundwater flow to a trout stream would be 1.2 mgd from Pebble Brook. The spatial extent over which groundwater drawdown of 5 feet or greater and of 1 foot or greater is shown in Appendix 6-3 at the end of this section.

Lake Michigan Water Supply (City of Milwaukee)

Withdrawal from Lake Michigan for any Lake Michigan supply alternative would not involve groundwater withdrawals, except for the emergency purposes described in the Water Supply Service Area Plan. As a result, no adverse impacts to aquifers would occur. Withdrawal from Lake Michigan with return flow would have an insignificant change in lake water levels, and thus is not expected to result in adverse effects to regional aquifer supplies influenced by Lake Michigan.

Lake Michigan Water Supply (City of Oak Creek) Alignments 1 and 2

The Lake Michigan–Oak Creek Supply alternative will have the same effects on groundwater resources as the Milwaukee Supply alternative.

Lake Michigan Water Supply (City of Racine)

The Lake Michigan–Racine Supply alternative will have the same effects on groundwater resources as the Milwaukee Supply alternative.

Underwood Creek to Lake Michigan Return Flow

The impacts of the Underwood Creek return flow on groundwater are expected to be insignificant. Because of the small change in Lake Michigan tributary water depth from return flow, significant adverse effects are not expected to regional aquifer supplies that are influenced by a Lake Michigan tributary.

Root River to Lake Michigan Return Flow Alignments 1 and 2

Groundwater impacts from Root River to Lake Michigan return flow are expected to be insignificant. Because of the small change in a Lake Michigan tributary water depth from return flow, no adverse effects to regional aquifer supplies that are influenced by a Lake Michigan tributary are expected.

Direct to Lake Michigan Return Flow

The impacts of the Direct to Lake Michigan return flow alternative to groundwater would be insignificant because the alternative would have an insignificant change in lake water levels and therefore would not result in adverse effects to regional aquifer supplies influenced by Lake Michigan.

Deep Aquifer**No Action Alternative**

The No Action alternative will continue use of the Cambrian-Ordovician sandstone aquifer (deep aquifer). Water withdrawal from the deep aquifer is described in detail in the Water Supply Service Area Plan. The long-term water withdrawal from the deep aquifer would continue to impact the aquifer level and increase the water treatment required to ensure a safe drinking water supply. Drawdown of the deep aquifer would continue to cause water to migrate toward Waukesha County, away from Lake Michigan, as the cone of depression in the deep aquifer fills with water from nearby aquifer sources.

Deep and Shallow Aquifers Water Supply

The Deep and Shallow Aquifers supply alternative lies entirely within Waukesha County. The aquifers that would be used for water supply are the Quaternary and Late Tertiary unconsolidated sand-and-gravel-aquifer (shallow aquifer) and the Cambrian-Ordovician sandstone aquifer (deep aquifer). As discussed in the Water Supply Service Area Plan, Volume 2 of the Application, long-term water withdrawal from the deep and shallow

aquifers would continue to impact the aquifer levels and increase the water treatment required to ensure a safe drinking water supply. Drawdown of the deep aquifer would continue to cause water to migrate toward Waukesha County, away from Lake Michigan, as the cone of depression in the deep aquifer fills with water from nearby aquifer sources.

Shallow Aquifer and Fox River Alluvium Water Supply

The Shallow Aquifer and Fox River Alluvium alternative lies entirely within Waukesha County. The aquifer used for this water supply alternative is the Quaternary and Late Tertiary unconsolidated sand-and-gravel aquifer (shallow aquifer) and alluvium under and near the Fox River. Water withdrawal from this aquifer is described in detail in the Water Supply Service Area Plan, Volume 2 of the Application. Under this alternative, the deep aquifer would no longer be used. No longer using the deep aquifer will result in a beneficial partial rebound of the deep aquifer groundwater level.

Lake Michigan Water Supply (City of Milwaukee)

A water supply from Lake Michigan would involve discontinuing use of the deep aquifer except for emergency conditions when the Lake Michigan supply was temporarily unavailable. Thus, no adverse impacts to groundwater aquifers would occur. No longer using the deep aquifer would have the benefit of a partial rebound of the deep aquifer groundwater level.

Lake Michigan Water Supply (City of Oak Creek) Alignments 1 and 2

The Lake Michigan–Oak Creek Supply alternative would have the same effects on groundwater resources as the Milwaukee Supply alternative.

Lake Michigan Water Supply (City of Racine)

The Lake Michigan–Racine Supply alternative will have the same effects on groundwater resources as the Milwaukee Supply alternative.

Underwood Creek to Lake Michigan Return Flow

Groundwater impacts from Underwood Creek to Lake Michigan return flow are expected to be insignificant. Because of the small change in a Lake Michigan tributary water depth from return flow, no adverse effects to regional deep aquifer supplies are expected.

Root River to Lake Michigan Return Flow Alignments 1 and 2

Groundwater impacts from Root River to Lake Michigan return flow are expected to be insignificant. Because of the small change in a Lake Michigan tributary water depth from return flow, no adverse effects to regional deep aquifer supplies are expected.

Direct to Lake Michigan Return Flow

Impacts under the Direct to Lake Michigan return flow alternative to groundwater would be insignificant, because the alternative would have an insignificant change in lake water levels and thus not have adverse effects to regional deep aquifer supplies.

Springs

Deep and Shallow Aquifers Water Supply

Several springs exist within this groundwater drawdown footprint. Maps depicting the Wisconsin Geological and Natural History Service spring inventory were reviewed and compared to the groundwater drawdown to see which springs may be affected (WGNHS, 2010). Maps in Appendix 6-3 at the end of this Section show the spring locations. The 1-foot drawdown would affect 7 springs that range in known flow rate from 5 to 50 gpm (0.11 cfs).

Shallow Aquifer and Fox River Alluvium Water Supply—Waukesha County

Several springs exist within the groundwater drawdown footprint. Maps depicting the Wisconsin Geological and Natural History Service spring inventory were reviewed and compared to the groundwater drawdown to see which springs may be affected (WGNHS, 2010). Maps in Appendix 6-3 at the end of this Section show the spring locations. The 1-foot drawdown would affect 12 springs that range in flow rate from 0 at the time of survey to 50 gpm (0.11 cfs).

Lake Michigan Water Supply (City of Milwaukee)

Withdrawal from Lake Michigan for the Lake Michigan–Milwaukee Supply alternative would mean withdrawal of surface water from Lake Michigan, with no groundwater withdrawals influencing springs. As a result, no adverse impacts to springs would occur.

Lake Michigan Water Supply (City of Oak Creek) Alignments 1 and 2

The Lake Michigan–Oak Creek Supply alternative would have the same effects on springs as the Milwaukee Supply alternative.

Lake Michigan Water Supply (City of Racine)

The Lake Michigan–Racine Supply alternative will have the same effects on springs as the Milwaukee Supply alternative.

Underwood Creek to Lake Michigan Return Flow

The Underwood Creek to Lake Michigan return flow alternative impacts to springs are expected to be insignificant.

Root River to Lake Michigan Return Flow Alignment 1

The Root River to Lake Michigan return flow alternative will have the same effects on regional groundwater resources as the Underwood Creek return flow alternative.

Root River to Lake Michigan Return Flow Alignment 2

The Root River to Lake Michigan return flow impacts to springs are expected to be insignificant. Springs are absent from the pipeline corridor based upon the WGNHS spring inventory.

Direct to Lake Michigan Return Flow

The Direct to Lake Michigan return flow alternative impacts to springs are expected to be insignificant.

6.4.4.1.3 Environmental Effects Comparison: Groundwater—Aquifers and Water Use

Adverse impacts from changes to groundwater are summarized below for each alternative. Level of relative impact to groundwater use was developed to compare one alternative to another. Impacts were compared based upon Table 6-49. Table 6-50 summarizes the impacts to groundwater.

Deep and Shallow Aquifers Water Supply

This alternative would reduce existing impacts to the deep aquifer because there would be less pumping of the deep aquifer and thus some rebound of the deep aquifer would occur in the City of Waukesha over time. Increased pumping of the shallow aquifer would, however, decrease baseflow to the Fox River by 2.3 mgd (RJN Environmental Services, 2010, 2013).

TABLE 6-49
Environmental Impact Category Description: Groundwater Resources

Category	Deep Aquifer Drawdown	Shallow Aquifer Drawdown	Baseflow Reduction Streams from Groundwater Pumping
No adverse impact	Rebound or no additional drawdown	No drawdown	No stream flow reduction
Minor adverse impact	Pumping contributes less than 50 feet of drawdown	Less than 5 feet	Up to 25% reduction in warm water streams; Up to 15% reduction in cold water streams
Moderate adverse impact	Pumping contributes between 50 and 149 feet of drawdown	5 feet to 49 feet	Greater than 25%, but less than 50% reduction in warm water streams; Greater than 15%, but less than 25% reduction in cold water streams
Significant adverse impact	Pumping contributes greater than 150 feet of drawdown	Greater than 50 feet	50% or more reduction in warm water streams; 25% or more reduction in cold water streams

TABLE 6-50
Water Supply and Return Flow Alternative Environmental Impact Comparison Summary: Groundwater Resources

Alternative	Groundwater Resources
Water Supply	
Deep and Shallow Aquifers	Significant adverse impact
Shallow Aquifer and Fox River Alluvium	Significant adverse impact
Lake Michigan (City of Milwaukee)	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 1	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 2	No adverse impact
Lake Michigan (City of Racine)	No adverse impact
Return Flow Alternatives for Lake Michigan Water Supplies	
Underwood Creek to Lake Michigan	No adverse impact
Root River to Lake Michigan Alignment 1	No adverse impact
Root River to Lake Michigan Alignment 2	No adverse impact
Direct to Lake Michigan	No adverse impact

The small cold water streams Pebble Brook, Pebble Creek, and Mill Brook would experience baseflow reduction from groundwater pumping, with a 85 percent reduction in Mill Brook on average, and an even greater reduction during low flow conditions. The baseflow reduction to the cold water streams would be a significant adverse impact.

Groundwater pumping would reduce the groundwater level by 5 feet or more over nearly 1,000 wetland acres. Drawdown of 1 foot or greater would occur over 3,000 wetland acres. Because a wetland is designated by plant type, hydrology, and soil type, groundwater drawdown in wetlands can reduce or eliminate the hydrology element required to sustain wetland conditions. The groundwater drawdown to wetlands from groundwater pumping would be a significant adverse impact.

Shallow Aquifer and Fox River Alluvium Water Supply

Impacts to the deep aquifer are further reduced with this alternative because there would be no pumping of the deep aquifer for the City of Waukesha water supply, leading to some rebound of the aquifer over time. However, increased pumping from the shallow aquifer would further decrease baseflow to various streams. Groundwater modeling indicated that the Fox River would experience 4.8 mgd less flow (RJN Environmental Services, 2010, 2013). The baseflow reduction to the Fox River from groundwater pumping would be a minor adverse impact.

Pebble Brook, Pebble Creek, and Mill Brook would also experience baseflow reduction from groundwater pumping, with Mill Brook experiencing a baseflow reduction of 77 percent on average, and an even greater reduction during low flow conditions. The baseflow reduction to the cold water streams would be a significant adverse impact.

Groundwater pumping would reduce the groundwater level by 5 feet or more over nearly 2,000 wetland acres. A 1-foot or greater groundwater drawdown would occur over more than 4,000 wetland acres. Because a wetland is designated by plant type, hydrology, and soil type, groundwater drawdown in wetlands can reduce or eliminate the hydrological elements required to sustain wetland conditions. The groundwater drawdown to wetlands from groundwater pumping would be a significant adverse impact.

Lake Michigan Water Supply (Cities of Milwaukee, Oak Creek Alignments 1 and 2, and Racine)

The Lake Michigan water supply would eliminate the need for pumping the deep aquifer, which would cause a partial rebound in the deep aquifer in the City of Waukesha. The Return Flow Plan (Volume 4 of the Application) has been designed to meet the Compact requirements with a maximum return flow rate equivalent to the maximum withdrawal rate that also minimizes out of basin water in return flow. Withdrawal from Lake Michigan with return flow protects lake volume, and therefore it is not anticipated that withdrawal from the lake would result in adverse effects to regional aquifer supplies influenced by Lake Michigan. Lake Michigan water supply consequently produces no adverse impact on groundwater resources.

Underwood Creek to Lake Michigan and Root River to Lake Michigan Alignments 1 and 2 Return Flow

Because of the small change in the Lake Michigan tributary water depth with return flow, this alternative is not anticipated to result in adverse impacts to regional aquifer supplies that are influenced by a Lake Michigan tributary. Return flow to Underwood Creek or the Root River consequently would have no adverse impact on groundwater resources.

Direct to Lake Michigan Return Flow

Withdrawal from Lake Michigan with return flow would have an insignificant change in lake water levels because of the volume of water present, and therefore is not anticipated to result in adverse effects to regional aquifer supplies influenced by Lake Michigan. Return flow to Lake Michigan consequently would have no adverse impact on groundwater resources.

6.4.4.2 Groundwater Quality

6.4.4.2.1 Affected Environment

Aquifer Water Quality

Shallow Aquifer

The unconsolidated sand-and-gravel aquifer consists of layers and lenses of sand and gravel interspersed with other fine-grained or low-permeability deposits. Well yields vary and are dependent on the permeability and thickness of the sand and gravel at a particular location. Recharge occurs through infiltration through surface soils and directly into the aquifer.

Groundwater from the shallow aquifer may require treatment to meet secondary drinking water standards of 0.3 mg/L for iron, 0.05 mg/L for manganese, and a primary standard of 10 ppb for arsenic. To remove these contaminants from the shallow aquifer supply and meet applicable drinking water standards, conventional surface water treatment, including coagulation, flocculation, sedimentation, filtration and disinfection is needed, as documented in the Water Supply Service Area Plan, Volume 2 of the Application.

Fox River Alluvium

The Fox River alluvium under and around the Fox River consists of sands, gravels, and clay layers. The water quality of the shallow aquifer described above is consistent with expected Fox River alluvium water quality. Water quality considerations for groundwater treatment under the influence of surface water have more stringent drinking water treatment requirements that are discussed in the Water Supply Service Area Plan. Use of the Fox River alluvium is not expected to have significant adverse impacts upon Fox River Alluvium water quality.

Deep Aquifer

The sandstone aquifer consists of alternating sequences of Cambrian- and Ordovician-age sandstone and dolomite, along with some shale. The sandstone aquifer underlies a low permeability layer called the Maquoketa shale. Due to the thickness of the sandstone aquifer, large water quantities can be produced from wells within the aquifer.

The City of Waukesha's groundwater supply has radium levels up to three times the USEPA's drinking water maximum contaminant level (MCL) of 5 picocuries per liter (pCi/L). The naturally occurring radioactive isotopes radium-226 and radium-228 are present in the aquifer because of parent elements in the sandstone. The radioactive isotopes are known to be carcinogenic (WDNR, 02/2012). The concentration of radium in the City's groundwater supply is as high as 15 pCi/L, among the highest in the country for a potable water supply.

City of Waukesha deep wells have observed high total dissolved solids (TDS). One well had TDS concentrations greater than 1,000 mg/L and was rehabilitated by blocking part of the well hole to reduce TDS, but in doing so well capacity was reduced more than 35 percent. Well capacity is also expected to decrease from the deep wells if the groundwater elevation continues to drop. Currently it is now more than 600 feet below predevelopment levels. The declining water level causes water quality problems in the form of increased TDS, radium, and gross alpha levels. As a result, treatment would be installed at the three largest deep wells (No. 6, 8, 10) to reduce TDS, as described in the Water Supply Service Area Plan.

Existing Contamination Sites

Areas in Wisconsin where groundwater is most susceptible to contamination are those where most of the groundwater is stored in shallow aquifers (Schmidt, 1987). The WDNR Bureau of Remediation and Redevelopment oversees the Remediation and Redevelopment (RR) Program and has a Web-based mapping system – RR Sites Map (WDNR, 01/2013b), – that contains information about contaminated properties and other activities related to the investigation and cleanup of contaminated soil or groundwater in Wisconsin. The RR Sites Map GIS registry layers contain groundwater contamination sites and groundwater and soil contamination sites. The GIS registry (WDNR, 2013a) yielded the following information about contaminated sites along the various project alternatives:

- Deep and Shallow Aquifers and Shallow Aquifer and Fox River Alluvium alternatives – two closed (cleaned up) groundwater-contamination sites and three closed (cleaned up) groundwater- and soil-contamination sites
- Lake Michigan–Milwaukee Supply – one open groundwater-contamination site and four closed groundwater- and soil-contamination sites
- Lake Michigan–Oak Creek Supply Alignment 1 – three closed groundwater and soil contamination sites
- Lake Michigan–Oak Creek Supply Alignment 2 – no contamination sites
- Lake Michigan–Racine Supply – one closed groundwater and soil contamination site
- Underwood Creek to Lake Michigan alternative – one closed groundwater-contamination site and four closed groundwater- and soil-contamination sites
- Root River to Lake Michigan Return Flow Alignment 2 – one closed soil-contamination site
- Return Flow Direct to Lake Michigan – four closed groundwater and soil contamination sites and five closed groundwater contamination sites and 14 closed groundwater and soil contamination sites

According to the WDNR's online tracking system, which is part of the WDNR Contaminated Lands Environmental Action Network (CLEAN), Milwaukee County has approximately 5,288 environmental repair (ERP) and leaky underground storage tank (LUST) sites, Racine County has approximately 807 ERP and LUST sites, and Waukesha County has approximately 1,667 ERP and LUST sites (WDNR, 2013b).

6.4.4.2.2 Environmental Effects

Environmental effects on groundwater quality for each of the water supply and return flow alternatives could occur either from the construction process or from operation and maintenance. The potential impacts from operation and maintenance vary depending upon the specific water supply alternative. The potential construction impacts are consistent for all alternatives.

Potential groundwater impacts from spills of heavy equipment fuel, lubrication oil, or hydraulic oil as a result of construction will be minimized by implementing BMPs for storing such materials, refueling equipment, developing and implementing a spill prevention plan, and cleaning up lost materials that may present a danger to the aquifer. Preventive measures will be implemented to avoid such spills, including compliance with

refueling zone practices. While BMPs will be used to prevent spills from occurring, if a spill were to occur, the material will be cleaned up to meet WDNR requirements. The volumes of petroleum-based fluids used during construction are likely to be minor, and so construction is not expected to represent a significant impact to regional aquifers. Prior to construction, the City will work with the applicable resource and municipal agency stakeholders to identify any high-risk areas for petroleum spills and coordinate the development of appropriate BMPs to protect important resources.

Aquifer Water Quality

Deep aquifer water quality will change with continued use either under the No Action or Deep and Shallow Aquifers alternative. Because the deep aquifer has had increasing TDS and gross alpha concentrations, continued pumping of the deep aquifer could continue to cause water quality to decline. The other water supply and return flow alternatives would be expected to lead to a partial recovery of the deep aquifer water level, which in turn could lead to better water quality. There are no known water quality changes that would occur in the shallow aquifer or Fox River alluvium if they are used as a water supply source.

Existing Contamination Sites

Because of the significant number of ERP and LUST sites along the alternative corridors, contaminated groundwater could be encountered during construction and operation. For final design, the City will work with WDNR to manage the crossing of contaminated-groundwater areas. If groundwater contamination is encountered, the City will work with the appropriate agencies to handle it appropriately.

6.4.4.2.3 Environmental Effects Comparison: Groundwater Quality

Operational impacts upon groundwater quality are associated with whether the deep aquifer continues to be used as a groundwater supply. Impacts to groundwater drawdown in the deep aquifer have been incorporated into the evaluation criteria for impacts to groundwater resources in Table 6-49. Consequently, no additional comparison of groundwater quality for water supply and return flow alternatives is provided.

6.5 Terrestrial Resources

Terrestrial resource evaluations include considering impacts to geomorphology and soils as well as flora and fauna. Each is discussed below.

6.5.1 Geomorphology and Soils

This section provides information about the geomorphology and soils for water supply and return flow alternatives. The pipeline alignments overlaid onto a USGS map for each supply and return flow alternative is found in Appendix 3-1 of Section 3 and Appendix 6-1 at the end of this Section.

6.5.1.1 Surficial and Bedrock Geology

6.5.1.1.1 Affected Environment

The maps in Appendix 6-8 show bedrock geology and surficial deposits for the State of Wisconsin and were the basis for preparation of this section.

Installation of water mains will require trenching to shallow depths of less than 10 feet. As a result, the supply and return flow alternatives are not expected to encounter significant bedrock and will have negligible temporary impacts to surficial geology during construction. Aboveground structures, including the proposed well houses and WTPs, associated with the Deep and Shallow Aquifers and Shallow Aquifer and Fox River Alluvium alternatives likely will not involve construction or excavation deeper than 10 feet. Parts of the foundations for the WTPs may be deeper than 10 feet below ground, but the WTPs are limited, nonlinear elements that will affect only a minor amount of surface area (up to 33.2 acres), and therefore will have only minor impacts on surficial geology.

Waukesha County exhibits the following types of bedrock: Silurian dolomite, Ordovician Maquoketa Formation of shale and dolomite, and Ordovician Sinnipee Group of dolomite, along with some limestone and shale. The project traverses only the Silurian dolomite bedrock areas, while the Ordovician Maquoketa Formation and Sinnipee Group exist in the western portion of the county (UW-Ext, 2005). The same depths to bedrock in Milwaukee County that are described above also exist within Waukesha County. Surficial deposits within Waukesha County are as follows: the very eastern edge of the county has clay deposits, similar to Milwaukee County, but further west of the county, a mixture of sand and sand/gravel deposits become dominant, with small, isolated areas of clay (WDNR, 2010h).

Bedrock within Milwaukee County is dominated by Silurian dolomite, which is a sedimentary carbonate rock, but it also has very limited areas of Devonian dolomite and shale in the northeastern corner of the county (UW-Ext, 2005). The west central portion of the county, where this alternative is located, ranges in depth to bedrock from 100 feet to 50 feet, and 50 feet to 5 feet below the surface (WDNR, 2010i). All of Milwaukee County exhibits clay deposits, except for the northeast corner and the southern edge, where there are very small areas of sand and gravel surficial deposits (WDNR, 2010h).

Bedrock within the Racine County portion of the Lake Michigan–Racine water supply alternative is entirely Silurian dolomite, which is a sedimentary carbonate rock (UW-Ext, 2005). Depth to bedrock within the Racine County portions of the alternative are generally 100 feet to 50 feet below ground, with limited areas of 50 to 5 feet below the surface and greater than 100 feet below the surface. The potential for 70 percent of the bedrock to be 5 feet below the surface is very minimal (WDNR, 2010i).

Racine County is dominated by clay deposits, with narrow strips of sand/gravel deposits streaking the county (WDNR, 2010h).

There are no known geologic faults within Milwaukee, Racine, or Waukesha counties, and no known faults in Wisconsin have moved in millions of years. There are no recent faults or folds in Wisconsin (USGS, 2010h, i, j).

6.5.1.1.2 Environmental Effects

All water supply and return flow pipeline alternatives would cross similar geology. Information obtained from the geologic resources present will be used to develop the detailed design of the pipeline material, trench, and construction approaches. Construction within these geologic features is commonplace in southeastern Wisconsin. The WDNR has design review practices in place under the water supply review and wastewater plan review

for design drawings and specifications for pipeline projects. No significant impacts to the local geology are expected under any alternative.

6.5.1.2 Land Use

This section discusses land uses within alternative corridors that could be affected by construction or operation. It identifies sensitive land uses near the routes, including residential areas, hospitals, public lands, recreation areas, and other similar special use areas. Except for the wells, well access roads, and water treatment plant needed for the groundwater alternatives and the pump station for the Lake Michigan and return flow alternatives, all land will revert to existing land use after construction and consequently, little change and no adverse impact is anticipated.

6.5.1.2.1 Affected Environment

Land use data was assembled from the 2000 SEWRPC Digital Land Use Inventory and 2005 SEWRPC Park and Open Space Sites, both produced by SEWRPC's Land Use and GIS Divisions. The following descriptions were used in classifying land use in this section:

- *Residential*. Two-family and multifamily low-rise (up to three stories) and multifamily high-rise (four or more stories) buildings and low-, medium-, and high-density areas.
- *Commercial and Industrial*. Retail sales and service intensive areas; manufacturing, wholesaling and storage areas; and unused lands designated commercial or industrial.
- *Transportation and Communication Utilities*. Freeways, expressways, streets, and truck terminals; off-street parking areas; rail-related rights-of-way; and communication and utility areas/structures.
- *Government and Institutional*. Administrative, safety, or assembly areas, both local and regional; educational areas (local and regional); and cemeteries.
- *Recreational Areas*. Land-related recreational areas, both public and nonpublic.
- *Agricultural Lands*. Cropland, pasture, lowland pasture, farm buildings, and other agricultural areas.
- *Open Lands*. Urban and rural open areas.
- *Woodlands*. Open lands that are forested.
- *Surface Water*. Open lands that are bodies of water.
- *Wetlands*. Wetland areas in designated open land, transportation, and communication/utility areas.

Table 6-51 summarizes the total land impacts expected under the various supply and return flow alternatives. Note that groundwater drawdown affecting land is not included below, but rather is discussed in Section 6.4.3, Wetlands, on natural communities and wetland impacts.

TABLE 6-51
Summary of Land Acreage Impacts

Alternative Name	Land Affected (acres)	
	Overall ^a	During Operation ^b
Water Supply Alternatives		
Deep and Shallow Aquifers pipeline alignment	121.11	0
Aboveground structures and access roads ^c	31.49	31.49
Deep and Shallow Aquifers (Total)	152.6	31.49
Shallow Aquifer and Fox River Alluvium pipeline alignment	134.51	0
Aboveground structures and access roads ^c	56.19	56.19
Shallow Aquifer and Fox River Alluvium (Total)	190.7	56.19
Lake Michigan (City of Milwaukee)	122.4 ^d	0
Lake Michigan (City of Oak Creek) Alignment 1	230.2 ^d	0
Lake Michigan (City of Oak Creek) Alignment 2	176.8 ^d	0
Lake Michigan (City of Racine)	341.6 ^d	0
Return Flow Alternatives for Lake Michigan Water Supplies		
Underwood Creek to Lake Michigan	104.8	0 ^e
Root River to Lake Michigan Alignment 1	141.4	0 ^e
Root River to Lake Michigan Alignment 2	183.7	0 ^e
Direct to Lake Michigan to Lake Michigan	206	0 ^e

^a Includes areas affected by the supply and return flow alternatives, both temporary and permanent.

^b Includes land disturbed during construction also regarded as permanent workspace, including new aboveground structures and new access roads.

^c Includes new access roads (15 feet wide), well houses, and WTP.

^d A pump station may be required from the water provider. If required, it is expected to only be approximately 0.25 acres of impact and will be sited to minimize impacts.

^e Aboveground structures may include only a single pump station, to be constructed within the Waukesha WWTP site in a previously disturbed area.

6.5.1.2.2 Environmental Effects

Table 6-52 provides quantitative data for land use types affected by temporary construction impacts and the operational impacts of the supply and return flow alternatives. Most of the land affected by any alternative is categorized as transportation and communication utilities, most of which is made up of the roadways affected by the routes. This emphasizes the fact that the pipelines associated with this project primarily use public rights-of-way or utility corridors. Impacts are evaluated assuming a 75-foot right-of-way for construction. Note that Table 6-52 uses SEWRPC landuse data. The SEWRPC wetland landuse data is different from the WWI wetland data. Consequently, wetland acreage is different between Table 6-43 and Table 6-52. WWI wetland data was used for wetland analysis while SEWRPC wetland data was used for landuse analysis.

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TABLE 6-52
Land Use Impacts in Acres

Route	Residential	Commercial & Industrial	Transportation & Communication/ Utilities	Government. & Institutional	Recreational Areas	Agricultural Lands	Open Lands	Woodlands	Surface Water	Wetlands	Total ^a
Water Supply Routes											
Deep and Shallow Aquifers	10.84	2.18	77.57	0.82	0.66	46.53	6.31	0.00	0.24	7.46	152.61
Shallow Aquifer and Fox River Alluvium	10.70	2.18	77.70	0.82	0.66	73.72	6.31	0.00	0.55	18.10	190.74
Lake Michigan (City of Milwaukee) ^b	3.03	3.29	97.86	0.04	2.35	0.00	7.97	0.45	0.00	7.21	122.20
Lake Michigan (City of Oak Creek) Alignment 1 ^b	10.25	2.60	160.16	0.59	5.16	4.24	31.37	2.12	0.16	13.54	230.19
Lake Michigan (City of Oak Creek) Alignment 2 ^d	5.60	0.25	165.57	0.36	0.25	2.62	1.18	0.48	0.00	0.49	176.79
Lake Michigan (City of Racine)	9.31	4.24	33.85	0.04	3.75	213.05	30.70	7.74	0.26	38.67	341.61
Return Flow Alternatives for Lake Michigan Water Supplies											
Underwood Creek to Lake Michigan ^b	2.38	3.92	74.85	0.92	3.08	0.00	6.03	0.00	0.17	13.44	104.79
Root River to Lake Michigan Alignment 1 ^b	1.61	2.31	92.18	0.92	9.14	0.00	19.68	1.18	0.17	14.23	141.42
Root River to Lake Michigan Alignment 2 ^d	6.39	0.43	167.62	1.13	0.22	3.92	3.51	0.09	0.05	0.36	183.70
Direct to Lake Michigan ^b	4.80	9.81	154.77	4.29	4.51	0.00	11.33	0.08	0.17	10.03 ^b	199.79^c

Source: SEWRPC (2000).

^a Represents the total land along each alternative that had a specific land use designation within the SEWRPC Digital Land Use Inventory.

^b Lake Michigan supply and return flow options share the same workspace for about 6 miles. Actual land use totals would be less than reported if a Lake Michigan Supply and Return flow option were selected.

^c Total does not include 6.2 acres of surface waters within Lake Michigan that were not included in the SEWRPC Digital Land Use Inventory.

^d Lake Michigan City of Oak Creek Alignment 2 supply and Root River to Lake Michigan Alignment 2 return flow share the same workspace for about 15 miles. Actual land use totals would be less than reported if a Lake Michigan Supply and Return flow option were selected.

The return flow alignments all follow streets, alleys, bike paths, active and abandoned railroad corridors, utility corridors, city and county lands, and previously disturbed areas. Table 6-53 includes the percentage of each alignment closely associated with utility or transportation corridors. Some utility corridors have paved or gravel access roads. Unpaved corridors generally are maintained by mowing and removal of woody vegetation. Consequently, using previously disturbed areas that are developed or actively maintained minimizes disturbance to land uses and natural resources. Most of the alignment for the Racine water supply alternative follows utility routes even though much of the land use is designated agricultural rather than utility. Consequently, the Racine water supply percentages listed in Table 6-53 consider agriculture in the estimate for utility corridor use.

TABLE 6-53
Use of Existing Utility and Transportation Corridors

Water Supply and Return Flow Alternatives	Percent Existing Utility Corridor	Percent Existing Utility or Transportation Corridors
Deep and Shallow Aquifers	0	8
Shallow Aquifer and Fox River Alluvium	0	7
Lake Michigan (City of Milwaukee)	25	80
Lake Michigan (City of Oak Creek) Alignment 1	26	70
Lake Michigan (City of Oak Creek) Alignment 2	0	94
Lake Michigan (City of Racine)	59	69
Underwood Creek to Lake Michigan	50	74
Root River to Lake Michigan Alignment 1	36	66
Root River to Lake Michigan Alignment 2	0	95
Direct to Lake Michigan	32	79

The second largest land use category that could be affected under some individual routes is agricultural lands. Even though the Lake Michigan Supply-Milwaukee and all the return flow alternatives cross prime farmland, they would not affect active agricultural lands. Transportation, communication utilities, and agricultural lands combined account for the majority of the area affected by the various supply and return flow alternatives.

The second largest land use category for the proposed project that could be affected under the proposed water supply and return flow routes is residential. The residential land within the assumed 75-foot construction corridor borders roads. The majority of residential land that could be affected by either alignment is described as single family low density. The construction corridor may be further minimized to avoid private property or temporary construction easements will be obtained by the City.

Once selected project has been approved and constructed, land with temporary impacts from pipeline construction will be restored to or allowed to revert to its previous use. Land use change during the operational phase of the project will occur almost exclusively for either of the Deep and Shallow Wells alternative or the Shallow Aquifer and Fox River Alluvium alternative because they require a new WTP, new access roads, and aboveground structures.

6.5.1.2.3 Access Roads

Existing roads and highways would be used to gain access to workspaces along the supply and return flow alternatives, for both construction crews and delivery of pipe and equipment. Equipment would be moved across public roads that intersect workspaces as work progresses. This would be done in accordance with applicable safety requirements and with due regard for maintenance of existing road surface conditions. Use of access roads during the construction period would have a similar effect as other construction activities on adjacent land uses.

The only new access roads proposed would be under the Deep and Shallow Aquifers and Shallow Aquifer and Fox River Alluvium supply alternatives in Waukesha County. The new gravel access roads would be used for access to the well houses, during construction and operation.

No new access roads would be required for the Lake Michigan supply alternatives or the return flow alternatives. Existing public or private roads would be used. Table 6-54 summarizes proposed new access roads for each alternative.

TABLE 6-54
Access Roads

Alternative Name	New Access Roads	Acreage Affected by New Roads
Water Supply Alternatives		
Deep and Shallow Aquifers	2 ^a	3.0 ^b
Shallow Aquifer and Fox River Alluvium	3 ^a	5.0 ^b
Lake Michigan (City of Milwaukee)	None proposed ^c	—
Lake Michigan (City of Oak Creek) Alignment 1	None proposed ^c	—
Lake Michigan (City of Oak Creek) Alignment 2	None proposed ^c	—
Lake Michigan (City of Racine)	None proposed ^c	—
Return Flow Alternatives for Lake Michigan Water Supplies		
Underwood Creek to Lake Michigan	None proposed ^c	—
Root River to Lake Michigan Alignment 1	None proposed ^c	—
Root River to Lake Michigan Alignment 2	None proposed ^c	—
Direct to Lake Michigan	None proposed ^c	—

^a Access will also include existing municipal roadways and trails

^b Assumes access roads will be 15 feet wide, constructed only between well houses, and will not involve water body crossings.

^c Access is anticipated to be from existing municipal roadways and trails.

6.5.1.2.4 Aboveground Structures

Under the supply and return flow alternatives, all water main pipelines would be installed underground through Milwaukee, Racine, or Waukesha counties. However, depending upon the alternative, some aboveground structures are required which will cause permanent impacts. The shallow aquifer alternatives include well houses, pump stations, and a WTP.

Table 6-55 summarizes the proposed aboveground structures and acreages associated with each of the alternatives. The aboveground structures are primarily associated with the Deep and Shallow Aquifer and Shallow Aquifer and Fox River Alluvium alternatives. Lake Michigan water supply and return flow alternatives have an insignificant impact for aboveground structures.

TABLE 6-55
Aboveground Structures

Alternative Name	Structures	Acres
Water Supply Alternatives		
Deep and Shallow Aquifers	11 well houses	13.75
	WTP	14.74
Shallow Aquifer and Fox River Alluvium	15 well houses	17.99
	WTP	33.20 ^a
Lake Michigan (City of Milwaukee)	1 pump station ^b	—
Lake Michigan (City of Oak Creek) Alignment 1	1 pump station ^b	—
Lake Michigan (City of Oak Creek) Alignment 2	1 pump station ^b	—
Lake Michigan (City of Racine)	1 pump station ^b	—
Return Flow Alternatives for Lake Michigan Water Supplies		
Underwood Creek to Lake Michigan	Pump station ^c	—
Root River to Lake Michigan Alignment 1	Pump station ^c	—
Root River to Lake Michigan Alignment 2	Pump station ^c	—
Direct to Lake Michigan	Pump station ^c	—

^a Includes the same 14.74 acres listed for the Deep and Shallow Aquifers alternative, plus additional 18.46 acres for more expansive plant needed for treatment of groundwater under the influence of surface water.

^b If the water provider requires a pump station, it will be sited to minimize impacts. If required, it is expected to only be approximately 0.25 acres in size.

^c Will be constructed within the Waukesha WWTP site, in a previously disturbed area.

6.5.1.2.5 Residential and Commercial Areas

The supply and return flow alternatives would affect no private residences. A single private building in Waukesha County is located within the proposed 75-foot-wide construction corridor at the terminus of the three Lake Michigan supply alternatives. Based on a review of aerial photography, it appears to be used as a storage structure. The City will coordinate with the owner of the building if a Lake Michigan supply is approved and minimize or avoid this impact.

For the proposed project, four single private buildings in the City of Franklin, Milwaukee County, are partially located within the estimated 75-foot-wide construction corridor of the proposed supply project. The pipeline corridor is planned to be within existing street rights-of-way. These impacts should be able to be minimized by adjusting the construction technique at these locations. Based on a review of aerial photography, the structures appear to be two garages, one apartment complex and one storage shed and impacts should be

avoidable. The City will coordinate with the owners of each structure if the proposed project is approved and minimize or avoid this impact. Appropriate mitigation measures will be taken to restore properties disturbed during construction.

Public or Conservation Land and Natural, Recreational, or Scenic Areas

The alternatives were evaluated to identify Public or Conservation Land and Natural, Recreational, or Scenic Areas within the respective routes' 75-foot-wide construction corridor. Table 6-56 summarizes the Public or Conservation Land and Natural, Recreational, or Scenic Areas within or adjacent to proposed workspaces for the supply and return flow alternatives. Public or Conservation Land and Natural, Recreational, or Scenic Areas may include the following:

- Federal or state wild and scenic rivers
- USFWS designated areas, USDA Forest Service areas
- U.S. National Parks
- National Wilderness Areas
- National Trails System
- National Historic Landmarks
- Critical habitat areas of NOAA Fisheries
- State designated natural areas and state managed lands
- State, county, and/or city parks
- Golf courses and athletic fields
- Designated greenspace corridors
- School properties

TABLE 6-56

Public or Conservation Lands within or Adjacent to the Alternatives

Alternative Name	Name of Resource	Acres within Proposed 75-ft Construction Workspace
Water Supply Alternatives		
Deep and Shallow Aquifers	Vernon Marsh Wildlife Area	1.25
	American Legion Memorial Park	0.10
	Fox River Park	1.40
	Hillcrest Park	0.06
	Spring City Soccer Club Athletic Fields	0.72
Shallow Aquifer and Fox River Alluvium	Vernon Marsh Wildlife Area	1.25
	American Legion Memorial Park	0.10
	Fox River Park	1.41
	Hillcrest Park	0.06
	Spring City Soccer Club Athletic Fields	0.72
Lake Michigan (City of Milwaukee)	Greenfield Park	0.17
	Hillcrest Park	1.16
	New Berlin Golf Course	1.51

TABLE 6-56
Public or Conservation Lands within or Adjacent to the Alternatives

Alternative Name	Name of Resource	Acres within Proposed 75-ft Construction Workspace
	Root River Parkway	21.28
Lake Michigan (City of Oak Creek) Alignment 1	Former North Shore ROW	9.38
	Greenfield Park	0.17
	Greenlawn Park	0.05
	Hillcrest Park	1.16
	Milwaukee Metropolitan Sewerage District Conservation Plan area	0.54
	New Berlin Hills Golf Course	1.51
	Oak Creek Parkway	1.10
	Root River Parkway	39.40
	Whitnall Park	5.41
Lake Michigan (City of Oak Creek) Alignment 2	Franklin Woods Nature Center	0.65
	Hidden Lakes Park	0.38
	Hillcrest Park	0.04
	Park Arthur	0.48
	Prospect Hill School	0.62
Lake Michigan (City of Racine)	WDNR designated Big Muskego Lake Wildlife Area	2.64
	Cheska Farms Riding Stables WDNR site	2.29
	WDNR designated area	5.66
	Hillcrest Park	1.16
	Minooka Park	8.64
Return Flow Alternatives for Lake Michigan Water Supplies		
Underwood Creek to Lake Michigan	Bethesda Springs Park	0.30
	Carroll College athletic fields	0.28
	Fox River Sanctuary	2.48
	Greenfield Park	0.17
	Krueger Park (which becomes Rainbow Park on the south side of Interstate 94)	0.89
	Underwood Creek Parkway and Corridor	3.83
Root River to Lake Michigan Alignment 1	Bethesda Springs Park	0.30
	Carroll College athletic fields	0.28

TABLE 6-56
Public or Conservation Lands within or Adjacent to the Alternatives

Alternative Name	Name of Resource	Acres within Proposed 75-ft Construction Workspace
	Fox River Sanctuary	2.48
	Greenfield Park	0.17
	New Berlin Hills Golf Course	1.00
	Root River Parkway	43.99
Root River to Lake Michigan Alignment 2	Buchner Park	0.09
	Carroll College (Athletic Fields)	0.05
	Catholic Memorial High School	0.15
	Fox River Sanctuary	<0.01
	Hidden Lakes Park	0.38
	Park Arthur	0.48
	Prospect Hill School	0.62
	Randall School	0.18
Direct to Lake Michigan	Root River Parkway	0.20
	Bethesda Springs Park	0.30
	Carroll College athletic fields	0.28
	Fox River Sanctuary	2.48
	Greene Park	0.61
	Greenfield Park	0.64
	Kinnickinnic River Parkway	0.35
	Sheridan Park	0.60
	Saint Francis High School	0.49
	Saint Francis Property	0.30

Source: Google Earth (2009); SEWRPC (2005).

A review of Google Earth (2009, 2012) and the SEWRPC Land Use Division and GIS Division, Park and Open Spaces Sites data (2005) indicated no federally designated or managed Public or Conservation Land and Natural, Recreational, or Scenic Areas would be affected by the supply and return flow alternatives.

Temporary construction impacts may occur to state and local Public or Conservation Land and Natural, Recreational, or Scenic Areas as a result of construction, depending on the final project. Impacts to state and local resources can be divided into two main categories: temporary and permanent construction-related impacts, and impacts resulting from groundwater table drawdown. Temporary construction-related impacts will be short in duration and minimized by implementing BMPs designed to reduce impacts to sensitive resources. At this time, no permanent aboveground structures are envisioned within areas

designated as state or local Public or Conservation Land and Natural, Recreational, or Scenic Areas. Depending upon the final booster pump station location, a local public park could be affected, however the extent of impact would be limited to approximately 0.25 acres and would be coordinated with local public officials and the public.

Permanent impacts resulting from a potential drawdown of the groundwater table are applicable only to the Deep and Shallow Aquifers and Shallow Aquifer and Fox River Alluvium Alternatives. The groundwater drawdown affects the Vernon Wildlife Area and is described in Section 6.4.3.2.2, Environmental Effects to Wetland Flora and Fauna, and Appendix 6-4, Vernon Marsh Wildlife Area Wetland Habitat Impact Analysis.

Coastal Zone Management Areas

Coastal Zone Management Areas are enforced within Wisconsin counties that border the Great Lakes, including Milwaukee County. The Lake Michigan supply, Underwood Creek return flow, and Root River return flow alternatives are within Milwaukee County but do not affect coastal areas.

The Deep and Shallow Aquifers and Shallow Aquifer and Fox River Alluvium alternatives and their associated aboveground structures (well houses and WTP) are entirely within Waukesha County and, therefore, will not impact a Coastal Zone Management Area.

The Direct to Lake Michigan return flow alternative is within the designated Wisconsin Coastal Zone (DOA, 2010). If this alternative is utilized, the City will coordinate with the WDNR, USACE, and applicable agencies regarding avoidance and minimization of impacts to the Wisconsin Coastal Zone.

6.5.1.2.6 Environmental Effects Comparison: Terrestrial Resources – Land Use

Adverse impacts from changes to land use are summarized below for each alternative. Level of relative impact to land use were developed to compare one alternative to another. Impacts were compared based upon Table 6-57. Table 6-58 summarizes the impacts to land use.

TABLE 6-57
Environmental Impact Category Description: Land Use

No adverse impact	Temporary construction impacts and operational impacts that result in land use changes already frequently occurring in the area.
Minor adverse impact	Operational impacts result in land use changes to Public or Conservation Land and Natural, Recreational, or Scenic Areas less than 5 acres.
Moderate adverse impact	Operational impacts result in land use changes to Public or Conservation Land and Natural, Recreational, or Scenic Areas greater than 5, but less than 50 acres.
Significant adverse impact	Operational impacts result in land use changes to Public or Conservation Land and Natural, Recreational, or Scenic Areas greater than 50 acres.

Pipeline routes under all alternatives are in areas that have been already developed or disturbed to minimize impacts to Public or Conservation Land and Natural, Recreational, or Scenic Areas. The pipeline routes would be restored after construction. Consequently, all alternatives are similar and would have no significant adverse operational impacts to public or conservation land or to natural, recreational, or scenic areas.

6.5.1.3 Soil

Prime farmland soils crossed by the supply and return flow alternatives were identified and characterized using the Natural Resource Conservation Service (NRCS) 2009 Soil Survey Geographic (SSURGO) database. The prime farmland soils series were identified in a linear progression along the proposed routes.

Prime farmland is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is available for such use. It has the soil quality, growing season, and moisture supply needed to produce economically sustained high yields of crops when treated and managed according to acceptable farming methods, including water management. Prime farmlands have an adequate and dependable water supply from precipitation or irrigation, a favorable temperature and growing season, acceptable acidity or alkalinity, acceptable salt and sodium content, and few or no rocks.

Prime farmlands are not excessively erodible or saturated with water for long periods. They do not flood frequently or are protected from flooding. Not all areas designated prime farmland are active agriculturally. There may be locations that exhibit extensive historical disturbance from development, such as residential or roadway construction. The presence of active agricultural areas for each water supply and return flow alternative is discussed below.

6.5.1.3.1 Affected Environment

Soil series descriptions were obtained through SSURGO (NRCS, 2009). The descriptions provided are based on information available at the county level for soil series. Table 6-59 through Table 6-68 contain specific information on soil characteristics and limitations for the supply and return flow alternatives.

TABLE 6-58
Water Supply and Return Flow Alternative Environmental Impact
Comparison Summary: Land Use

Alternative	Land Use
Water Supply	
Deep and Shallow Aquifers	No adverse impact
Shallow Aquifer and Fox River Alluvium	No adverse impact
Lake Michigan (City of Milwaukee)	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 1	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 2	No adverse impact
Lake Michigan (City of Racine)	No adverse impact
Return Flow Alternatives for Lake Michigan Water Supplies	
Underwood Creek to Lake Michigan	No adverse impact
Root River to Lake Michigan Alignment 1	No adverse impact
Root River to Lake Michigan Alignment 2	No adverse impact
Direct to Lake Michigan	No adverse impact

6.5.1.3.2 Environmental Effects

Construction will have short-term and permanent impacts to the soils within a given supply or return flow alternative corridor. Impacts may include soil erosion on steep slopes by wind and water, mixing of topsoil and subsoil, soil compaction and rutting from construction equipment, and poor revegetation potential. These impacts will be mitigated by sustainable construction techniques and an ambitious revegetation program.

Because the pipeline routes follow previously disturbed areas (streets, alleys, bike paths, active and abandoned railroad corridors, utility corridors, and city and county lands), few impacts would occur to active agricultural lands, even if the soil is classified as prime agricultural land. Potential impacts to active agricultural lands are listed in Section 6.5.1.2 on Land Use and Table 6-52. As noted in the table, the Lake Michigan Supply-Milwaukee and all return flow alternatives cross lands classified as prime farmland, but they have no impacts on active agricultural lands.

If an alternative has impacts on active agricultural lands, crop production may be lost in the temporary workspaces if construction takes place during the growing season. Losses would be short term in areas where no permanent aboveground structures or access roads are proposed, because the land would be returned to production for the growing season following completion of construction. Topsoil would be carefully managed during construction to ensure that the productive capacity of the land would be retained after construction.

The land disturbed during construction would be restored as practicable to pre-construction conditions. The City would employ BMPs, such as topsoil segregation, sediment and erosion control measures, and site restoration, to minimize long-term impacts to construction areas. Information regarding specific BMPs and restoration measures proposed to be used will be provided to the appropriate agency stakeholders during the design process should active agricultural areas be impacted. Operational impacts to prime farmland would occur under the Deep and Shallow Wells and Shallow Aquifer and Fox River Alluvium alternatives because of the aboveground structures required for the project.

Acreage impacts are listed in the discussion below for all alternatives. Impacts are evaluated assuming a 75-foot right-of-way for construction.

Deep and Shallow Aquifers Water Supply

The operational and maintenance impacts to soils are those that occur from the facilities which will permanently alter the land use, such as the WTP, wells, and service roads. The WTP proposed for the Deep and Shallow Wells Alternative would affect 33.20 acres, all prime farmland soils. The 11 well houses would affect 38.41 acres, of which 30.96 acres, or 80.6 percent, are prime farmland. This alternative would affect prime farmland soil (Table 6-59), but actual land in active agriculture use is much less (Table 6-52). Land uses other than agricultural occur on most of the remaining soil classified as prime farmland.

Shallow Aquifer and Fox River Alluvium Water Supply

Operational and maintenance impacts to soils are those caused by the facilities that will permanently alter the land use, such as the WTP, wells, and service roads. The proposed WTP would affect 14.74 acres, all prime farmland. The 15 well houses proposed for the Shallow Aquifer and Fox River Alluvium Alternative would affect 51.26 acres, of which 50.62 acres, or

99 percent, are as prime farmland. This alternative would affect prime agricultural land (Table 6-60), but actual land in active agriculture use is much less (Table 6-52). Land uses other than agricultural exist on most of the remaining soil that is prime farmland.

TABLE 6-59
Prime Farmlands Crossed by the Deep and Shallow Aquifers Supply Alternative

Prime Farmland Soil Series	Soil Series Description	Acres Crossed
AzA	Aztalan loam, 0 to 2 percent slopes	4.55
CeB	Casco loam, 2 to 6 percent slopes	2.55
Dt	Drummer silt loam, gravelly substratum	1.42
FmA	—	11.24
FmB	Fox sandy loam, 1 to 6 percent slopes	1.10
FoA	Fox loam, 0 to 2 percent slopes	16.33
FoB	Fox loam, 2 to 6 percent slopes	1.77
FoC2	Fox loam, 6 to 12 percent slopes, eroded	0.33
FsA	Fox silt loam, 0 to 2 percent slopes	3.34
FsB	Fox silt loam, 2 to 6 percent slopes	0.76
HeA	Hebron loam, 0 to 2 percent slopes	3.88
HeB	Hebron loam, 2 to 6 percent slopes	0.86
HmB	Hochheim loam, 2 to 6 percent slopes	4.30
HmB2	Hochheim loam, 2 to 6 percent slopes, eroded	4.39
HmC2	Hochheim loam, 6 to 12 percent slopes, eroded	7.59
HtA	Houghton muck, 0 to 2 percent slopes	0.59
KeA	Kane silt loam, 1 to 3 percent slopes	3.29
LyB2	Lorenzo loam, 2 to 6 percent slopes, eroded	0.09
MgA	Martinton silt loam, 1 to 3 percent slopes	0.41
MmA	Matherton silt loam, 1 to 3 percent slopes	6.89
MoB	Mayville silt loam, 2 to 6 percent slopes	0.73
Na	Navan silt loam	2.74
Oc	Ogden muck	0.07
OmB	Oshtemo loamy sand, 1 to 6 percent slopes	9.68
Pa	Palms muck	3.59
Ph	Pella silt loam	4.09
PrA	Pistakee silt loam, 1 to 3 percent slopes	0.12
Sm	Sebewa silt loam	1.23
ThB	Theresa silt loam, 2 to 6 percent slopes	2.69
WeA	Warsaw loam, 0 to 2 percent slopes	1.36
WeB	Warsaw loam, 2 to 6 percent slopes	21.24
WhA	Warsaw silt loam, 0 to 2 percent slopes	16.29
Total		139.53

TABLE 6-60
Prime Farmlands Crossed by the Shallow Aquifer and Fox River Alluvium Alternative

Prime Farmland Soil Series	Soil Series Description	Acres Crossed
AzA	Aztalan loam, 0 to 2 percent slopes	4.55
CeB	Casco loam, 2 to 6 percent slopes	2.55
Dt	Drummer silt loam, gravelly substratum	2.33
FmA	—	14.98
FmB	Fox sandy loam, 1 to 6 percent slopes	4.54
FoA	Fox loam, 0 to 2 percent slopes	25.47
FoB	Fox loam, 2 to 6 percent slopes	4.07
FoC2	Fox loam, 6 to 12 percent slopes, eroded	0.33
FsA	Fox silt loam, 0 to 2 percent slopes	3.34
FsB	Fox silt loam, 2 to 6 percent slopes	0.76
HeA	Hebron loam, 0 to 2 percent slopes	5.16
HeB	Hebron loam, 2 to 6 percent slopes	0.86
HmB	Hochheim loam, 2 to 6 percent slopes	4.31
HmB2	Hochheim loam, 2 to 6 percent slopes, eroded	5.05
HmC2	Hochheim loam, 6 to 12 percent slopes, eroded	7.59
HtA	Houghton muck, 0 to 2 percent slopes	4.21
KeA	Kane silt loam, 1 to 3 percent slopes	3.29
LyB2	Lorenzo loam, 2 to 6 percent slopes, eroded	0.09
MgA	Martinton silt loam, 1 to 3 percent slopes	0.41
MmA	Matherton silt loam, 1 to 3 percent slopes	9.61
MoB	Mayville silt loam, 2 to 6 percent slopes	0.73
MtA	Mequon silt loam, 1 to 3 percent slopes	0.00
Na	Navan silt loam	2.74
Oc	Ogden muck	0.07
OmB	Oshtemo loamy sand, 1 to 6 percent slopes	12.89
Pa	Palms muck	3.72
Ph	Pella silt loam	4.92
PrA	Pistakee silt loam, 1 to 3 percent slopes	0.12
Sm	Sebewa silt loam	1.23
ThB	Theresa silt loam, 2 to 6 percent slopes	2.69
WeA	Warsaw loam, 0 to 2 percent slopes	1.36
WeB	Warsaw loam, 2 to 6 percent slopes	23.88
WhA	Warsaw silt loam, 0 to 2 percent slopes	16.29
Ww	Wet alluvial land	3.15
Total		177.29

Lake Michigan Water Supply (City of Milwaukee)

This alternative would affect prime farmland (Table 6-61), but the actual land use of such land is other than agricultural.

TABLE 6-61

Prime Farmlands Crossed by the Lake Michigan (City of Milwaukee) Alternative

Prime Farmland Soil Series	Soil Series Description	Acres Crossed
AsA	Ashkum silty clay loam, 0 to 3 percent slopes	5.37
AzB	Aztalan loam, 2 to 6 percent slopes	1.08
FoB	Fox loam, 2 to 6 percent slopes	1.07
FsB	Fox silt loam, 2 to 6 percent slopes	1.00
FsC2	Fox silt loam, 6 to 12 percent slopes, eroded	0.10
HmB	Hochheim loam, 2 to 6 percent slopes	0.93
HmB2	Hochheim loam, 2 to 6 percent slopes, eroded	0.91
HmC2	Hochheim loam, 6 to 12 percent slopes, eroded	3.63
HtA	Houghton muck, 0 to 2 percent slopes	13.24
LmB	Lamartine silt loam, 1 to 4 percent slopes	1.49
Lo	Lawson silt loam	8.70
MgA	Martinton silt loam, 1 to 3 percent slopes	0.75
MmA	Matherton silt loam, 1 to 3 percent slopes	2.93
MtA	Mequon silt loam, 1 to 3 percent slopes	20.41
Mzb	Montgomery silty clay loam	1.23
Na	Navan silt loam	0.08
Oc	Ogden muck	5.07
OuB	Ozaukee silt loam, 2 to 6 percent slopes	8.96
OuB2	Ozaukee silt loam, 2 to 6 percent slopes, eroded	9.38
OuC2	Ozaukee silt loam, 6 to 12 percent slopes, eroded	1.68
Ph	Pella silt loam	2.32
PrA	Pistakee silt loam, 1 to 3 percent slopes	0.31
ShC2	Saylesville silt loam, 6 to 12 percent slopes, eroded	0.08
Sm	Sebewa silt loam	9.42
ThB	Theresa silt loam, 2 to 6 percent slopes	0.33
Wa	Wallkill silt loam	0.35
Ww	Wet alluvial land	7.58
Total		108.42

Lake Michigan Water Supply (City of Oak Creek) Alignment 1

There are few facilities that alter the land use associated with this alternative. Impacts to active agricultural lands would be from pipeline construction, and thus temporary in nature. This alternative would affect soil classified as prime farmland (Table 6-62), but land in actual active agricultural use is much less. Land uses other than agricultural exist on most of the remaining soil that is prime farmland.

TABLE 6-62

Prime Farmlands Crossed by the Lake Michigan (City of Oak Creek) Alignment 1 Alternative

Prime Farmland Soil Series	Soil Series Description	Acres Crossed
AsA	Ashkum silty clay loam, 0 to 3 percent slopes	7.58
AzB	Aztalan loam, 2 to 6 percent slopes	5.17
BIA	Blount silt loam, 1 to 3 percent slopes	19.75
CeB	Casco loam, 2 to 6 percent slopes	0.06
Dt	Drummer silt loam, gravelly substratum	11.38
FoB	Fox loam, 2 to 6 percent slopes	1.91
FsB	Fox silt loam, 2 to 6 percent slopes	1.00
FsC2	Fox silt loam, 6 to 12 percent slopes, eroded	0.79
GrB	Grays silt loam, 2 to 6 percent slopes	1.79
HeB	Hebron loam, 2 to 6 percent slopes	1.21
HmB	Hochheim loam, 2 to 6 percent slopes	0.93
HmB2	Hochheim loam, 2 to 6 percent slopes, eroded	0.91
HmC2	Hochheim loam, 6 to 12 percent slopes, eroded	3.63
HtA	Houghton muck, 0 to 2 percent slopes	13.77
KwB	Knowles silt loam, 2 to 6 percent slopes	6.10
LmB	Lamartine silt loam, 1 to 4 percent slopes	1.49
Lo	Lawson silt loam	10.77
MgA	Martinton silt loam, 1 to 3 percent slopes	2.16
MmA	Matherton silt loam, 1 to 3 percent slopes	6.21
MtA	Mequon silt loam, 1 to 3 percent slopes	13.80
Mzb	Montgomery silty clay loam	1.23
MzdB	Morley silt loam, 2 to 6 percent slopes	6.82
MzdB2	Morley silt loam, 2 to 6 percent slopes, eroded	41.90
MzdC2	Morley silt loam, 6 to 12 percent slopes, eroded	4.30
MzfA	Mundelein silt loam, 1 to 3 percent slopes	0.16
Na	Navan silt loam	1.80
Oc	Ogden muck	5.97
OuB	Ozaukee silt loam, 2 to 6 percent slopes	9.88
OuB2	Ozaukee silt loam, 2 to 6 percent slopes, eroded	5.54
OuC2	Ozaukee silt loam, 6 to 12 percent slopes, eroded	0.40
Ph	Pella silt loam	2.32
PrA	Pistakee silt loam, 1 to 3 percent slopes	0.31
RkB	Ritchey silt loam, 1 to 6 percent slopes	1.39
ShB	Saylesville silt loam, 2 to 6 percent slopes	1.17
ShC2	Saylesville silt loam, 6 to 12 percent slopes, eroded	0.08
Sm	Sebewa silt loam	14.26
ThB	Theresa silt loam, 2 to 6 percent slopes	0.33
Wa	Wallkill silt loam	0.35
Ww	Wet alluvial land	8.89
Total		217.51

Lake Michigan Water Supply (City of Oak Creek) Alignment 2

There are few facilities that alter the land use associated with this alternative. Impacts to active agricultural lands would be from pipeline construction, and thus temporary in nature. This alternative would affect soil classified as prime farmland (Table 6-63), but land in actual active agricultural use is much less. Land uses other than agricultural exist on most of the remaining soil that is prime farmland.

Lake Michigan Water Supply (City of Racine)

Few facilities that would alter land use are associated with this alternative. Impacts to active agricultural lands would be from pipeline construction, which would all be temporary. This alternative would affect soil classified as prime farmland (Table 6-64), but actual active agricultural is much less. Land uses other than agricultural exist on most of the remaining soil classified as prime farmland.

Underwood Creek to Lake Michigan Return Flow

This alternative would affect soil classified as prime farmland (Table 6-65), but actual active agriculture is much less. Land uses other than agricultural exist on all the remaining soil classified as prime farmland.

Root River to Lake Michigan Alignment 1 Return Flow

This alternative would affect soil classified as prime farmland (Table 6-66), but none is used actively for agriculture. Land uses other than agricultural occur on all the remaining soil classified as prime farmland.

Root River to Lake Michigan Alignment 2 Return Flow

There are few facilities that alter the land use associated with this route. Impacts to active agricultural lands would be from pipeline construction, and thus temporary in nature. This alternative would affect soil classified as prime farmland (Table 6-67), but land in actual active agricultural use is much less. Land uses other than agricultural exist on most of the remaining soil that is prime farmland.

Direct to Lake Michigan Return Flow

This alternative would affect soil classified as prime farmland (Table 6-68), but none is used actively for agriculture. Land uses other than agricultural occur on all the remaining soil classified as prime farmland.

TABLE 6-63

Prime Farmlands Crossed by the Lake Michigan (City of Oak Creek) Alignment 2 Alternative

Prime Farmland Soil Series	Soil Series Description	Acres Crossed
AsA	Ashkum silty clay loam, 0 to 3 percent slopes	16.52
AzB	Aztalan loam, 2 to 6 percent slopes	0.31
BIA	Blount silt loam, 1 to 3 percent slopes	22.74
BsA	Brookston silt loam, 0 to 3 percent slopes	0.25
CcB	Casco sandy loam, 2 to 6 percent slopes	0.42
CeB	Casco loam, 2 to 6 percent slopes	0.80
Cw	Colwood silt loam	0.76
FoB	Fox loam, 2 to 6 percent slopes	2.76
FsC2	Fox silt loam, 6 to 12 percent slopes, eroded	0.38
Ftb	Fox silt loam, loamy substratum, 2 to 6 percent slopes	0.85
GrB	Grays silt loam, 2 to 6 percent slopes	0.47
HeA	Hebron loam, 0 to 2 percent slopes	1.41
HeB	Hebron loam, 2 to 6 percent slopes	0.76
HmB	Hochheim loam, 2 to 6 percent slopes	7.94
HmB2	Hochheim loam, 2 to 6 percent slopes, eroded	5.40
HmC2	Hochheim loam, 6 to 12 percent slopes, eroded	13.07
HtA	Houghton muck, 0 to 2 percent slopes	2.93
JuA	Juneau silt loam, 1 to 3 percent slopes	0.95
KIA	Kendall silt loam, 1 to 3 percent slopes	1.16
LmB	Lamartine silt loam, 1 to 4 percent slopes	7.69
Lo	Lawson silt loam	0.66
MgA	Martinton silt loam, 1 to 3 percent slopes	1.67
MmA	Matherton silt loam, 1 to 3 percent slopes	1.93
MoB	Mayville silt loam, 2 to 6 percent slopes	2.35
MtA	Mequon silt loam, 1 to 3 percent slopes	9.05
Mzb	Montgomery silty clay loam	0.82
MzdB	Morley silt loam, 2 to 6 percent slopes	12.54
MzdB2	Morley silt loam, 2 to 6 percent slopes, eroded	19.87
MzdC2	Morley silt loam, 6 to 12 percent slopes, eroded	3.79
MzfA	Mundelein silt loam, 1 to 3 percent slopes	0.36
Oc	Ogden muck	0.11
OuB	Ozaukee silt loam, 2 to 6 percent slopes	2.02
OuB2	Ozaukee silt loam, 2 to 6 percent slopes, eroded	4.76

TABLE 6-63
Prime Farmlands Crossed by the Lake Michigan (City of Oak Creek) Alignment 2 Alternative

Prime Farmland Soil Series	Soil Series Description	Acres Crossed
OuC2	Ozaukee silt loam, 6 to 12 percent slopes, eroded	1.18
Pa	Palms muck	0.88
Ph	Pella silt loam	2.74
ScB	St. Charles silt loam, 2 to 6 percent	1.54
SeA	St. Charles silt loam, gravelly substratum, 0 to 2 percent slopes	0.16
Sg	Sawhill silt loam, calcareous variant	0.05
ShB	Saylesville silt loam, 2 to 6 percent slopes	0.84
Sm	Sebewa silt loam	1.12
ThB	Theresa silt loam, 2 to 6 percent slopes	4.04
ThB2	Theresa silt loam, 2 to 6 percent slopes, eroded	8.39
ThC2	Theresa silt loam, 6 to 12 percent slopes, eroded	0.45
Ww	Wet alluvial land	0.06
Total		168.93

TABLE 6-64
Prime Farmlands Crossed by the Lake Michigan (City of Racine) Alternative

Prime Farmland Soil Series	Soil Series Description	Acres Crossed
Am	Alluvial land	0.11
AsA	Ashkum silty clay loam, 0 to 3 percent slopes	6.01
AtA	Ashkum silty clay loam, 0 to 3 percent slopes	21.08
AzB	Aztalan loam, 2 to 6 percent slopes	2.44
BcA	Beecher silt loam, 1 to 3 percent slopes	13.17
BIA	Blount silt loam, 1 to 3 percent slopes	14.36
BnB	Boyer sandy loam, 2 to 6 percent slopes	0.33
BsA	Brookston silt loam, 0 to 3 percent slopes	4.17
CeB	Casco loam, 2 to 6 percent slopes	0.02
Cw	Colwood silt loam	0.92
EtA	Elliott silty clay loam, 0 to 2 percent slopes	7.77
EtB	Elliott silty clay loam, 2 to 6 percent slopes	6.80
FoB	Fox loam, 2 to 6 percent slopes	1.07
FrB	Fox loam, clayey substratum, 2 to 6 percent slopes	1.08
FsB	Fox silt loam, 2 to 6 percent slopes	1.00
FtB	Fox silt loam, loamy substratum, 2 to 6 percent slopes	0.41
GrB	Grays silt loam, 2 to 6 percent slopes	0.18
HeA	Hebron loam, 0 to 2 percent slopes	0.69
HeB	Hebron loam, 2 to 6 percent slopes	0.34
HeB2	Hebron loam, 2 to 6 percent slopes, eroded	0.64
HeC2	Hebron loam, 6 to 12 percent slopes, eroded	0.09
HmB	Hochheim loam, 2 to 6 percent slopes	10.72
HmB2	Hochheim loam, 2 to 6 percent slopes, eroded	7.70
HmC2	Hochheim loam, 6 to 12 percent slopes, eroded	11.35
HoC3	Hochheim soils, 6 to 12 percent slopes, severely eroded	0.20
Ht	Houghton muck	5.12
HtA	Houghton muck, 0 to 2 percent slopes	17.75
HtB	Houghton muck, 2 to 6 percent slopes	1.16
JuA	Juneau silt loam, 1 to 3 percent slopes	0.20
KaA	Kane loam, 1 to 3 percent slopes	0.95
KhA	Kane silt loam, clayey substratum, 1 to 3 percent slopes	7.01
LmB	Lamartine silt loam, 1 to 4 percent slopes	6.52
MeB	Markham silt loam, 2 to 6 percent slopes	21.10

TABLE 6-64
Prime Farmlands Crossed by the Lake Michigan (City of Racine) Alternative

Prime Farmland Soil Series	Soil Series Description	Acres Crossed
MeB2	Markham silt loam, 2 to 6 percent slopes, eroded	9.56
MeC2	Markham silt loam, 6 to 12 percent slopes, eroded	0.34
MgA	Martinton silt loam, 1 to 3 percent slopes	6.13
MkA	Matherton loam, 1 to 3 percent slopes	2.35
MmA	Matherton silt loam, 1 to 3 percent slopes	2.24
MoB	Mayville silt loam, 2 to 6 percent slopes	2.83
Mzb	Montgomery silty clay loam	3.17
Mzc	Montgomery silty clay	4.35
MzdB	Morley silt loam, 2 to 6 percent slopes	33.02
MzdB2	Morley silt loam, 2 to 6 percent slopes, eroded	14.62
MzdC2	Morley silt loam, 6 to 12 percent slopes, eroded	12.51
MzfA	Mundelein silt loam, 1 to 3 percent slopes	0.28
Na	Navan silt loam	4.07
Oc	Ogden muck	18.37
Ph	Pella silt loam	3.56
PrA	Pistakee silt loam, 1 to 3 percent slopes	1.81
RaA	Radford silt loam, 0 to 3 percent slopes	0.92
ScB	St. Charles silt loam, 2 to 6 percent slopes	0.28
Sg	Sawmill silt loam, calcareous variant	0.62
ShA	Saylesville silt loam, 0 to 2 percent slopes	1.36
ShB	Saylesville silt loam, 2 to 6 percent slopes	4.93
ShB2	Saylesville silt loam, 2 to 6 percent slopes, eroded	1.21
ShC2	Saylesville silt loam, 6 to 12 percent slopes, eroded	1.53
Sm	Sebewa silt loam	1.68
So	Sebewa silt loam, clayey substratum	0.38
ThA	Theresa silt loam, 0 to 2 percent slopes	0.55
ThB	Theresa silt loam, 2 to 6 percent slopes	6.03
ThB2	Theresa silt loam, 2 to 6 percent slopes, eroded	1.56
ThC2	Theresa silt loam, 6 to 12 percent slopes, eroded	0.51
VaB	Varna silt loam, 2 to 6 percent slopes	7.53
Wa	Wallkill silt loam	1.11
WgB	Warsaw loam, clayey substratum, 2 to 6 percent slopes	0.02
Total		321.89

TABLE 6-65
Prime Farmlands Crossed by the Underwood Creek to Lake Michigan Return Flow Alternative

Prime Farmland Soil Series	Soil Series Description	Acres Crossed
AsA	Ashkum silty clay loam, 0 to 3 percent slopes	4.88
CeB	Casco loam, 2 to 6 percent slopes	0.54
FoA	Fox loam, 0 to 2 percent slopes	0.08
FsC2	Fox silt loam, 6 to 12 percent slopes, eroded	0.10
GrB	Grays silt loam, 2 to 6 percent slopes	0.43
HmB	Hochheim loam, 2 to 6 percent slopes	8.97
HmB2	Hochheim loam, 2 to 6 percent slopes, eroded	0.57
HmC2	Hochheim loam, 6 to 12 percent slopes, eroded	0.73
HtA	Houghton muck, 0 to 2 percent slopes	17.74
KeA	Kane silt loam, 1 to 3 percent slopes	0.66
LmB	Lamartine silt loam, 1 to 4 percent slopes	0.66
LyB2	Lorenzo loam, 2 to 6 percent slopes, eroded	0.92
MgA	Martinton silt loam, 1 to 3 percent slopes	0.75
MmA	Matherton silt loam, 1 to 3 percent slopes	3.82
MtA	Mequon silt loam, 1 to 3 percent slopes	12.36
Mzb	Montgomery silty clay loam	1.23
MzfA	Mundelein silt loam, 1 to 3 percent slopes	0.79
Oc	Ogden muck	5.07
OuB	Ozaukee silt loam, 2 to 6 percent slopes	9.34
OuB2	Ozaukee silt loam, 2 to 6 percent slopes, eroded	4.93
OuC2	Ozaukee silt loam, 6 to 12 percent slopes, eroded	1.01
Ph	Pella silt loam	13.14
PrA	Pistakee silt loam, 1 to 3 percent slopes	0.31
Sm	Sebewa silt loam	2.37
WeB	Warsaw loam, 2 to 6 percent slopes	9.08
WeC2	Warsaw loam, 6 to 12 percent slopes, eroded	0.33
Ww	Wet alluvial land	1.93
Total		102.75

TABLE 6-66
Prime Farmlands Crossed by the Root River to Lake Michigan Return Flow Alternative

Prime Farmland Soil Series	Soil Series Description	Acres Crossed
AsA	Ashkum silty clay loam, 0 to 3 percent slopes	4.21
AzB	Aztalan loam, 2 to 6 percent slopes	0.85
CeB	Casco loam, 2 to 6 percent slopes	0.72
Dt	Drummer silt loam, gravelly substratum	15.71
FoA	Fox loam, 0 to 2 percent slopes	0.08
FsC2	Fox silt loam, 6 to 12 percent slopes, eroded	0.10
HmB	Hochheim loam, 2 to 6 percent slopes	8.97
HmB2	Hochheim loam, 2 to 6 percent slopes, eroded	0.57
HmC2	Hochheim loam, 6 to 12 percent slopes, eroded	0.73
HtA	Houghton muck, 0 to 2 percent slopes	17.86
KeA	Kane silt loam, 1 to 3 percent slopes	0.66
LmB	Lamartine silt loam, 1 to 4 percent slopes	0.66
Lo	Lawson silt loam	9.97
LyB2	Lorenzo loam, 2 to 6 percent slopes, eroded	0.92
MgA	Martinton silt loam, 1 to 3 percent slopes	0.75
MmA	Matherton silt loam, 1 to 3 percent slopes	5.99
MtA	Mequon silt loam, 1 to 3 percent slopes	13.65
Mzb	Montgomery silty clay loam	1.23
Na	Navan silt loam	0.04
Oc	Ogden muck	5.07
OuB	Ozaukee silt loam, 2 to 6 percent slopes	7.95
OuB2	Ozaukee silt loam, 2 to 6 percent slopes, eroded	3.70
OuC2	Ozaukee silt loam, 6 to 12 percent slopes, eroded	0.47
Ph	Pella silt loam	3.06
PrA	Pistakee silt loam, 1 to 3 percent slopes	0.34
ShC2	Saylesville silt loam, 6 to 12 percent slopes, eroded	0.02
Sm	Sebewa silt loam	11.40
WeB	Warsaw loam, 2 to 6 percent slopes	9.08
WeC2	Warsaw loam, 6 to 12 percent slopes, eroded	0.33
Ww	Wet alluvial land	11.01
Total		136.13

TABLE 6-67
Prime Farmlands Crossed by the Root River to Lake Michigan Return Flow Alignment 2 Alternative

Prime Farmland Soil Series	Soil Series Description	Acres Crossed
AsA	Ashkum silty clay loam, 0 to 3 percent slopes	11.94
AzB	Aztalan loam, 2 to 6 percent slopes	0.31
BIA	Blount silt loam, 1 to 3 percent slopes	25.61
BsA	Brookston silt loam, 0 to 3 percent slopes	0.25
CeB	Casco loam, 2 to 6 percent slopes	2.93
Cw	Colwood silt loam	0.76
FoA	Fox loam, 0 to 2 percent slopes	0.14
FoB	Fox loam, 2 to 6 percent slopes	3.97
GrB	Grays silt loam, 2 to 6 percent slopes	0.33
HmB	Hochheim loam, 2 to 6 percent slopes	13.26
HmB2	Hochheim loam, 2 to 6 percent slopes, eroded	4.49
HmC2	Hochheim loam, 6 to 12 percent slopes, eroded	8.80
HtA	Houghton muck, 0 to 2 percent slopes	0.01
KIA	Kendall silt loam, 1 to 3 percent slopes	1.16
LmB	Lamartine silt loam, 1 to 4 percent slopes	6.37
Lo	Lawson silt loam	2.61
LyB2	Lorenzo loam, 2 to 6 percent slopes, eroded	0.98
MeB	Markham silt loam, 2 to 6 percent slopes	1.64
MgA	Martinton silt loam, 1 to 3 percent slopes	2.97
MmA	Matherton silt loam, 1 to 3 percent slopes	3.57
MoB	Mayville silt loam, 2 to 6 percent slopes	2.35
MtA	Mequon silt loam, 1 to 3 percent slopes	9.05
MzdB	Morley silt loam, 2 to 6 percent slopes	14.15
MzdB2	Morley silt loam, 2 to 6 percent slopes, eroded	20.98
MzdC2	Morley silt loam, 6 to 12 percent slopes, eroded	2.76
MzfA	Mundelein silt loam, 1 to 3 percent slopes	1.74
Oc	Ogden muck	0.11
OuB	Ozaukee silt loam, 2 to 6 percent slopes	2.02
OuB2	Ozaukee silt loam, 2 to 6 percent slopes, eroded	4.76
OuC2	Ozaukee silt loam, 6 to 12 percent slopes, eroded	1.18
Ph	Pella silt loam	2.71
ScB	St. Charles silt loam, 2 to 6 percent	1.54
SeA	St. Charles silt loam, gravelly substratum, 0 to 2 percent slopes	0.16
Sg	Sawhill silt loam, calcareous variant	0.61
Sm	Sebewa silt loam	1.12
ThB	Theresa silt loam, 2 to 6 percent slopes	3.61
ThB2	Theresa silt loam, 2 to 6 percent slopes, eroded	8.39
ThC2	Theresa silt loam, 6 to 12 percent slopes, eroded	0.45
Wa	Wallkill silt loam	0.23
WeB	Warsaw loam, 2 to 6 percent slopes	7.36
WeC2	Warsaw loam, 6 to 12 percent slopes, eroded	0.49
Ww	Wet alluvial land	0.06
Total		177.91

TABLE 6-68
Prime Farmlands Crossed by the Direct to Lake Michigan Return Flow Alternative

Prime Farmland Soil Series	Soil Series Description	Acres Crossed
AsA	Ashkum silty clay loam, 0 to 3 percent slopes	4.21
CeB	Casco loam, 2 to 6 percent slopes	0.91
FoA	Fox loam, 0 to 2 percent slopes	0.08
FsC2	Fox silt loam, 6 to 12 percent slopes, eroded	0.10
GrB	Grays silt loam, 2 to 6 percent slopes	1.47
HmB	Hochheim loam, 2 to 6 percent slopes	8.97
HmB2	Hochheim loam, 2 to 6 percent slopes, eroded	0.57
HmC2	Hochheim loam, 6 to 12 percent slopes, eroded	0.73
HtA	Houghton muck, 0 to 2 percent slopes	17.74
KeA	Kane silt loam, 1 to 3 percent slopes	0.66
LmB	Lamartine silt loam, 1 to 4 percent slopes	0.66
LyB2	Lorenzo loam, 2 to 6 percent slopes, eroded	0.92
MgA	Martinton silt loam, 1 to 3 percent slopes	0.75
MmA	Matherton silt loam, 1 to 3 percent slopes	7.20
MtA	Mequon silt loam, 1 to 3 percent slopes	12.35
Mzb	Montgomery silty clay loam	1.23
MzfA	Mundelein silt loam, 1 to 3 percent slopes	1.05
Oc	Ogden muck	5.07
OuB	Ozaukee silt loam, 2 to 6 percent slopes	7.95
OuB2	Ozaukee silt loam, 2 to 6 percent slopes, eroded	3.13
OuC2	Ozaukee silt loam, 6 to 12 percent slopes, eroded	0.40
Ph	Pella silt loam	3.06
PrA	Pistakee silt loam, 1 to 3 percent slopes	0.31
Sm	Sebewa silt loam	2.54
WeB	Warsaw loam, 2 to 6 percent slopes	9.08
WeC2	Warsaw loam, 6 to 12 percent slopes, eroded	0.33
Ww	Wet alluvial land	1.93
Total		93.41

6.5.1.3.3 Environmental Effects Comparison: Soils

Adverse impacts from changes to soils are summarized below for each alternative. The level of relative impact (no adverse impact, minor adverse impact, etc.) to soils were developed to compare one alternative to another. Impacts were compared based upon Table 6-69. The impacts to soils are summarized in Table 6-70.

Temporary construction-related impacts to soils are associated with all alternatives. All have pipeline routes that run through areas that have been already developed or disturbed to

minimize impacts to vegetation and species of concern. This summary focuses upon operational impacts to soils that would occur from aboveground structures.

Deep and Shallow Aquifers Water Supply

The aboveground structures would affect prime farmland soils that occur in the project area. The WTP proposed for this alternative would affect 33.20 acres, all of which are prime farmland. The 11 well houses proposed would affect 38.41 acres, of which 30.96 acres, or 80.6 percent, are prime farmland soils. These impacts would be limited to soil types frequently found in the area, and consequently adverse impacts would be minor.

Shallow Aquifer and Fox River Alluvium Water Supply

The aboveground structures would affect prime farmland soils. Prime farmland soil is commonly found in the project vicinity. The WTP proposed for this alternative would impact approximately 14.74 acres, of which all is classified as prime farmland soils. The 15 proposed well houses would affect 51.26 acres, of which 50.62 acres, or 99 percent, are designated prime farmland. Impacts would be limited to soil types frequently found in the area, and consequently adverse impacts would be minor.

TABLE 6-69
Environmental Impact Category Description: Soils

No adverse impact	No operational impacts and only temporary construction impacts.
Minor adverse impact	Operational impacts are limited to soil types frequently found in the area.
Moderate adverse impact	Operational impacts occur to soil types infrequently occurring in the area.
Significant adverse impact	Operational impacts occur to soil types rarely occurring in the area.

TABLE 6-70
Water Supply and Return Flow Alternative
Environmental Impact Comparison Summary: Soils

Alternative	Soils
Water Supply	
Deep and Shallow Aquifers	Minor adverse impact
Shallow Aquifer and Fox River Alluvium	Minor adverse impact
Lake Michigan (City of Milwaukee)	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 1	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 2	No adverse impact
Lake Michigan (City of Racine)	No adverse impact
Return Flow Alternatives for Lake Michigan Water Supplies	
Underwood Creek to Lake Michigan	No adverse impact
Root River to Lake Michigan Alignment 1	No adverse impact
Root River to Lake Michigan Alignment 2	No adverse impact
Direct to Lake Michigan	No adverse impact

Lake Michigan Water Supply (Cities of Milwaukee, Oak Creek Alignments 1 and 2, and Racine)

Other than a pump station approximately 0.25 acres in size which is not expected to be located in active agricultural areas, there would be no significant aboveground structures with these alternatives and thus insignificant impacts to prime farmland. Consequently, there would be no adverse impacts.

Underwood Creek, Root River Alignments 1 and 2, or Direct to Lake Michigan Return Flow

There would be no significant aboveground structures other than a return flow pump station in a previously disturbed area at the Waukesha WWTP. This route thus has insignificant impacts to prime farmland. Consequently, there would be no adverse impacts.

6.5.2 Flora and Fauna

Game and nongame wildlife species are regulated and protected under various legislation including the State of Wisconsin's wild game regulations, Wisconsin's Endangered and Threatened Species regulations (NR 27), the federal Fish and Wildlife Conservation Act of 1980 (16 U.S.C. 2901-2911), the Endangered Species Act, and the Fish and Wildlife Coordination Act of 1958.

6.5.2.1 Affected Environment

Wildlife species require adequate food, water, cover, and living space for the survival of individuals and to maintain population viability. The various habitats within the project area support a variety of widespread and tolerant mammals, birds, reptiles, amphibians, and invertebrates. Refer to the maps found in Appendix 3-1 of Section 3 and to Appendix 6-1 at the end of this Section for maps associated with the proposed project and alternatives to the proposed project. The wildlife habitats along the proposed workspace fall into four categories and several subcategories:

- *Open Unforested Areas* that will be affected by the project generally include cropland (fallow and active), undeveloped nonforested areas, and scrub-shrub land. Farm crops may serve as a food source for certain species, including whitetail deer and Canada goose. Uncultivated grasslands, pasture, scrub-shrub land, and maintained rights-of-way may support herbaceous and low-level woody vegetation, offering protective cover and forage food sources. Open areas may function as travel corridors where adjacent land is wooded or developed. Open, uncultivated areas may sustain abundant populations of small mammals, such as deer mouse and meadow vole, larger herbivorous mammals, such as woodchuck and eastern cottontail rabbit, and predatory omnivores or carnivores, such as opossum, striped skunk, and red fox. Open areas may provide suitable habitat for bird species, including red-winged blackbird, Canada goose, meadowlark, mourning dove, American crow, American robin, European starling, common grackle, and various sparrows. Open areas bordered by woodland habitats or hedgerows are of particular value to birds and other wildlife because of the nesting and refuge opportunities they afford. Reptiles and amphibians that frequent open grassy areas include the eastern garter snake, blue racer, and American toad.
- *Wooded Areas* that will be affected by the project generally consist of deciduous upland forests. Forested areas exhibit a more complex structure than open areas and generally provide a higher-quality wildlife habitat. Large unfragmented tracts of forested land can provide important habitat for larger, territorial mammals (coyote, deer) and may provide

habitat for migratory birds. Food sources from mature trees, as well as berries and other fruits from some understory shrubs and woody vines, are an important wildlife food source. Secondary canopy shrubs and saplings, brush piles, and fallen logs provide cover for various small- to medium-sized mammals. There will be little change in permanent forested riparian areas affected by the proposed aboveground structures, as shown in the maps found in Appendix 3-1 of Section 3 and to Appendix 6-1 at the end of this Section. Impacts to forested riparian areas and wetlands may occur as a result of pipeline installation, but such impacts would be temporary and would be managed by avoidance, minimization, and mitigation measures developed in coordination with the appropriate regulatory agencies. As a result, temporary impacts do not represent a significant concern.

- *Aquatic Areas* that will be affected by the project consist generally of streams and wetlands from pipeline construction and return flow receiving waters, including Lake Michigan and its tributaries. Aquatic areas can provide habitat to a diverse wildlife population, and several common species (beaver, muskrat, herons, etc.) are dependent on aquatic habitat for food and shelter. Animals and birds such as beaver, muskrat, and herons depend on aquatic habitats for food and shelter. Others, such as raccoon, are less restricted but prefer to be close to water. Amphibians and many reptiles favor aquatic habitats. Representative species include bullfrog and northern water snake. Aquatic habitat is discussed further in Section 6.4.2.2.4, Aquatic Habitat.
- *Developed Areas* that will be affected by the project generally consist of residential, commercial, and industrial land, and active recreational parks. These areas generally have asphalt and concrete surfaces, maintained turf grass, and landscape trees and shrubs. In general, they provide poor wildlife habitat, but opportunistic species such as raccoon, opossum, squirrel, American crow, American robin, European starling, common grackle, various sparrows, and others have adapted well and thrive in urban and suburban settings. The landscape of the project area originally was a combination of hardwood forest, prairie, savanna, and wetlands. Today, most of the area is dominated by agriculture and urban development. Forests dominated by maple and beech trees are common forest types, along with oak-hickory dominated and lowland hardwood forest types. There are also some areas of wet-mesic and wet prairie, but only small preserves remain since the landscape is heavily disturbed and fragmented. Because of isolation, fragmentation, and disturbance, nonnative plants are abundant throughout the project area (WDNR, 12/2011a).

The USFWS and WDNR were contacted to determine federal- or state-listed species known to occur in the terrestrial areas along the project corridor. The species identified by the agencies as potentially occurring within all proposed project corridor alignments are summarized in Section 6.4.3, Wetlands, since most of the impacts would be to wetlands.

The maps found in Appendix 3-1 of Section 3 and to Appendix 6-1 at the end of this Section show an aerial view of the alternative alignments, portraying land use and general vegetation along each route. Table 6-52 lists the land uses affected by each alternative.

U.S. Department of Agriculture's *Descriptions of the Ecoregions of the United States* (1995) contains a hierarchical classification system for ecological units on national and regional scales. Areas are described as being within a specific domain, division, province, section, subsection, and landscape. Southeast Wisconsin is within the Humid Temperate Domain,

Hot Continental Division, and Eastern Broadleaf Forest Province (USDA, 2010). Descriptions of these ecoregions are as follows.

6.5.2.1.1 Humid Temperate Domain

The Humid Temperate Domain, located in the middle latitudes (30° to 60°N), has a climate governed by both tropical and polar air masses. The middle latitudes are subject to cyclones. Much of the precipitation in this belt comes from rising moist air along fronts within the cyclones. Pronounced seasons are the rule, with strong annual cycles of temperature and precipitation. Climates of the middle latitudes have a distinctive winter season, which tropical climates do not.

The Humid Temperate Domain contains forests of broadleaf deciduous and needleleaf evergreen trees. The variable importance of winter frost determines six divisions: warm continental, hot continental, subtropical, marine, prairie, and Mediterranean (USDA, 2010).

6.5.2.1.2 Hot Continental Division

The Hot Continental Division is characterized by hot summers and cool winters. The frost-free, or growing, season lasts 5 to 6 months in the division's warmer sections, and only 3 to 5 months in the colder sections. Snow cover is deeper and lasts longer in the northerly areas.

Vegetation in this climate division is winter deciduous forest, dominated by tall broadleaf trees that provide a continuous dense canopy in summer but shed their leaves completely in winter. Lower layers of small trees and shrubs are weakly developed. In spring, a ground cover of herbs develops quickly, but it is greatly reduced after trees reach full foliage and shade the ground.

Soils are chiefly inceptisols, ultisols, and alfisols, which are rich in humus and moderately leached, with a distinct light-colored leached zone under the dark upper layer. The ultisols have a low supply of bases and a horizon in which clay has accumulated. Where topography is favorable, diversified farming and dairying are the most successful agricultural practices.

Rainfall decreases with distance from the ocean. Therefore, this division is subdivided into moist oceanic and dry continental provinces (USDA, 2010).

6.5.2.1.3 Eastern Broadleaf Forest Province

Most of the Eastern Broadleaf Forest Province has rolling hills, but some parts have close to flat topography. In Wisconsin the province has been glaciated. Broadleaf deciduous forests dominate the province and, because of lower precipitation, the province supports the oak-hickory association. The Eastern Broadleaf Forest in northern states such as Wisconsin also supports the maple-basswood association (USDA, 2010).

6.5.2.1.4 Vegetation Communities of Special Concern

According to correspondence from the USFWS (2010, 2013), no vegetation communities of special concern or critical habitat occur within the construction workspaces associated with the supply and return flow alternatives.

WDNR (2010c, 2011c, 2013c) identified several vegetation communities of special concern (referred to in Wisconsin as "natural communities") that may be in the area of the supply and return flow alternatives. Because most of the natural communities that will be affected

by the project are associated with wetland habitats, natural communities are discussed under Section 6.4.3.2.1, Affected Environment for Wetlands.

6.5.2.2 Environmental Effects

In general, impacts to wildlife resources from constructing supply and return flow pipelines will be minor and limited to temporary impacts during construction to tolerant opportunistic species. Clearing and grading the construction areas will result in loss of vegetative cover and may result in the mortality of less mobile fauna, such as small rodents, reptiles, and invertebrates, which may be unable to escape the construction area.

Construction likely will cause the temporary displacement of more mobile wildlife from workspaces and adjacent areas. Wooded habitat removed by construction will be replaced initially by nonwoody vegetation, which may provide food, shelter, and breeding space for small mammals and birds. Trees will be allowed to grow back on cleared workspace beyond the maintained maintenance corridor. Surface restoration will include coordination with regulatory agencies to provide preferred habitat vegetation applicable to adjacent land use and operational considerations.

After construction, wildlife is expected to return and recolonize. Because the pipeline routes follow streets, alleys, bike paths, active and abandoned railroad corridors, utility corridors, city and county lands, and other disturbed areas, long-term impacts to wildlife resources are only associated with the permanent aboveground structures (see Table 6-55). Plans will accommodate general and site-specific protective measures for sensitive wildlife habitats and species identified during the course of detailed design and permitting. Seasonal construction scheduling to accommodate reproductive and migratory patterns will be coordinated with state and federal agencies.

Siting for the alternatives was chosen to minimize the overall land use impact by using roadways, utility corridors, or previously disturbed areas.

Stream crossings will be constructed as quickly as possible and stream habitats restored upon completion of construction. State-approved BMPs will be used to minimize sedimentation, turbidity, and other impacts that may temporarily affect stream vegetation and wildlife.

The City will continue to work with local, state, and federal agencies, landowners, and soil conservation authorities so that construction and mitigation procedures are compatible with both site-specific and regional environmental protection objectives.

6.6 Air Quality

6.6.1 Affected Environment

The project area is located in an attainment area for carbon monoxide, lead, sulfur dioxide and 1-hour and 8-hour ozone. The project area is in a non-attainment area for particulate matter (PM/PM_{2.5}) (EPA, 12/2012).

6.6.2 Environmental Effects

Particulate air emissions (fugitive dust) are expected to be generated by construction associated with the project alternatives. The emissions will be temporary and last only during the construction period. The impact of emissions will be highly localized and limited to areas where restoration of the construction corridor has not yet been completed. Fugitive dust will be minimized by requiring restoration as construction proceeds along the pipeline corridor. The City of Waukesha will take reasonable precautions to prevent fugitive dust from construction work from becoming airborne, such as by applying water as appropriate. Therefore, it is not anticipated that the construction-related emission will have a significant impact on air quality.

During operation, energy use to pump water to the City of Waukesha and to discharge treated wastewater effluent will release emissions. Table 6-71 compares the energy use and the greenhouse gas emissions of each alternative.

TABLE 6-71
Estimated Energy Use and Greenhouse Gas Emissions

Alternative	Estimated Annual Energy Usage (MWh)	Estimated Annual GHG Emissions (tons CO ₂)
Water Supply		
Deep and Shallow Aquifers	26,500	24,600
Shallow Aquifer and Fox River Alluvium	24,100	22,400
Lake Michigan (City of Milwaukee)	11,500	13,200
Lake Michigan (City of Oak Creek) Alignment 1	16,000	17,300
Lake Michigan (City of Oak Creek) Alignment 2	14,200	15,700
Lake Michigan (City of Racine)	16,100	17,500
Return Flow Alternatives for Lake Michigan Water Supplies		
Underwood Creek to Lake Michigan	2,700	2,500
Root River to Lake Michigan Alignment 1	4,400	4,100
Root River to Lake Michigan Alignment 2	7,300	6,800
Direct to Lake Michigan	4,600	4,300

Note: the energy use and greenhouse gas emission were conducted using an ADD of 10.1 mgd; greenhouse gas emissions will change proportionally with a change in ADD.

The Lake Michigan water sources with return flow generally contribute fewer greenhouse gas emissions than the groundwater source alternatives. The water supply and return flow alternatives would have fewer emissions than what occurs currently.

Other emissions could come from backup electrical generators at the water supply and return flow pump stations. Backup generators would operate only when primarily electrical supply from the regional electrical utility is unavailable; that is, rarely. Emissions from a backup electrical generator therefore would be minimal.

6.7 Socioeconomic Environment

This section describes socioeconomic resources that could be affected by the water supply and return flow alternatives and also the potential impacts.

The University of Wisconsin–Milwaukee (UWM) prepared an evaluation of the socioeconomic implications of water supply alternatives in support of SEWRPC's regional water supply plan (SEWRPC, 2010a). Based on recommendations by SEWRPC's Environmental Justice Task Force, SEWRPC contracted with the UWM Center for Economic Development (CED) in 2009 as a nonpartisan agency to evaluate the recommendations set forth in the regional water supply plan and the socioeconomic impact of the recommendations. *A Socio-Economic Impact Analysis of SEWRPC's Regional Water Supply Plan* was finalized and released in July 2010. The analysis included extensive interviews with planners and utility personnel from the communities, and considered a wide range of socioeconomic attributes. The analysis in this section summarizes the findings of the report. The alternatives evaluated as part of this environmental report are consistent with SEWRPC's regional water supply plan, the CED evaluation, SEWRPC's Environmental Justice Task Force recommendations, and *A Socio-Economic Impact Analysis of SEWRPC's Regional Water Supply Plan*.

This section summarizes data where reported in the SEWRPC Socio-Economic Impact Analysis report (UWM, 2010) using 2000 census data because the SEWRPC report was published prior to 2010 census data becoming available. For population information not readily available in the SEWRPC Socio-Economic Impact Analysis report, 2010 census data was used.

6.7.1 Population

6.7.1.1 Population Affected

Waukesha county population more than doubled between 1960 and 2007. This growth is much greater than that in the 7 county SEWRPC planning region. Whereas Waukesha accounted for only 10 percent of the regional population, it now represents almost 20 percent (Table 6-72). The City of Waukesha has experienced a similar population growth, increasing from 30,000 in 1960 to more than 64,000 in 2000. The rate of growth in the City is expected to decline over the next 25 years, reaching a projected total of 88,500 in 2035 (36 percent increase). The water supply needs for the City are partially based on these population projections, but the water needs include an enlarged water supply service area beyond the City and changes in manufacturing, commercial, industrial and other water-consuming sectors (see the Water Supply Service Area Plan, Volume 2 of the Application).

TABLE 6-72
Waukesha and Southeastern Wisconsin Regional Population

County	1960		2007		Change	
	Number	% of Region	Number	% of Region	Number	%
Waukesha	158,249	10.1	376,978	18.9	218,729	138.2
Southeastern Wisconsin	1,573,614	100.0	1,995,901	100.0	422,287	26.8

Source: US Census Bureau as reported in UWM, 2010

6.7.1.1.1 Age

Based on the results of the 2010 census, the median age in Waukesha County is 42 (USCB, 2010a). Table 6-73 summarizes age statistics for the state, Waukesha County, and the City of Waukesha.

TABLE 6-73
Waukesha and Southeastern Wisconsin Regional Population Age Statistics: 2010

State of Wisconsin		Waukesha County		City of Waukesha	
Age Group	% of Total	Age Group	% of Total	Age Group	% of Total
Under 5 years	6.3	Under 5 years	5.5	Under 5 years	7.1
5 to 9 years	6.5	5 to 9 years	6.7	5 to 9 years	6.8
10 to 14 years	6.6	10 to 14 years	7.2	10 to 14 years	6.1
15 to 19 years	7.0	15 to 19 years	6.8	15 to 19 years	6.7
20 to 24 years	6.8	20 to 24 years	4.7	20 to 24 years	7.8
25 to 29 years	6.5	25 to 29 years	5.1	25 to 29 years	8.6
30 to 34 years	6.1	30 to 34 years	5.2	30 to 34 years	8.1
35 to 39 years	6.1	35 to 39 years	6.0	35 to 39 years	7.0
40 to 44 years	6.7	40 to 44 years	7.3	40 to 44 years	6.7
45 to 49 years	7.7	45 to 49 years	8.8	45 to 49 years	7.0
50 to 54 years	7.7	50 to 54 years	8.8	50 to 54 years	6.8
55 to 59 years	6.8	55 to 59 years	7.5	55 to 59 years	5.8
60 to 64 years	5.5	60 to 64 years	6.1	60 to 64 years	5.1
65 to 69 years	4.0	65 to 69 years	4.2	65 to 69 years	3.2
70 to 74 years	3.1	70 to 74 years	3.1	70 to 74 years	2.2
75 to 79 years	2.5	75 to 79 years	2.7	75 to 79 years	1.9
80 to 84 years	2.1	80 to 84 years	2.2	80 to 84 years	1.6
85 and over	2.1	85 and over	2.0	85 and over	1.7
Median age	38.5	Median age	42	Median age	34.2

Source: USCB 2010a

6.7.1.1.2 Race and Ethnicity

The City of Waukesha is predominately white, but racial diversity has risen since 1960. The percent of nonwhites increased from 0.5 percent in 1960 to almost 9 percent in 2000, more than 5,500 nonwhite residents moved into the City over the period. The percent increase in nonwhites is similar to that in other communities in the southeastern Wisconsin region. The Waukesha County nonwhite population is projected to almost double by 2035, to almost 17 percent of the total population.

6.7.1.1.3 Health and Disabilities

In 2000 the national average of persons reporting one or more disabilities was 19.3 percent (UWM, 2010). Wisconsin reported a lower percentage at 14.7 percent of the state's population. Waukesha County provided an even lower percentage than the national and

state average, with only 10.8 percent of the population reporting one or more disabilities. The City of Waukesha was slightly higher than the state average, with 14.9 percent of the population reporting one or more disabilities.

6.7.1.1.4 Population Trends

Changes in population are based on three variables: birth and death rates, migration of people moving into and out of the community, and the ability of a community/town to annex neighboring lands, which increases the size and population.

The birth and death rate, or the balance between births and deaths in a given area, is considered a population's "natural increase." According to SEWRPC, the region experienced a population increase of 120,800 people between 1990 and 2000. It is estimated that, of the 120,800 people, 116,900 were attributed to natural increase.

Based on *The Economic State of Milwaukee's Inner City: 2006* (Levine and Williams) and numerous SEWRPC technical reports the general trend over the past 50 years has been an outward population and job migration from larger cities along the lakeshore to outlying towns and counties (SEWRPC, 2004). The reduction in manufacturing jobs in the historically larger cities and the increased economic development within inland areas has reduced jobs in the large lakeshore cities and increased jobs in inland areas.

It is possible for population growth to be constrained by the unavailability of adjacent land for development. Unless a community has the capability to annex adjacent, developable land, it may experience "buildout" or near buildout conditions. Milwaukee, which is bordered by Lake Michigan, is an example of a community facing buildout conditions. Milwaukee has exhibited a population decline, which SEWRPC projects to continue partially because of the lack of available adjacent developable land. On the contrary, the City of Waukesha has developable land that will support population growth.

6.7.1.2 Population Effects

The water demand projections used to specify the water supply quantities for all sources (groundwater and Lake Michigan) were based partially on the population projections discussed above, and all alternative sources can meet the projected demand. Thus, meeting the demand using any alternative source would not have any constraints on population. Any of the water supply sources also can support the projected increase in nonwhite population in the City of Waukesha. This is consistent with conclusions in the CED socioeconomic study, in which planners and utilities managers reported that the water supply source will not affect population growth or distribution.

6.7.2 Economy

6.7.2.1 Existing Economic Conditions

The economy in Waukesha County also has grown over the last 20 years. Economic growth in the City of Waukesha has been much greater than the overall southeastern Wisconsin region, increasing from nearly 5 percent of the total in 1960 to more than 22 percent in 2000 (Table 6-74). This is consistent with the regional trend of employment migration from the urban areas to the more suburban areas and the shift from manufacturing to service sector jobs in the

southeastern Wisconsin region. Table 6-75 provides an overview of state, regional, and local leading industries (historical and present).

TABLE 6-74
Waukesha and Regional Economy

County	1960		1970		1980		1990		2000	
	Jobs	%	Jobs	%	Jobs	%	Jobs	%	Jobs	%
Waukesha	32,600	4.8	81,000	10.3	132,800	14.0	189,700	16.6	270,800	22.1
Southeastern Wisconsin	673,000	100.0	784,900	100	948,200	100	1,143,700	100	1,222,800	100

Source: Bureau of Labor Statistics and the US Census Bureau as reported in UWM 2010.

The economy in Waukesha County is projected to increase by 67,000 jobs, or 25 percent, by 2035. This is considerably higher than for Milwaukee County (7 percent increase) but similar to the surrounding counties.

Much of the industry in the southeastern Wisconsin region is considered to be water-intensive, but many large industrial water users rely on private high-capacity groundwater wells rather than municipal water. A review of the large businesses in Waukesha County indicates there are no known major water-intensive businesses or industries using municipal supplies (UWM, 2010, p. 15).

6.7.2.1.1 Employment and Industry

As shown in Table 6-75, the leading industry in Wisconsin shifted from manufacturing in 2000 to educational services by 2010. In Waukesha County, educational services remained the leading industry from 2000 to 2010. Similar to the Wisconsin trend, the City of Waukesha experienced a shift in leading industries, from manufacturing in 2000 to educational services in 2010 (USCB, 2000 and 2010b).

6.7.2.1.2 Unemployment

Unemployment throughout the southeastern Wisconsin region has increased over the past decade. In 2000, Wisconsin's unemployment rate was 3.2 percent. It had risen to 6.1 percent in 2010; and in November of 2011, the Bureau of Labor Statistics (BLS, 2011) reported the state average at 7.3 percent.

Waukesha County and the City of Waukesha reported similar unemployment trends over the past decade. The County's unemployment rate in 2000 was 3.7 percent. It had risen to 5.4 percent in 2010, and by November 2011 it had slightly increased to 5.7 percent (BLS, 2011). The City of Waukesha's unemployment rate was 2.5 percent in 2000. It had risen to 5.9 percent in 2010; and by November 2011 to 7.6 percent, which is slightly higher than the state average and nearly 2 percent higher than the surrounding county average (BLS, 2011).

TABLE 6-75
Leading Industries in 2000 and 2010

Geography	Industries											
	Manufacturing		Educational Services		Retail Trade		Recreation & Entertainment		Professional, Scientific, & Management		In Labor Force (population 16 years and older)	
	2000	2010	2000	2010	2000	2010	2000	2010	2000	2010	2000	2010
Wisconsin	22.2%	17.9%	20.0%	23.0%	11.6%	11.6%	7.3%	9.1%	6.6%	7.9%	69.1%	68.3%
Milwaukee County	18.5%	14.3%	22.4%	27.1%	10.4%	10.4%	7.7%	9.6%	9.3%	10.7%	65.4%	66.8%
City of Milwaukee	18.5%	13.6%	23.4%	27.7%	9.9%	11.0%	8.6%	10.4%	8.9%	11.2%	63.9%	66%
Waukesha County	14.1%	16.5%	19.9%	23.3%	11.7%	12.1%	7.9%	7.1%	9.3%	10.6%	63.9%	70.3%
City of Waukesha	22.0%	16.6%	20.5%	22.3%	12.0%	14.2%	6.8%	10.7%	9.2%	9.6%	73.2%	74.8%

Source: 2010 Census (USCB, 2010b); 2000 American Community Survey (USCB, 2000)

6.7.2.1.3 Trends

As described in the report *A Socio-Economic Impact Analysis of the Regional Water Supply Plan for Southeastern Wisconsin* (UWM, 2010), Waukesha County experienced a significant increase in jobs from 1960 to 2000 by approximately 5.4 percent annually. Before 1960, less than 5 percent of the regional distribution of jobs was from Waukesha County. However, by 2000, Waukesha County provided 22 percent of the jobs in the southeastern Wisconsin region. Percent increases and decreases in the number of jobs in a specific area is considered separately from changes in employment and unemployment rates, which are based on the total number of employable persons in an area.

A similar increase was reflected in the historical labor force pattern. Before 1960, most of the regional labor force, about 68 percent, resided in Milwaukee County. Although Milwaukee County's labor force continued to grow through 1990, its share of the regional labor force decreased to 46.5 percent by 2000. Meanwhile, Waukesha County's share of the regional labor force grew from 9.1 percent in 1960 to 19.9 percent in 2000. Waukesha County experienced an average annual growth rate of 3.15 percent from 1960 to 2000, whereas Milwaukee County experienced an annual growth rate of only 0.21 percent. These changes in labor force percentages throughout the southeastern Wisconsin region show that, percentagewise, more workers are migrating to Waukesha County than Milwaukee County.

Table 6-75 provides a 10-year overview of leading industries and labor force records for the State, Milwaukee and Waukesha counties, and the cities of Milwaukee and Waukesha.

6.7.2.1.4 Tax Base

Municipal tax rates, known as tax base, are based on the total value of all taxable property in a particular municipality. To compare tax bases accurately across multiple municipalities, the State of Wisconsin equalizes assessed values by using tools such as market sales analysis, random appraisals, and local assessors' reports to bring all values to a uniform level. Tax base analysis uses equalized values determined by the Wisconsin Department of Revenue. An overview of relevant equalized values for 2010 (Table 6-76), shows that, within the 7-county region of southeastern Wisconsin, Milwaukee County comprises 35 percent of the tax base and Waukesha County 28 (Public Policy Forum, 2011).

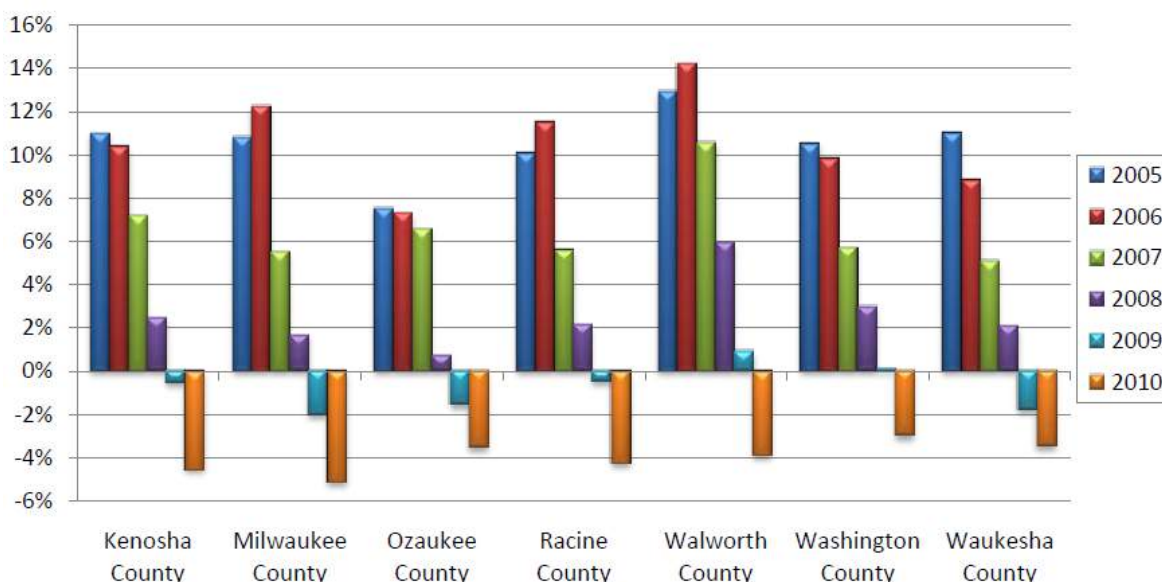
In recent years, property values in southeast Wisconsin have declined by at least 3 percent in each of the 7 counties (Public Policy Forum, 2011). Milwaukee County has seen the greatest decline. Figure 6-13 provides a visual representation of property value trends in southeast Wisconsin from 2005 to 2010.

TABLE 6-76
2010 Total Equalized Value: Southeastern Wisconsin

Geography	2010 Total Equalized Value	1 Year Change in Property Value
Milwaukee County	\$63,403,508,200	-4.9%
City of Milwaukee	\$29,500,535,100	-5.6%
Waukesha County	\$50,270,294,500	-2.9%
City of Waukesha	\$5,904,933,100	-3.2%
SE Wisconsin (7 counties)	\$182,621,628,700	-4.2%

Source: Public Policy Forum, 2011

FIGURE 6-13
County Aggregate Changes in Property Values: 2005–2010



Source: Public Policy Forum, 2011

The Public Policy Forum (2011) reported that the major factors contributing to the decline in property values in southeast Wisconsin were the economic change in real estate values and the slowed growth of new construction in the region. Table 6-77 summarizes real estate values and money spent on new construction over the seven county region in 2009 and 2010. The noticeable decline of 5 percent is believed to be a result of declining property values. New construction is an important criterion in measuring real estate values, as “new construction drives total value growth because as parcels are used more intensively, they generate a higher land utility and thus a higher value” (Public Policy Forum, 2011).

TABLE 6-77
Changes in Aggregate Real Estate Values: 2009–2010 (USD)

County	2009 Real Estate Value	Economic Change	New Construction	Other Change	2010 Real Estate Value
Kenosha	\$14,641,117,700	(\$885,124,100)	\$237,637,200	(\$56,119,800)	\$13,937,511,000
Milwaukee	\$64,849,423,300	(\$3,611,491,400)	\$398,632,100	(\$213,156,700)	\$61,423,407,300
Ozaukee	\$11,053,112,400	(\$459,394,700)	\$89,167,800	(\$40,538,800)	\$10,642,346,700
Racine	\$15,584,722,400	(\$713,582,400)	\$69,673,000	(\$39,075,600)	\$14,901,737,400
Walworth	\$15,450,442,800	\$738,054,200	\$134,579,100	\$1,621,600	\$14,848,589,300
Washington	\$13,857,974,100	(\$512,119,500)	\$120,946,200	(\$26,570,000)	\$13,440,230,800
Waukesha	\$51,011,477,100	(\$2,182,165,900)	\$394,097,100	(\$37,613,800)	\$49,185,794,500
SE Wisconsin	\$186,448,269,800	(\$9,101,932,200)	\$1,444,732,500	(\$411,453,100)	\$178,379,617,000
State of Wisconsin	\$499,856,206,900	(\$19,377,213,300)	\$4,575,602,300	(\$1,087,907,700)	\$483,966,688,200

Source: Public Policy Forum, 2011

6.7.2.2 Potential Changes in Economy

Projections of water demand take into account the City of Waukesha's economy and associated water demand as it relates to the City's water supply service area (see the Water Supply Service Area Plan, Volume 2 of the Application). By serving the projected demand, water supply would not constrain or otherwise affect economic growth and thus be consistent with all land use planning. The source of the supply does not affect the quantity; thus, all supply source alternatives are similar with respect to quantity and do not affect the economy.

The CED study found that the source of water is not a differentiating factor on development within a municipal service area (UWM, 2010, p. 19). The only exception to this view is related to groundwater with radium exceeding allowable levels. The study found some planners and utility managers in the southeastern Wisconsin region understood groundwater quality problems to be associated with radium contamination, when the groundwater was withdrawn from deep aquifer sources. There were no contamination concerns expressed for surface water sources, because contamination, specifically by radium, is associated only with deep aquifer sources.

6.7.3 Land Use, Zoning, and Transportation

6.7.3.1 Affected Land Use, Zoning, and Transportation

The pipeline routes associated with the project primarily use existing public right-of-way or utility corridors. Existing utility or transportation corridors range from 80 percent of the Lake Michigan–Milwaukee supply corridor to 8 percent of the Deep and Shallow Aquifer water supply (Table 6-53).

The second largest land use category affected for some individual routes is agricultural lands. Even though the Lake Michigan–Milwaukee supply and all the return flow alternatives cross lands classified as prime farmland (Section 6.5.1.3, Soil), they will have no permanent impact on active agricultural lands. Combined, transportation and communication utilities and agricultural lands account for approximately 75 percent of the total area affected by the supply and return flow alternatives. For the proposed project, transportation lands account for approximately 95 percent of the total area affected by the supply and return flow routes.

The Deep and Shallow Wells alternative and the Shallow Aquifer and Fox River Alluvium alternative also would not result in long-term or permanent impacts to agricultural land.

All alternative routes offer access to potential construction areas on existing public roadways. Public roadways should be sufficient access points, with no need for improvements. With the exception of the access roads to wells under the Deep and Shallow Wells and Shallow Aquifer and Fox River Alluvium alternatives, only a few temporary access roads would need to be constructed.

6.7.3.2 Land Use, Zoning, and Transportation Effects

6.7.3.2.1 Land Use

Once a final alternative has been selected and constructed, land with temporary impacts from pipeline construction will be restored to its previous use. Land use change during the

operational phase of the project would almost exclusively occur only for the Deep and Shallow Wells alternative and the Shallow Aquifer and Fox River Alluvium alternative because of the need for a new water treatment plant, new driveways/access roads, and aboveground structures.

Numerous land use types would be traversed by the supply and return flow alternatives. Existing transmission/right-of-way corridors and agricultural land are the most common land use types. Section 6.5.1.2, Land Use, of this environmental report provides a more detailed examination of existing land use. Table 6-52 lists quantitative data for land use types affected by a combination of temporary construction impacts and operation impacts of the supply and return flow alternatives.

6.7.3.2.2 Zoning

Construction and operation of the Lake Michigan–Milwaukee supply and all the return flow alternatives would not require changes to zoning conditions. Construction will not affect any areas subject to federal visual resource management standards, and no designated sensitive viewpoints are known to occur along the supply or return flow alternatives.

As required by the State of Wisconsin under Chapters NR 115 and NR 116, environmental corridors and isolated natural resource areas may be subject to local and county zoning regulations. Shorelands and floodplains are subject to local or county regulation.

The project would be designed to avoid zoning or rezoning issues to the greatest extent practicable. The only alternative that might be associated with shoreline is the Direct to Lake Michigan Return Flow alternative. The pipeline would be buried, minimizing the potential for shoreline impacts once restoration occurs. Therefore, shoreline zoning is not expected to be an issue. Once designed, the project will meet all federal, state, and local requirements before applicable permits will be issued.

6.7.3.2.3 Transportation

The regional transportation system would be minimally affected by construction and by the travel of construction workers and equipment. Since construction would move sequentially along the pipeline routes, any transportation impacts on any given roadway would be temporary. An increased number of vehicles would be encountered during morning and evening peak times, corresponding to normal workday hours.

The pipelines would be installed by boring underneath all major paved roadway crossings wherever possible. Crossing of roadways with less traffic would likely be performed by open trenching, which may cause minor disruptions in local traffic patterns. Where construction follows a road, work schedules will be communicated with local residents and local authorities to minimize impacts. Access across these roadways will be maintained for emergency vehicles and passenger vehicles through the use of metal plates and other measures. If roads are temporarily closed to through traffic, information will be shared with local first responders regarding roadway conditions. Appropriate control measures will be used during construction, such as detouring of traffic where possible, flagmen, signage, and flashing lights. Roadways will be repaired to their preconstruction condition when installation of the pipelines is completed.

Traffic from commuter (worker) traffic and from the transportation of equipment and materials for the project is expected to increase. The initial staging, which would involve

transporting the bulk of the construction equipment and materials and the daily transportation of additional equipment and materials, may temporarily affect local transportation systems. To minimize the effect, delivery routes will be required to minimize traffic disruption when delivering equipment and materials to the project site. As construction progresses, much of the equipment movement will occur along the construction right-of-way. When it is necessary for construction equipment and material to cross roadways, traffic flow may be interrupted. The transportation of equipment and materials will be minimized through planning and coordination with local road jurisdictions. For example, the scheduling of heavy loads and delivery of materials can be coordinated so that it does not conflict with commuting hours.

No significant impact of transportation infrastructure is expected for any water supply or return flow alternative. Temporary and minor disruptions of traffic flow and pattern are expected to result from construction of the project.

6.7.4 Energy Use

6.7.4.1 Affected Energy Use

Water intake, treatment, and distribution in Waukesha is accomplished from the existing power grid. The supply is adequate and expected to accommodate projected population and economic growth.

6.7.4.2 Energy Use Effects

As described in Table 6-71, energy use and greenhouse gas emissions would be lower for the Lake Michigan-Milwaukee water supply including return flow compared to the groundwater supply alternatives. Energy use would be similar for the Lake Michigan-Oak Creek, and Lake Michigan-Racine water supply alternatives including return flow, to the groundwater supply alternatives. The return flow alternatives associated with the Lake Michigan supply have energy requirements proportional to the return flow pipeline length.

6.7.5 Recreation and Aesthetics

6.7.5.1 Affected Recreation and Aesthetics

6.7.5.1.1 Recreation

According to a review of Google Earth (2009, 2012) and the SEWRPC Land Use Division and GIS Division, Park and Open Spaces Sites data (2005), no federally designated or managed Public or Conservation Land and Natural, Recreational, or Scenic Areas would be affected by the supply and return flow alternatives. See Table 6-56 for a list of public (non-federal) parks, golf courses, and wildlife areas associated with the supply and return flow alternatives.

6.7.5.1.2 Aesthetics

There are no areas subject to federal visual resource management standards. No designated sensitive viewpoints are known to occur along the supply and return flow alternatives.

6.7.5.2 Recreation and Aesthetics Effects

6.7.5.2.1 Recreation

Limited temporary construction impacts may occur to state and local public or conservation land and natural, recreational, or scenic areas as a result of construction, depending on the supply and return flow alternative selected.

At this time, no permanent aboveground structures are envisioned within areas designated as state or local Public or Conservation Land and Natural, Recreational, or Scenic Areas. Depending upon the final booster pump station location, a local public park could be affected, however the extent of impact would be limited to approximately 0.25 acres and would be coordinated with local public officials and the public.

Impacts to state and local resources can fall into two main categories: construction-related impacts, and impacts resulting from groundwater table drawdown. Construction-related impacts to resources can be further divided into temporary and permanent impacts. Temporary construction-related impacts will be short in duration and minimized by implementing BMPs designed to reduce impacts to sensitive resources. No permanent aboveground structures are expected to be built within areas designated as state or local public or conservation land and natural, recreational, or scenic areas. As a result, there will be no permanent construction-related impacts.

Permanent impacts resulting from a drawdown of the groundwater table are applicable only to the Deep and Shallow Aquifers and Shallow Aquifer and Fox River Alluvium Alternatives. The groundwater drawdown affects the Vernon Wildlife Area and is described in Section 6.4.3, Wetlands.

6.7.5.2.2 Aesthetics

Construction will not affect any areas subject to federal visual resource management standards, and no designated sensitive viewpoints are known to occur along the supply and return flow alternatives.

The well houses and water treatment plant for the Deep and Shallow Aquifers and Shallow Aquifer and Fox River Alluvium alternatives would be located within primarily agricultural areas, with a small amount of wetlands and very limited residential areas (about 1.0 acre) impacted. The Lake Michigan supply and return alternatives would not require aboveground facilities or would be limited to a pump station and small service building at an existing treatment plant, water supply facility, or coordinated with local architectural requirements for a new site development. None of the proposed aboveground structures is located in any visually sensitive areas.

Visual impacts of the supply and return flow alternatives are expected to be minor and temporary. In agricultural areas, previously disturbed easements, roadway corridors, and residential properties, visual disturbance will be difficult to detect by the first growing season following completion of construction and surface restoration efforts.

6.7.6 Archeological and Historical Resources

6.7.6.1 Affected Resources

6.7.6.1.1 Archeological Resources

Archival investigations were conducted by The Public Service Archaeology & Architecture Program of the University of Illinois at Urbana-Champaign (PSAAP) to identify significant cultural resources within or adjacent to potential construction corridors of the proposed supply and return flow alternatives. The investigations included a review of the known archaeological sites and previous cultural resource surveys within 100 meters of each alternative's potential corridor. These findings contain archeologically sensitive and confidential information that is made available to necessary agencies for review. It is not summarized here, because it is not intended for public release.

Some of the alternatives evaluated share project corridors and thus have the potential to disturb the same cultural sites. Most alternatives corridors are separate, and therefore each alternative was investigated separately. The results of the archival investigations are summarized below.

Water Supply Alternatives

- Deep and Shallow Aquifers: 9 sites and 2 previous cultural resource surveys
- Shallow Aquifer and Fox River Alluvium: 10 sites and 2 previous cultural resource surveys
- Lake Michigan—Milwaukee Supply: 5 sites and 6 previous cultural resource surveys
- Lake Michigan—Oak Creek Supply Alignment 1: 11 sites and 11 previous cultural resource surveys
- Lake Michigan—Oak Creek Supply Alignment 2: 7 sites and 17 previous cultural resource surveys
- Lake Michigan—Racine Supply: 2 sites and 7 previous cultural resource surveys

Return Flow Alternatives

- Underwood Creek to Lake Michigan: 6 sites and 7 surveys
- Root River to Lake Michigan Alignment 1: 9 sites and 2 surveys
- Root River to Lake Michigan Alignment 2: 10 sites and 18 previous cultural surveys
- Direct to Lake Michigan: 17 sites and 7 survey

Appendix 5-3 contains additional information regarding potential sites.

6.7.6.1.2 Historical Resources

The National Parks Service's National Register of Historic Places (NRHP) was authorized under the National Historic Preservation Act of 1966. The NRHP is the official list of historic places throughout the U.S. and is part of a national program to coordinate and support efforts to identify, evaluate, and protect historic and archeological resources (NRHP, 2010).

The NRHP database, which can be used through Google Earth, provides the locations of NRHP sites for the Midwest Region, including Wisconsin. No NRHP sites are located within 0.1 mile of the Lake Michigan–Milwaukee, Lake Michigan–Oak Creek Alignments 1 or 2, or Lake Michigan–Racine supply alternatives.

There are 25 NRHP sites within 0.1 mile of the Deep and Shallow Aquifers and Shallow Aquifer and Fox River Alluvium supply alternatives in Waukesha County (NHRP, 2010). Thirteen NRHP sites were identified within 0.1 mile of the Underwood Creek to Lake Michigan return flow alternative, all within Waukesha County; no NRHP sites were identified within the Milwaukee County part of the Underwood Creek to Lake Michigan return flow alternative. There are 10 NRHP sites within 0.1 mile of the Root River to Lake Michigan Alignment 1 return flow alternative, of which all are within Waukesha County. There are 10 NRHP sites within 0.10 mile of the Direct to Lake Michigan return flow alternative within Waukesha County and two NRHP sites within Milwaukee County (NHRP, 2010). There are eight NRHP sites were identified within 0.1 mile of the Root River to Lake Michigan return flow Alignment 2 alternative, all within Waukesha County; no NRHP sites were identified within the Milwaukee County section of the Root River to Lake Michigan return flow Alignment 2 (NHRP, 2012).

6.7.6.2 Environmental Effects

6.7.6.2.1 Archeological Resources

Regardless of the alternatives selected, the City will meet regulatory requirements regarding archeological resources during the design and construction phases to prevent any significant impacts and mitigate impacts to known or potential sites. During operation, there will be no ground disturbance, and no impacts will occur to archeological resources.

6.7.6.2.2 Historical Resources

No NRHP sites will be affected by permanent structures associated with the project. Regardless of the alternatives selected, the City will follow regulatory requirements to prevent significant impacts and to mitigate impacts to known or potential NRHP sites. During operation, there will be no ground disturbance, and no impacts will occur to historical resources.

6.7.7 Public Water Supply and Uses

6.7.7.1 Affected Public Water Supply and Uses

6.7.7.1.1 Groundwater

The City of Waukesha currently obtains approximately 80 percent of its water supply from the deep St. Peter Sandstone Aquifer. Near and east of the City, the aquifer is confined by a geological feature—the Maquoketa shale layer—that limits natural recharge of the aquifer. Continued use of the aquifer by the City and surrounding communities since the 19th century and the presence of the Maquoketa shale have led to the 500- to 600-foot decline in aquifer water levels (SEWRPC, 2010a, pp. 108, 113). Reduced groundwater levels in southeastern Wisconsin have in turn affected regional surface waters, which now receive about 18 percent less in groundwater contribution as water migrates toward the deep aquifer (USGS, 2007). Significant water quality issues occur with declining water levels in the deep aquifer, including increased levels of salts and radium (a naturally occurring element in the deep aquifer that can cause cancer).

To provide drinking water with low levels of radium, the City treats some deep aquifer water to remove radium and mixes it with radium-free water from the shallow Troy Bedrock aquifer. The City obtains approximately 20 percent of its water supply from the shallow aquifer. Increased pumping of the shallow aquifer will stress surface water resources by reducing baseflows to local streams and wetlands (SEWRPC, 2010a).

Additional information on drawdown of the shallow aquifer for the Deep and Shallow Aquifers as well as the Shallow Aquifer and Fox River Alluvium alternatives is found in Section 6.4.4, Groundwater.

6.7.7.1.2 Surface Water

The City is seeking a water supply to meet future water demands of the City's projected water service area as delineated by the SEWRPC. The City seeks sufficient water to serve customers within its delineated service area. Detailed demand numbers are found in the Water Supply Service Area Plan (Volume 2 of the Application).

Lake Michigan, the preferred water supply alternative, is bordered by four states and connected through the other Great Lakes to four other Great Lakes states and two Canadian provinces. Lake Michigan is the second largest of the Great Lakes and the only one entirely within the borders of the U.S. (WDNR, 03/2010a).

6.7.7.1.3 Water Uses

The City of Waukesha actively tracks water use by customer class for the following:

- **Residential.** Residential water demand typically includes indoor water-using activities, such as those for bathroom, kitchen, and laundry, and outdoor water use, such as that
- for lawn irrigation, swimming pools, and car washing. Waukesha's four categories of residential customers were analyzed:
 - Single-family Residential
 - Two-family Residential
 - Three-family Residential
 - Multi-family Residential (multi-family is tracked separately as outlined below)

For summary purposes, residential water use is measured in accordance with requirements set forth by the Public Service Commission of Wisconsin.

- **Industrial.** Manufacturing, processing, warehouses, foundries, and dairies.
- **Commercial.** Commercial water use is presented by customers such as retail, restaurants, office buildings, medical facilities, and private schools.
- **Public.** Public water use includes water demands for municipal buildings, public facilities, parks, public schools and institutions
- **Unsold Accounted for Water.** Water uses that are measured (or estimated) but not included in sales. Examples of this water use include water used in annual water main flushing to maintain water quality and water used in fire fighting exercises.
- **Unaccounted for Water.** The difference between total pumpage and total water sales is termed nonrevenue water and is usually expressed as a percentage. The portion of nonrevenue water attributed to leakage, meter inaccuracies, and other unknown losses is often termed *unaccounted-for water*.

Water use categories aid the utility in effectively managing water, planning for future water demand, and in developing a strategic water conservation plan (CH2M HILL, 2012).

Water use by sector for 2010 is shown in Figure 6-14. Single family and multi-family residential water use accounts for nearly 60 percent of all water use in the City of Waukesha.

Unaccounted-for water in 2010 was 6.3 percent of all water use. The City's unaccounted-for water is below the American Water Works Association recommended value of 10 percent, and well below the Public Service Commission's recommended action level of 15 percent.

Trends in water use annually over the 1999 to 2010 period are shown in Figure 6-15. The figure combines multi-family water use with residential water use (one to three family buildings).

FIGURE 6-14
Water Use by Customer Class: Waukesha Water Utility

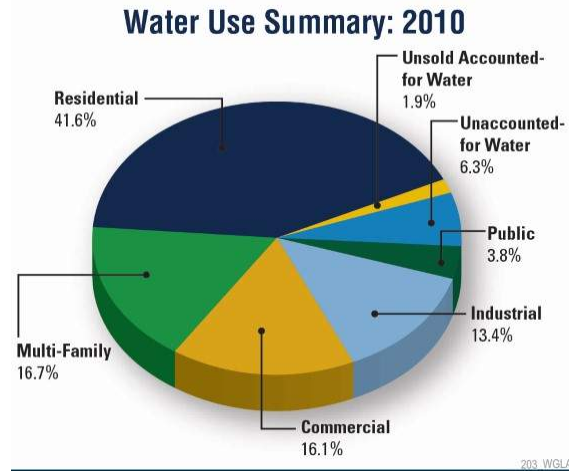
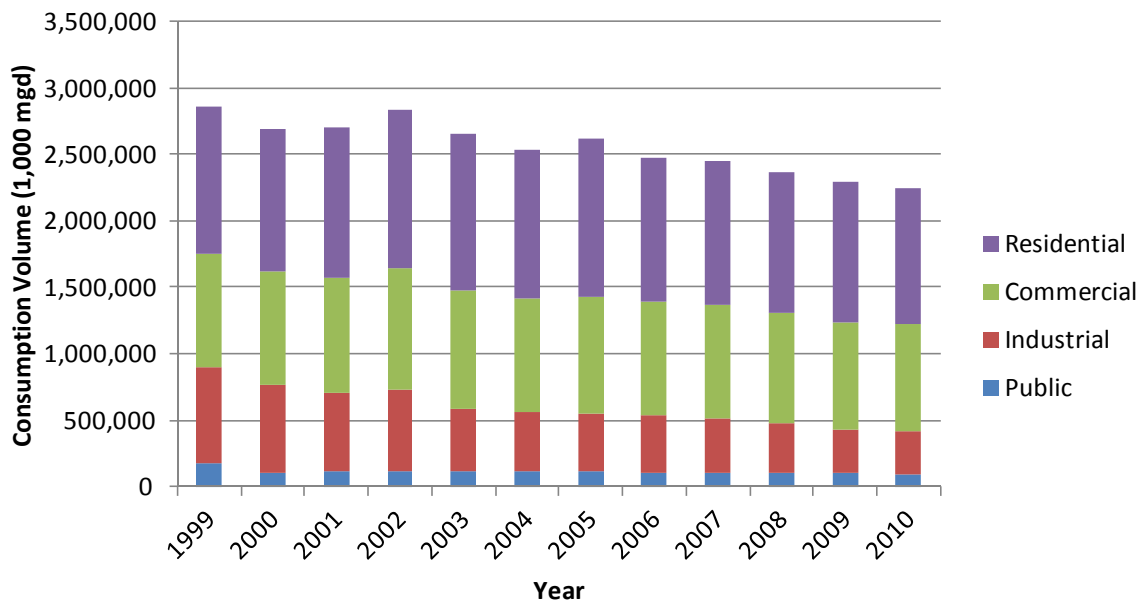


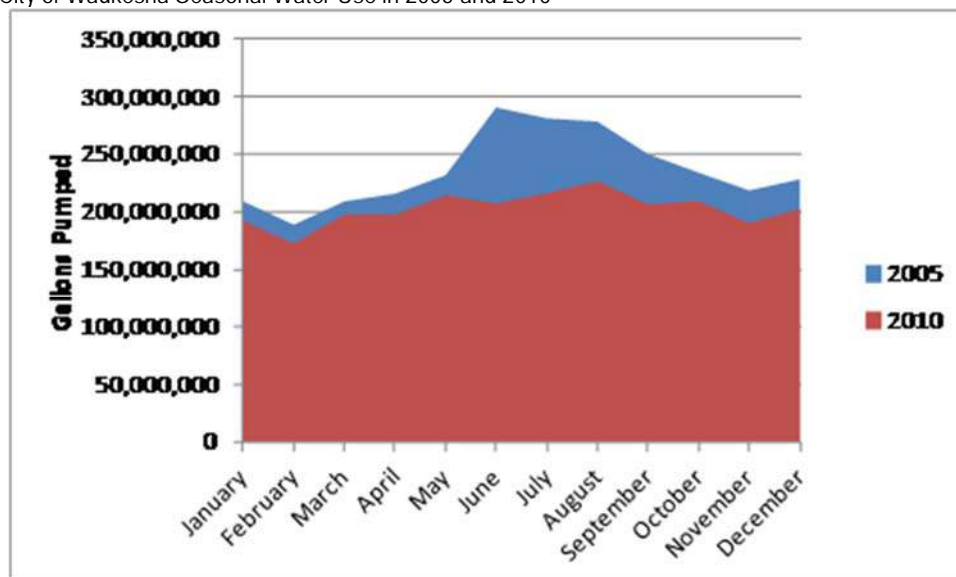
FIGURE 6-15
Annual Water Use Trend by Customer Class: Waukesha Water Utility



Seasonal water use patterns provide helpful information regarding the water use in the City's service area. Figure 6-16 presents monthly water use in 2005 and 2010. In 2006, the City restricted outdoor water use by municipal ordinance to conserve water. Since then, seasonal peak demands have declined significantly. The City must plan for a peak pumping season from May through September, but its water demand forecasts for the future assume the City will continue to restrict peak season outdoor water use. Additional information on water conservation can be found in the City of Waukesha Water Conservation Plan (Volume 3 of the Application).

FIGURE 6-16

City of Waukesha Seasonal Water Use in 2005 and 2010



Source: City of Waukesha Annual Report to the Wisconsin Public Service Commission, 2010

6.7.7.2 Public Water Supply and Use Effects

6.7.7.2.1 Groundwater

Using the Deep and Shallow Aquifer would continue to cause drawdown of the deep aquifer system. Both the Deep and Shallow Aquifer and the Shallow Aquifer and Fox River Alluvium water supply alternatives cause a drawdown in the shallow aquifer. The groundwater drawdown varies by alternative as described in Section 6.4.4, Groundwater. Groundwater drawdown affects wetland resources, as described in Section 6.4.3.1.2, Environmental Effects. Impacts to groundwater and wetland resources for these alternatives cause significant adverse impacts as documented in the sections cited.

The Lake Michigan water supply alternatives would eliminate the need to pump the deep aquifer, which would cause a partial rebound in the deep aquifer in the City of Waukesha. Because of the volume of water present, withdrawal from Lake Michigan with return flow would result in no changes in lake volume, and therefore it is not expected that withdrawal from the lake would result in adverse effects to regional aquifer supplies influenced by Lake Michigan. Lake Michigan water supply consequently produces no adverse impact on groundwater resources.

6.7.7.2.2 Surface Water

The shallow groundwater pumping in the Deep and Shallow Aquifer and the Shallow Aquifer and Fox River Alluvium water supply alternatives cause a drawdown in the aquifer and intercept groundwater flow to these cold water streams. Detailed groundwater modeling found average groundwater baseflows to the cold water streams (Pebble Brook, Pebble Creek, Mill Brook) could reduce significantly (RJN Environmental Services, 2010, 2013). These, as well as less significant baseflow reductions in the Fox River, are described in Inland Waterways, Section 6.4.2. There would be no changes in water supply sources with these changes, since

none of the surface waters is used for water supply. Consequently, no significant impacts are expected to surface water supplies.

The Return Flow Plan (Volume 4 of the Application) has been designed to meet the Compact requirements with a maximum return flow rate equivalent to the maximum withdrawal rate that also minimizes out of basin water in return flow. Withdrawal from Lake Michigan with return flow protects lake volume, and therefore it is not anticipated that withdrawal from the lake would result in adverse effects to regional aquifer supplies influenced by Lake Michigan. Lake Michigan water supply consequently produces no adverse impact on groundwater resources.

6.7.7.2.3 Water Uses

No changes in water use sectors are expected with a change in water supply source. Water use by residential, commercial, and industrial sectors is not dependent upon water source. Instead, it will change over time due to varying factors such regional economic conditions, impacts from water conservation, and climatic conditions.

6.7.8 Environmental Justice

Executive Order (EO) 12898 stipulates that Federal actions, or projects funded by Federal monies may not result in disproportionately high and adverse impacts to low-income or minority populations. *Low-income* means a household income at or below the Department of Health and Human Services poverty guidelines. *Minority* indicates a person who is Black, Hispanic, Asian American, American Indian, or Alaskan Native. EO 12898 directs federal agencies to consider environmental justice by identifying and mitigating disproportionately high and adverse human health and environmental effects. This includes the interrelated social and economic benefits of their programs, policies, and activities on low-income and minority populations.

No residents would be displaced by the construction or operation of the project and economic development projections are consistent under all the water supply alternatives. Therefore, no environmental justice populations would be displaced by the project or any of the alternatives, and the project operation is not expected to cause any adverse impacts to low income or minority populations.

6.7.9 Safety

6.7.9.1 Construction

Access to the construction site would be prohibited to nonconstruction workers or contractors unless special circumstances warranted entry, which would require pre-approval from the Construction Contractor. Signage, temporary fencing, or other means as appropriate to the location will be put in place to prevent trespassing. Appropriate safety procedures will be implemented to protect workers and the public. As needed, traffic warning signs, detour signs and other traffic control devices will be used as required by federal, state, and local Departments of Transportation and other regulating bodies. Road crossings will be completed in accordance with the requirements of road crossing permits.

6.7.9.2 Operation

6.7.9.2.1 Protection of Children

Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risk (FR: April 23, 1997, Volume 62, Number 78), specifies guidelines for the protection of children. This EO requires that Federal agencies make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children and to ensure that policies, programs, and standards address disproportionate risks to children that result from environmental health or safety risks.

None of the alternatives associated with the project would impose health or security risks to children. Additionally, temporary emissions from the construction equipment would fall within federal and state air quality standards, including those established to protect sensitive populations, such as children. The project would not cause an environmental risk that would disproportionately affect the health of children.

6.7.9.2.2 Protection of Sensitive Populations

The National Ambient Air Quality Standards include standards to protect public health and to protect public welfare and the environment. The USEPA established the standards for protection of public health through an evaluation of environmental health effects, which included a margin of safety to protect children and other sensitive populations.

Temporary emissions from the construction equipment would fall within federal and state air quality standards, including those established to protect sensitive populations, such as children. Emissions from the activities associated with operation of the project would be associated with electrical supply from regional electrical utilities and consequently would be very low and would not adversely affect the elderly or other sensitive populations. Electrical usage as shown above decreases from existing conditions, leading to fewer greenhouse gas emissions from electrical usage by the Waukesha Water Utility. Additionally, exposure to hazardous conditions is extremely unlikely.

6.7.10 Environmental Effects Comparison: Socioeconomics

Socioeconomic impacts are summarized below for each alternative. Level of relative impact (no adverse impact, minor adverse impact, etc.) to the socioeconomic environment were developed to compare one alternative to another. Although more than four areas of consideration are discussed in this socioeconomics section, Tables 6-78 and 6-79 evaluate four key areas of concern. Based on an initial review of potential socioeconomic impacts, neither the proposed project nor alternatives to the proposed project would have significant adverse impacts to the socioeconomic environment. They are all similar and would all consistently have no adverse impact to the socioeconomic environment.

Once the impact parameters were determined, each alternative was considered individually for the potential for impacts.

TABLE 6-78

Matrix for Determining Level of Potential Adverse Impact for Socioeconomic Environment

Key Considerations	No Adverse Impact	Minor Adverse Impact	Moderate Adverse Impact	Significant Adverse Impact
Population & Housing	No permanent adverse impacts; and little to no minor temporary adverse impacts to population numbers and available housing. Potential for reduction in population and adjacent housing market.	Temporary adverse impacts to population numbers and available housing. Potential for reduction in population and area housing market.	Long term adverse impacts to population numbers and available housing. Probable reduction in population and area housing market. Increased rental vacancy rates.	Permanent adverse impacts to population numbers and available housing. Potential for reduction in population and regional housing market.
Local Economy & Employment	No permanent adverse impacts; little to no minor temporary adverse impacts to local economic conditions. No adverse impact to existing employment and unemployment rates.	Temporary adverse impact to local economic conditions. Short-term increase in unemployment rates on a local level.	Long-term adverse impact to local economic conditions. Moderate increase in unemployment rates on a local and regional level.	Permanent adverse impacts to local economic conditions. Long- term increase in local and regional unemployment rates.
Environmental Justice	No disproportionately high and adverse human health or environmental effects on low-income populations, minority populations, or Indian tribes.	No displacement, but siting of project in area of localized low-income populations, minority populations, or Indian tribes. Potential for short-term minor hazardous exposure.	Temporary displacement or relocation of low-income populations, minority populations, or Indian tribes.	Displacement of or hazardous exposure to low-income populations, minority populations, or Indian tribes.
Safety	No reduction in the existing level of safety and security (including health and protection of children) will occur.	Potential for temporary impacts to existing level of safety and security (including health and protection of children) will occur as a result of construction or operation or Project.	Potential for short-term dangerous conditions or minimal exposure to toxins from construction and operation of the Project.	Potential for long-term dangerous conditions or exposure to toxins from construction and operation of the Project.

TABLE 6-79
Anticipated Socioeconomic Impacts

Alternatives	Key Socioeconomic Considerations: Population & Housing, Local Economy & Employment, Environmental Justice, and Safety
Water Supply Alternatives	
Deep and Shallow Aquifers	No adverse impact
Shallow Aquifer and Fox River Alluvium	No adverse impact
Lake Michigan (City of Milwaukee)	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 1	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 2	No adverse impact
Lake Michigan (City of Racine)	No adverse impact
Return Flow Alternatives for Lake Michigan Water Supplies	
Underwood Creek to Lake Michigan	No adverse impact
Root River to Lake Michigan Alignment 1	No adverse impact
Root River to Lake Michigan Alignment 2	No adverse impact
Direct to Lake Michigan	No adverse impact

Because no individual alternative will result in moderate or significant adverse impacts to the socioeconomic environment, a comprehensive discussion of each alternative is not included in this section, and socioeconomic impacts will not continue to be compared side by side with other impacts.

6.7.11 Impacts of the No Action Alternative on Socioeconomics

The No Action alternative would potentially have an adverse effect upon the health of City of Waukesha residents because the current water supply source is non-compliant for radium, a cancer causing chemical naturally occurring in the deep aquifer. The existing City of Waukesha deep aquifer wells do not provide sufficient quality and quantity of to meet the water supply needs of the City of Waukesha. Maintaining the current water supply condition will not meet the long-term water supply needs of the City of Waukesha.

6.8 Alternatives Impact Comparison Summary

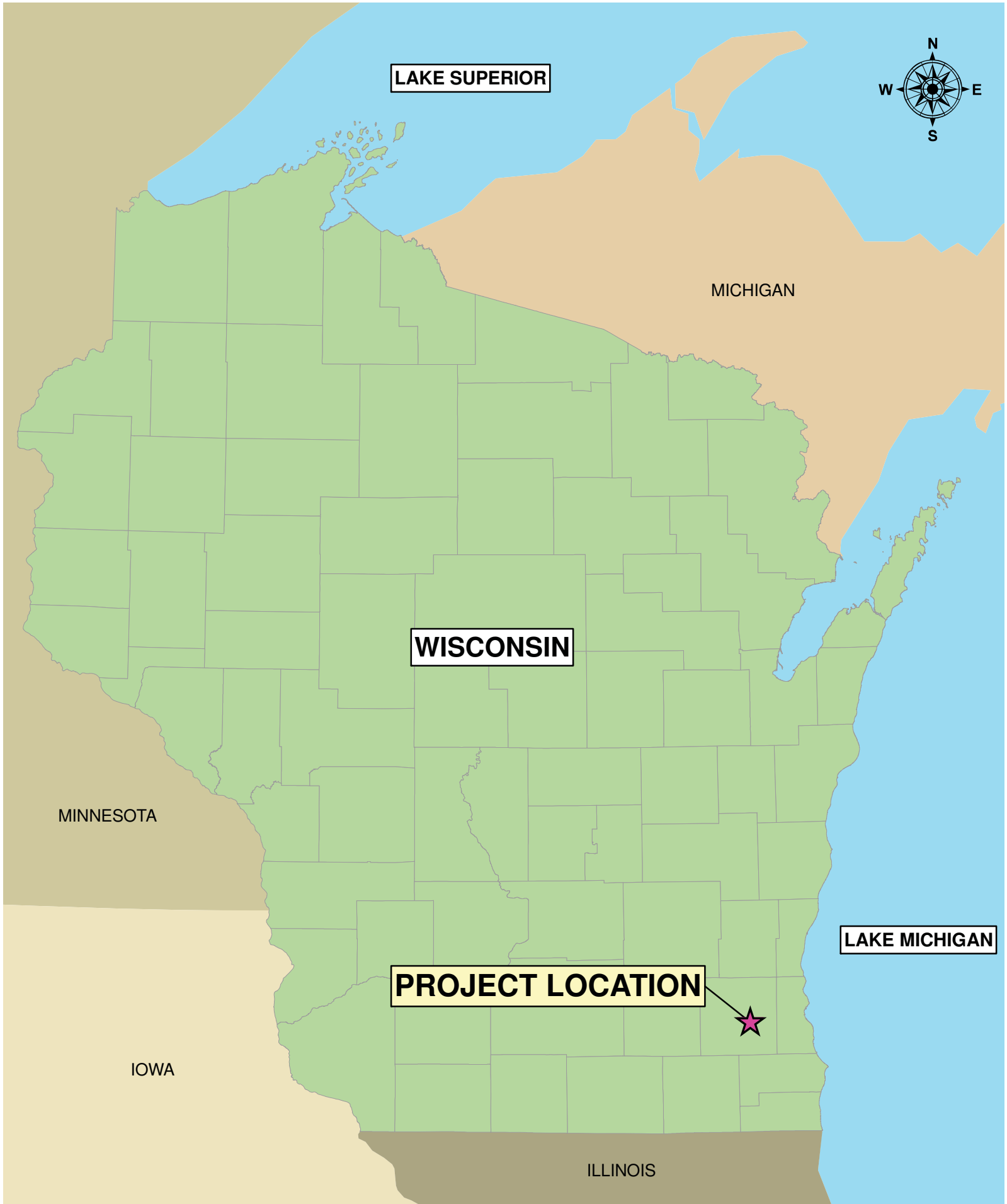
The side by side environmental impact comparison tables were compiled to have one overall comparison of the environmental impacts for all the water supply and return flow alternatives. Where resource impact tables occurred more than once (for example, water quality summary tables occur for both Lake Michigan and inland waterways), the impacts were added together to account for impacts to both resources. The side by side comparison of the environmental impacts is included in Table 6-80. A side by side comparison of system alternatives (water supply with return flow) is included in Appendix 6-2.

TABLE 6-80
Water Supply and Return Flow Alternative Environmental Impact Comparison Summary

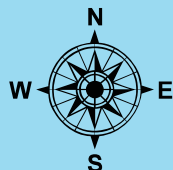
Water Supply Alternative	Groundwater Resources	Geomorphology and Sediments	Flooding	Aquatic Habitat	Water Quality	Wetlands	Soils	Land Use
Deep and Shallow Aquifers	Significant adverse impact	No adverse impact	No adverse impact	Significant adverse impact	Minor adverse impact	Significant adverse impact	Minor adverse impact	No adverse impact
Shallow Aquifer and Fox River Alluvium	Significant adverse impact	No adverse impact	No adverse impact	Significant adverse impact	No adverse impact	Significant adverse impact	Minor adverse impact	No adverse impact
Lake Michigan (City of Milwaukee)	No adverse impact	No adverse impact	No adverse impact	Minor adverse impact	No adverse impact	Minor adverse impact	No adverse impact	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 1	No adverse impact	No adverse impact	No adverse impact	Minor adverse impact	No adverse impact	Minor adverse impact	No adverse impact	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 2	No adverse impact	No adverse impact	No adverse impact	Minor adverse impact	No adverse impact	Minor adverse impact	No adverse impact	No adverse impact
Lake Michigan (City of Racine)	No adverse impact	No adverse impact	No adverse impact	Minor adverse impact	No adverse impact	Moderate adverse impact	No adverse impact	No adverse impact
Return Flow Alternatives for Lake Michigan Water Supplies								
Underwood Creek to Lake Michigan	No adverse impact	No adverse impact	Minor adverse impact	No adverse impact	No adverse impact	Minor adverse impact	No adverse impact	No adverse impact
Root River to Lake Michigan Alignment 1	No adverse impact	No adverse impact	Minor adverse impact	No adverse impact	No adverse impact	Minor adverse impact	No adverse impact	No adverse impact
Root River to Lake Michigan Alignment 2	No adverse impact	No adverse impact	Minor adverse impact	No adverse impact	No adverse impact	Minor adverse impact	No adverse impact	No adverse impact
Direct to Lake Michigan	No adverse impact	Minor adverse impact	No adverse impact	Minor adverse impact	No adverse impact	Minor adverse impact	No adverse impact	No adverse impact

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Appendix 6-1
Alternatives to the Proposed Project
Alignment Maps



LAKE SUPERIOR



MICHIGAN

WISCONSIN

MINNESOTA

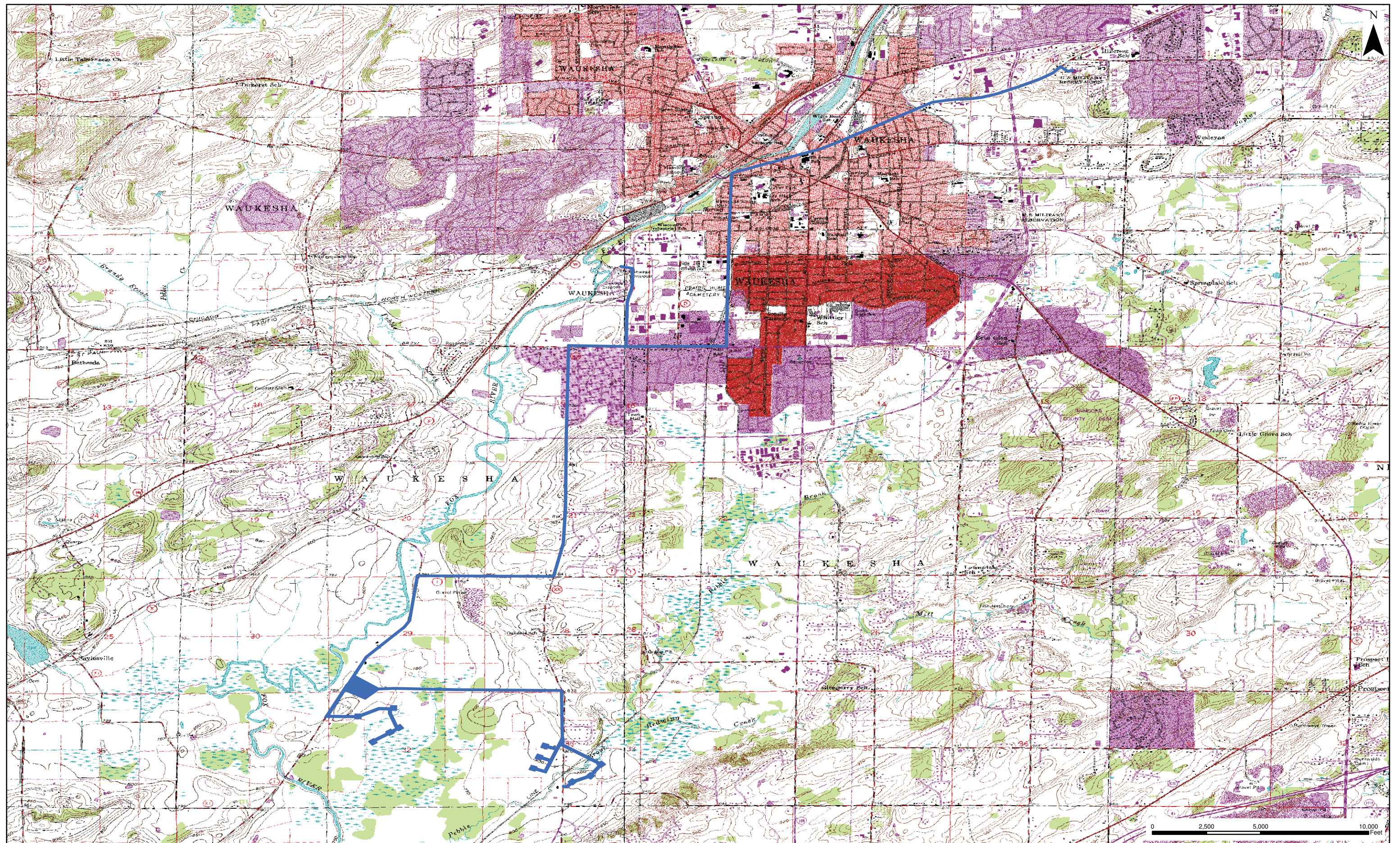
LAKE MICHIGAN

PROJECT LOCATION

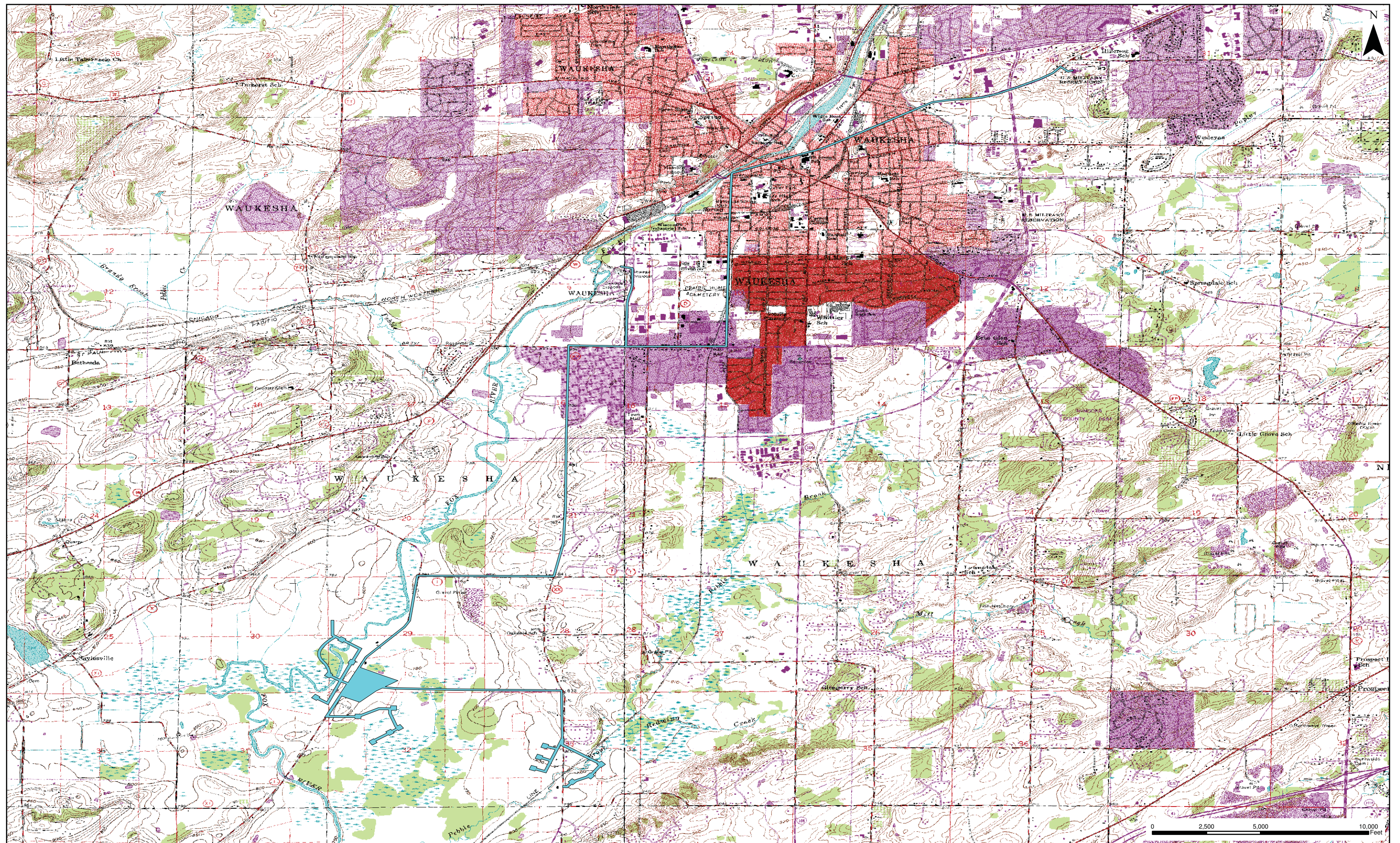


IOWA

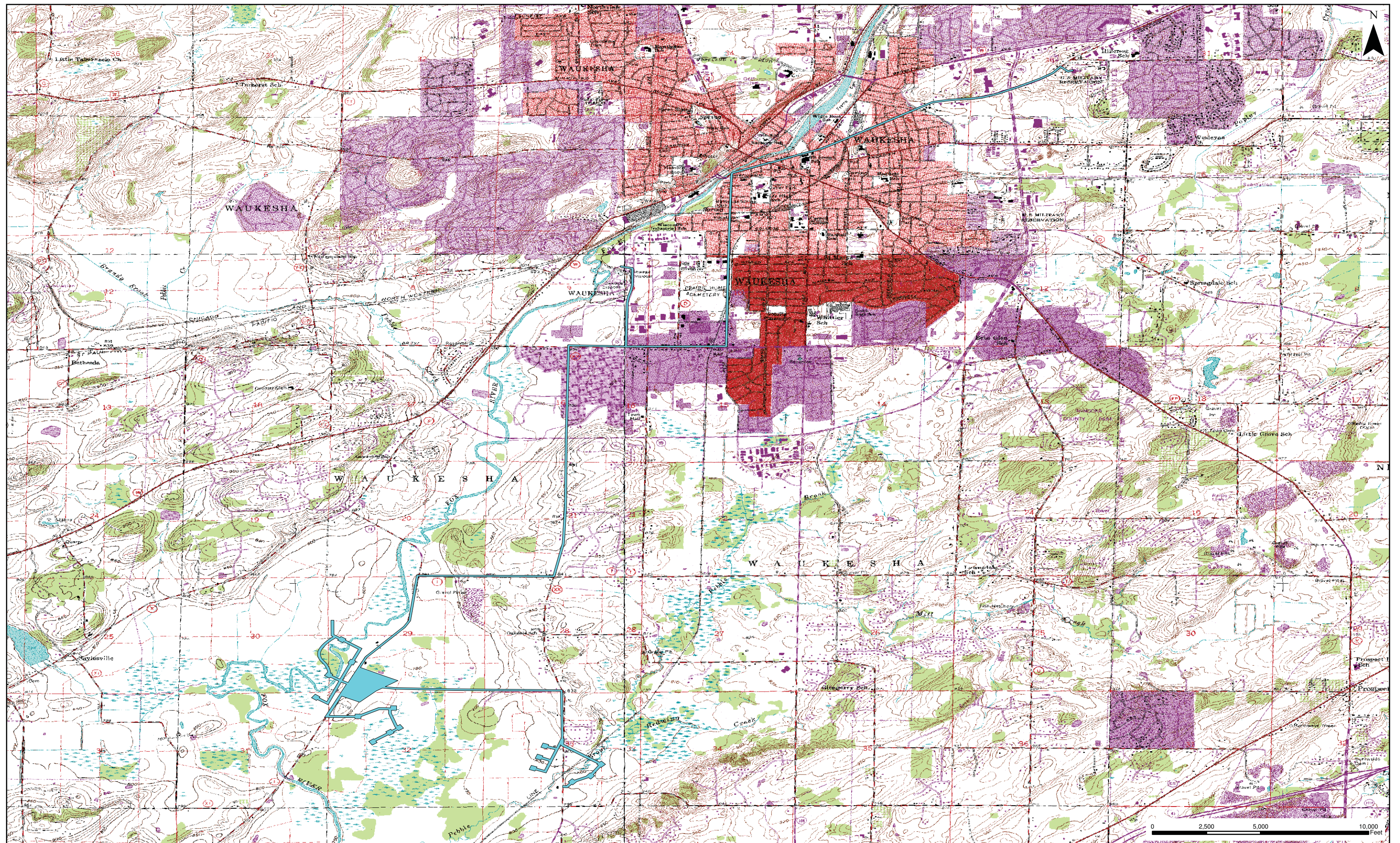
ILLINOIS



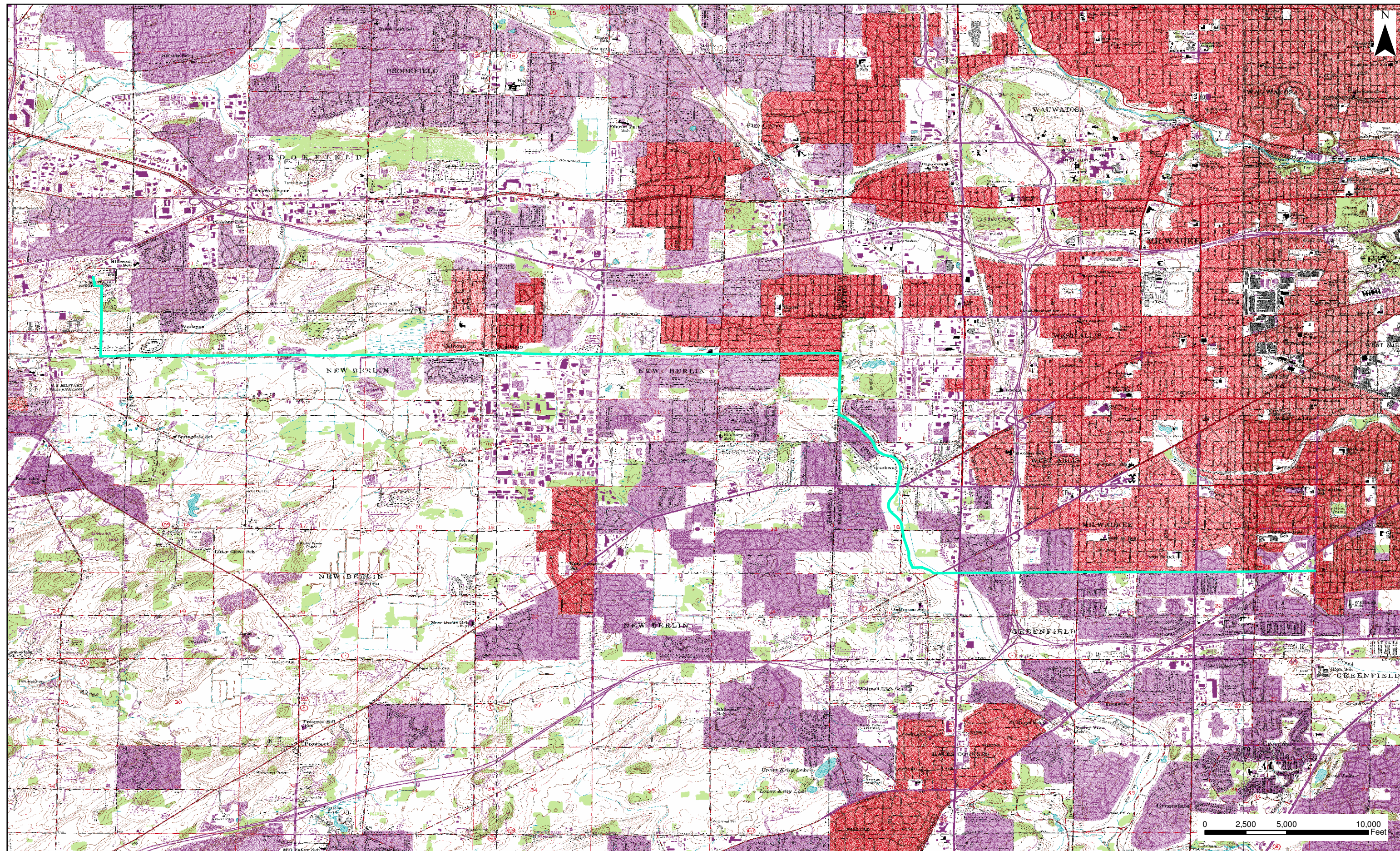
DEEP AND SHALLOW AQUIFERS

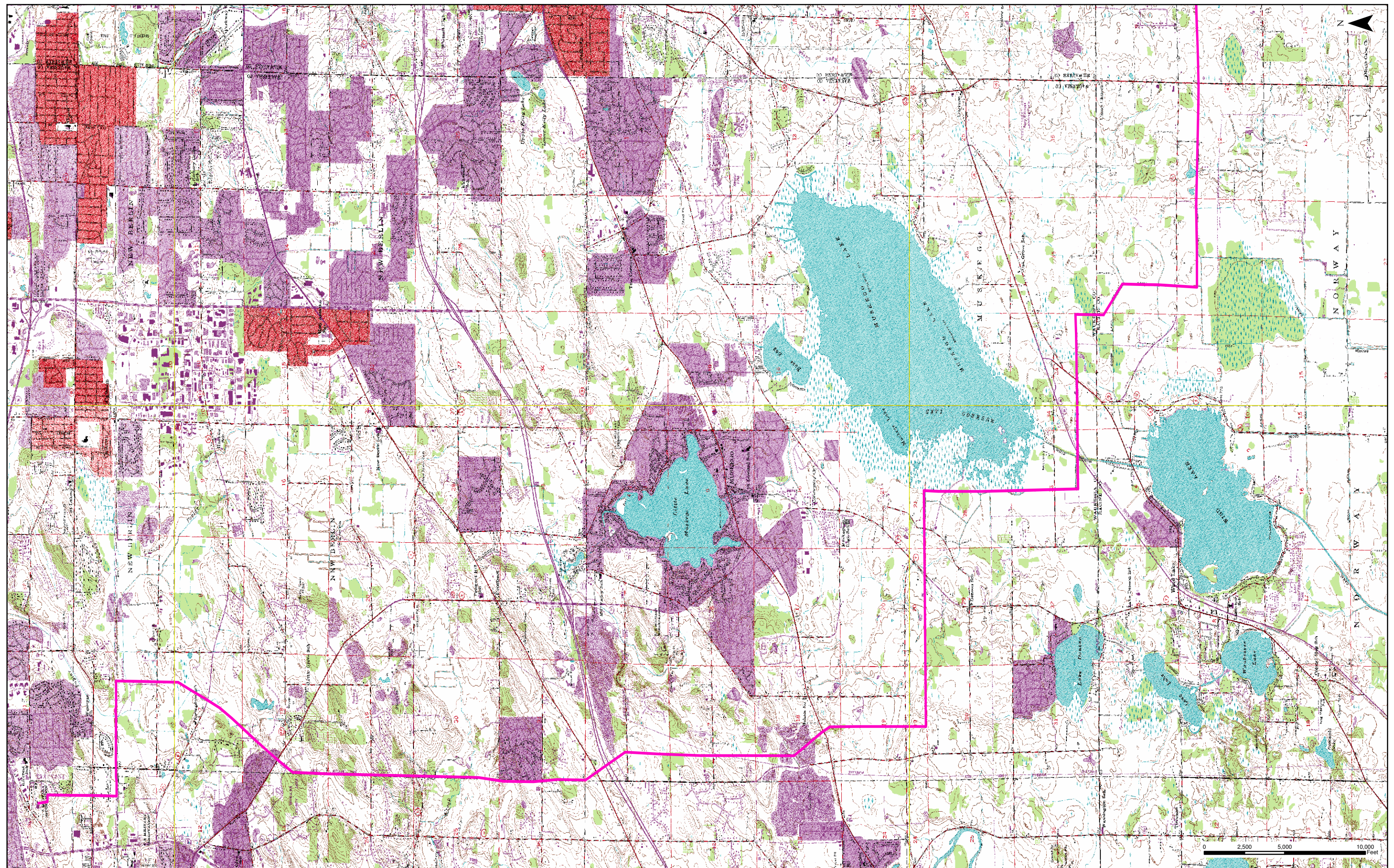


SHALLOW AQUIFER AND FOX RIVER ALLUVIUM

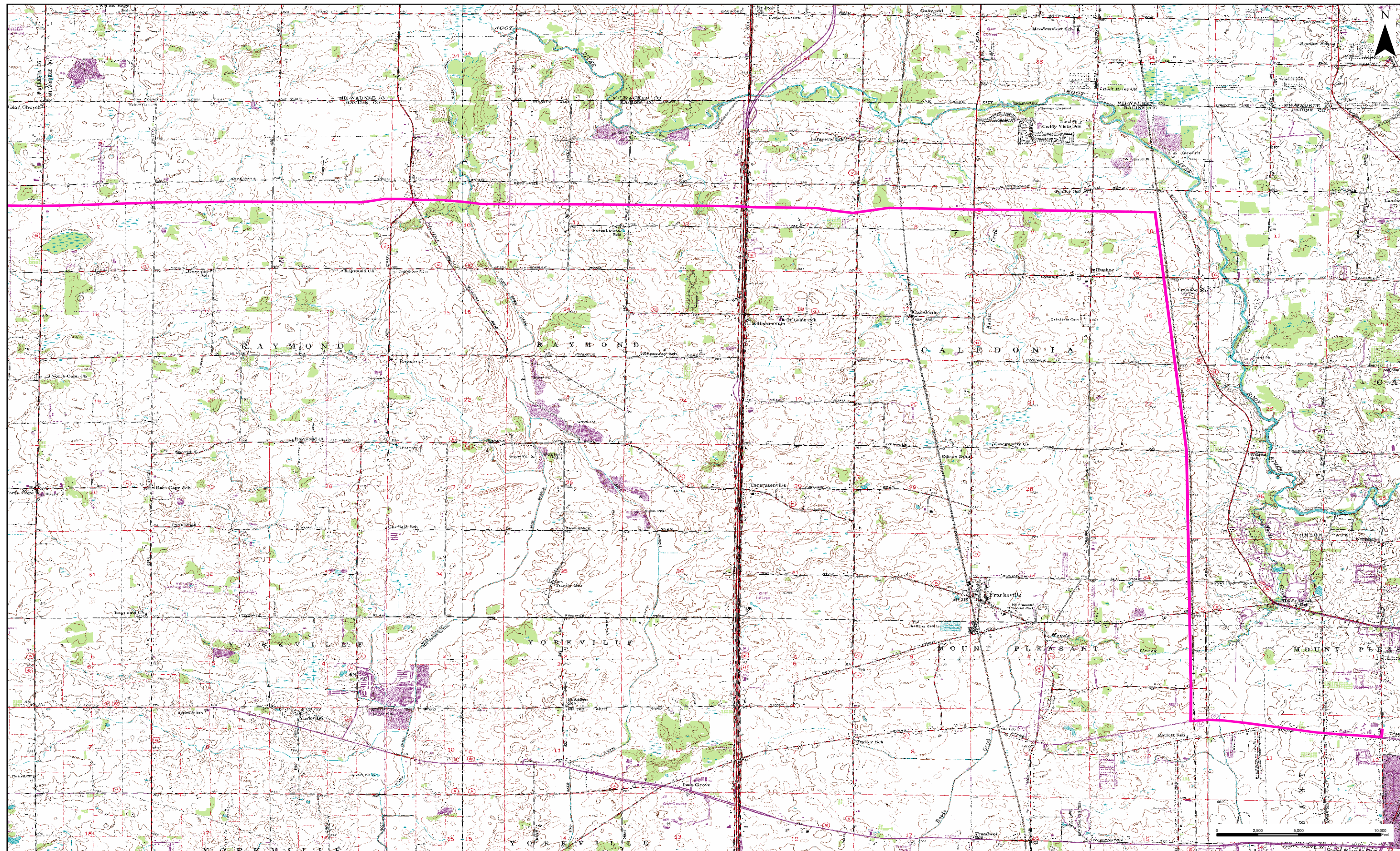


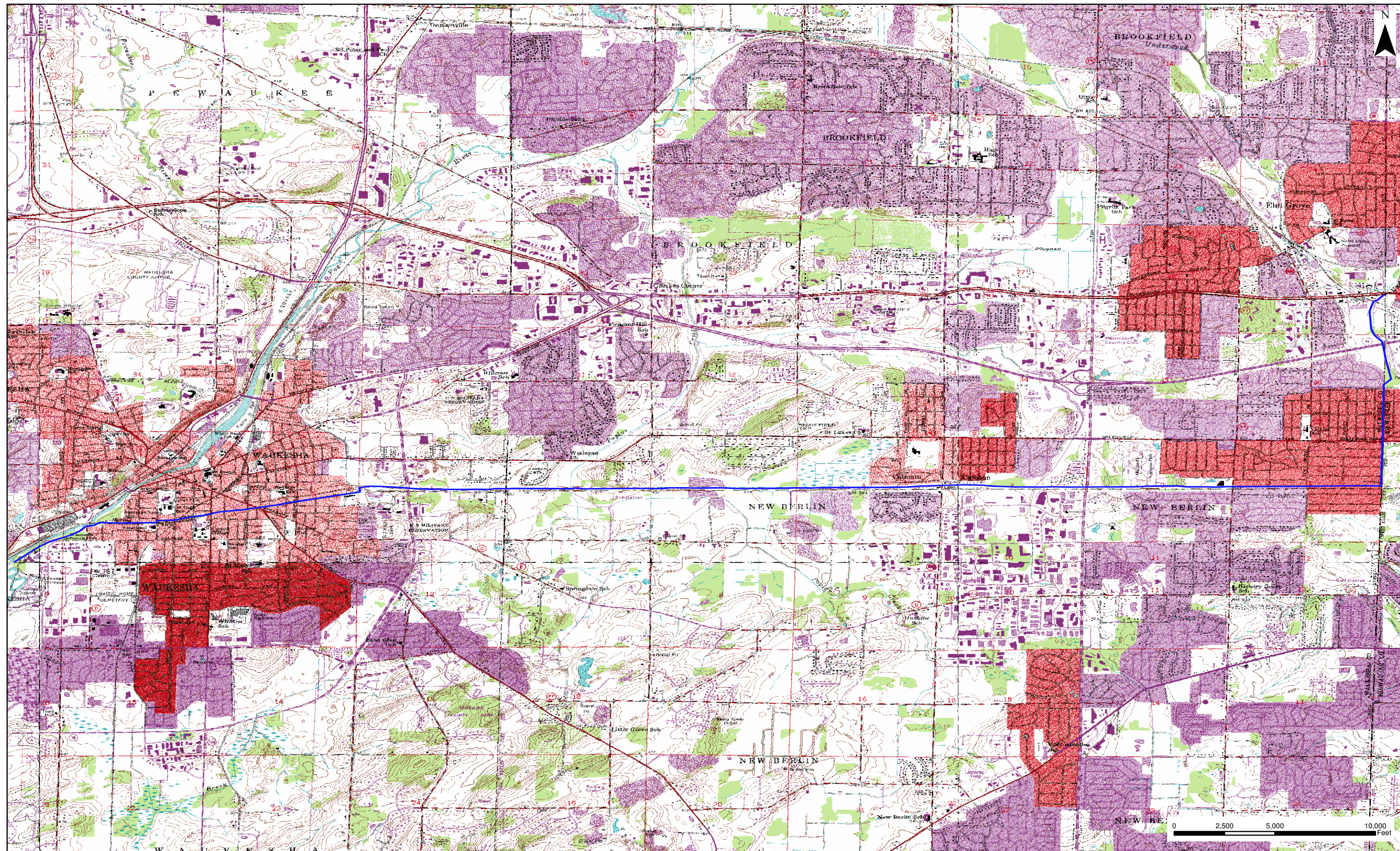
SHALLOW AQUIFER AND FOX RIVER ALLUVIUM



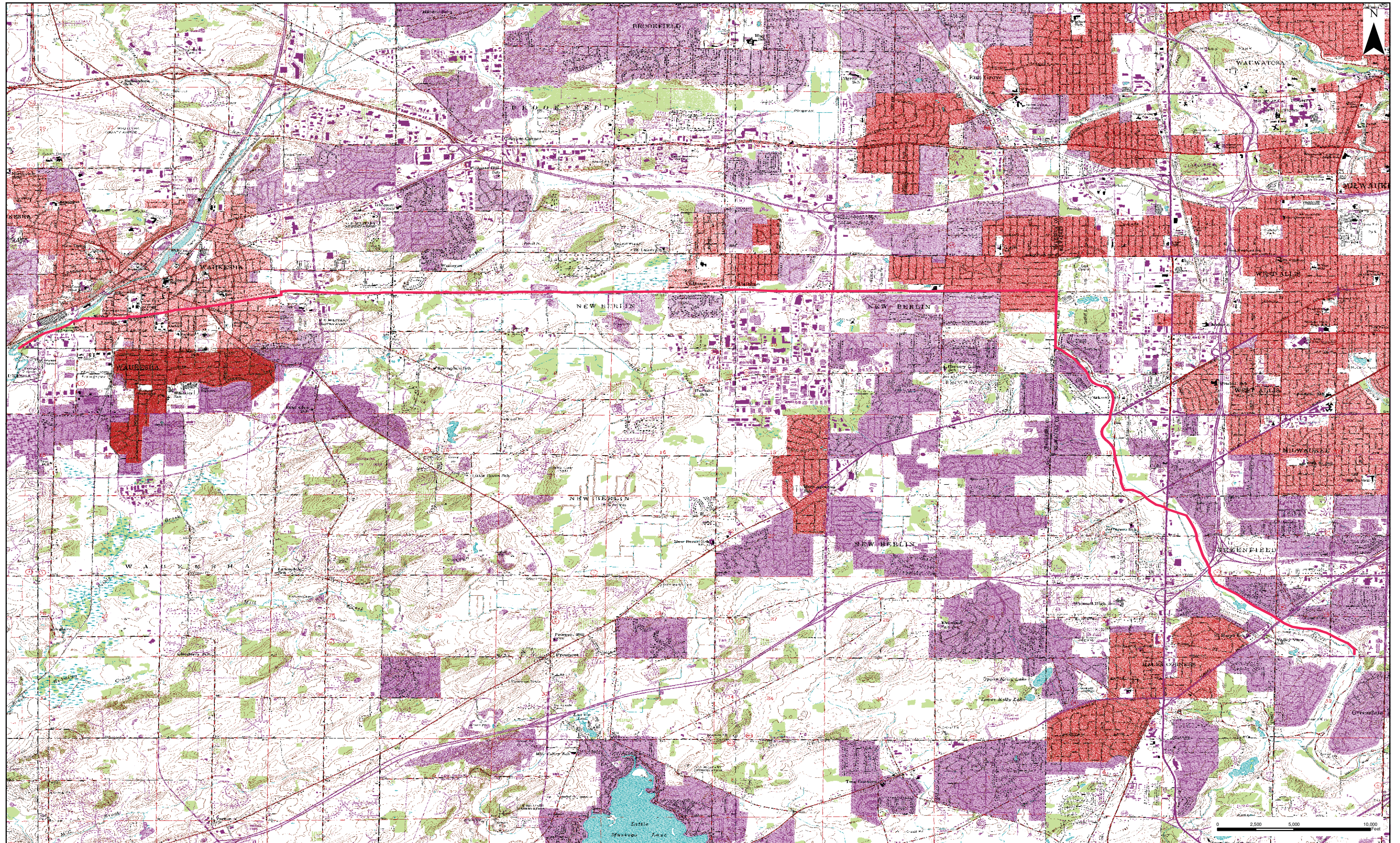


LAKE MICHIGAN RACINE SUPPLY TILE 1

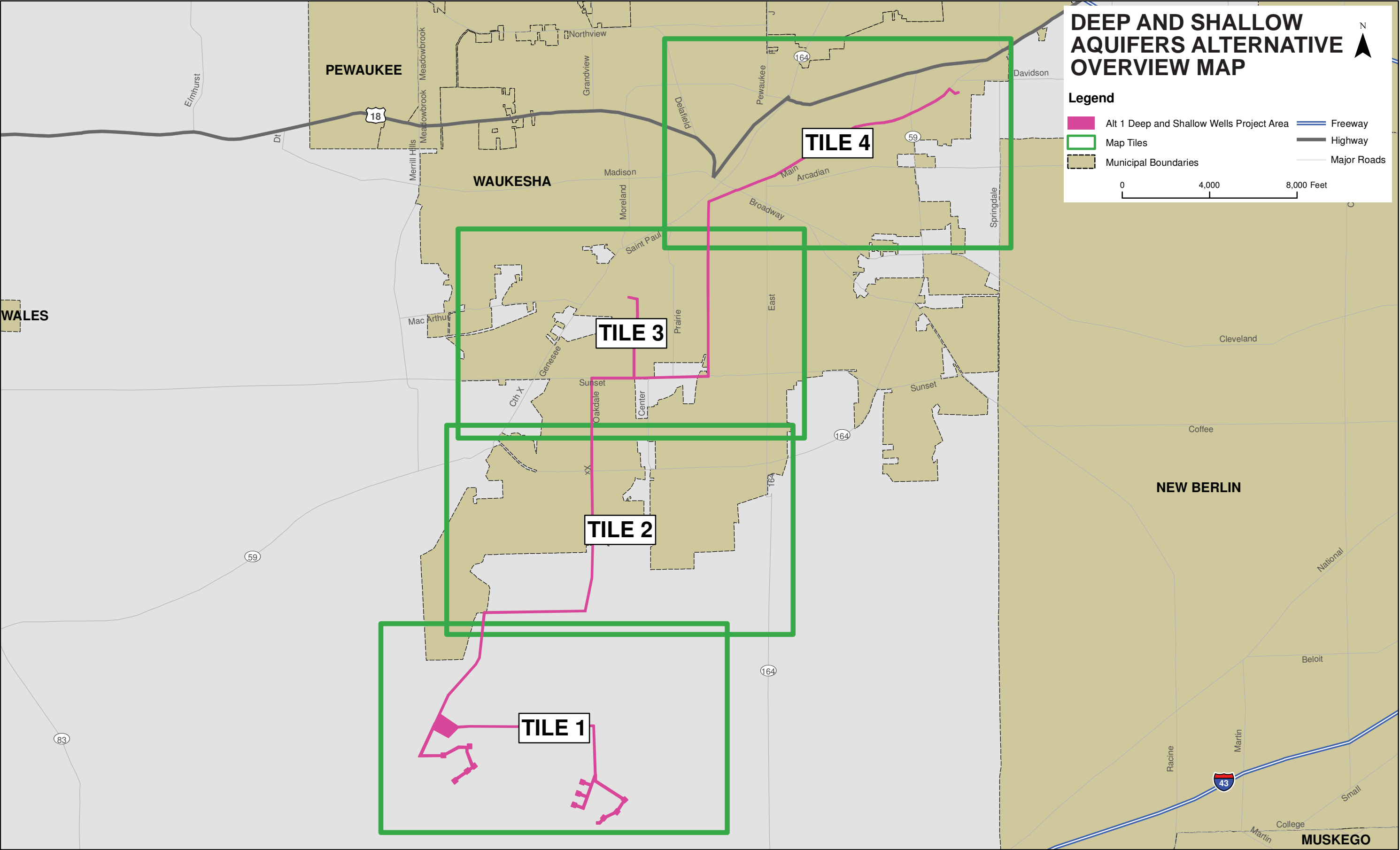


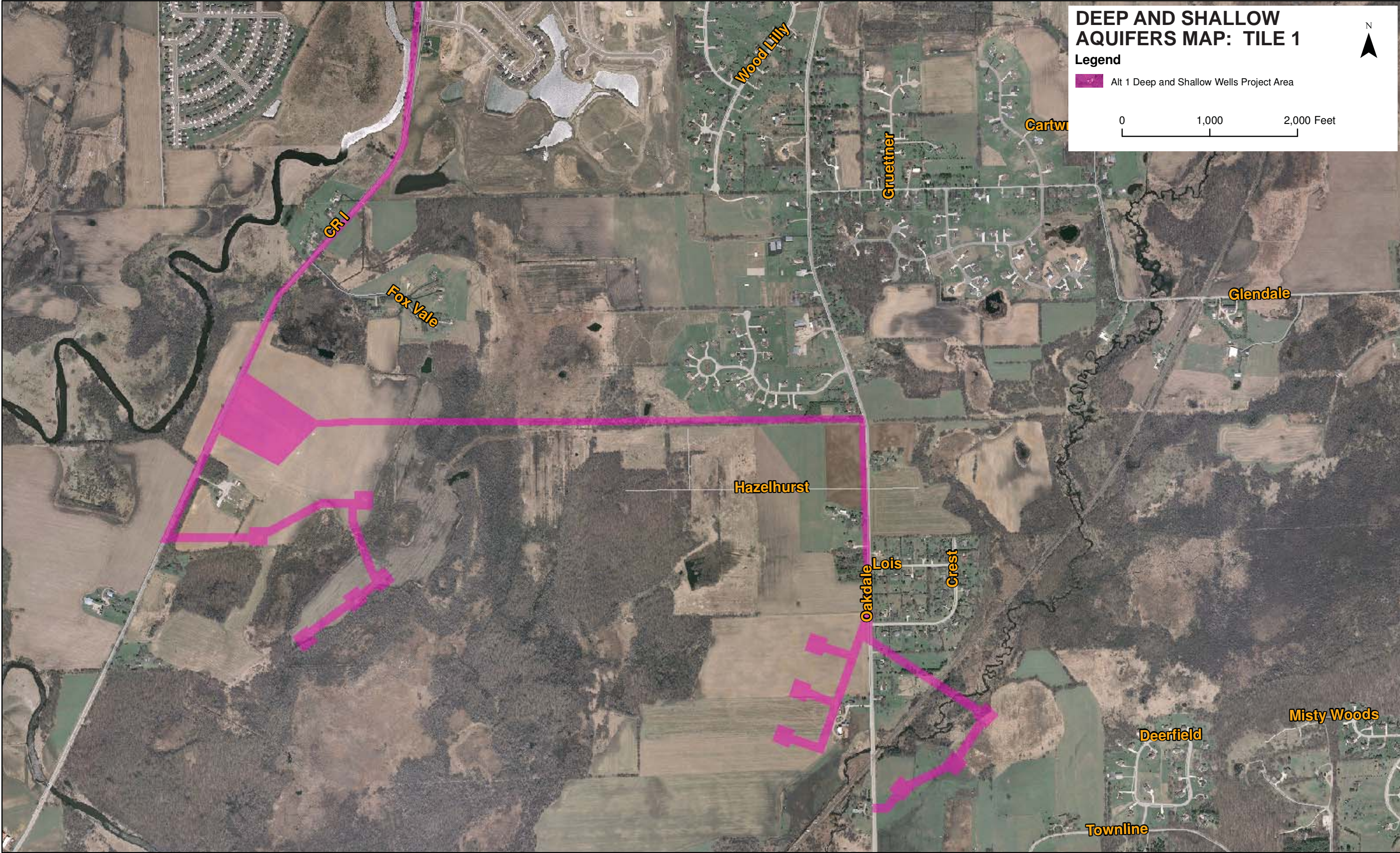


UNDERWOOD CREEK TO LAKE MICHIGAN RETURN FLOW




ALIGNMENT 1 ROOT RIVER TO LAKE MICHIGAN





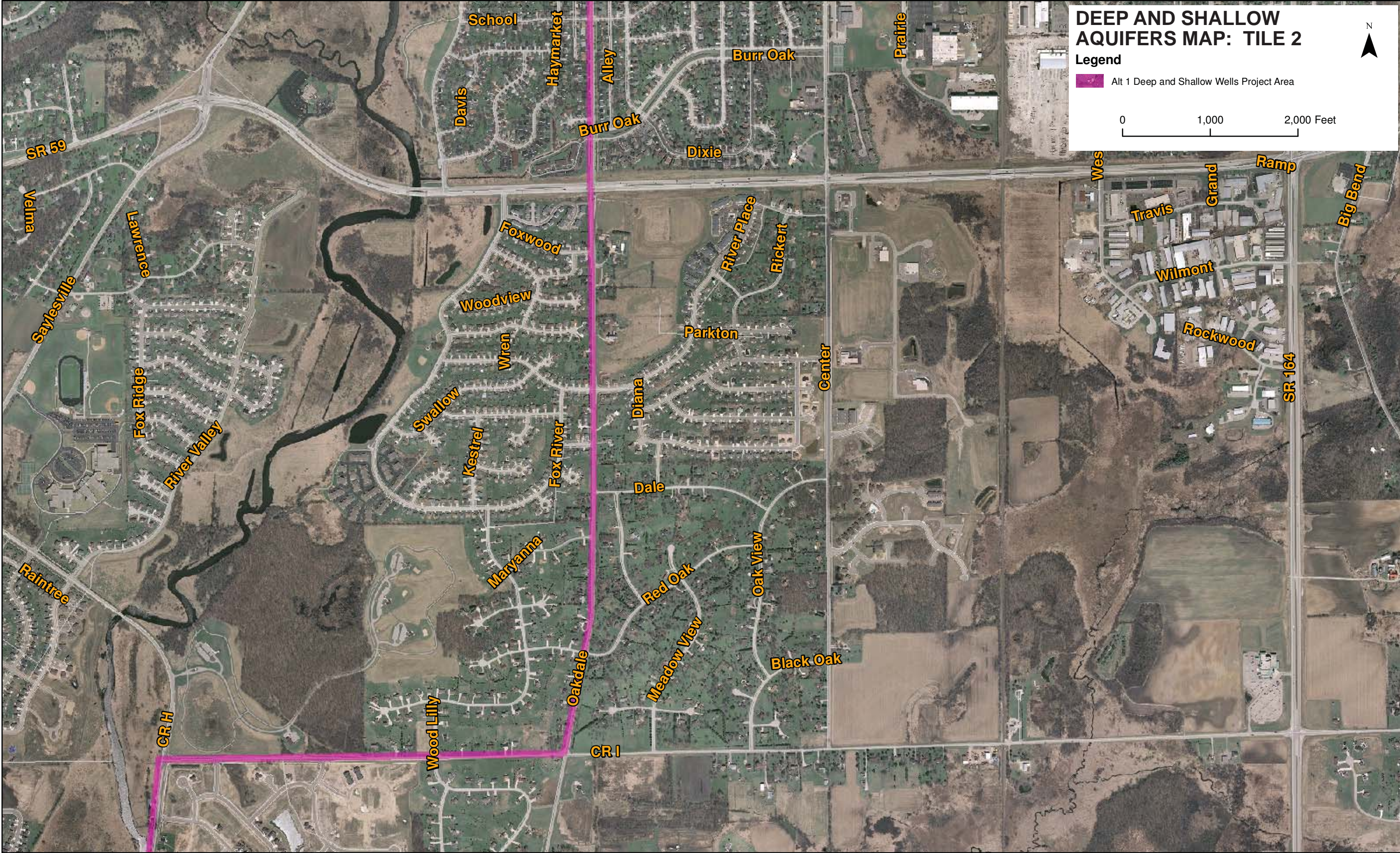
**DEEP AND SHALLOW
AQUIFERS MAP: TILE 1**

Legend

 Alt 1 Deep and Shallow Wells Project Area

0 1,000 2,000 Feet





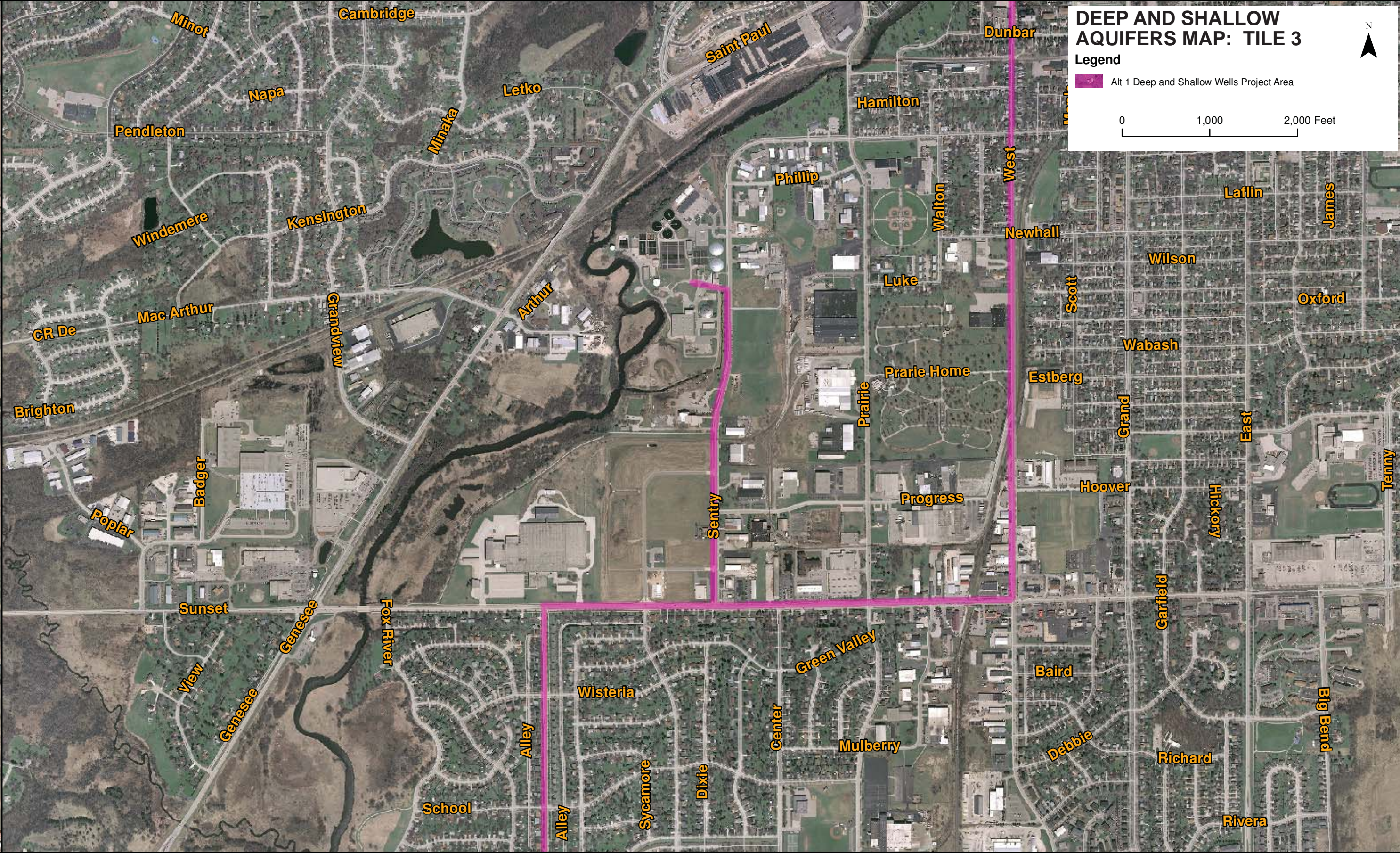
DEEP AND SHALLOW AQUIFERS MAP: TILE 2

Legend

Alt 1 Deep and Shallow Wells Project Area

01,0002,000 Feet

N



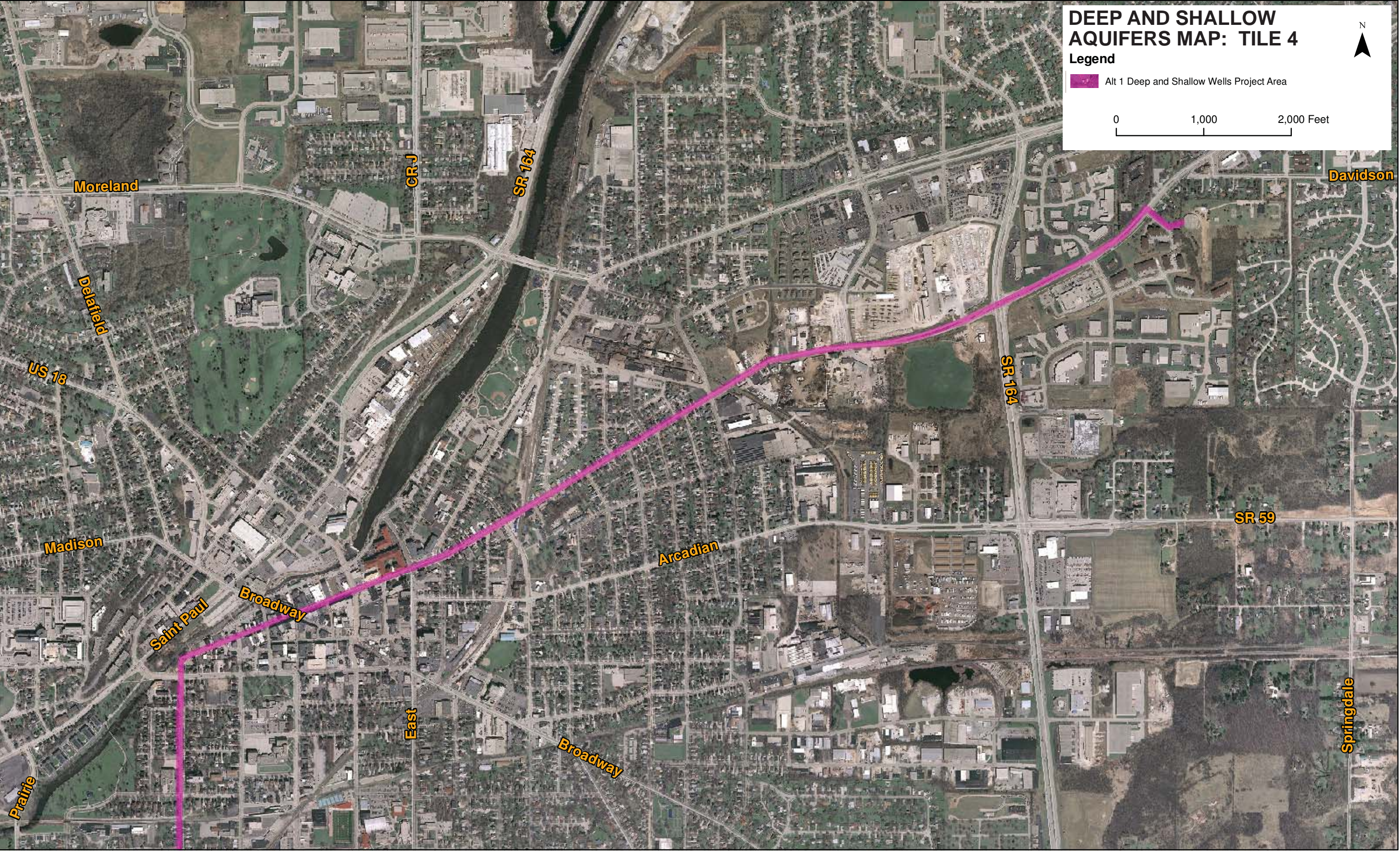
DEEP AND SHALLOW AQUIFERS MAP: TILE 3

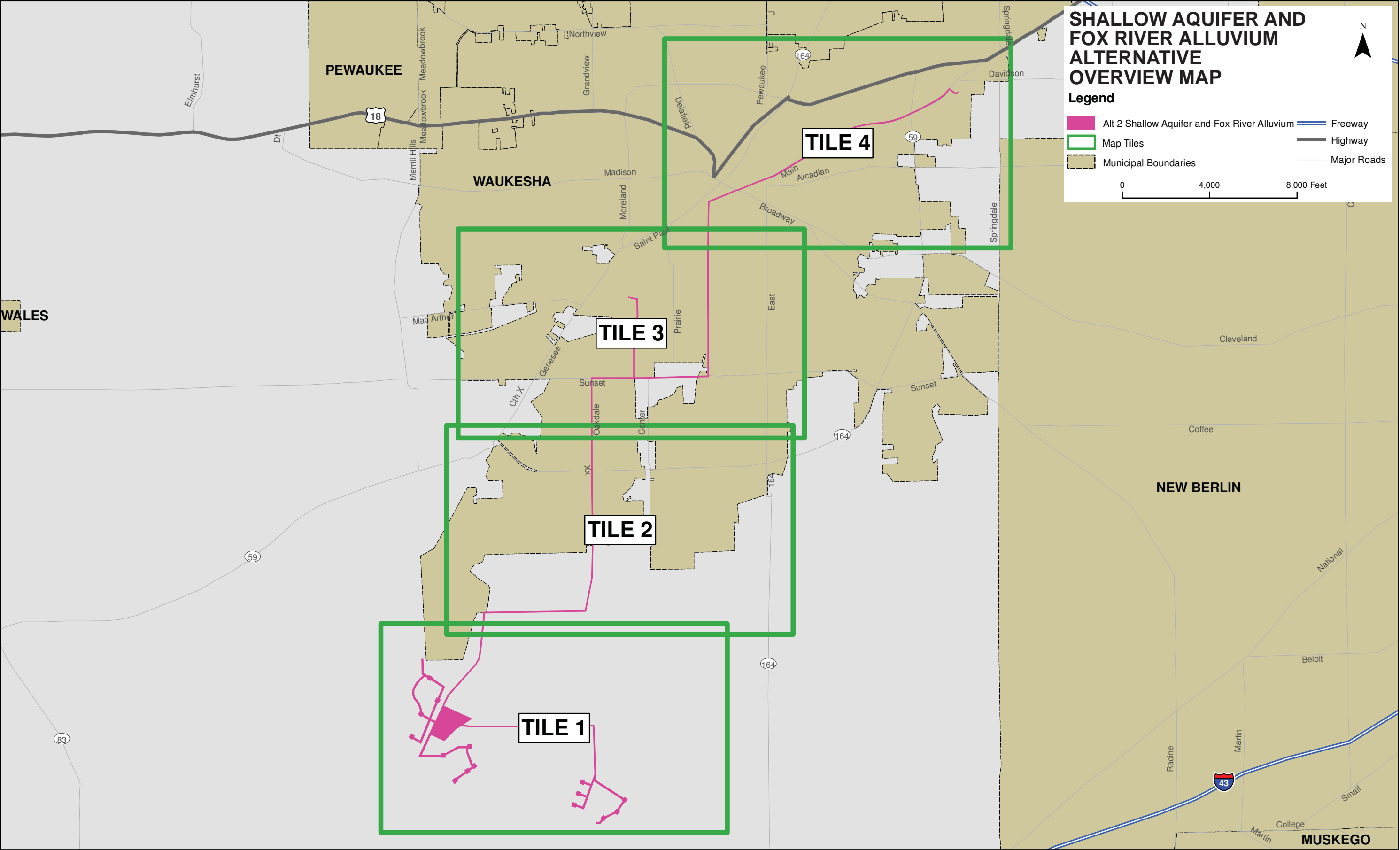
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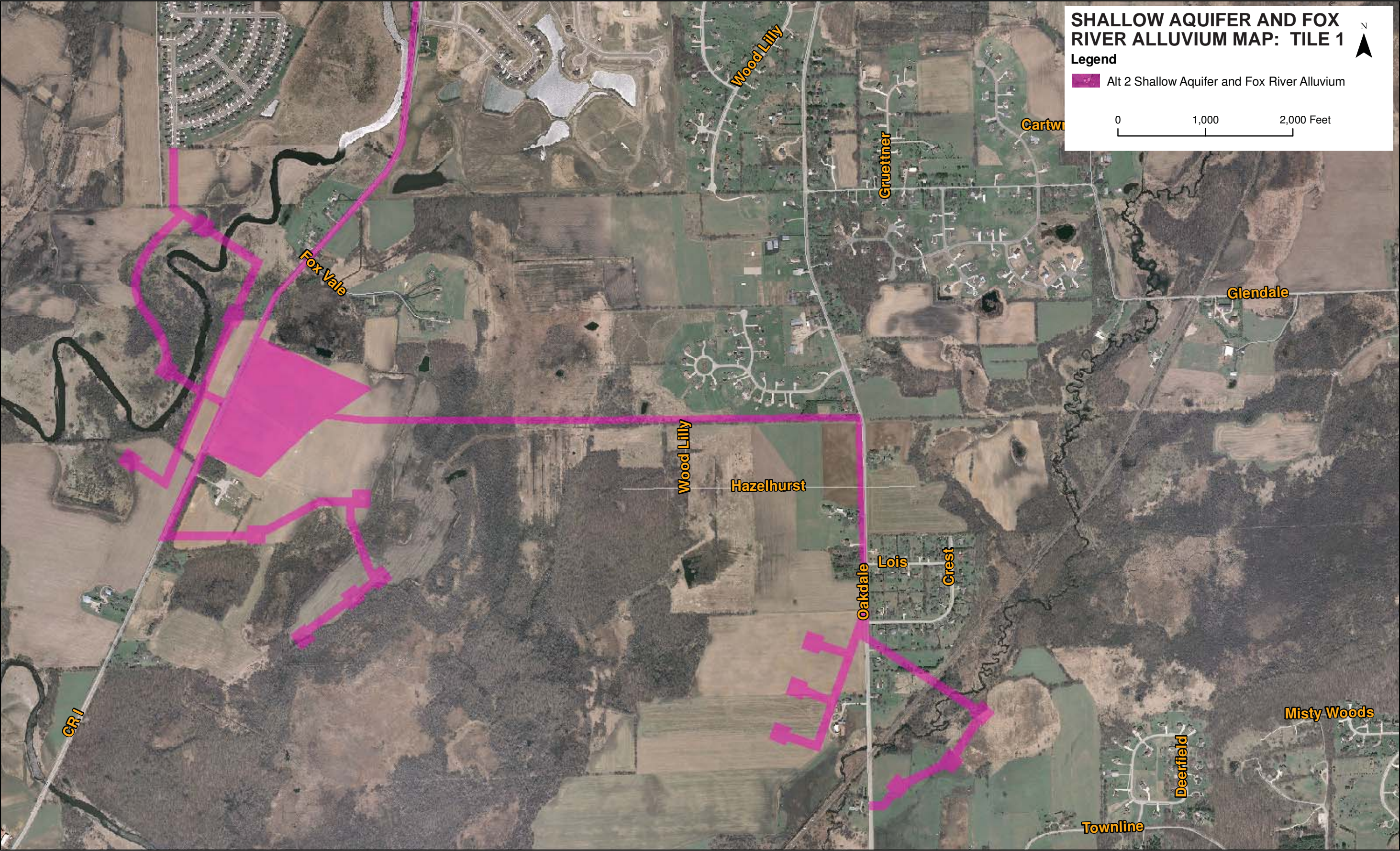
Alt 1 Deep and Shallow Wells Project Area

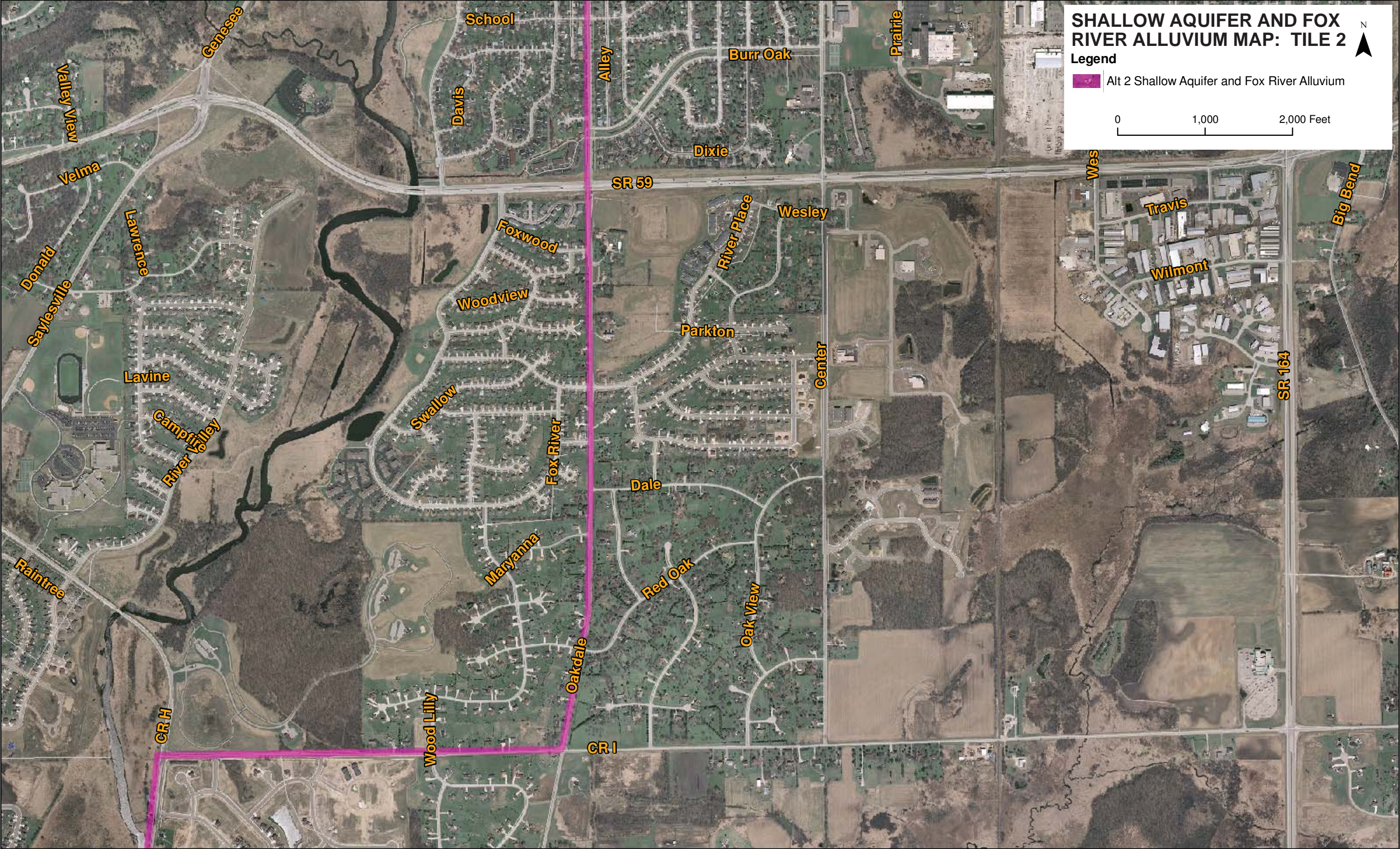
01,0002,000 Feet

N








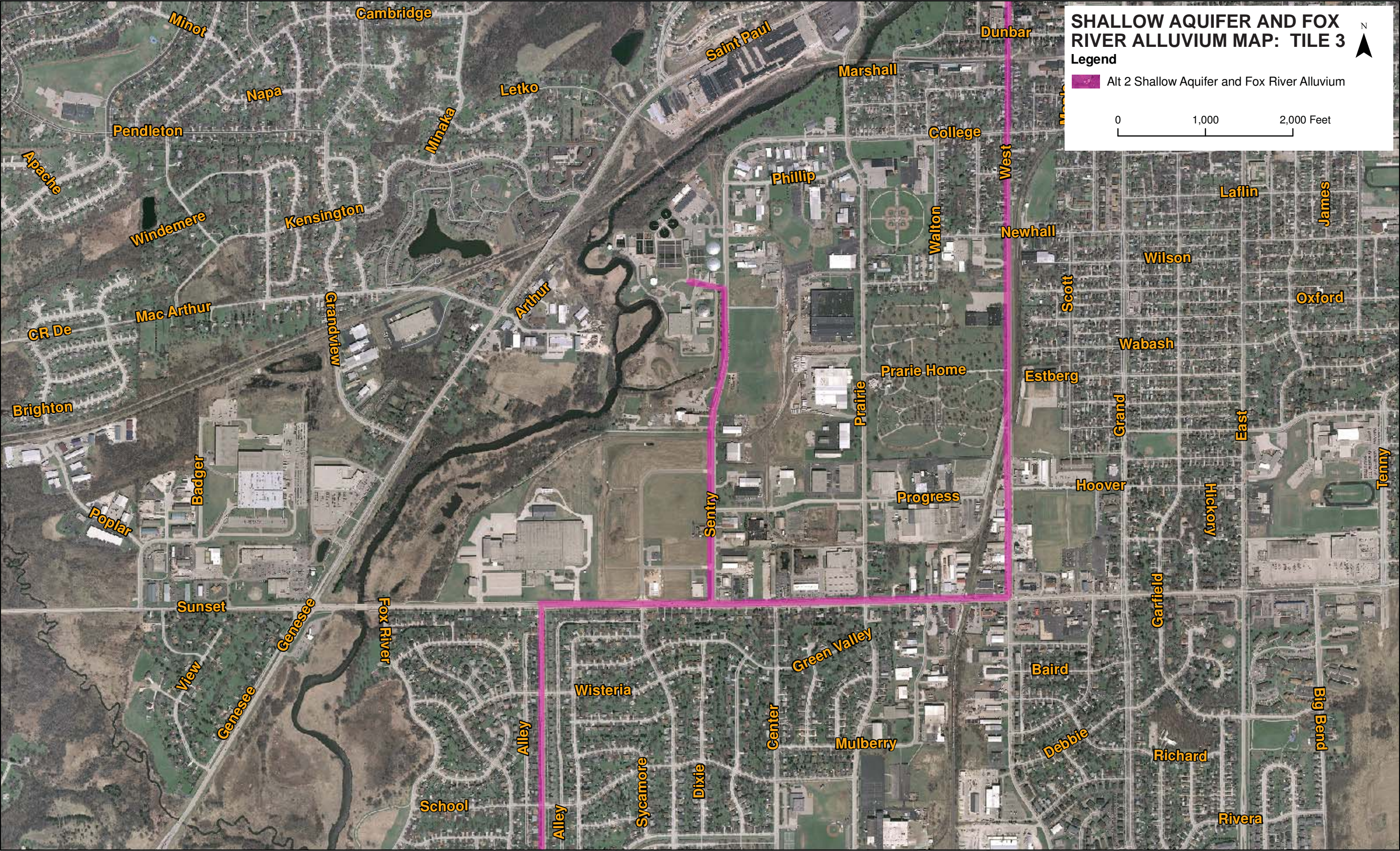


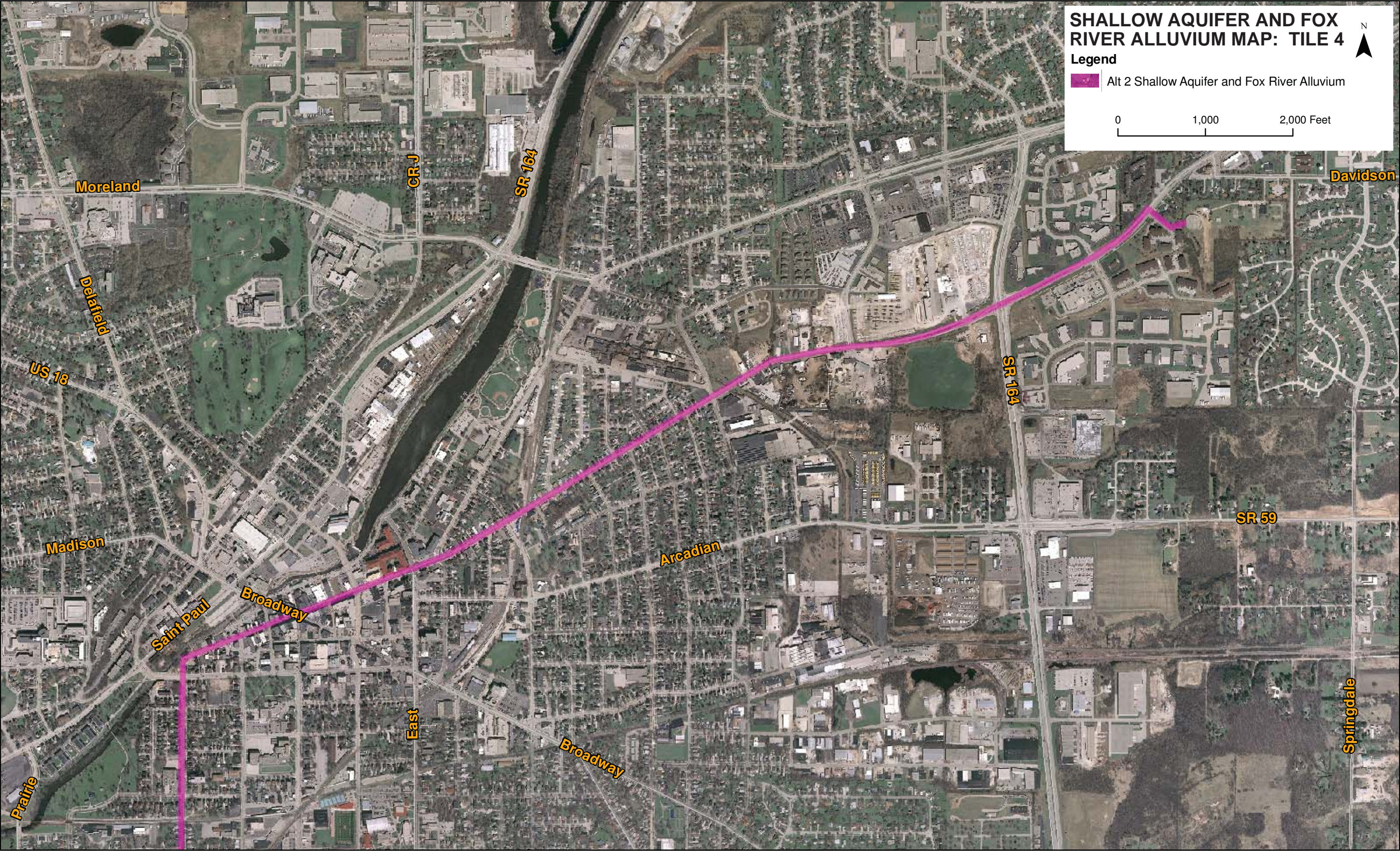
SHALLOW AQUIFER AND FOX RIVER ALLUVIUM MAP: TILE 2

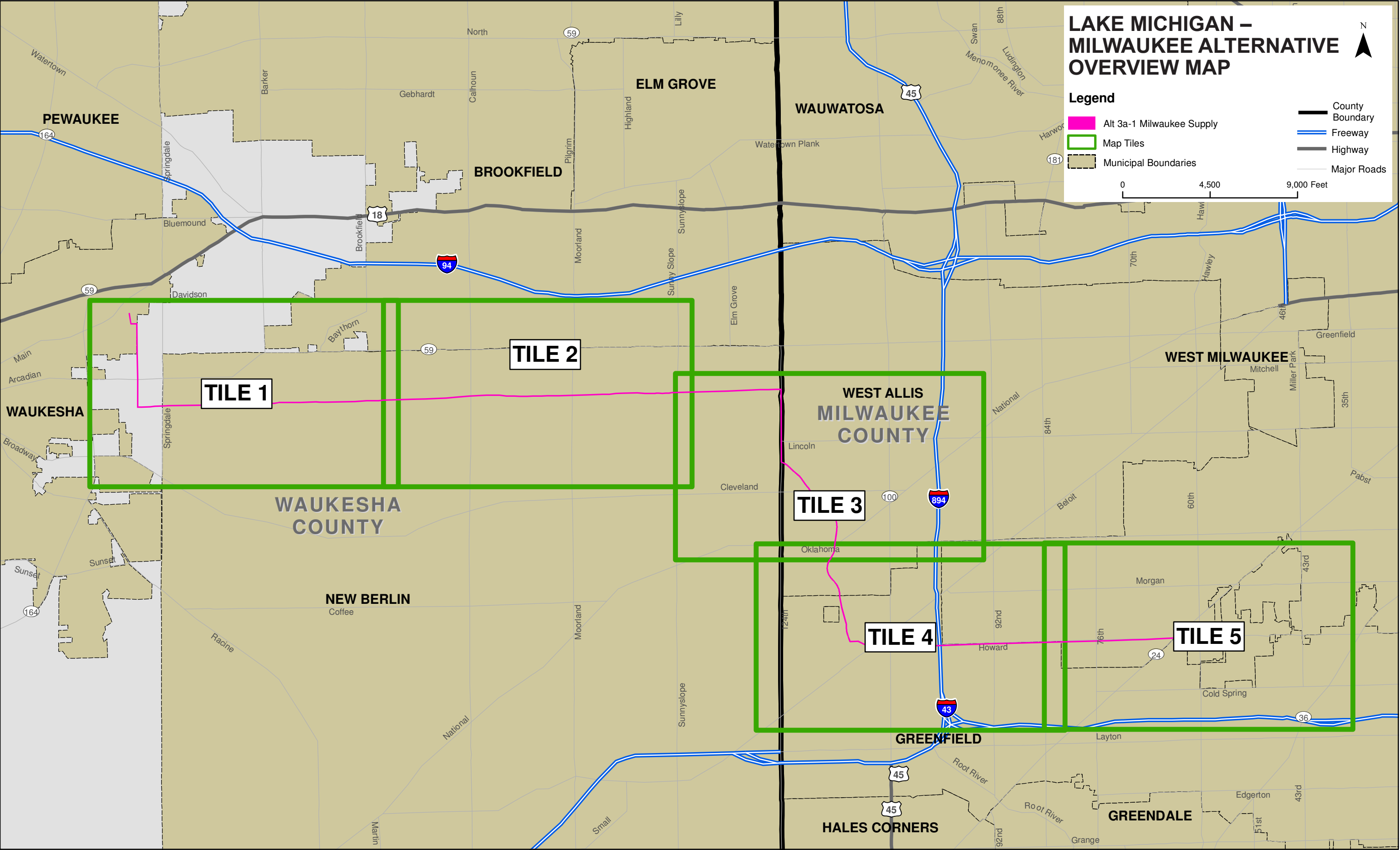
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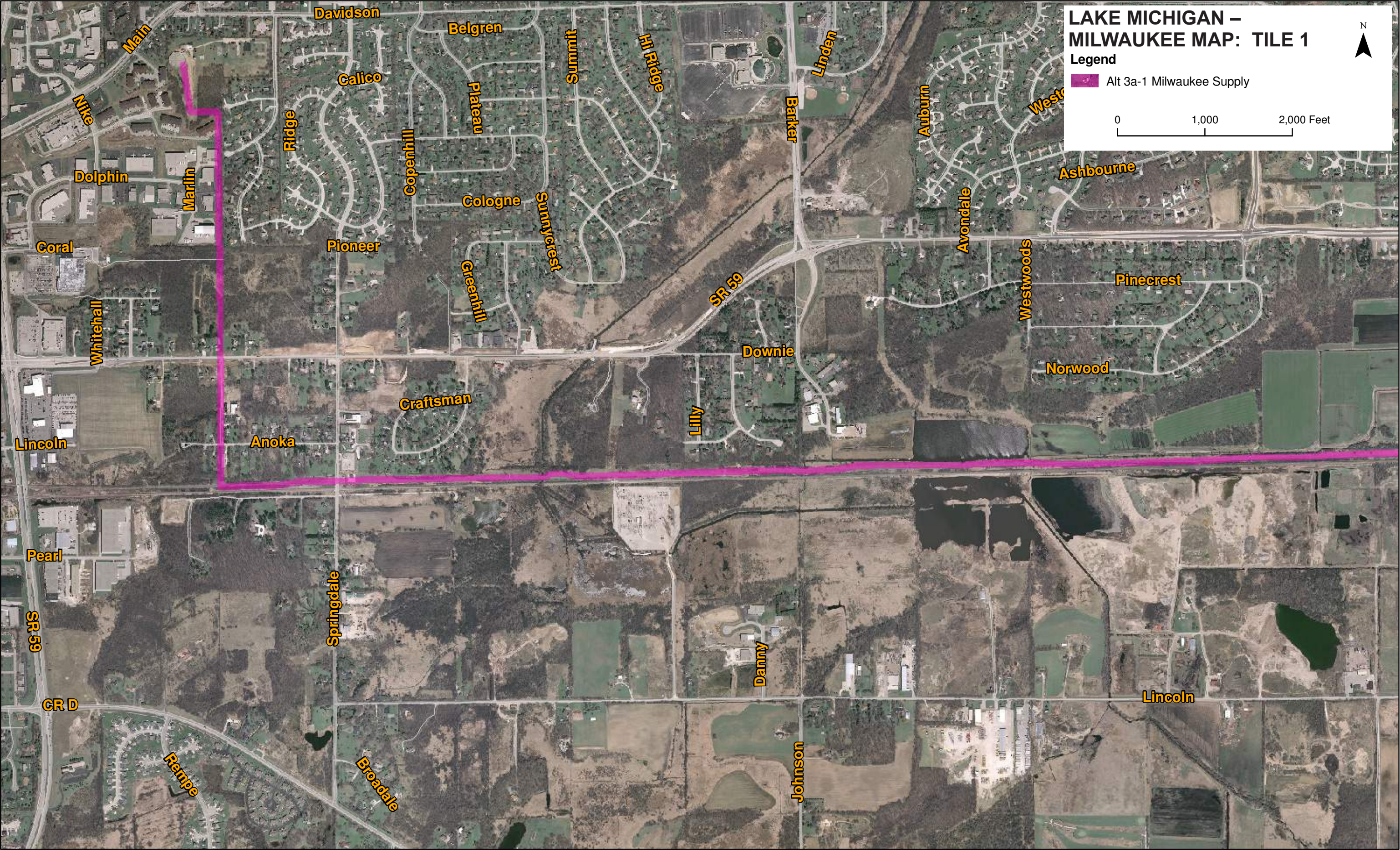
 Alt 2 Shallow Aquifer and Fox River Alluvium

0 1,000 2,000 Feet









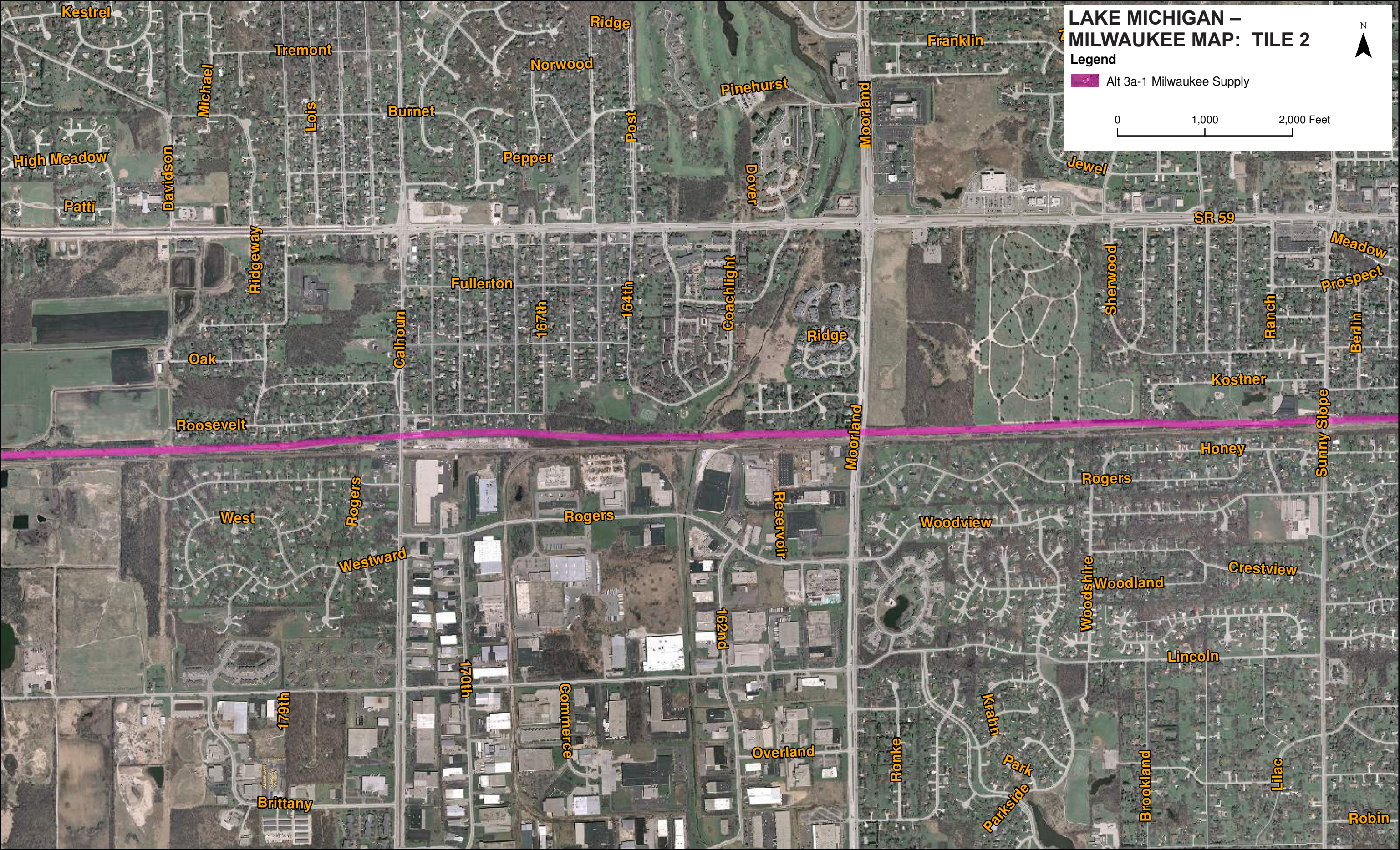
**LAKE MICHIGAN –
MILWAUKEE MAP: TILE 1**

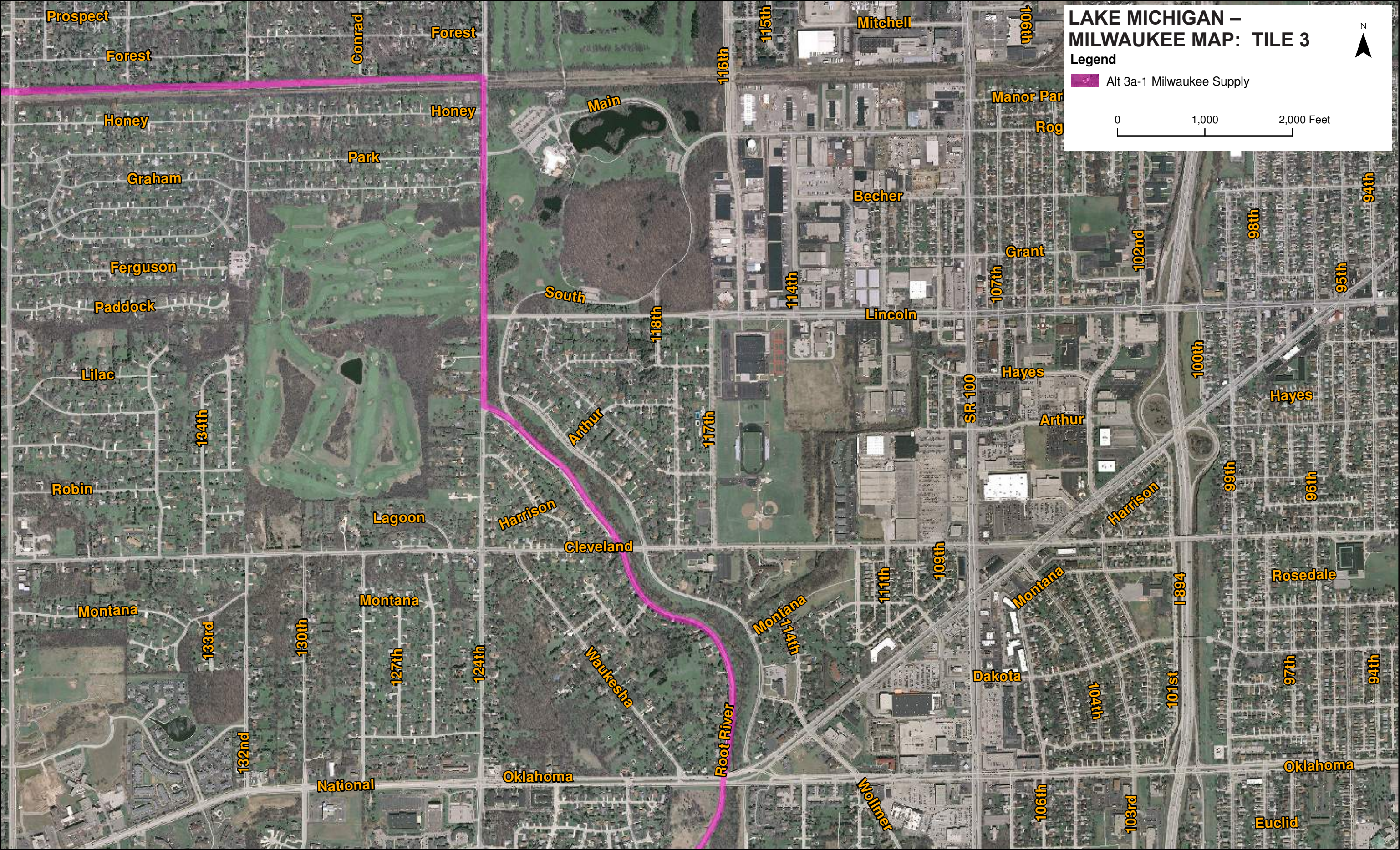
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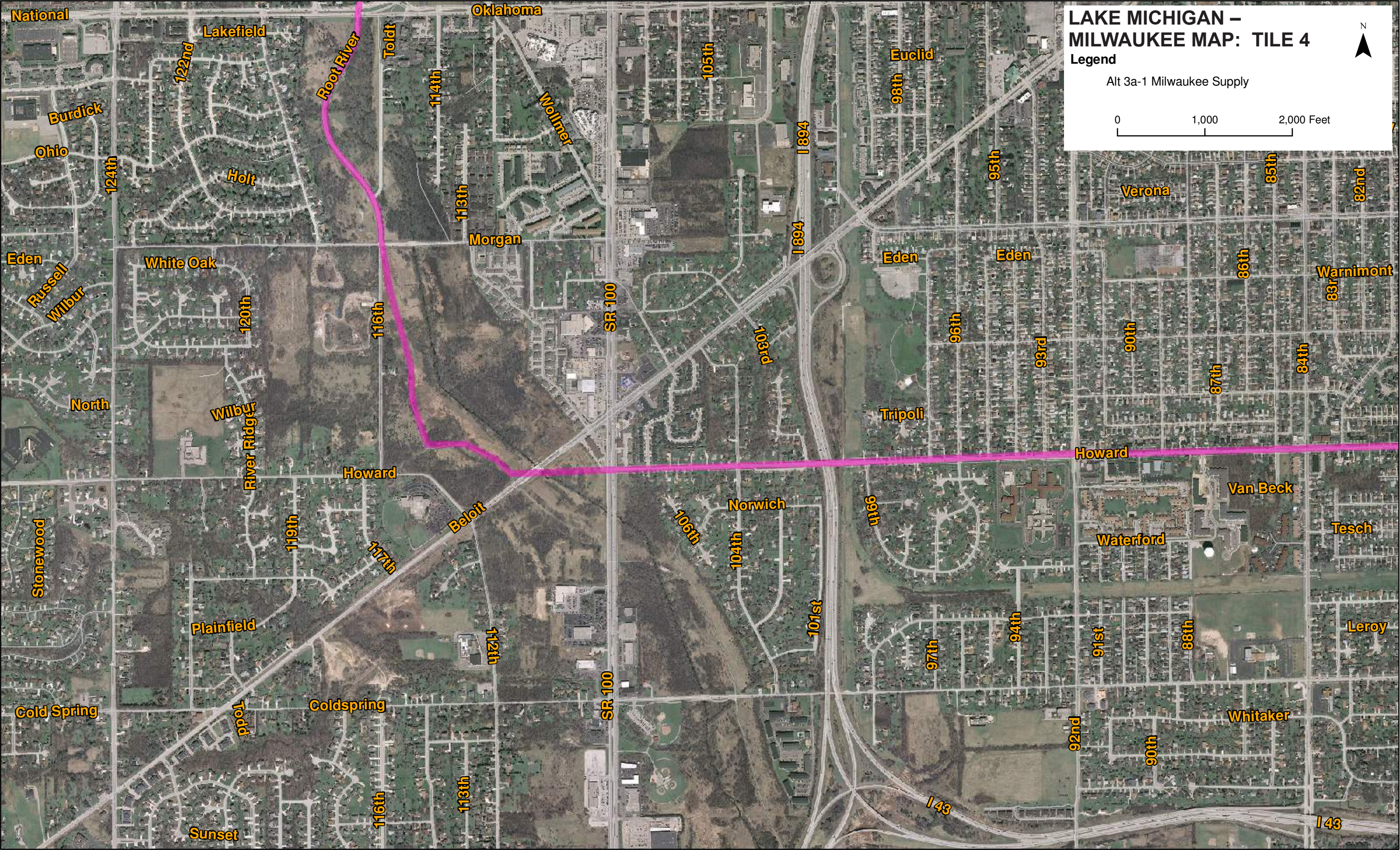
 Alt 3a-1 Milwaukee Supply

0 1,000 2,000 Feet









National

Lakefield

Oklahoma

LAKE MICHIGAN –
MILWAUKEE MAP: TILE 4

Legend

Alt 3a-1 Milwaukee Supply

0 1,000 2,000 Feet

N

Burdick

Ohio

122nd

Holt

Toldt

114th

Wollmer

105th

Euclid

98th

95th

Verona

85th

82nd

Eden

Russell
Wilbur

White Oak

120th

Morgan

SR 100

I 894

Eden

Eden

Warnimont

86th

North

Wilbur
River Ridge

116th

Howard

Beloit

SR 100

Norwich

106th

104th

101st

Tripoli

96th

Howard

Van Beck

Tesch

Waterford

88th

Leroy

Stonewood

119th

117th

112th

Plainfield

ppol

Coldspring

113th

Cold Spring

Sunset

116th

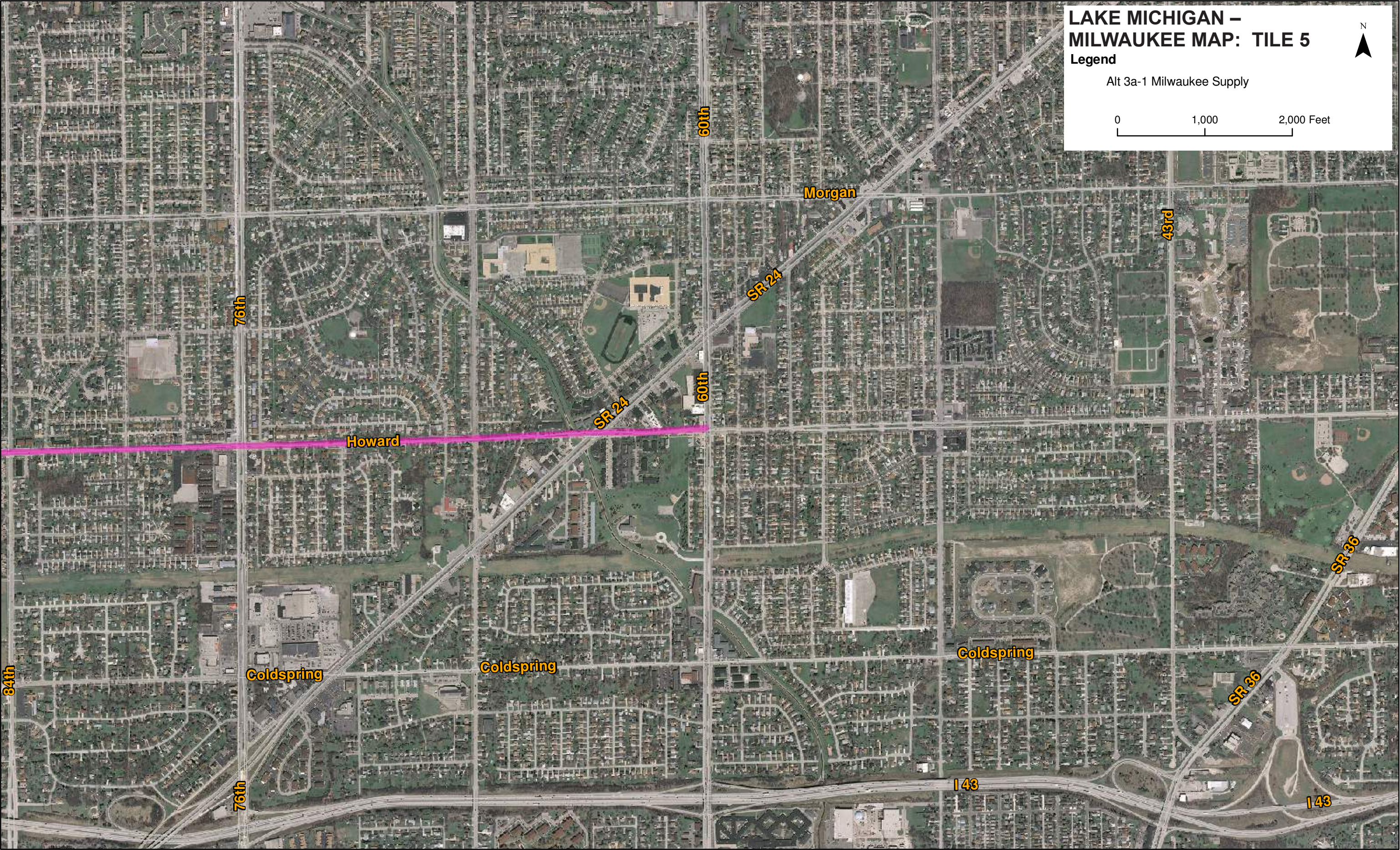
I 43

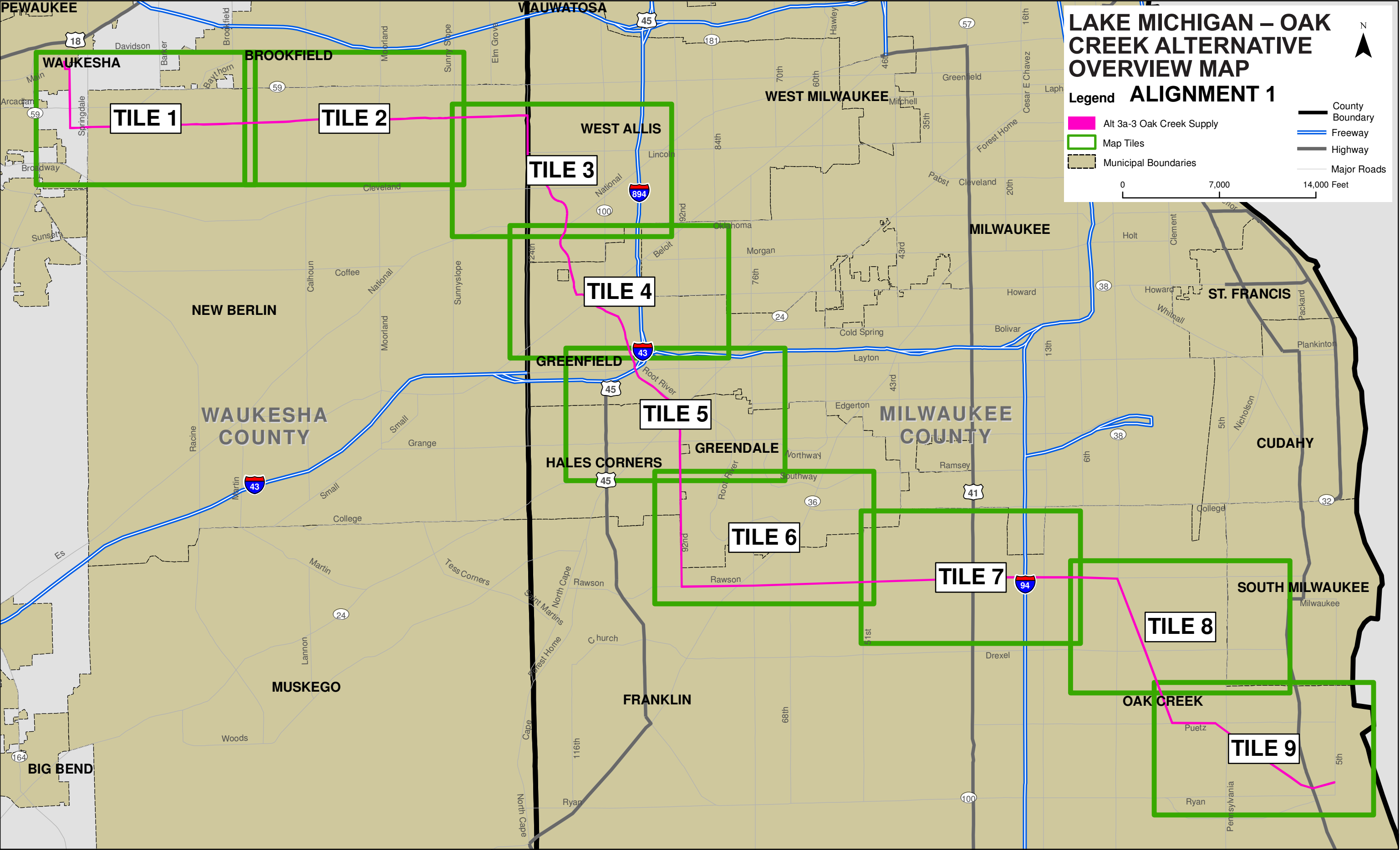
92nd

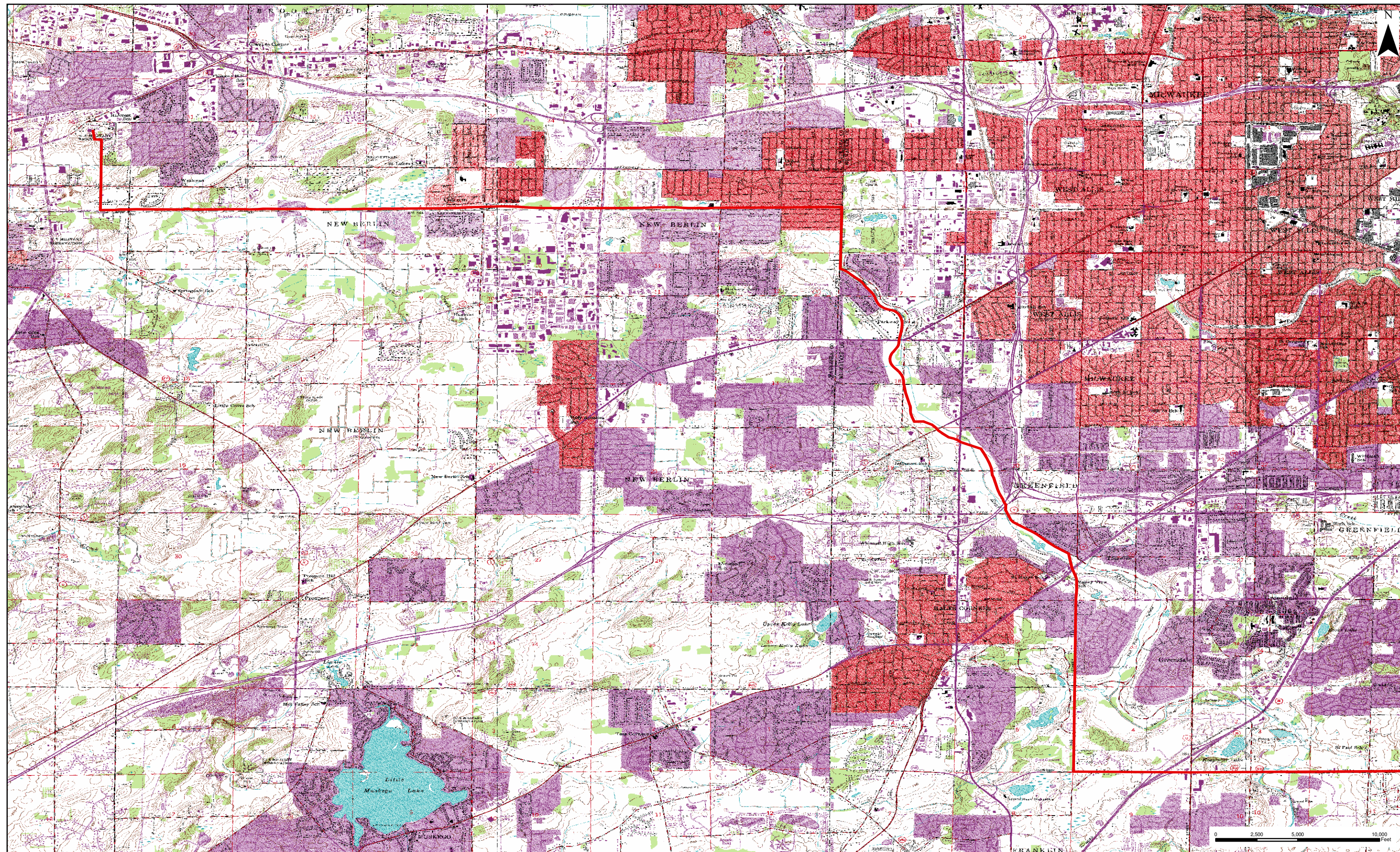
90th

Whitaker

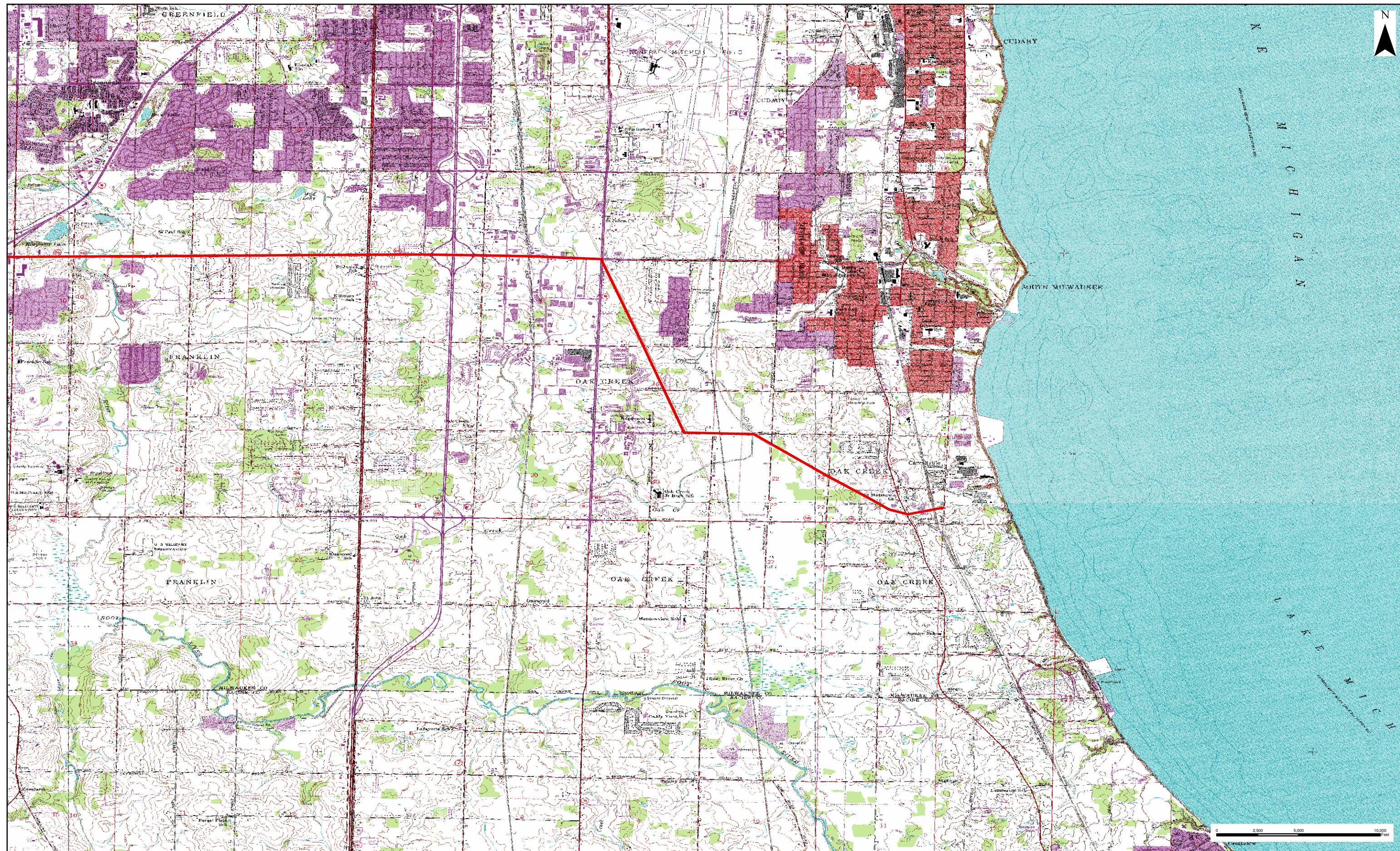
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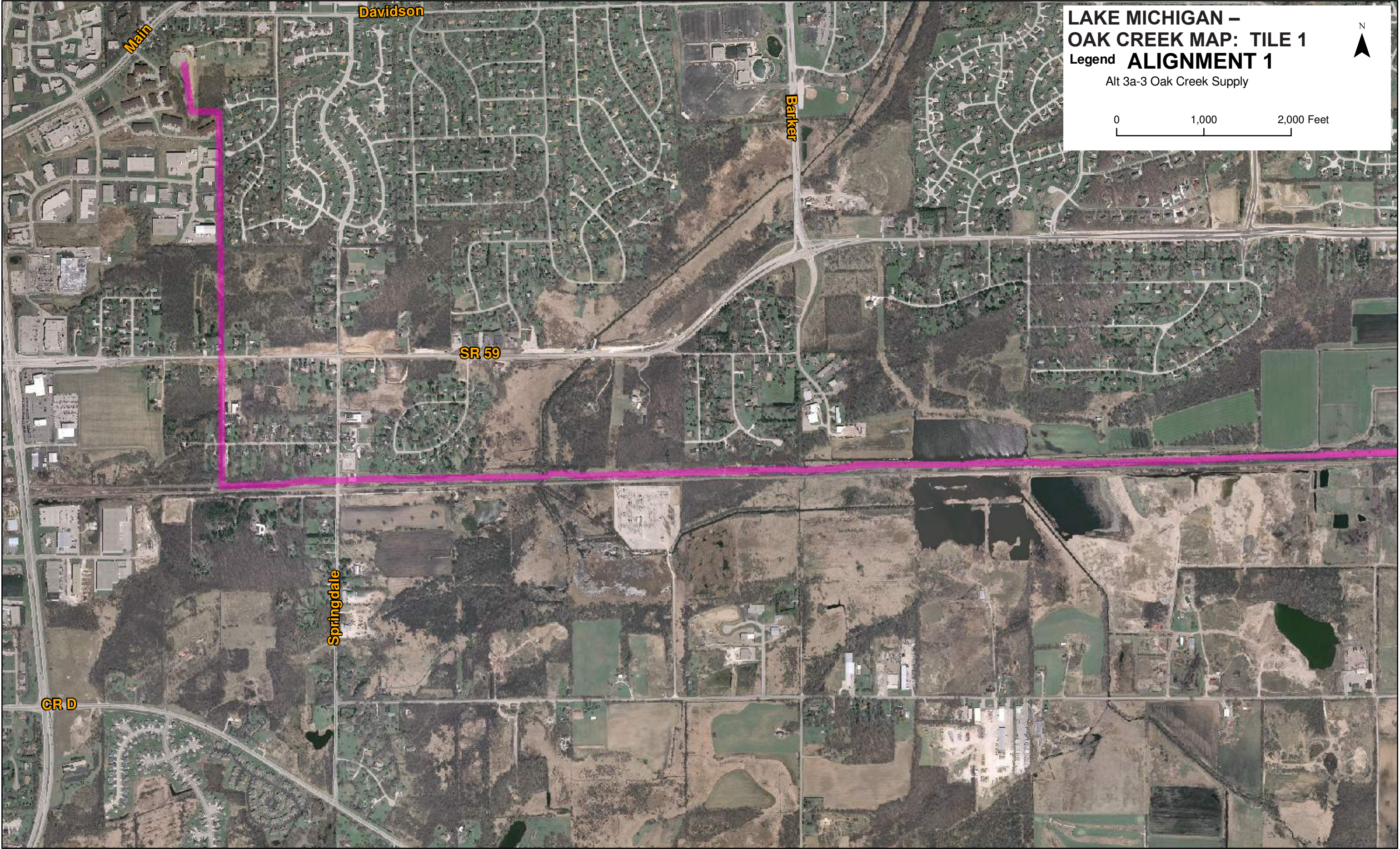




ALIGNMENT 1 LAKE MICHIGAN OAK CREEK SUPPLY TILE 1



ALIGNMENT 1 LAKE MICHIGAN OAK CREEK SUPPLY TILE 2



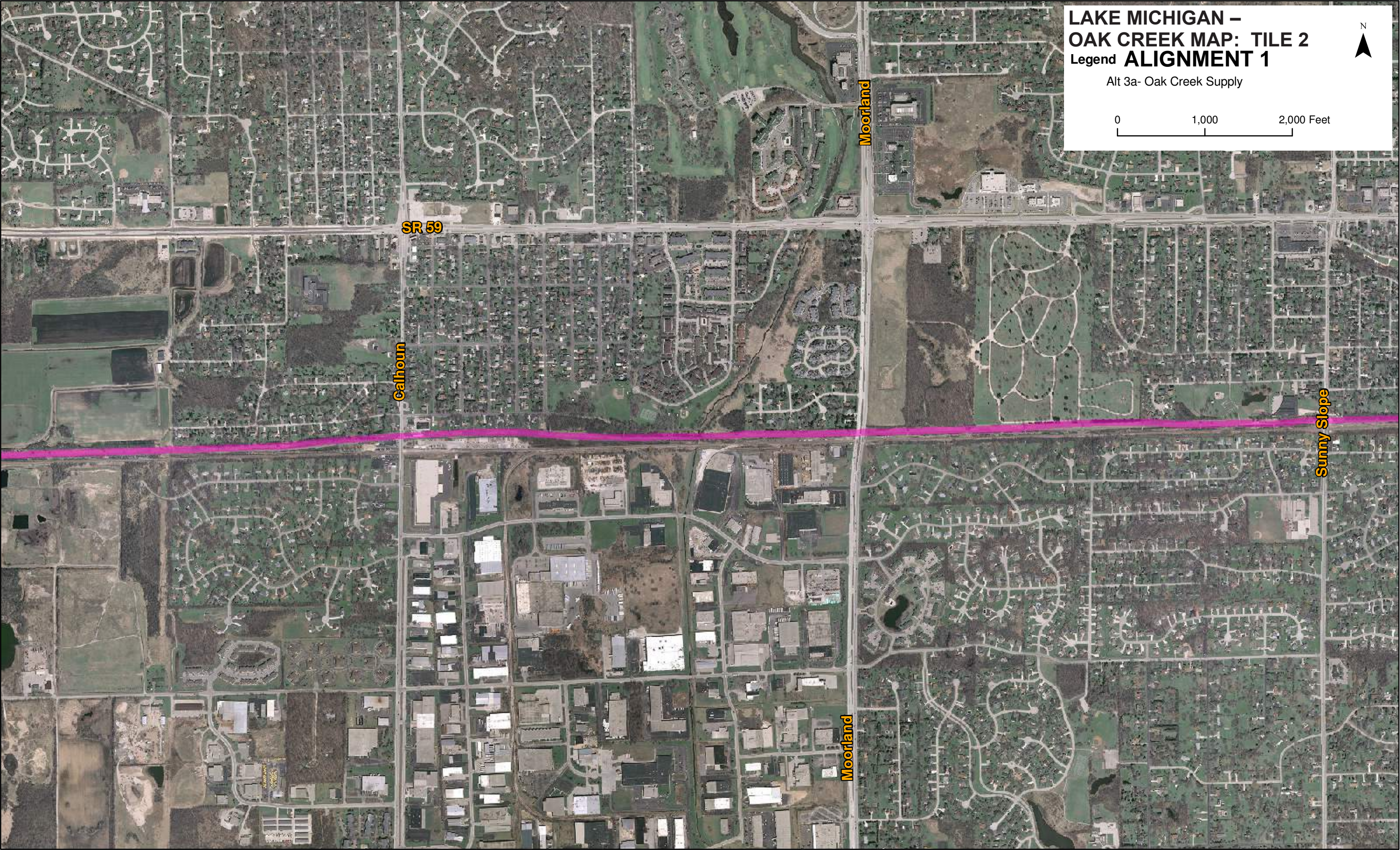
**LAKE MICHIGAN –
OAK CREEK MAP: TILE 1**

Legend **ALIGNMENT 1**

Alt 3a-3 Oak Creek Supply



0 1,000 2,000 Feet



LAKE MICHIGAN –
OAK CREEK MAP: TILE 2
Legend **ALIGNMENT 1**

Alt 3a- Oak Creek Supply

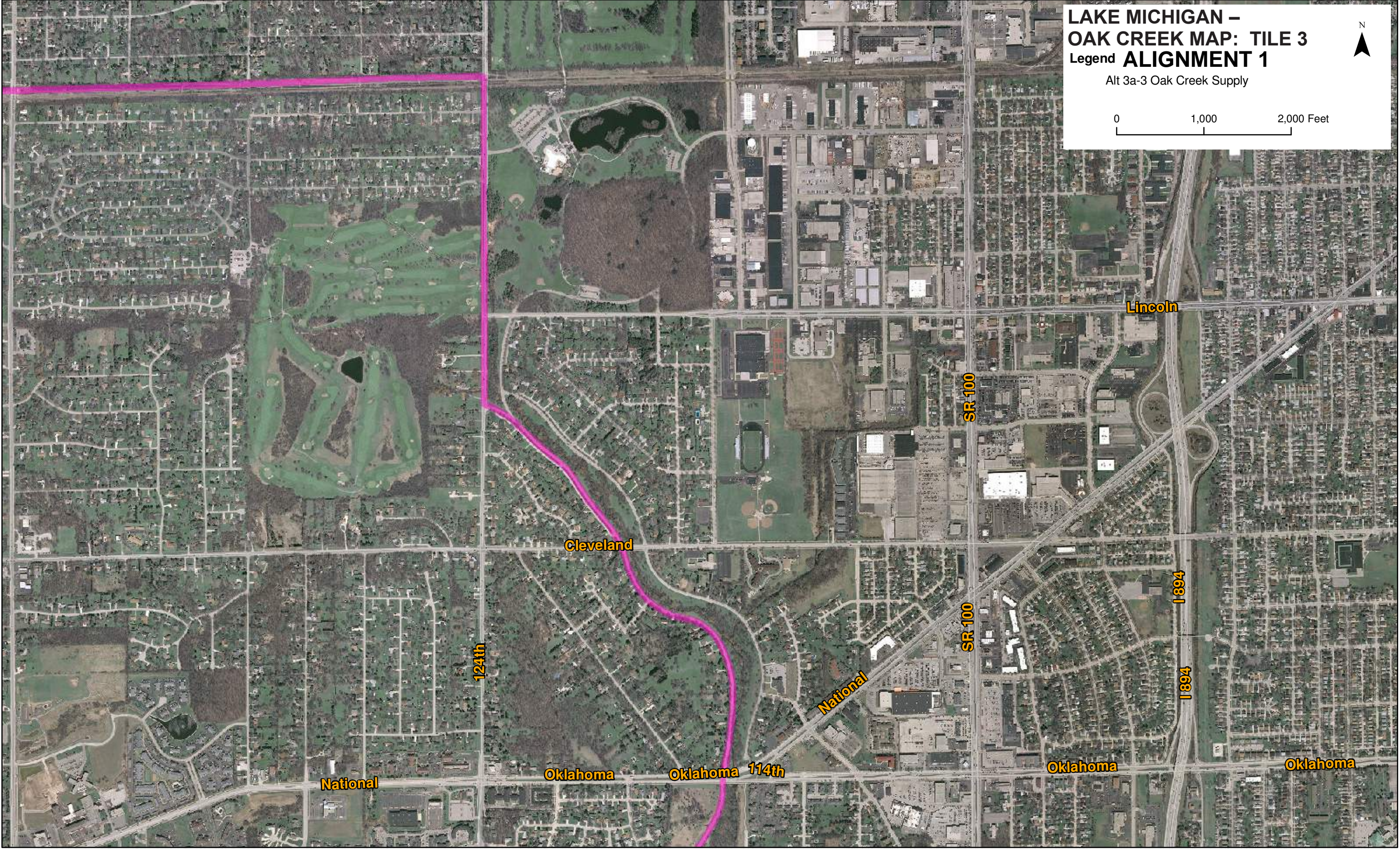
0 1,000 2,000 Feet

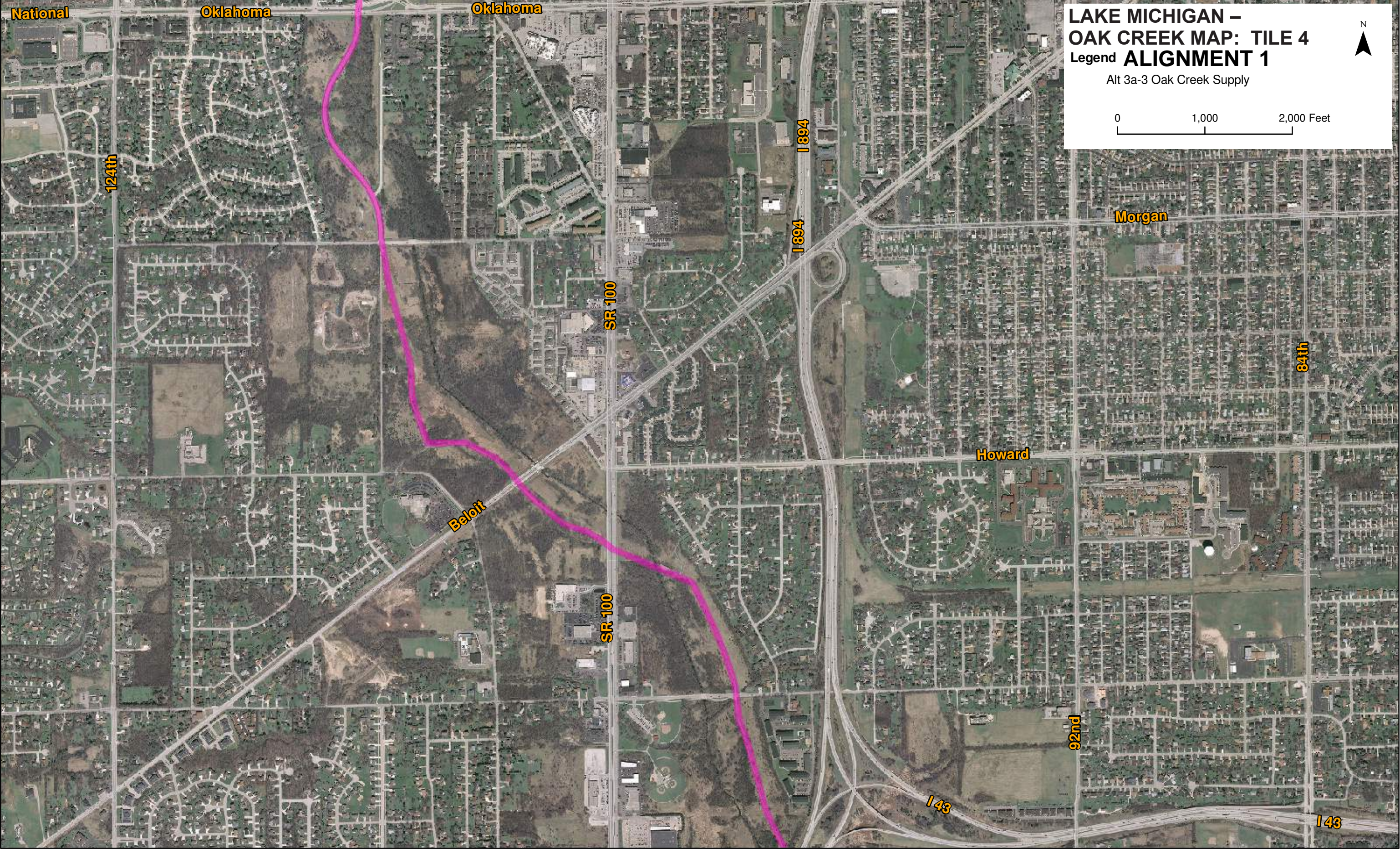


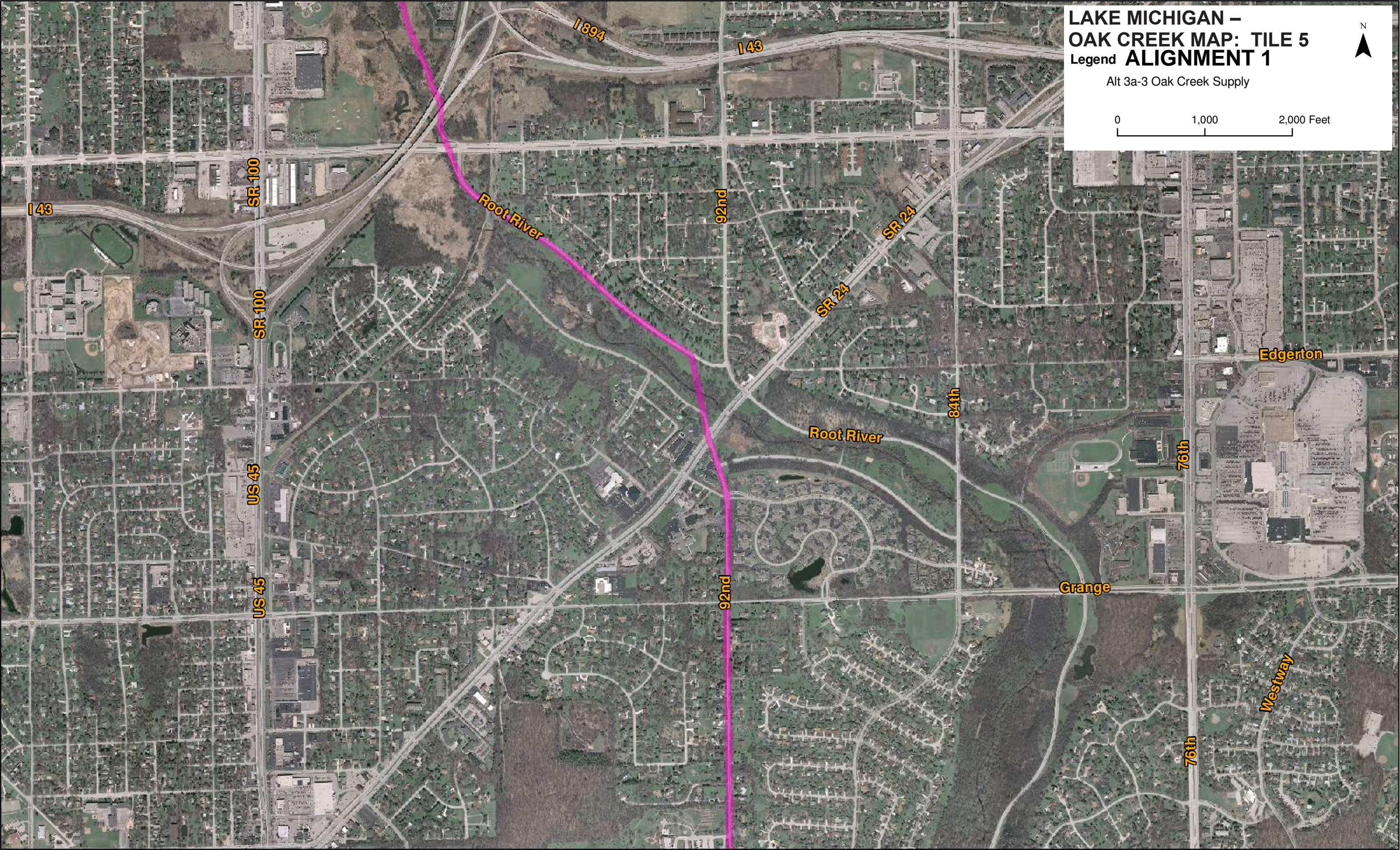
LAKE MICHIGAN –
OAK CREEK MAP: TILE 3
Legend **ALIGNMENT 1**

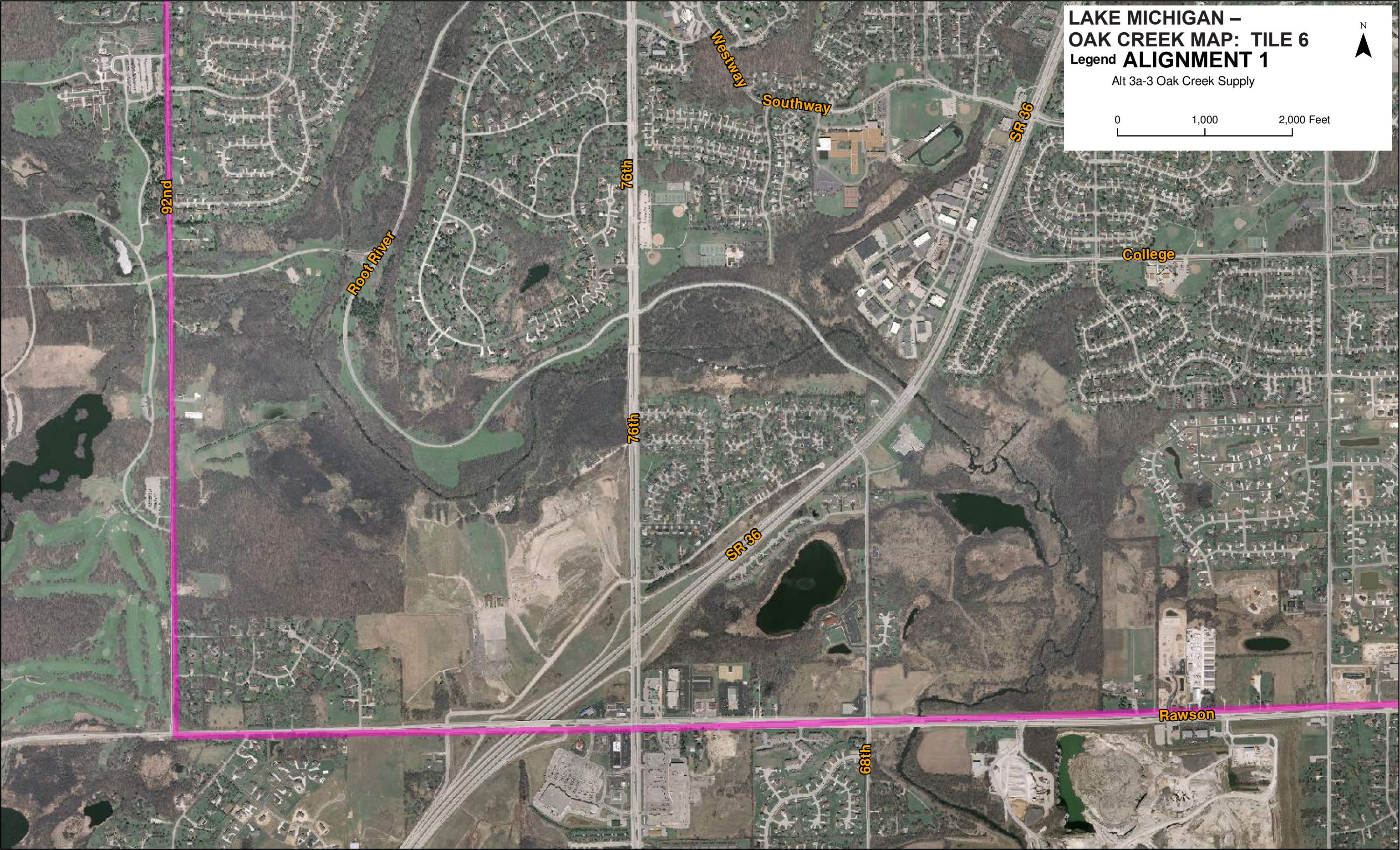
Alt 3a-3 Oak Creek Supply

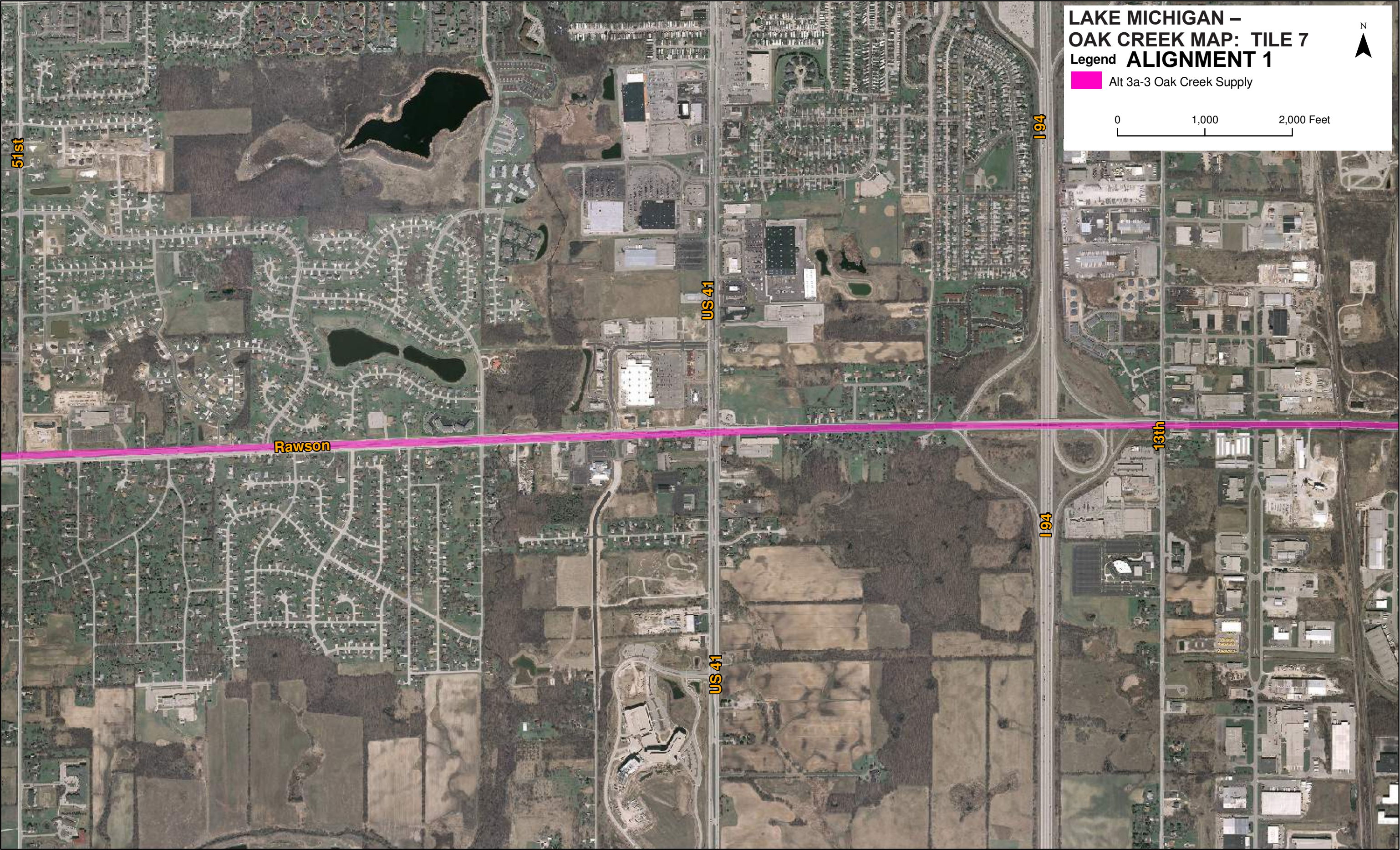
0 1,000 2,000 Feet

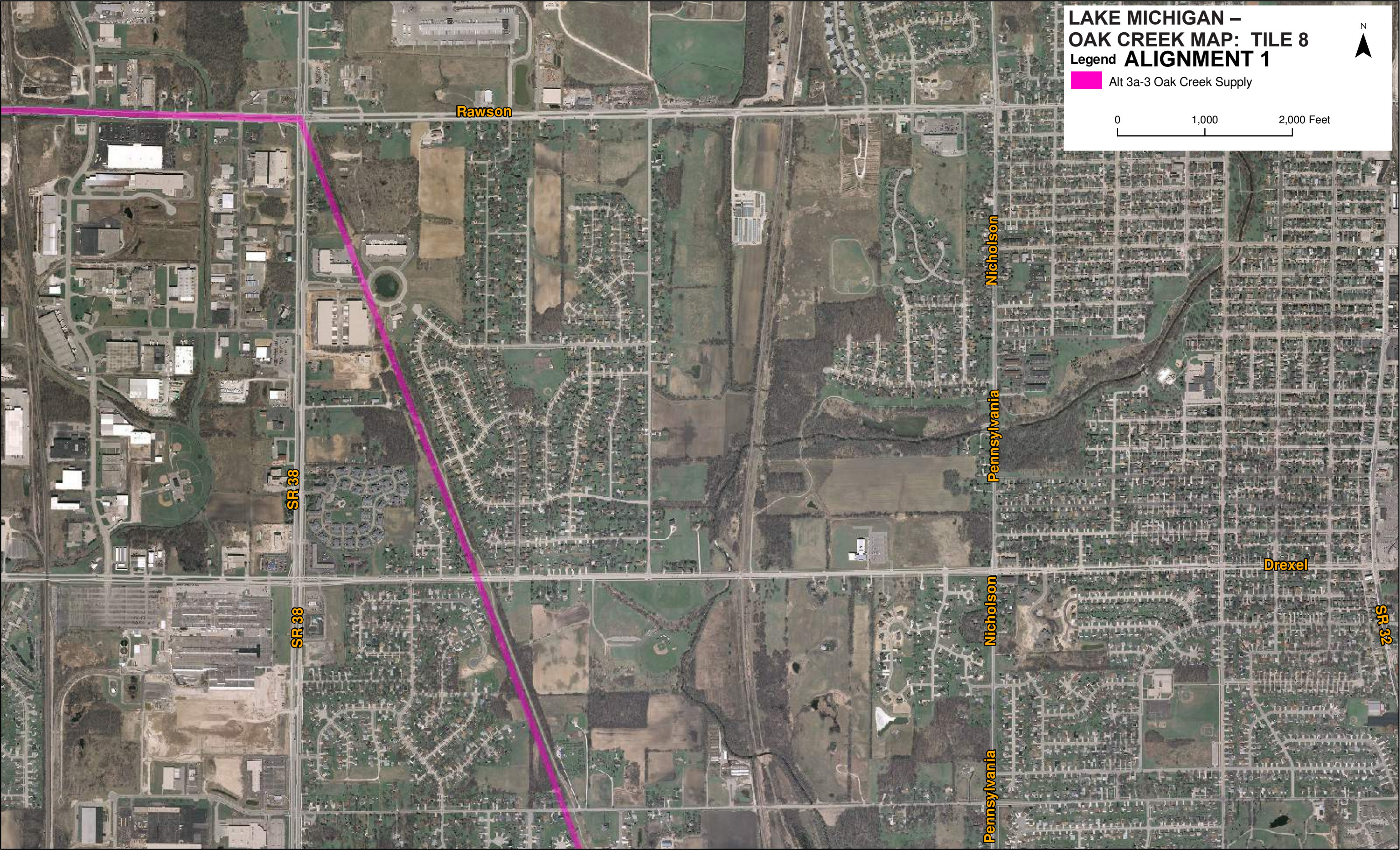











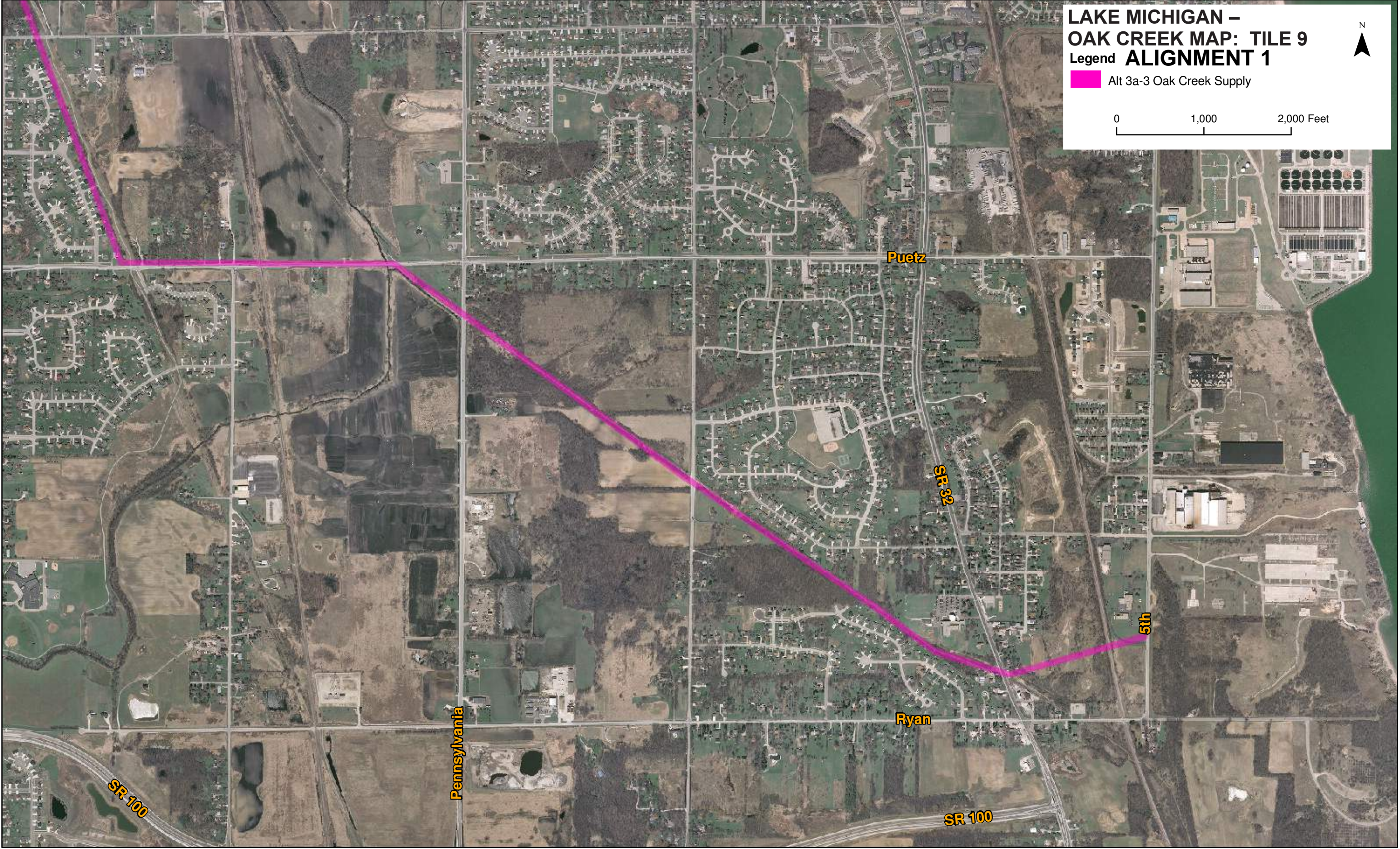


LAKE MICHIGAN –
OAK CREEK MAP: TILE 9

Legend **ALIGNMENT 1**




 Alt 3a-3 Oak Creek Supply

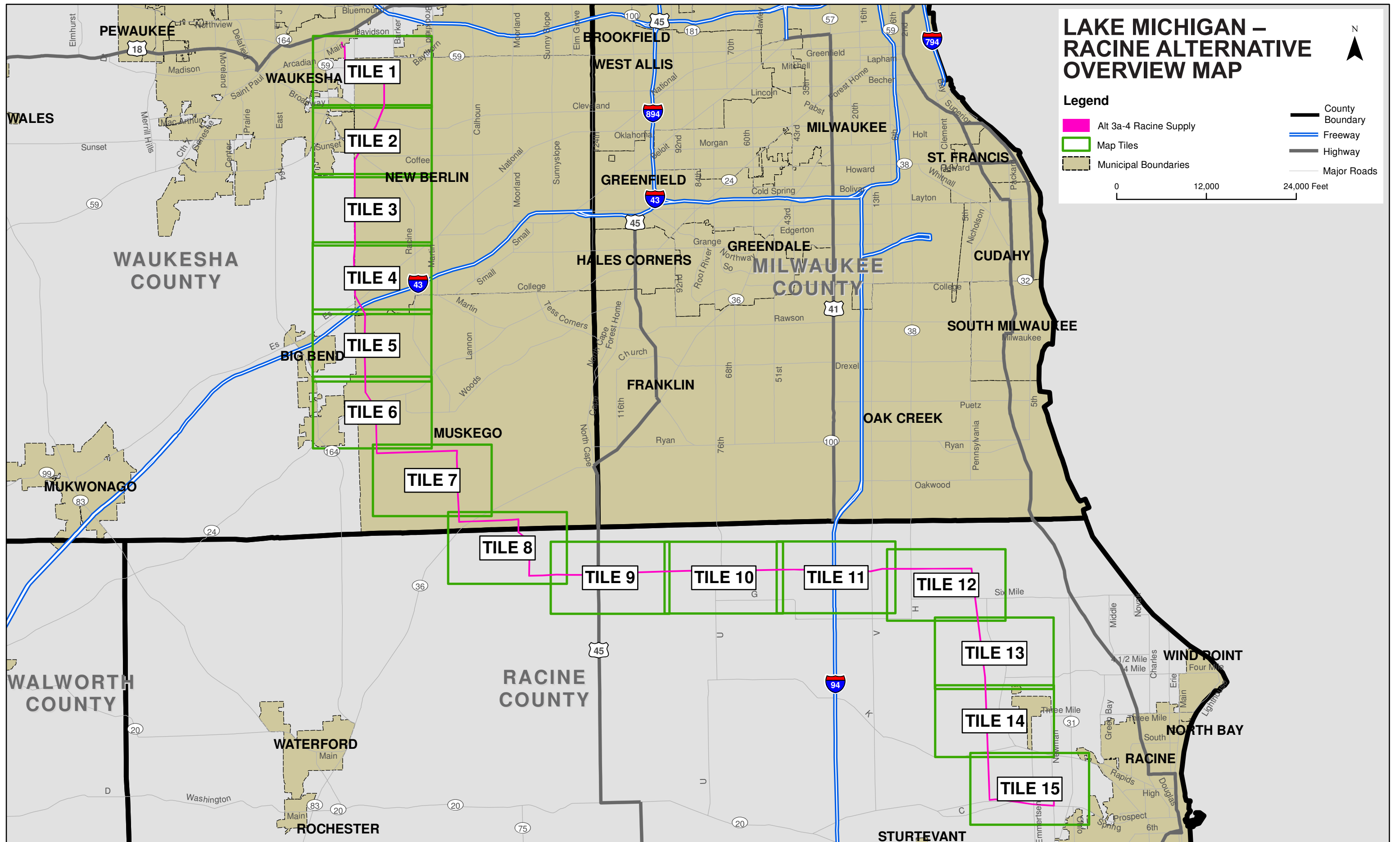
0 1,000 2,000 Feet

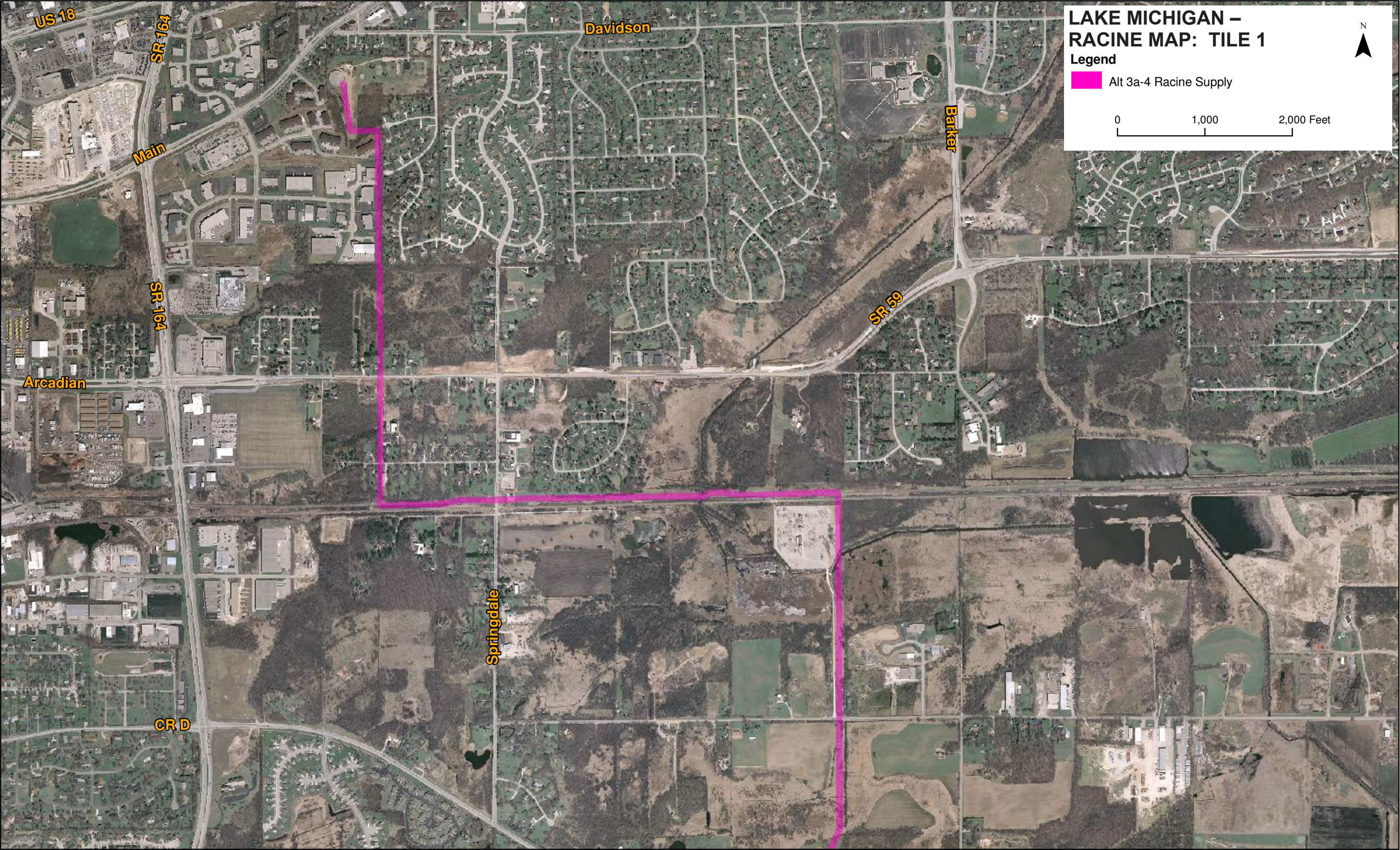


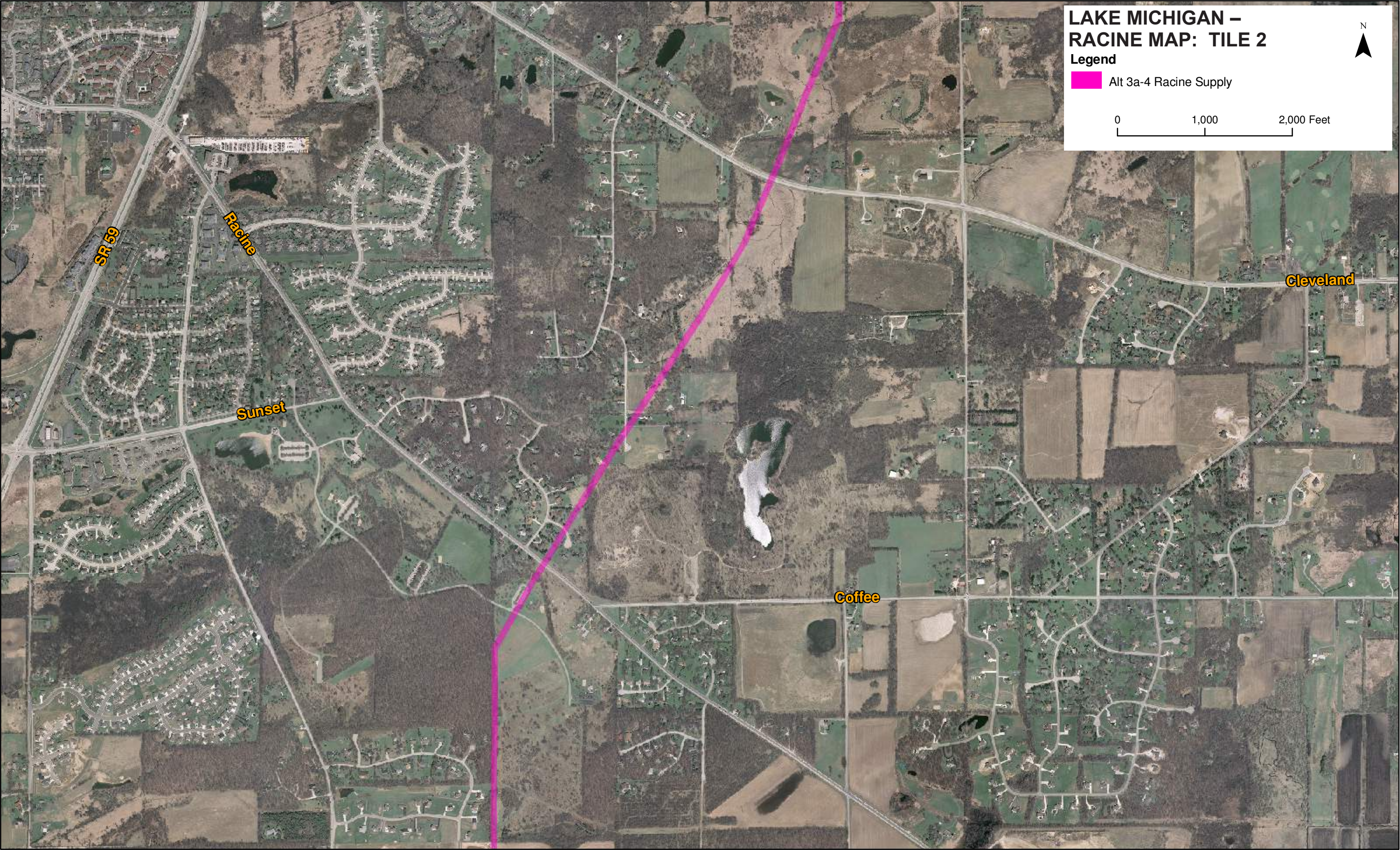
N



-  County Boundary
- Freeway
-  Highway
-  Major Roads







**LAKE MICHIGAN –
RACINE MAP: TILE 2**

Legend

Alt 3a-4 Racine Supply

0 1,000 2,000 Feet



LAKE MICHIGAN –
RACINE MAP: TILE 3

Legend

Alt 3a-4 Racine Supply

01,0002,000 Feet

An aerial photograph of a rural landscape, likely in Wisconsin, showing a patchwork of green fields, brown harvested fields, and clusters of trees. A prominent vertical pink line runs through the center of the image. In the lower right, a road is labeled 'Racine' in yellow text, and a road further down and to the right is labeled 'National' in yellow text. The map is part of a series, as indicated by the title 'LAKE MICHIGAN – RACINE MAP: TILE 3'.

LAKE MICHIGAN –
RACINE MAP: TILE 4

Legend

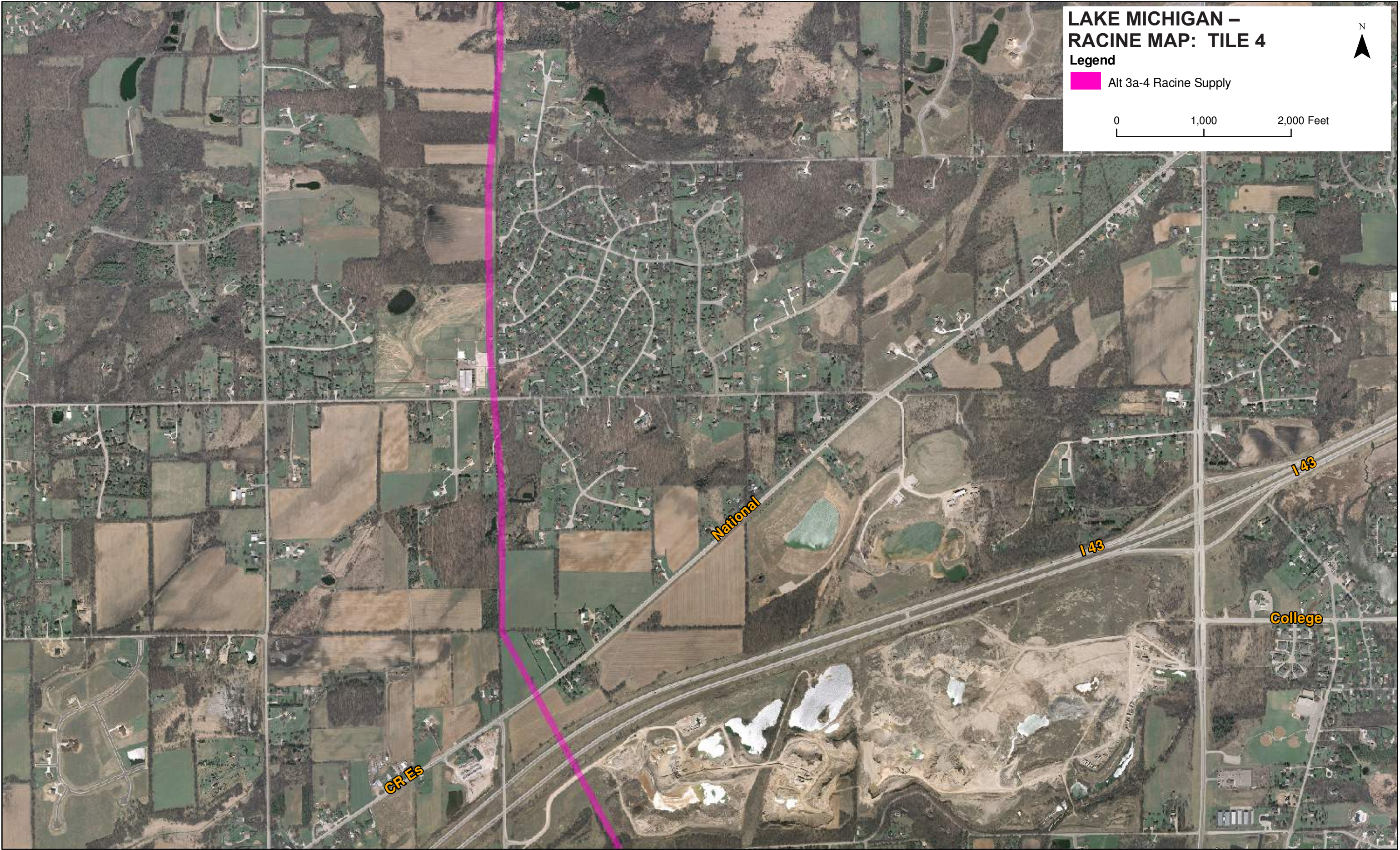
Alt 3a-4 Racine Supply

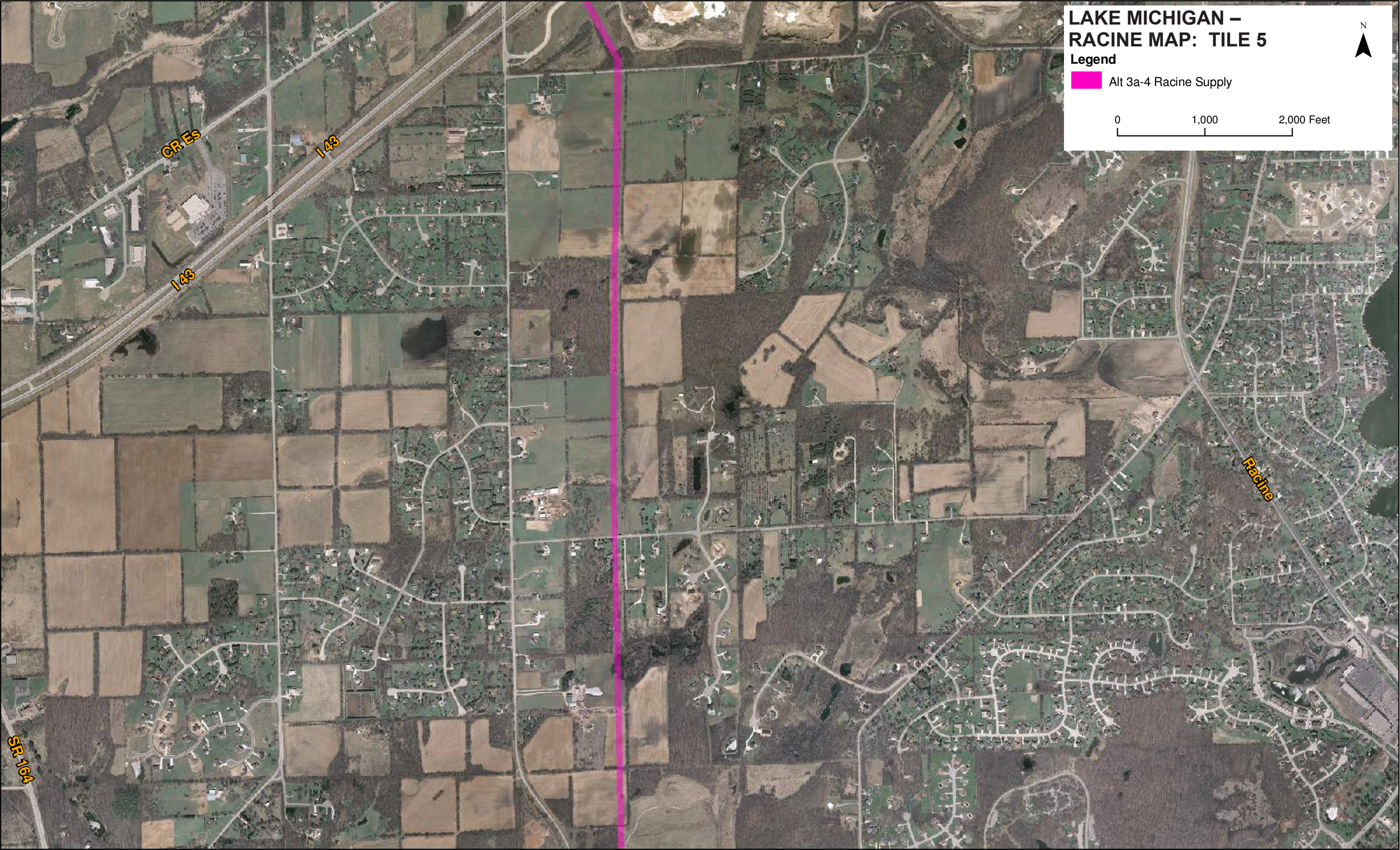
0

1,000

2,000 Feet


N





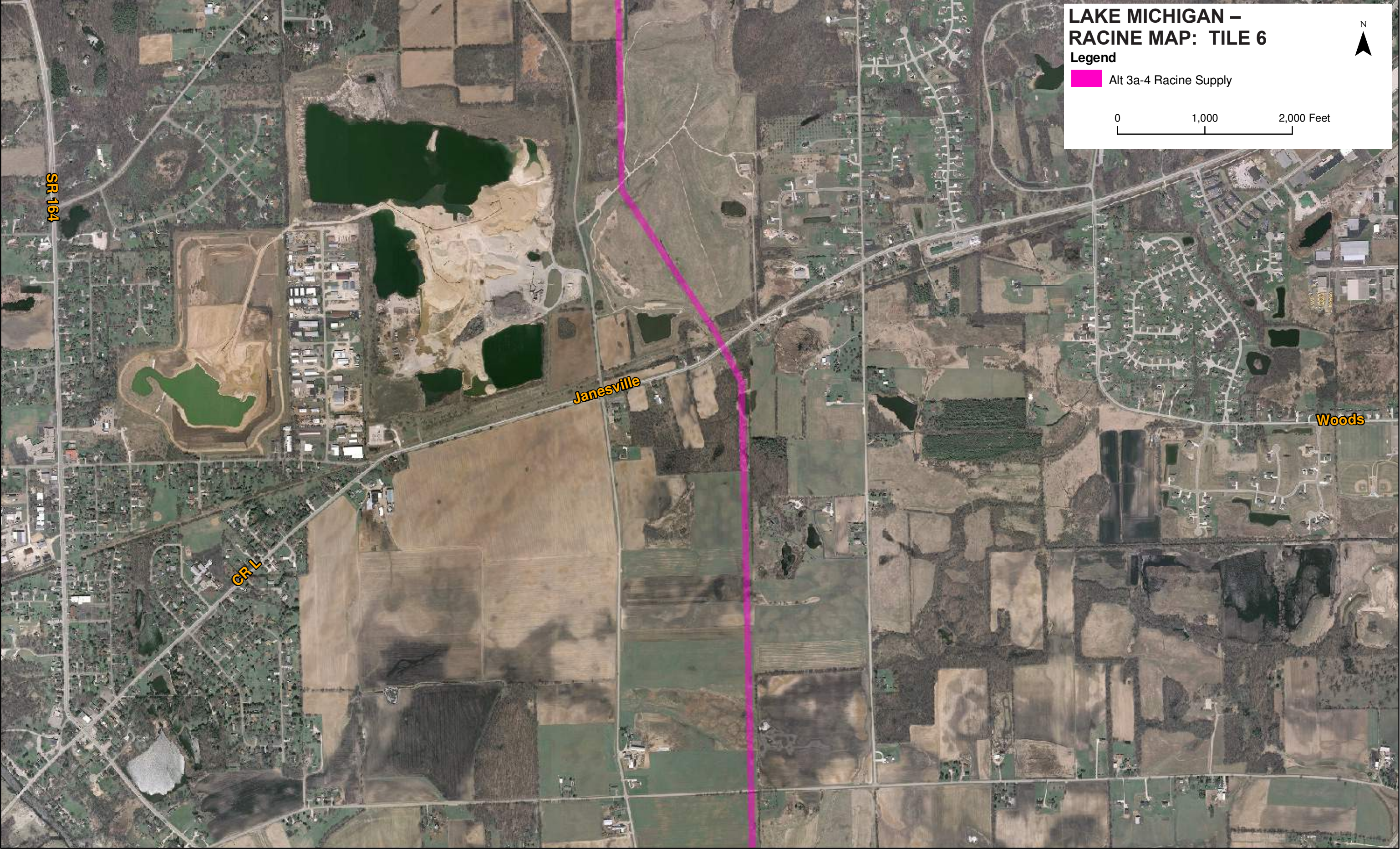
**LAKE MICHIGAN -
RACINE MAP: TILE 5**

Legend

 Alt 3a-4 Racine Supply

0 1,000 2,000 Feet





LAKE MICHIGAN –
RACINE MAP: TILE 6

Legend

Alt 3a-4 Racine Supply

01,0002,000 Feet

LAKE MICHIGAN –
RACINE MAP: TILE 7

Legend

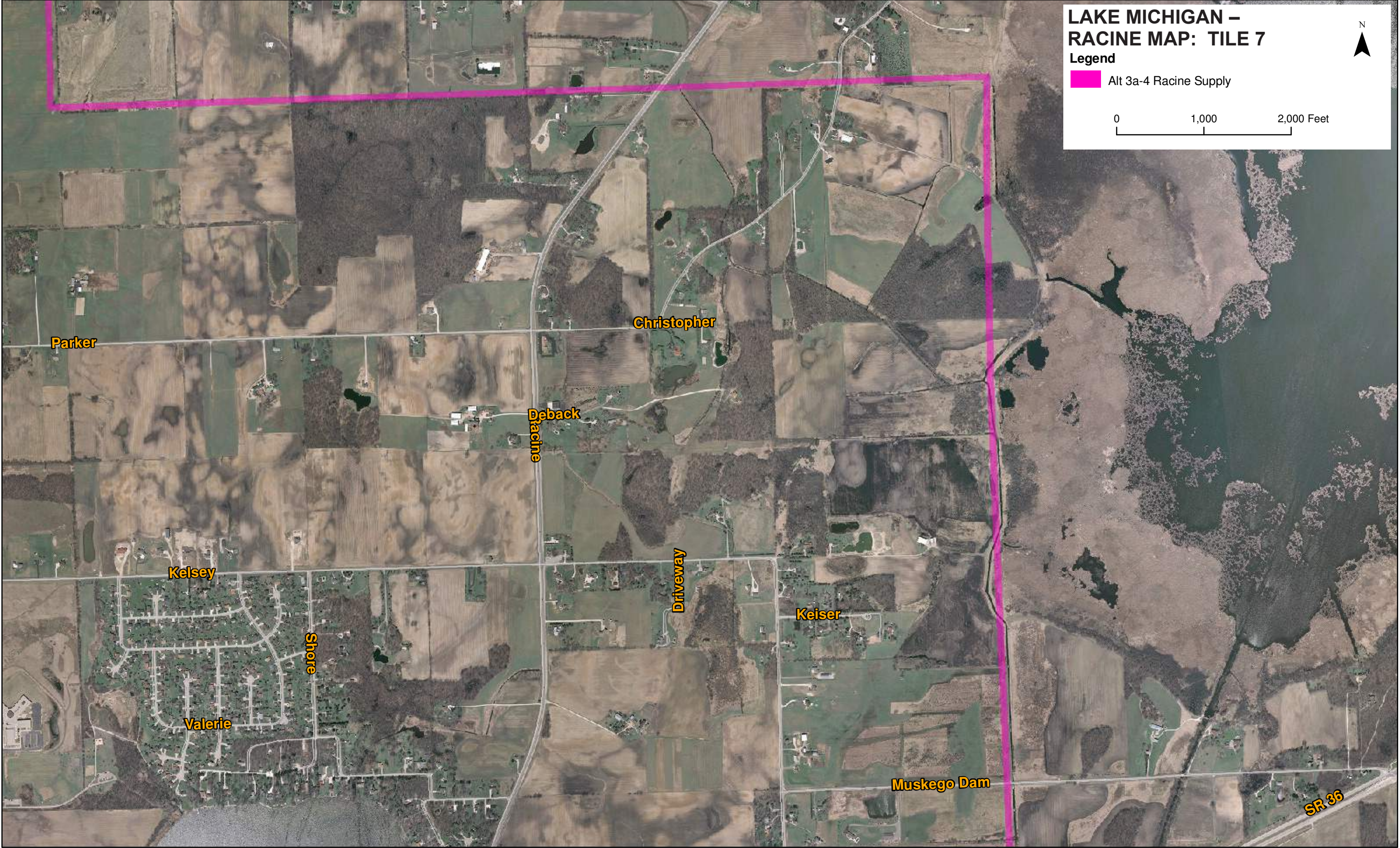
Alt 3a-4 Racine Supply

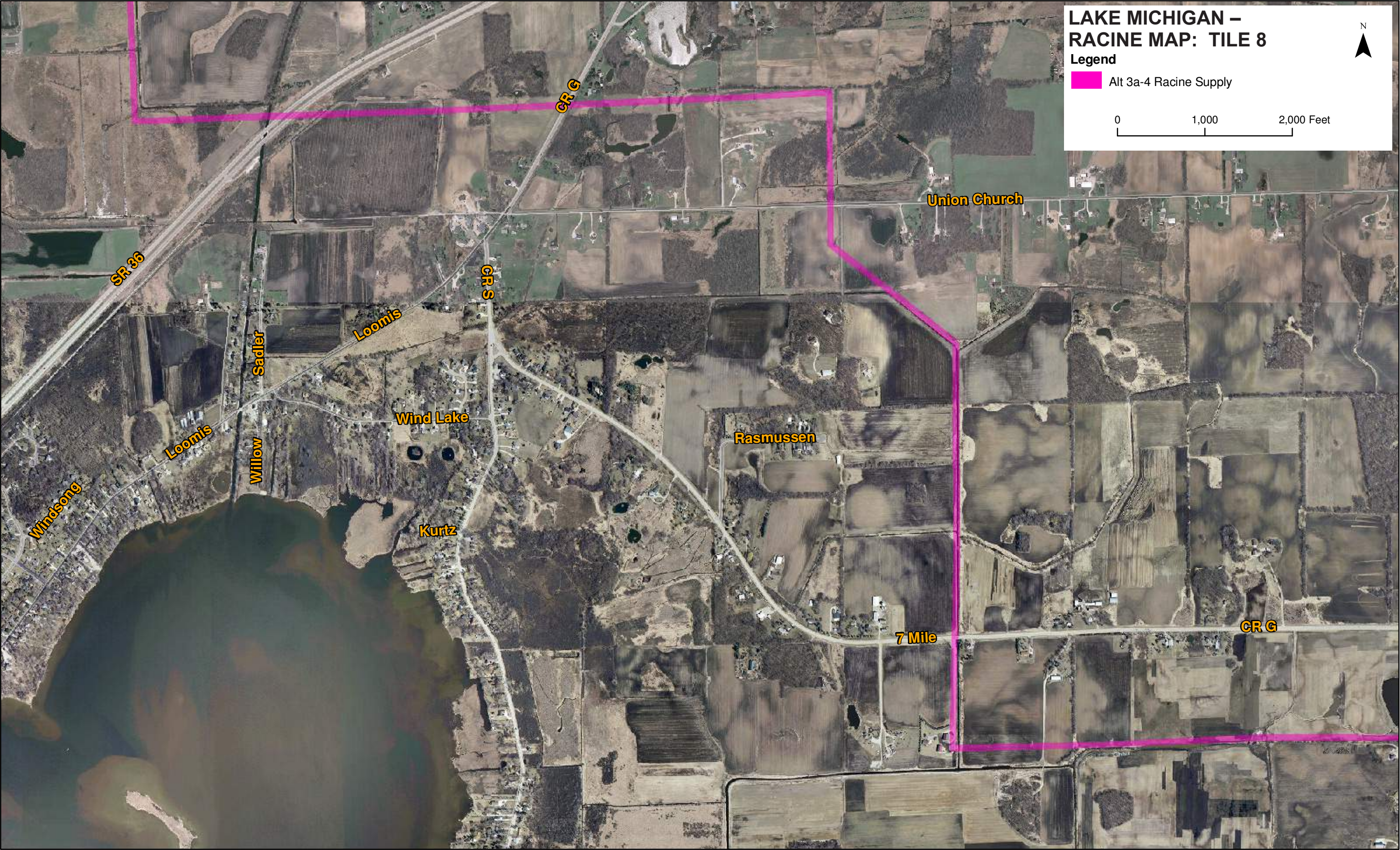
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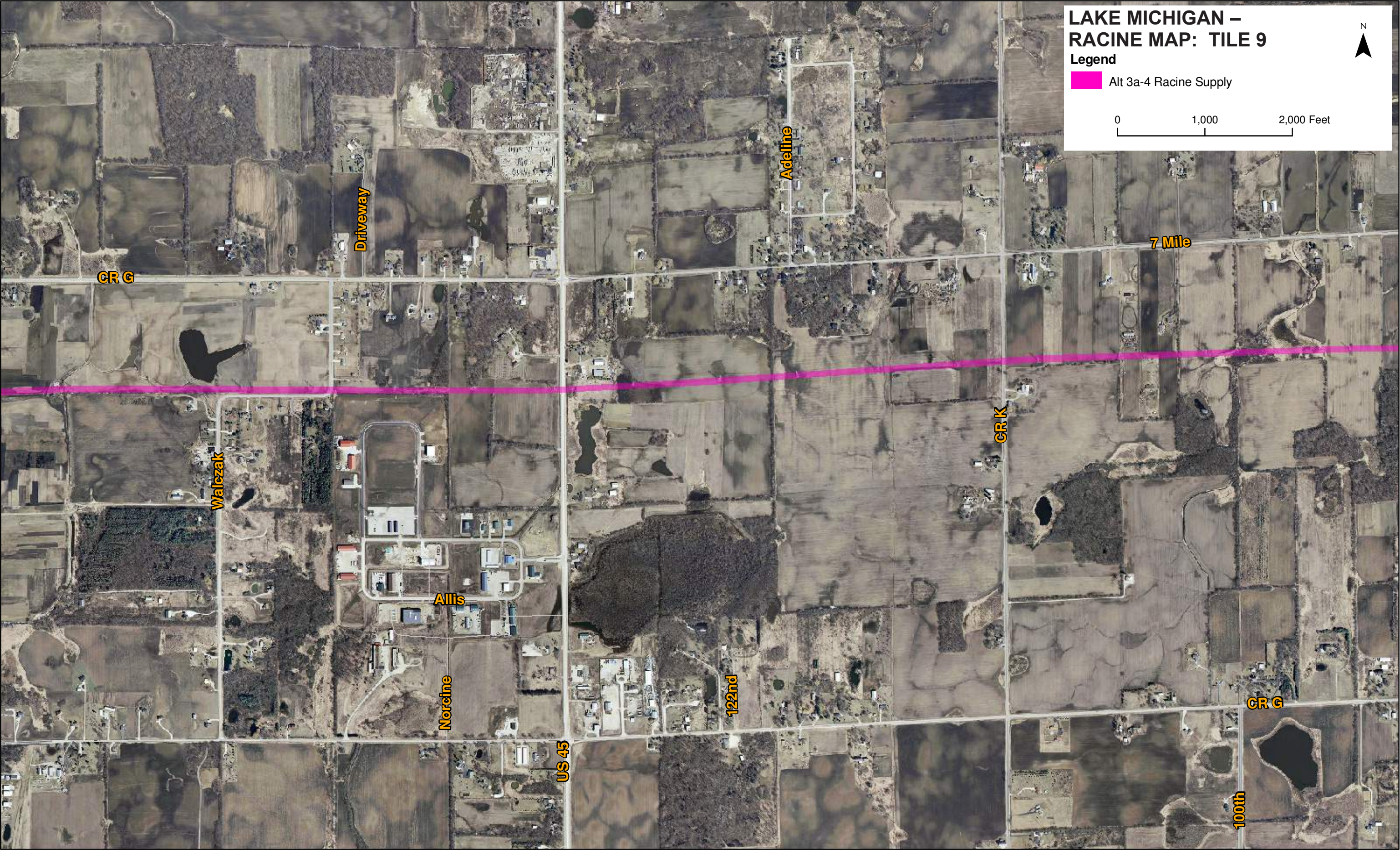
1,000

2,000 Feet

N







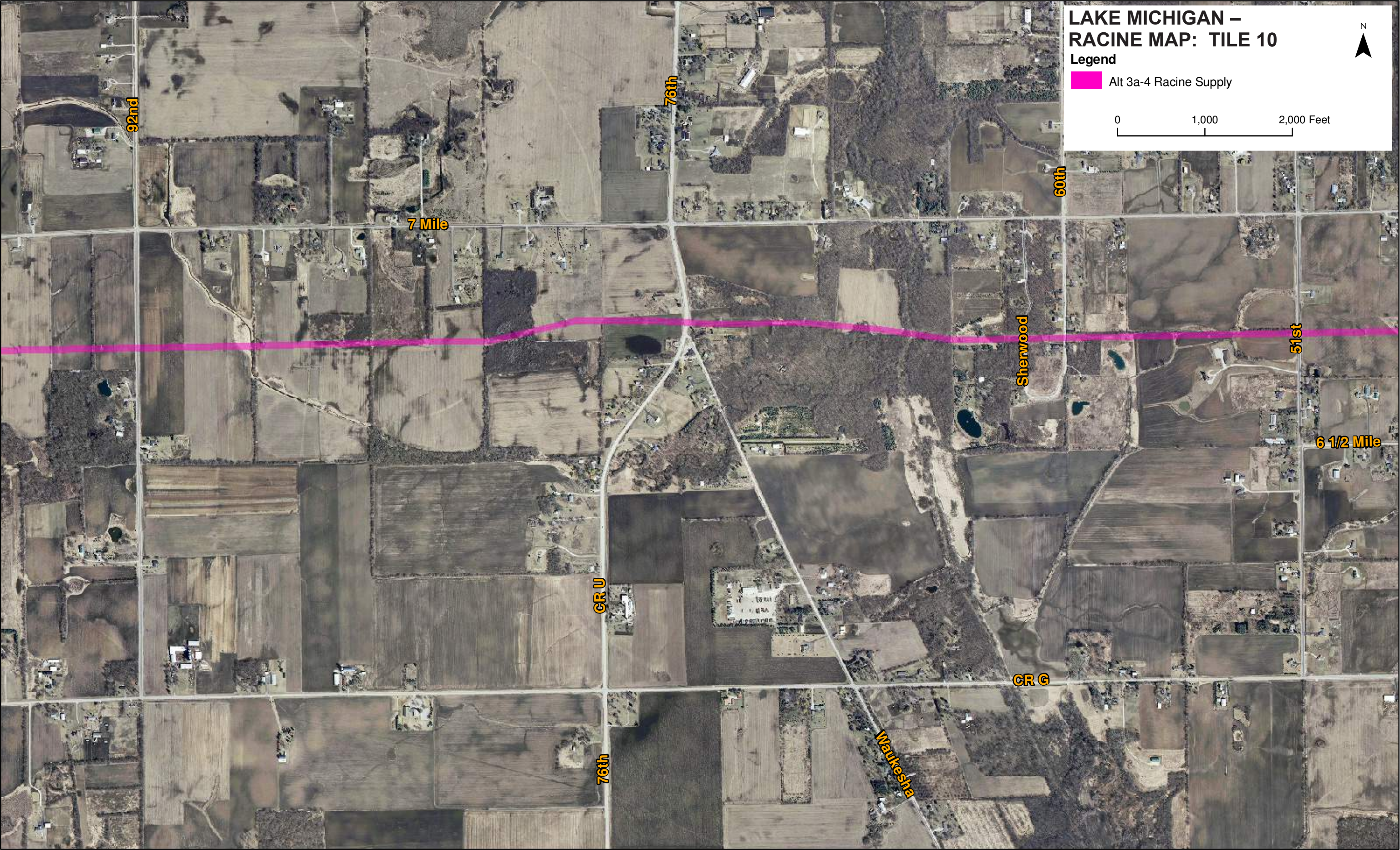
LAKE MICHIGAN –
RACINE MAP: TILE 9

Legend

Alt 3a-4 Racine Supply

01,0002,000 Feet

N



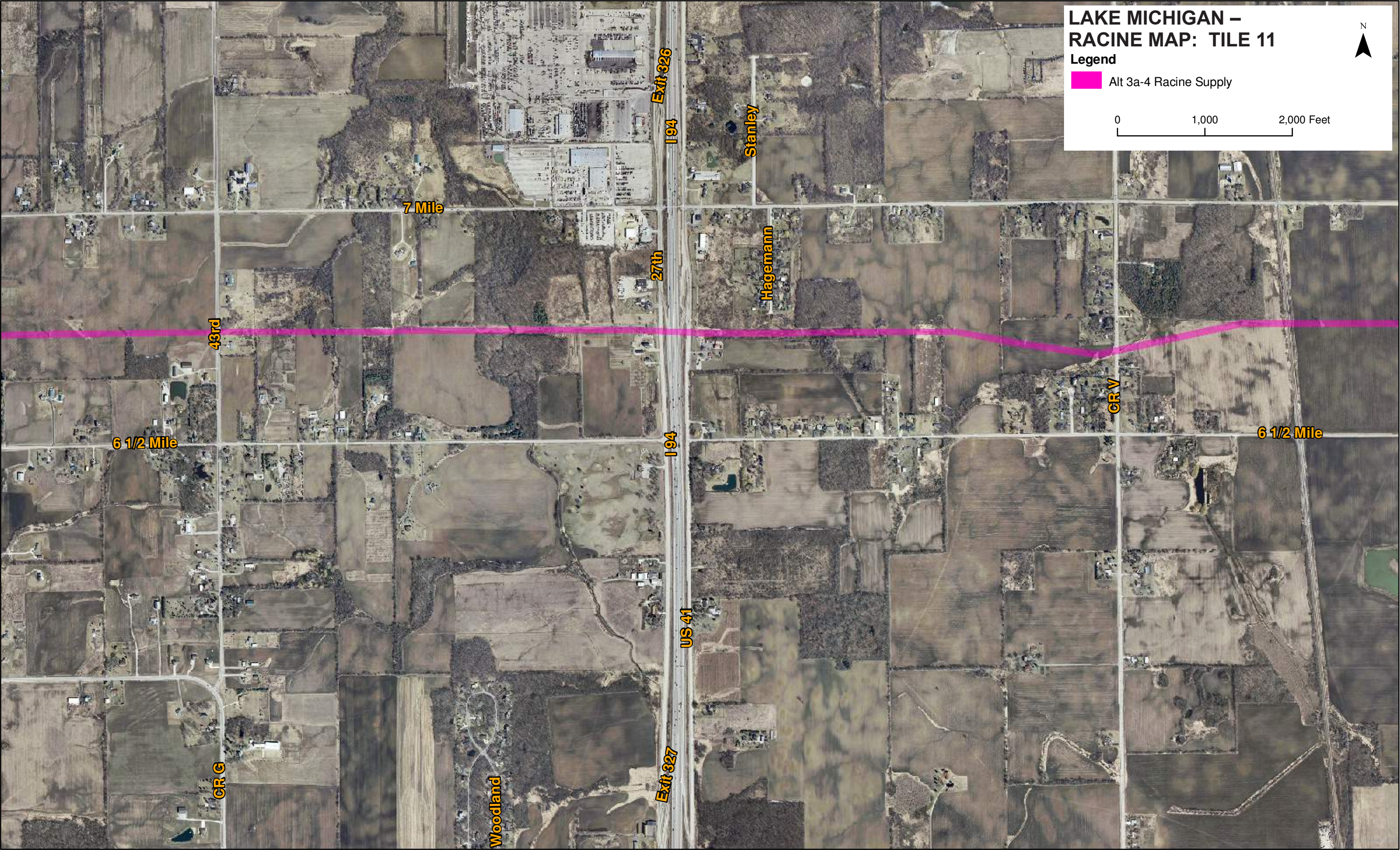
**LAKE MICHIGAN –
RACINE MAP: TILE 10**

Legend

Alt 3a-4 Racine Supply

01,0002,000 Feet

N



LAKE MICHIGAN -
RACINE MAP: TILE 11

Legend

Alt 3a-4 Racine Supply

0 1,000 2,000 Feet

LAKE MICHIGAN –
RACINE MAP: TILE 12

Legend

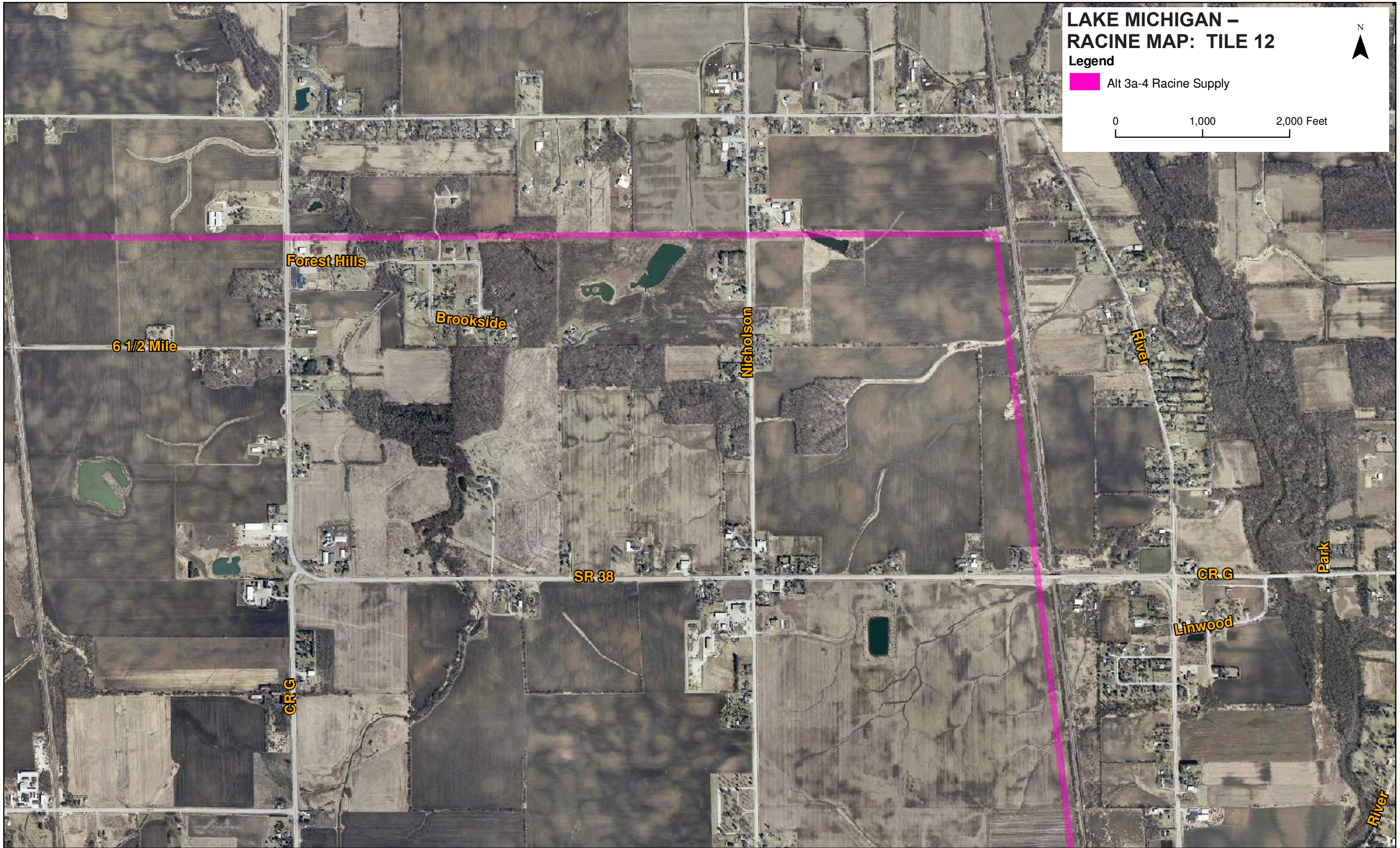
Alt 3a-4 Racine Supply

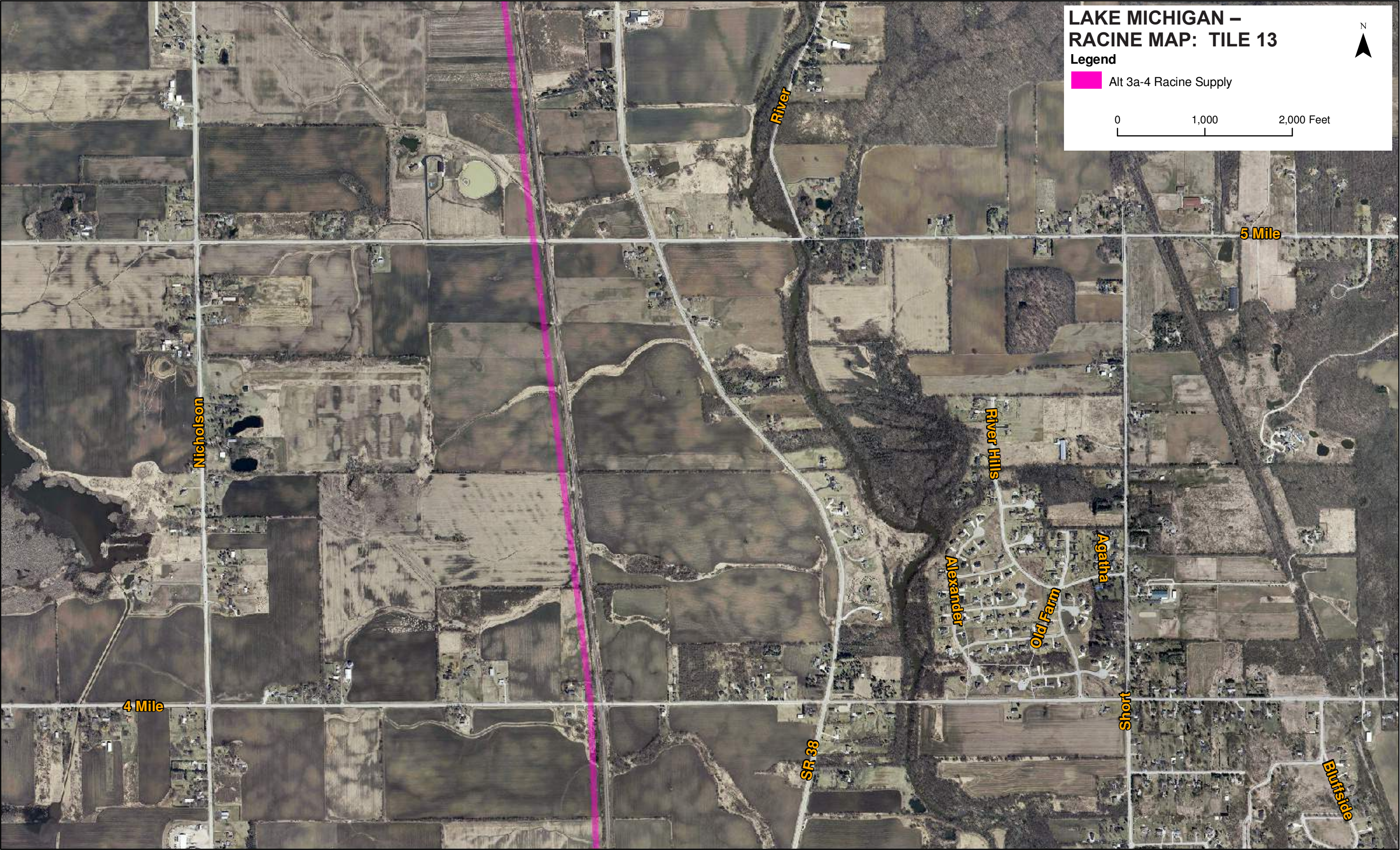
0

1,000

2,000 Feet

N



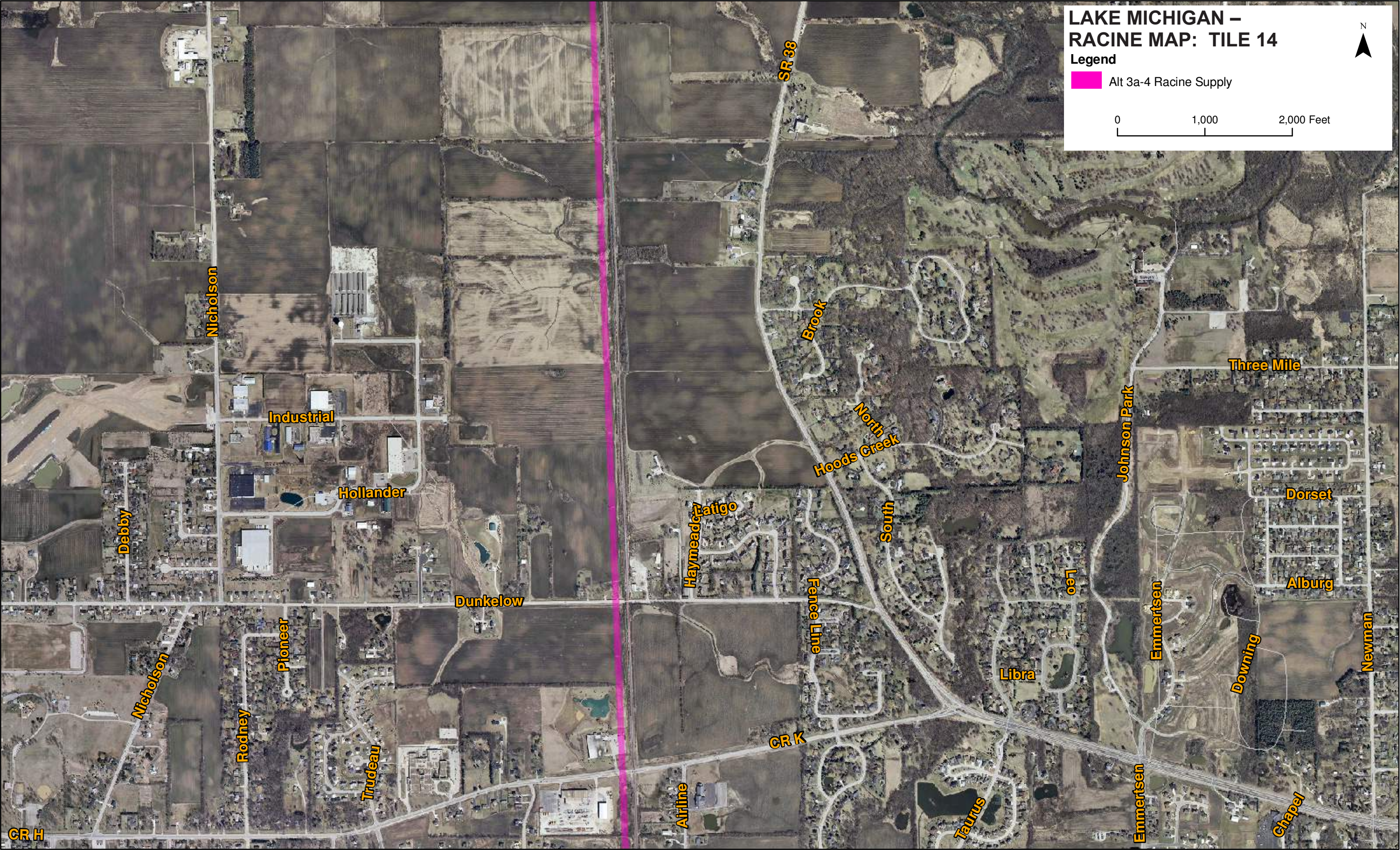


LAKE MICHIGAN -
RACINE MAP: TILE 13

Legend

Alt 3a-4 Racine Supply

0 1,000 2,000 Feet



LAKE MICHIGAN -
RACINE MAP: TILE 14

Legend

Alt 3a-4 Racine Supply

0 1,000 2,000 Feet

N

Nicholson

SR 38

Industrial

Hollander

Debbay

Dunkelow

Brook

North
Hoods Creek

South

Haymeadow
Patigo

Fence Line

CR K

Johnson Park

Three Mile

Dorset

Alburg

Leo

Libra

Emmeritsen

Downing

Newman

Nicholson

Rodney

Pioneer

Trudeau

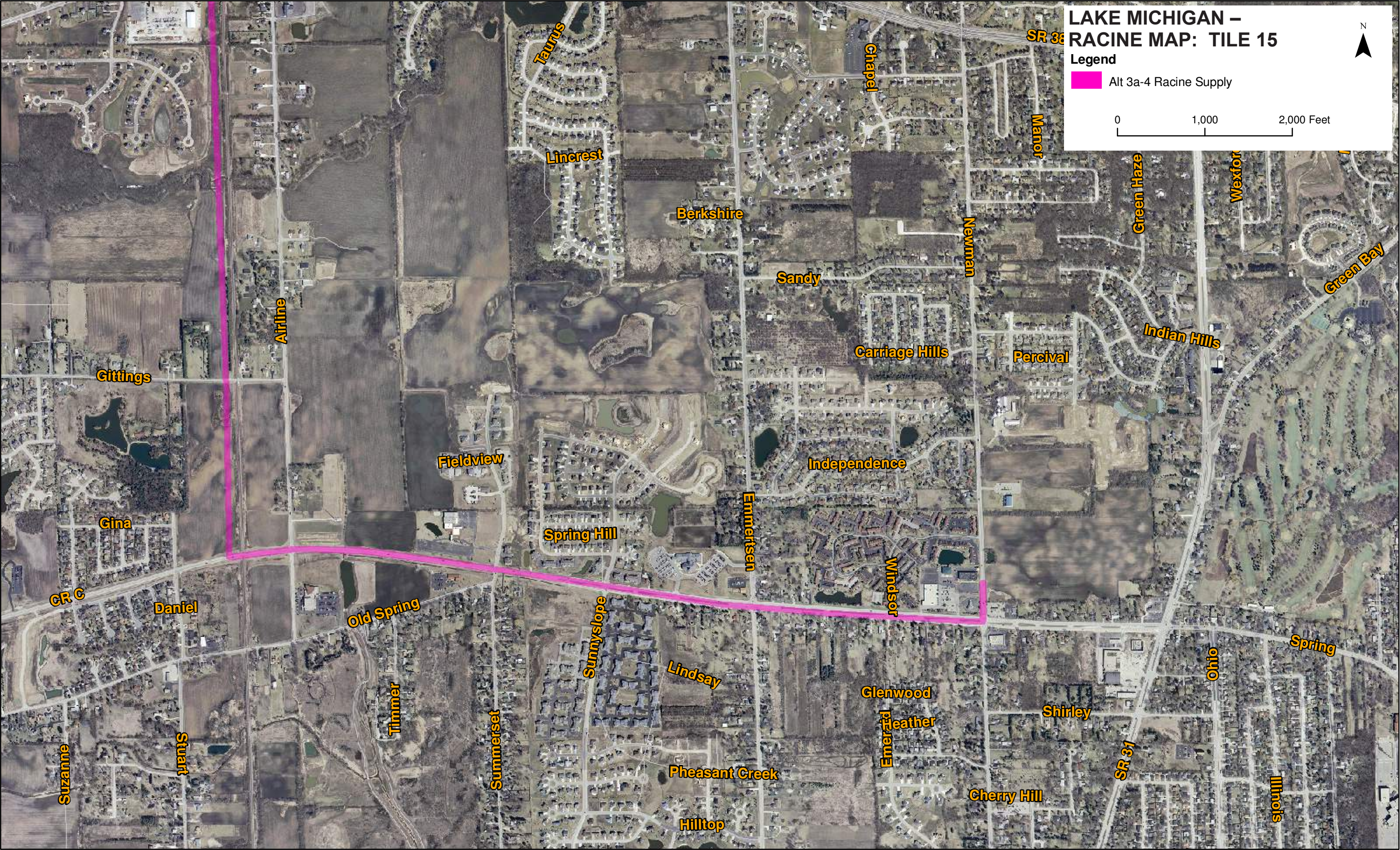
Airline

Taurus

Emmeritsen


Chapel

CR H



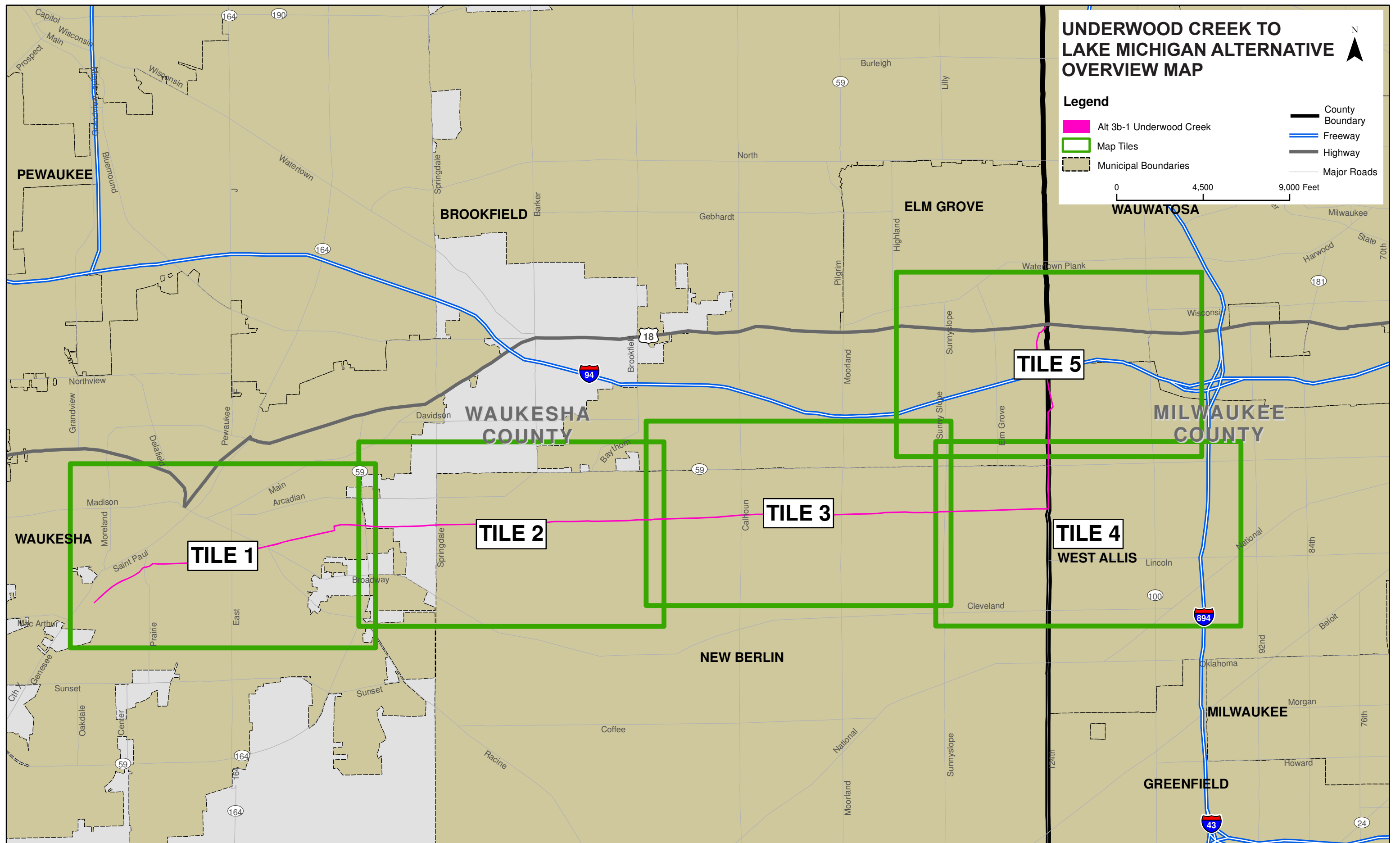
**LAKE MICHIGAN –
RACINE MAP: TILE 15**

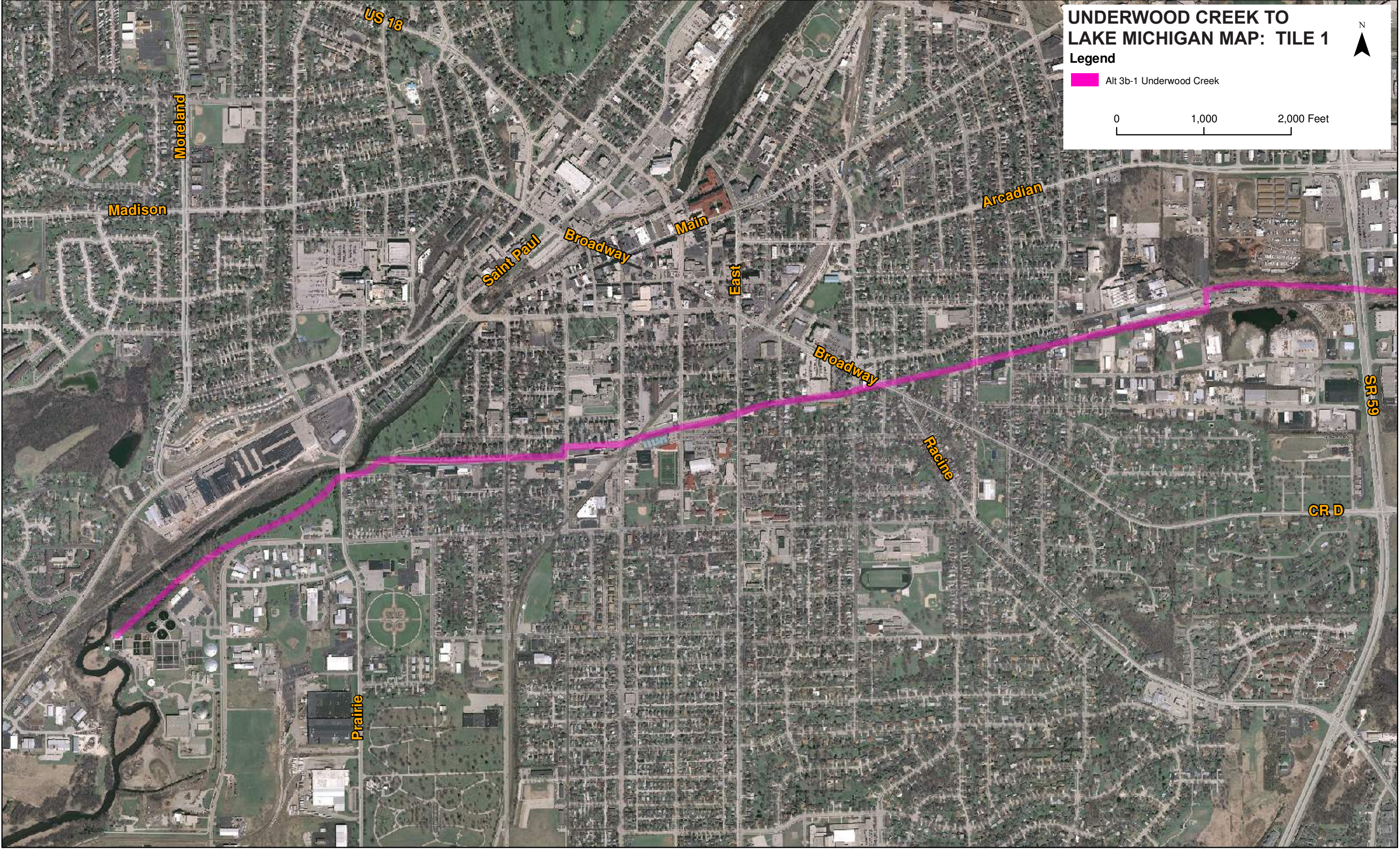
Legend

 Alt 3a-4 Racine Supply

0 1,000 2,000 Feet







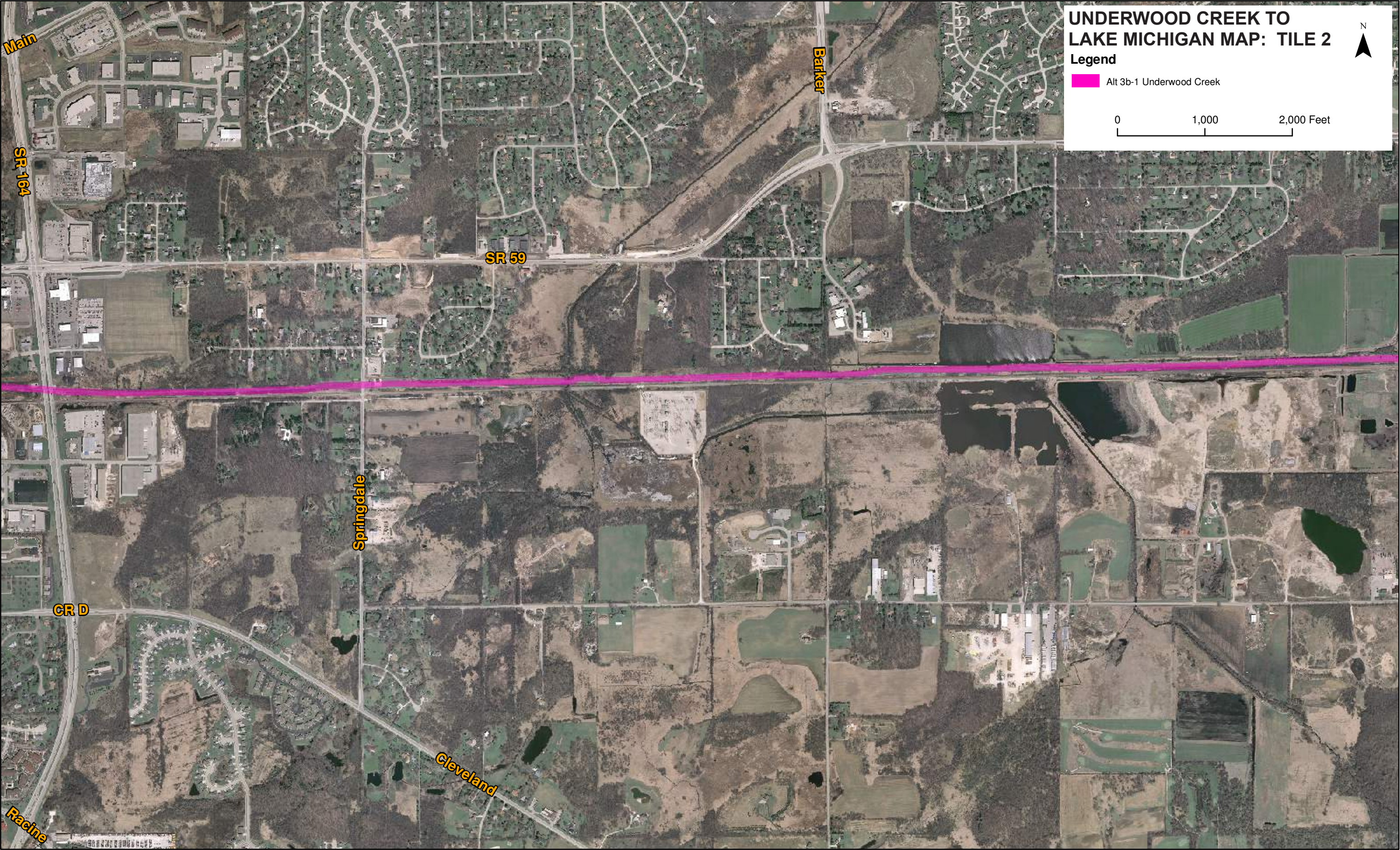
**UNDERWOOD CREEK TO
LAKE MICHIGAN MAP: TILE 1**

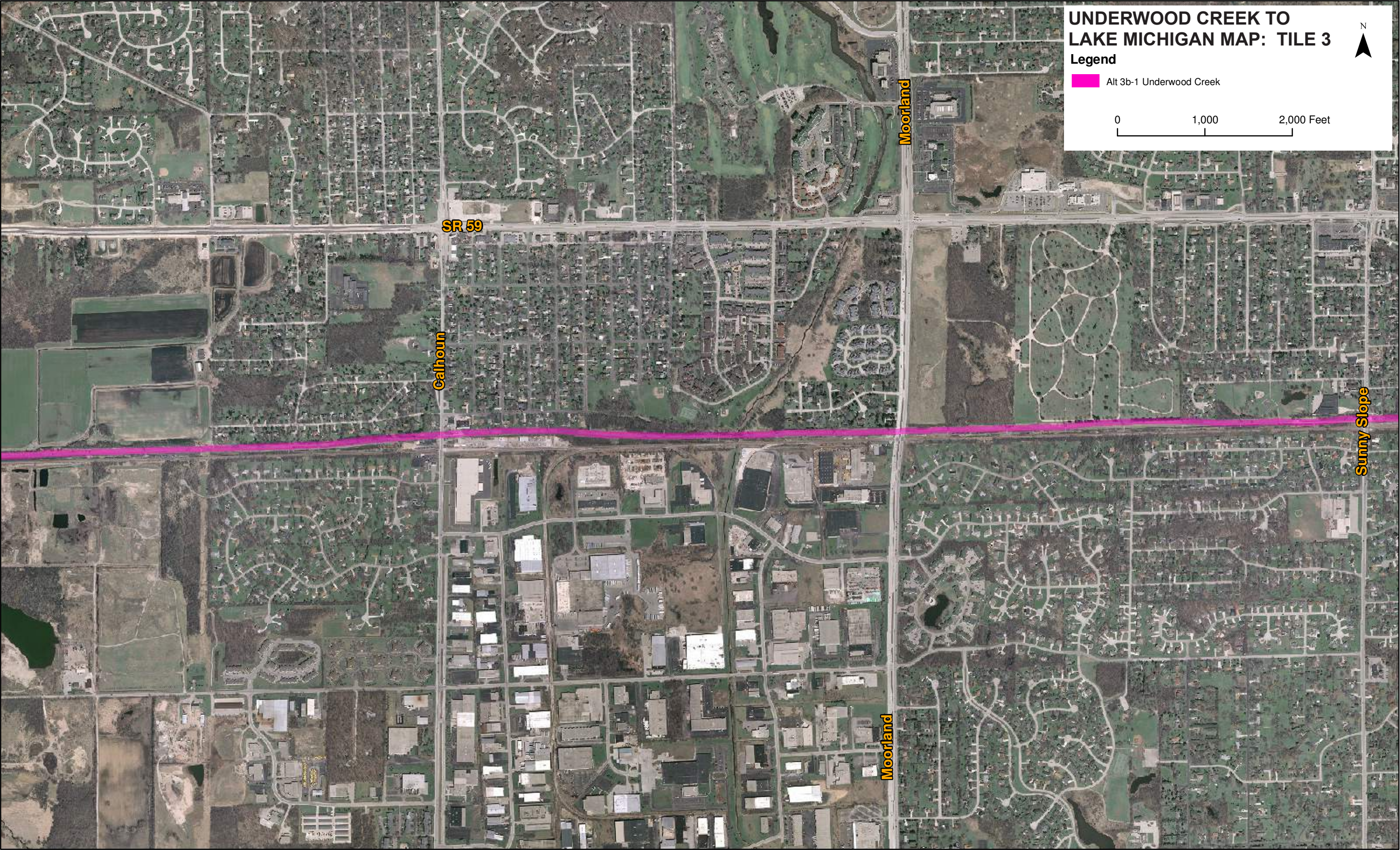
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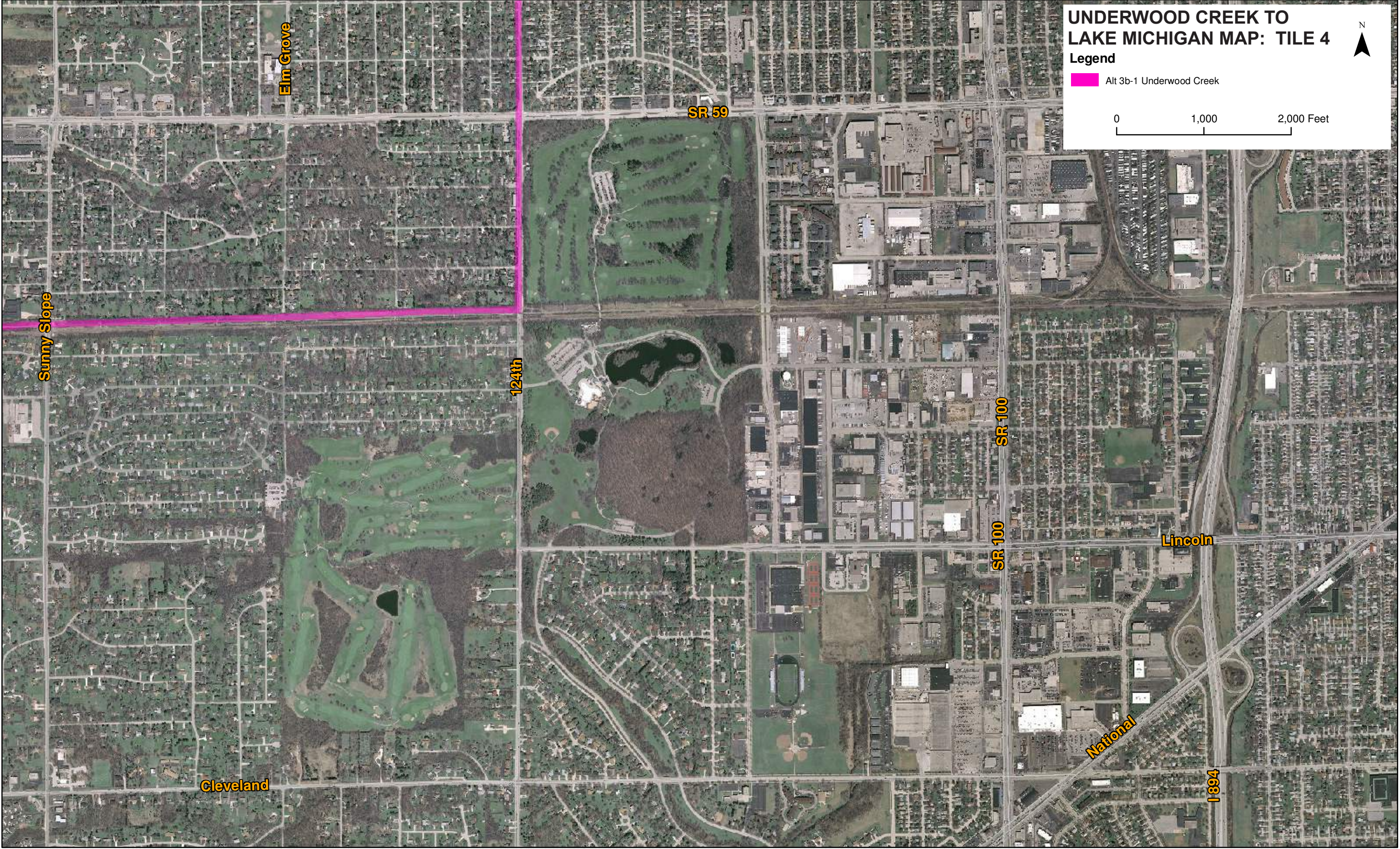
 Alt 3b-1 Underwood Creek

0 1,000 2,000 Feet









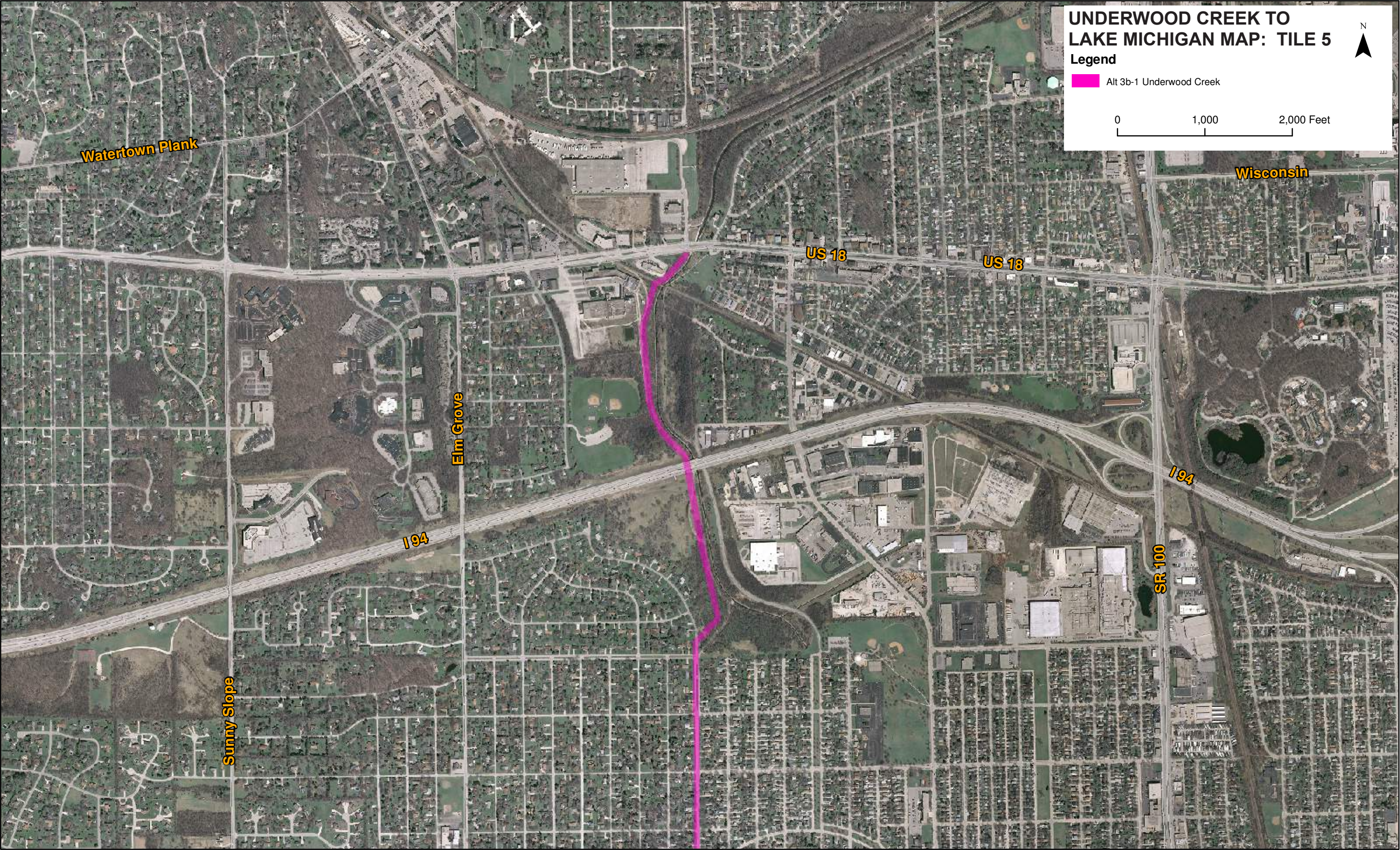
**UNDERWOOD CREEK TO
LAKE MICHIGAN MAP: TILE 4**

Legend

 Alt 3b-1 Underwood Creek

0 1,000 2,000 Feet





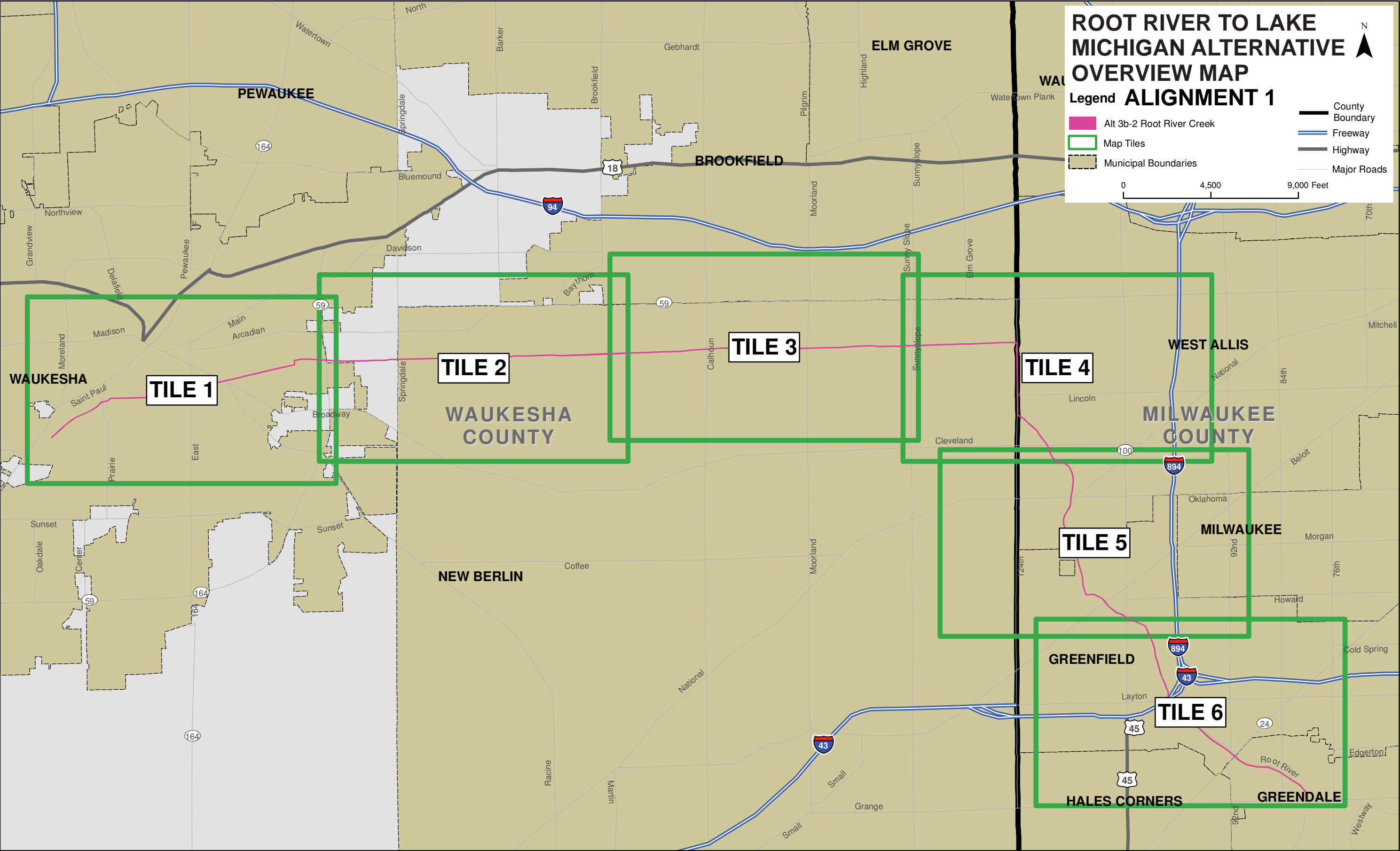
**UNDERWOOD CREEK TO
LAKE MICHIGAN MAP: TILE 5**

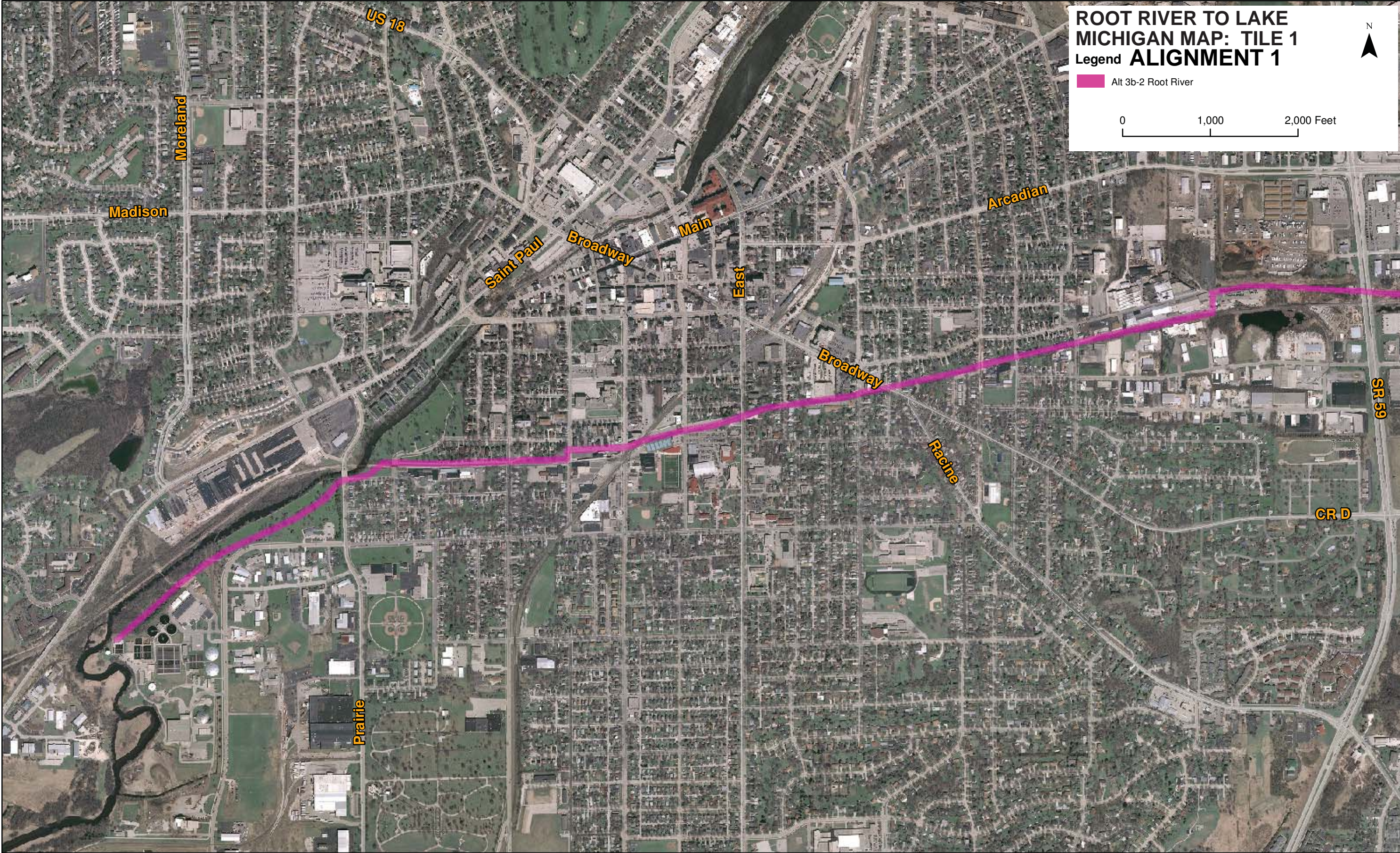
Legend

Alt 3b-1 Underwood Creek

0 1,000 2,000 Feet







ROOT RIVER TO LAKE MICHIGAN MAP: TILE 1

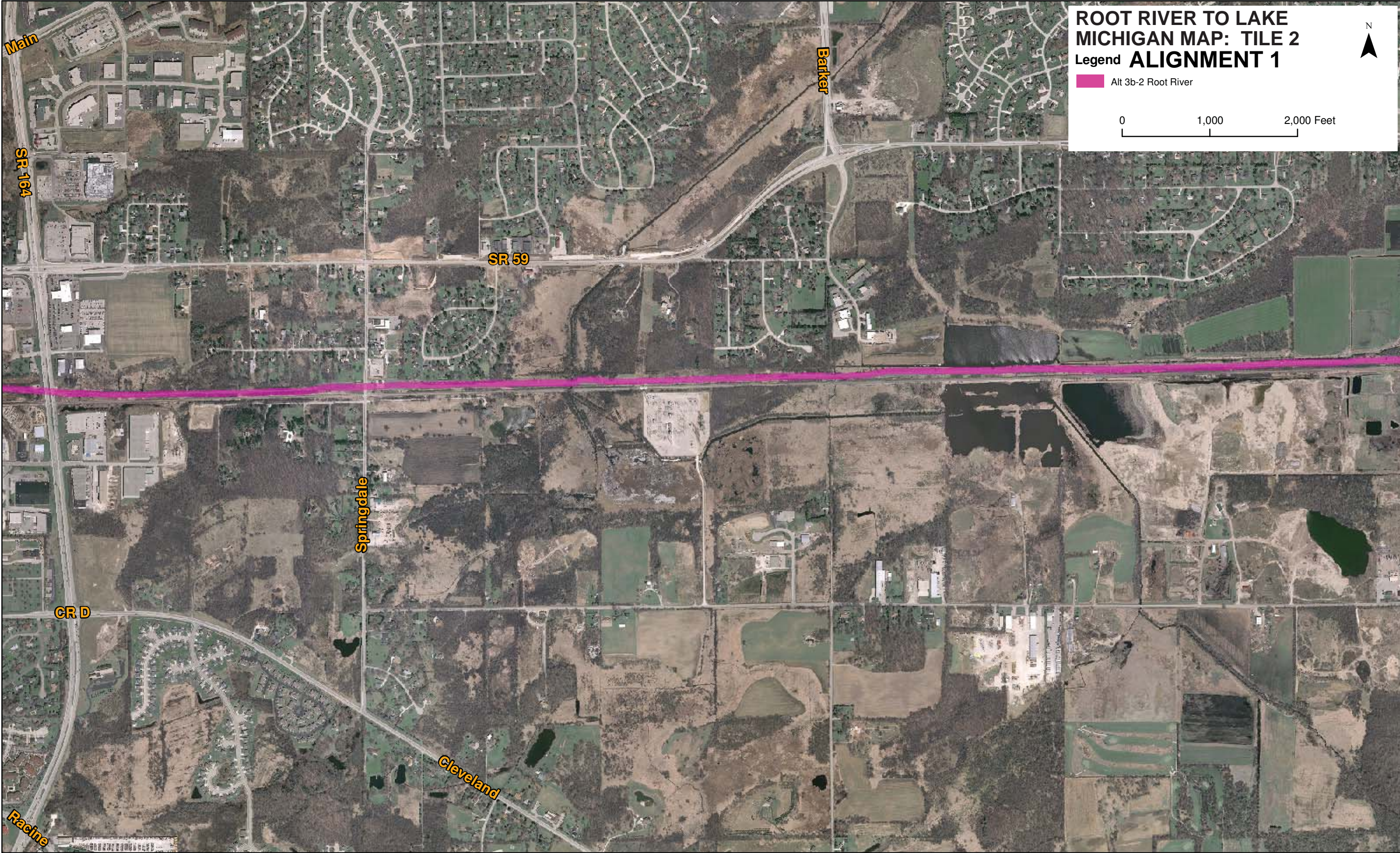
Legend **ALIGNMENT 1**

Alt 3b-2 Root River

01,0002,000

Feet

N

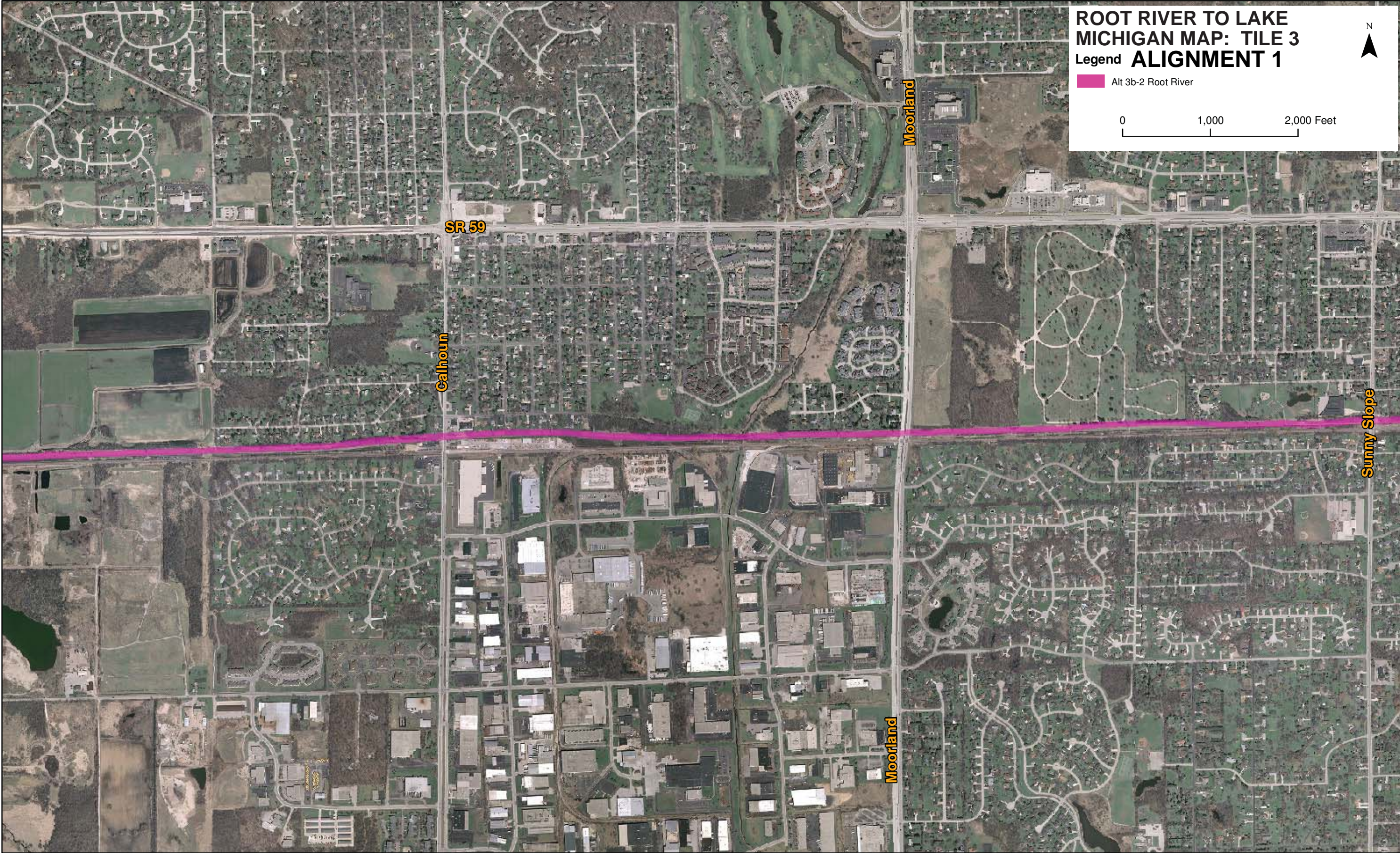


ROOT RIVER TO LAKE
MICHIGAN MAP: TILE 2
Legend **ALIGNMENT 1**

Alt 3b-2 Root River

0 1,000 2,000 Feet





ROOT RIVER TO LAKE MICHIGAN MAP: TILE 3

Legend **ALIGNMENT 1**

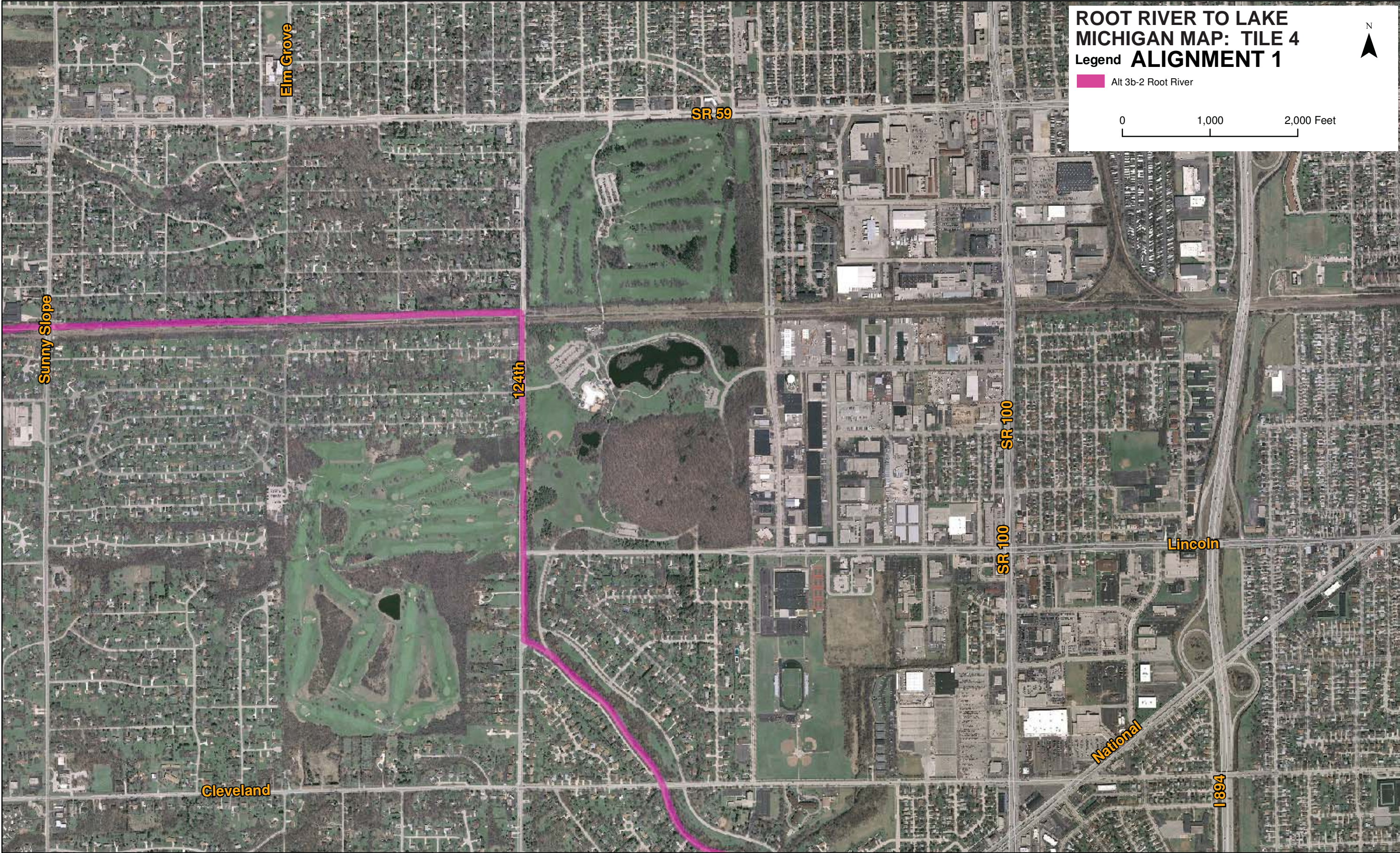
Alt 3b-2 Root River

0

1,000

2,000 Feet

N



ROOT RIVER TO LAKE MICHIGAN MAP: TILE 4

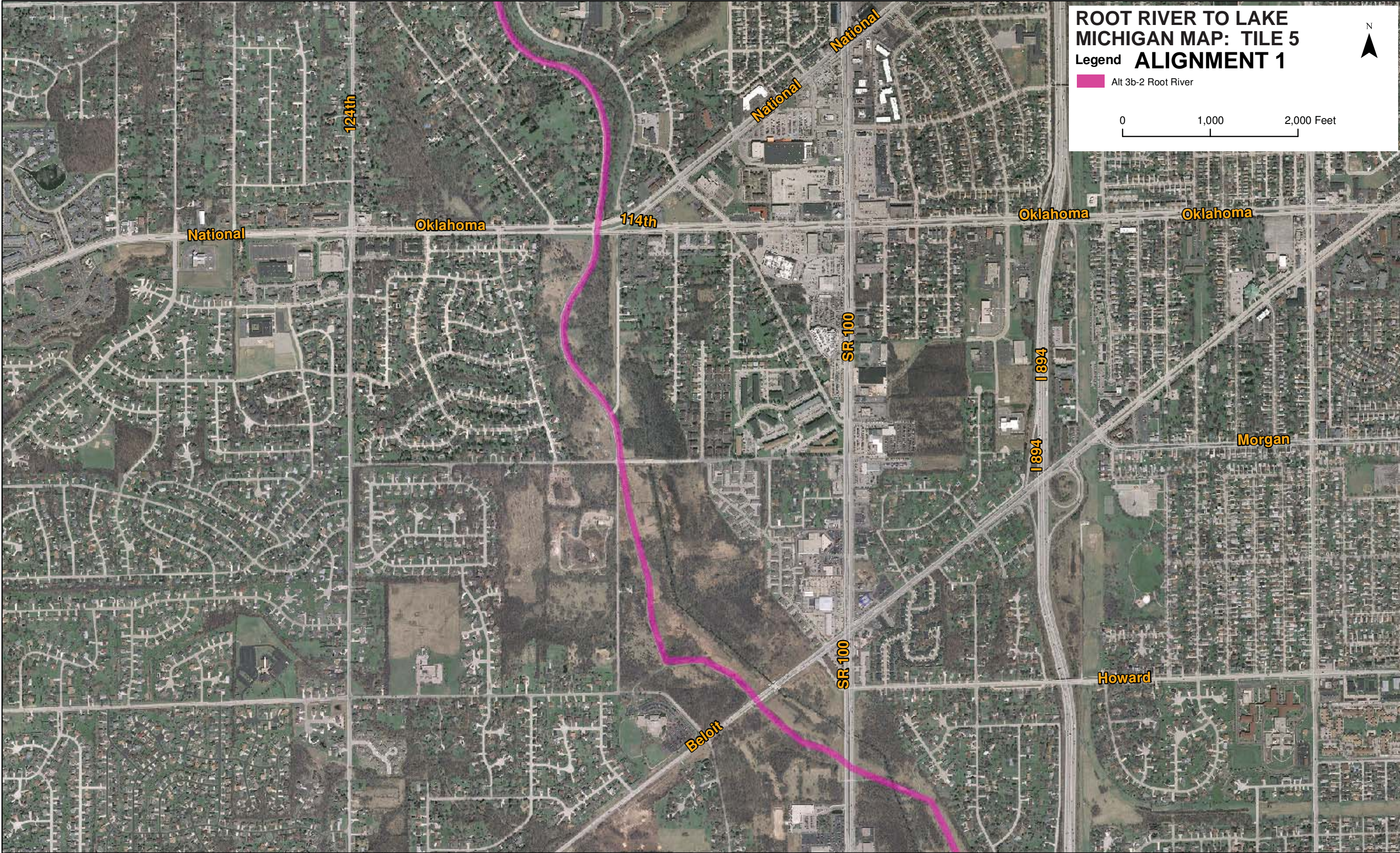
Legend **ALIGNMENT 1**

Alt 3b-2 Root River

01,0002,000

Feet

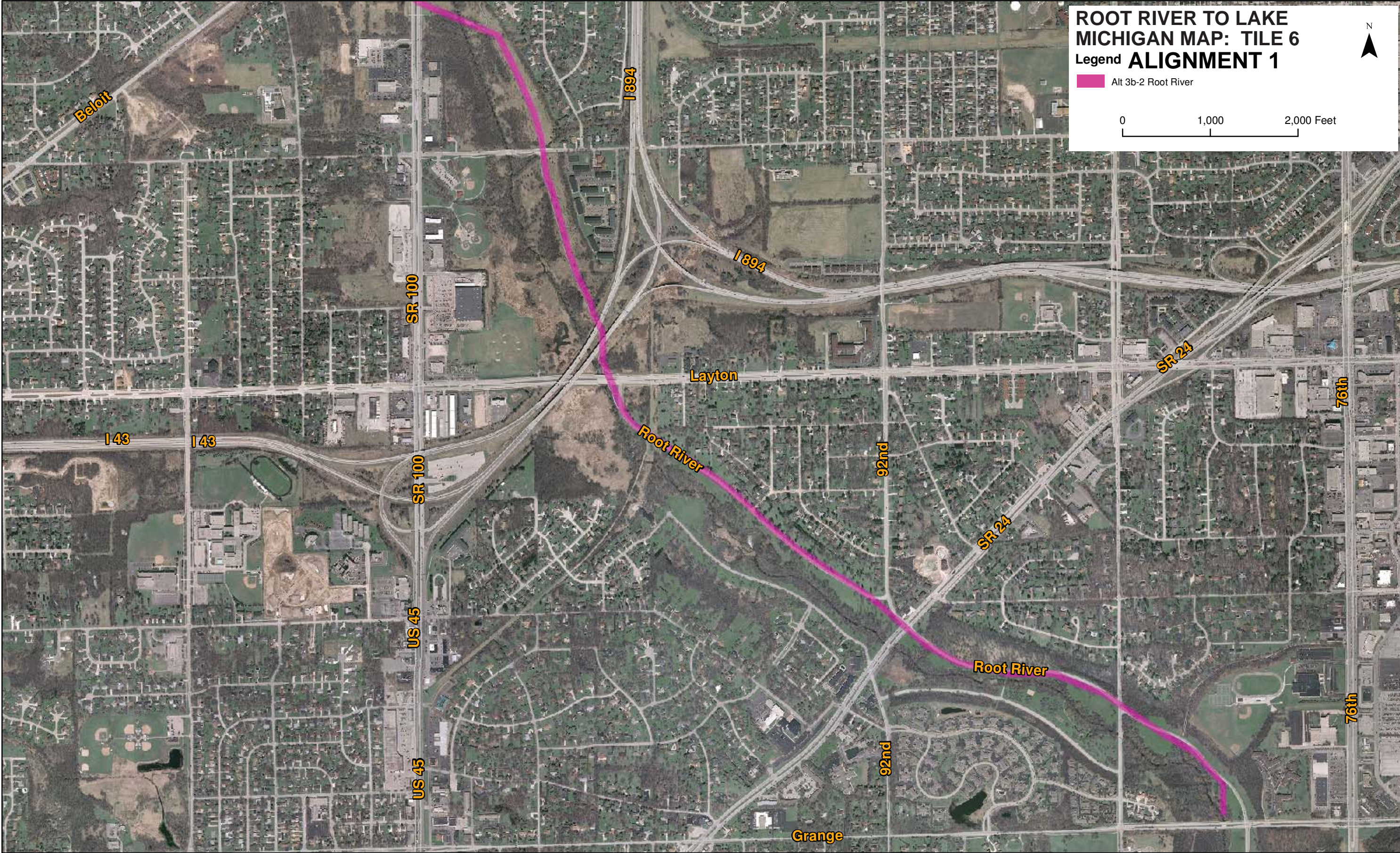
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ROOT RIVER TO LAKE MICHIGAN MAP: TILE 5
Legend ALIGNMENT 1

Alt 3b-2 Root River

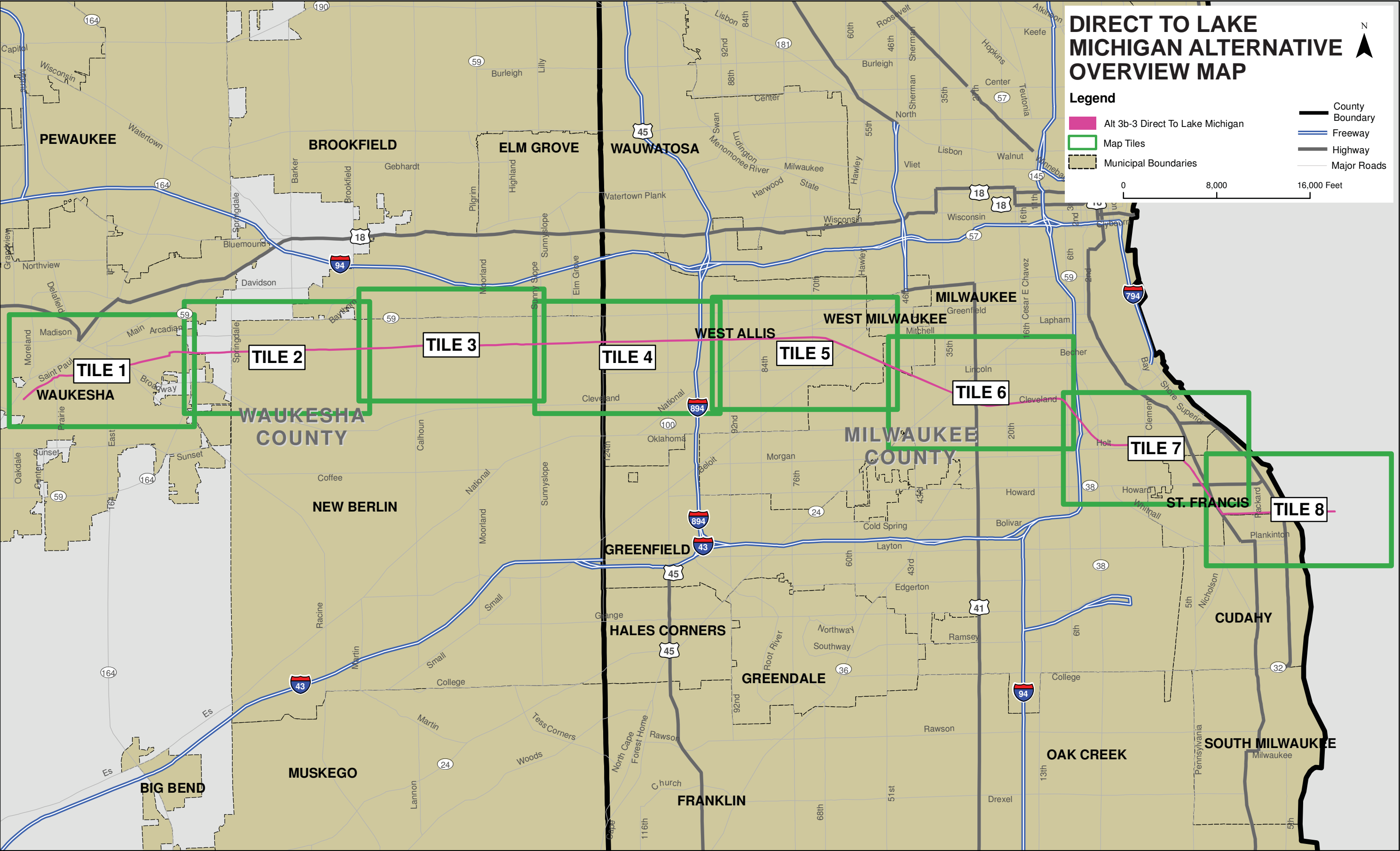
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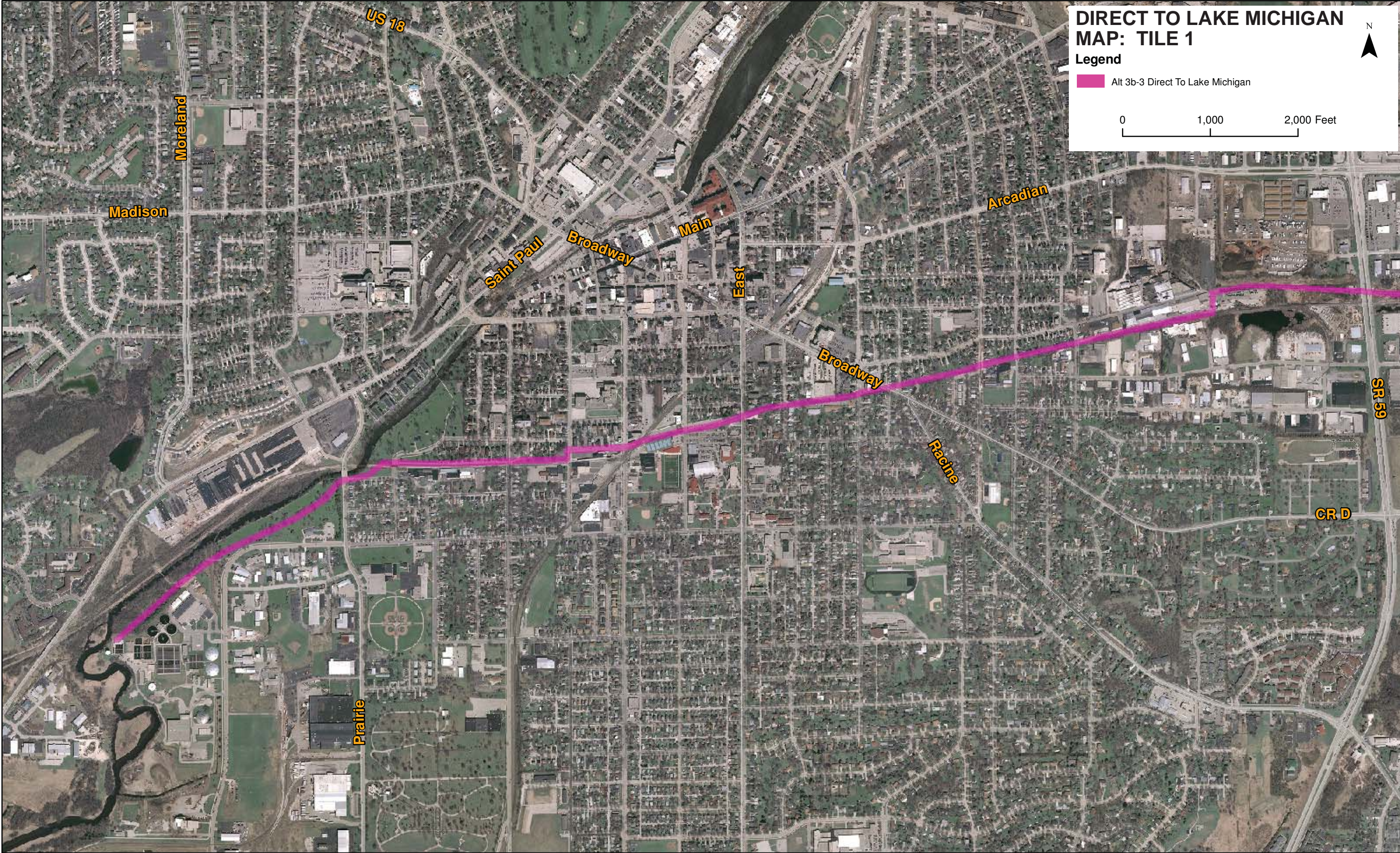


ROOT RIVER TO LAKE
MICHIGAN MAP: TILE 6
Legend **ALIGNMENT 1**

Alt 3b-2 Root River

0 1,000 2,000 Feet





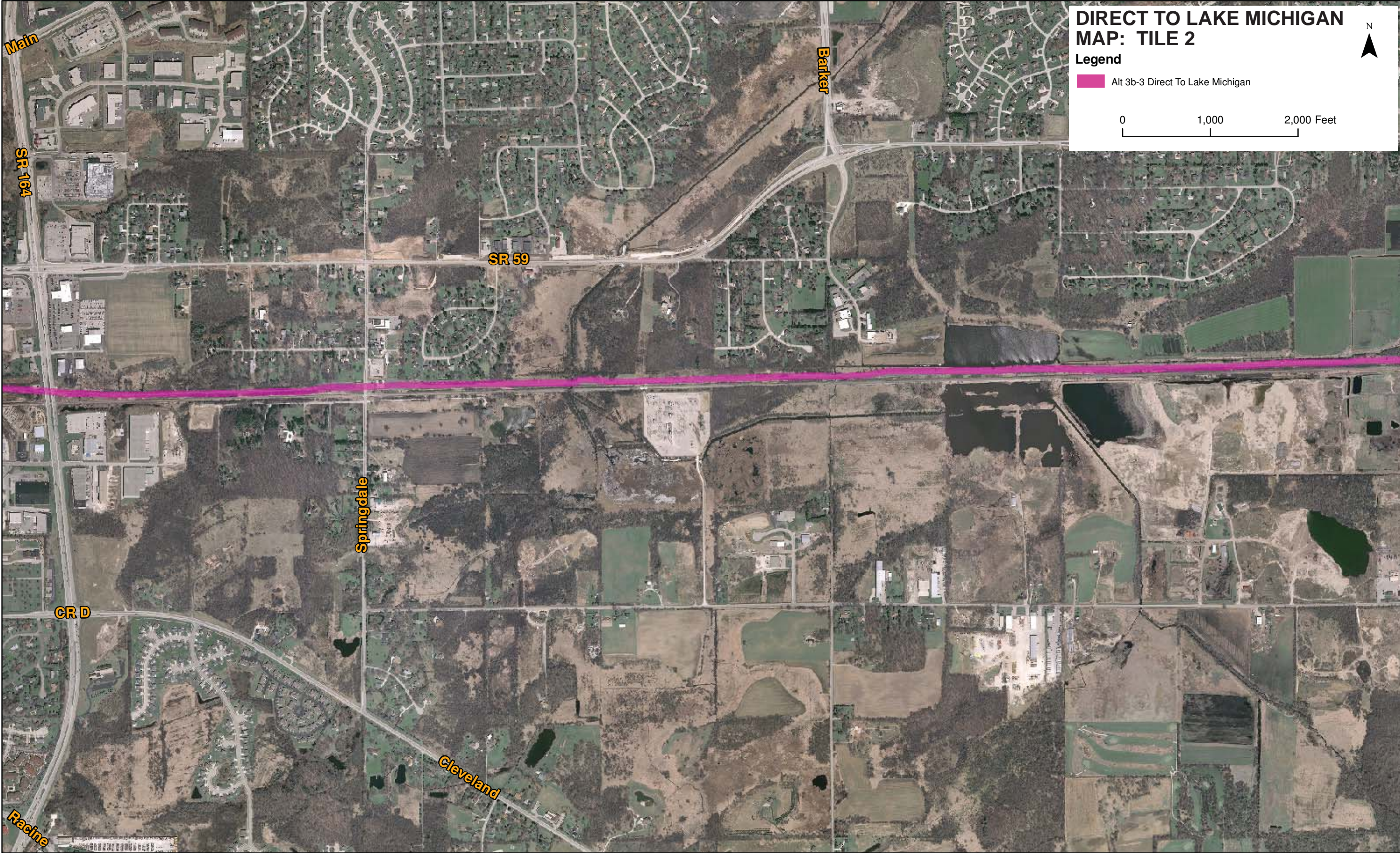
**DIRECT TO LAKE MICHIGAN
MAP: TILE 1**

Legend

 Alt 3b-3 Direct To Lake Michigan

0 1,000 2,000 Feet





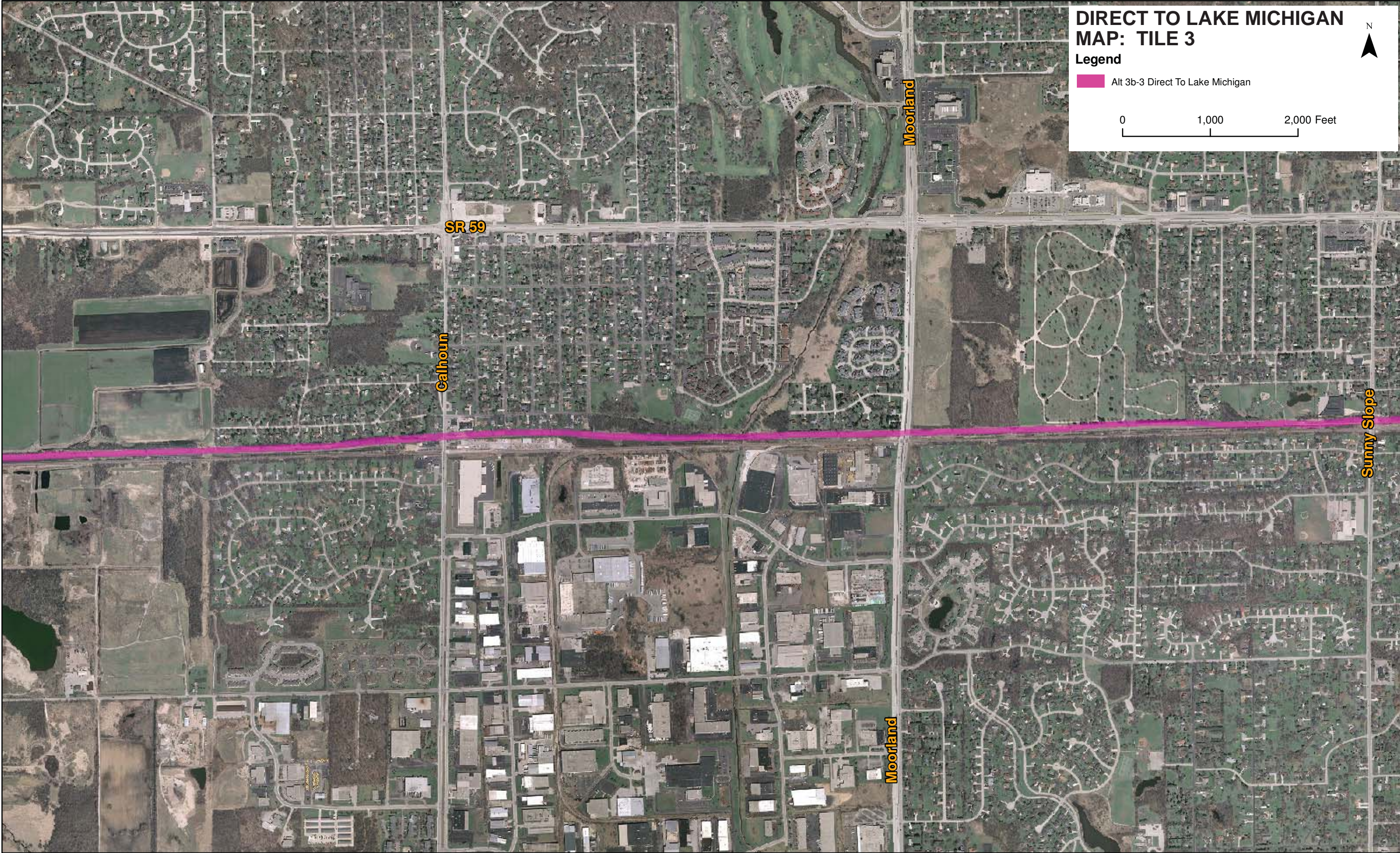
**DIRECT TO LAKE MICHIGAN
MAP: TILE 2**

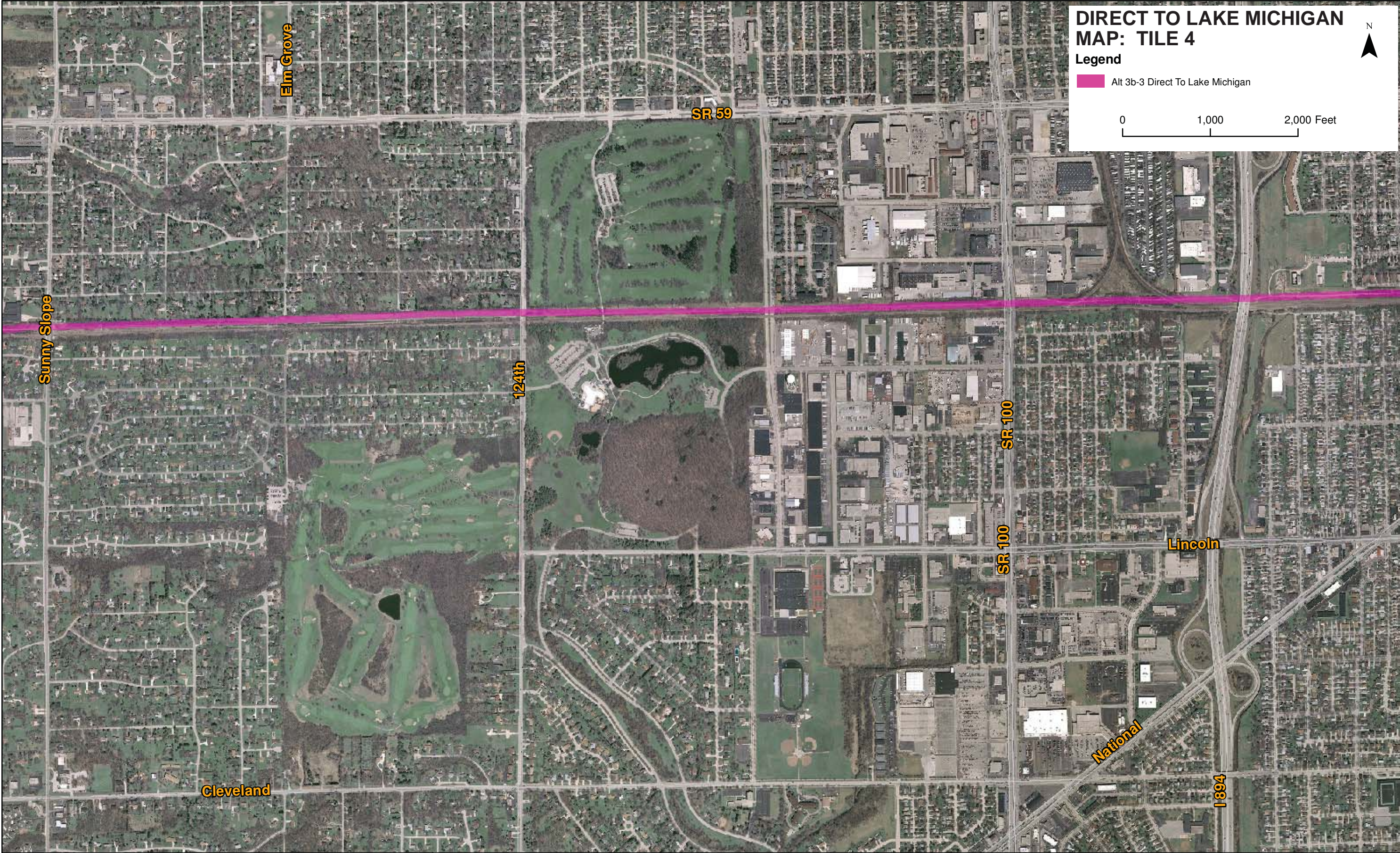
Legend

 Alt 3b-3 Direct To Lake Michigan

0 1,000 2,000 Feet







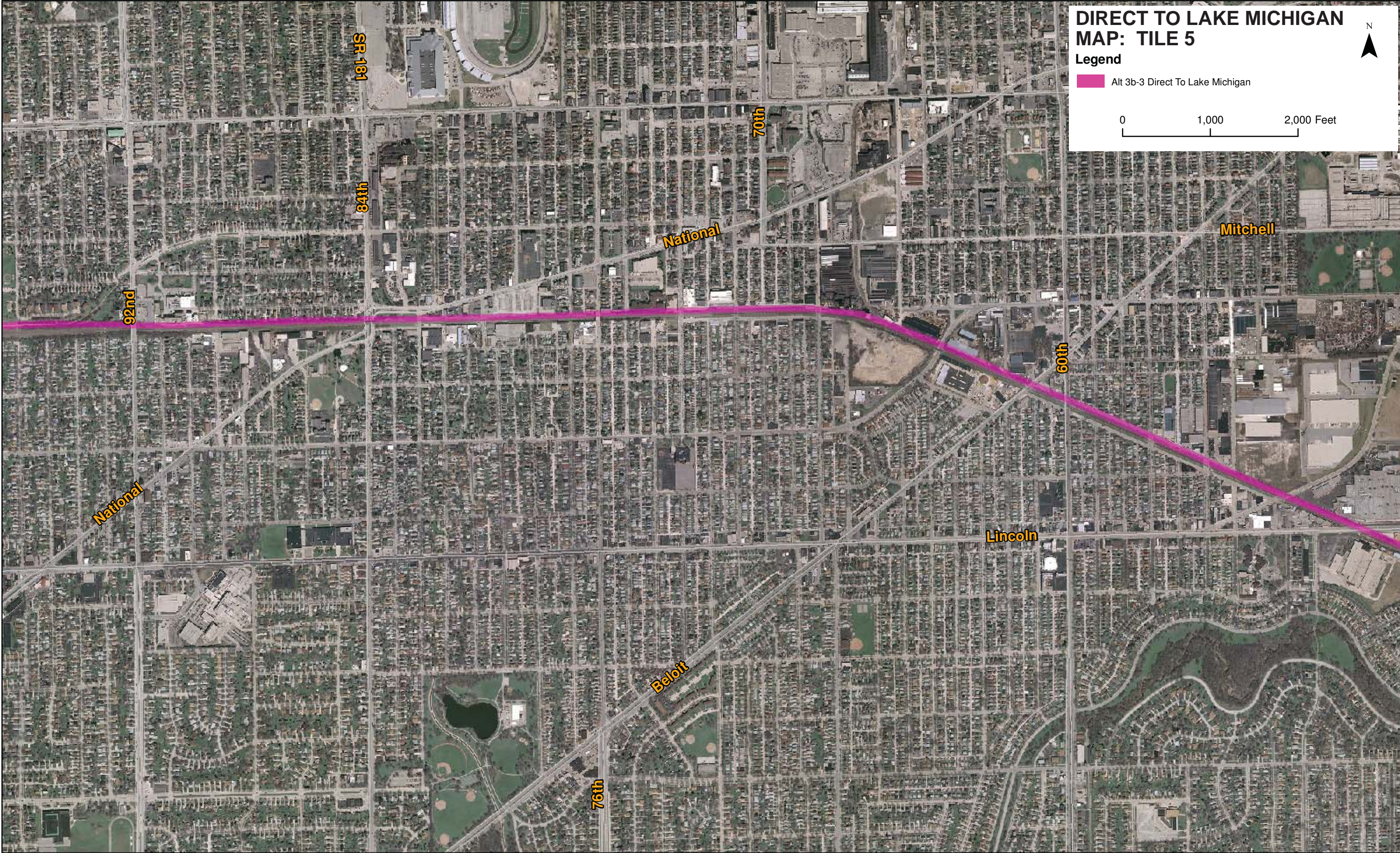
DIRECT TO LAKE MICHIGAN MAP: TILE 4

Legend

 Alt 3b-3 Direct To Lake Michigan

0 1,000 2,000 Feet





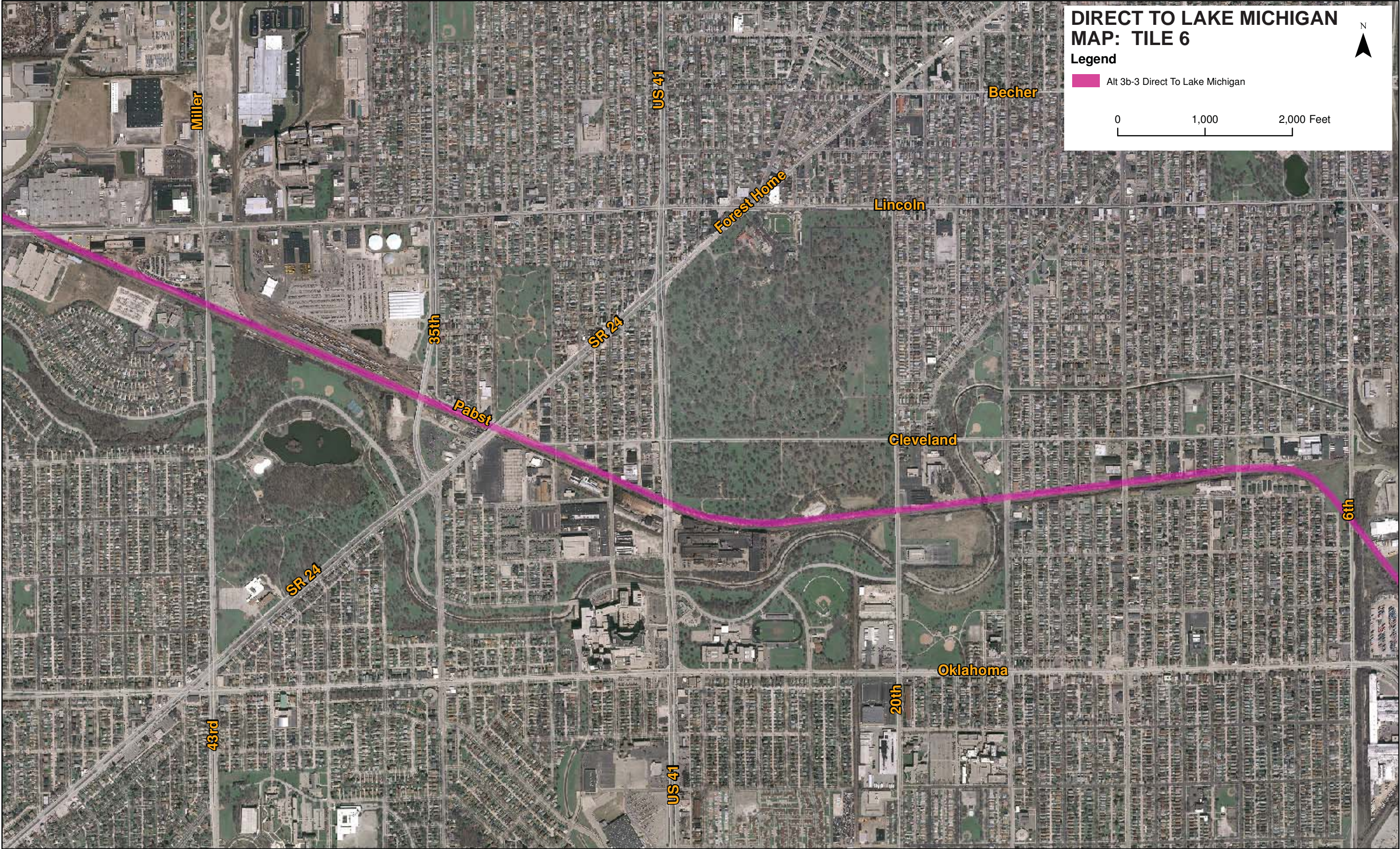
DIRECT TO LAKE MICHIGAN MAP: TILE 5

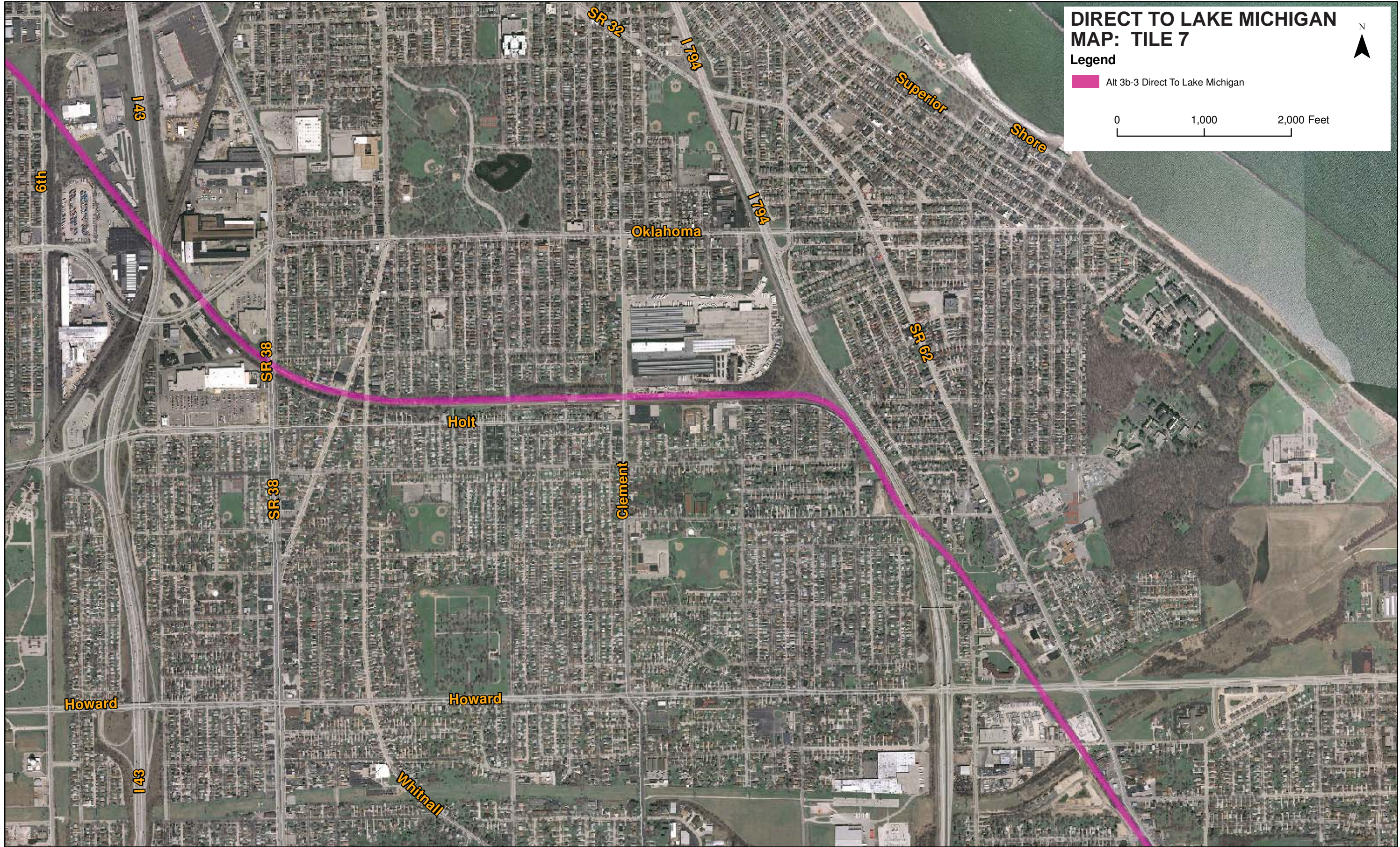
Legend

 Alt 3b-3 Direct To Lake Michigan

0 1,000 2,000 Feet





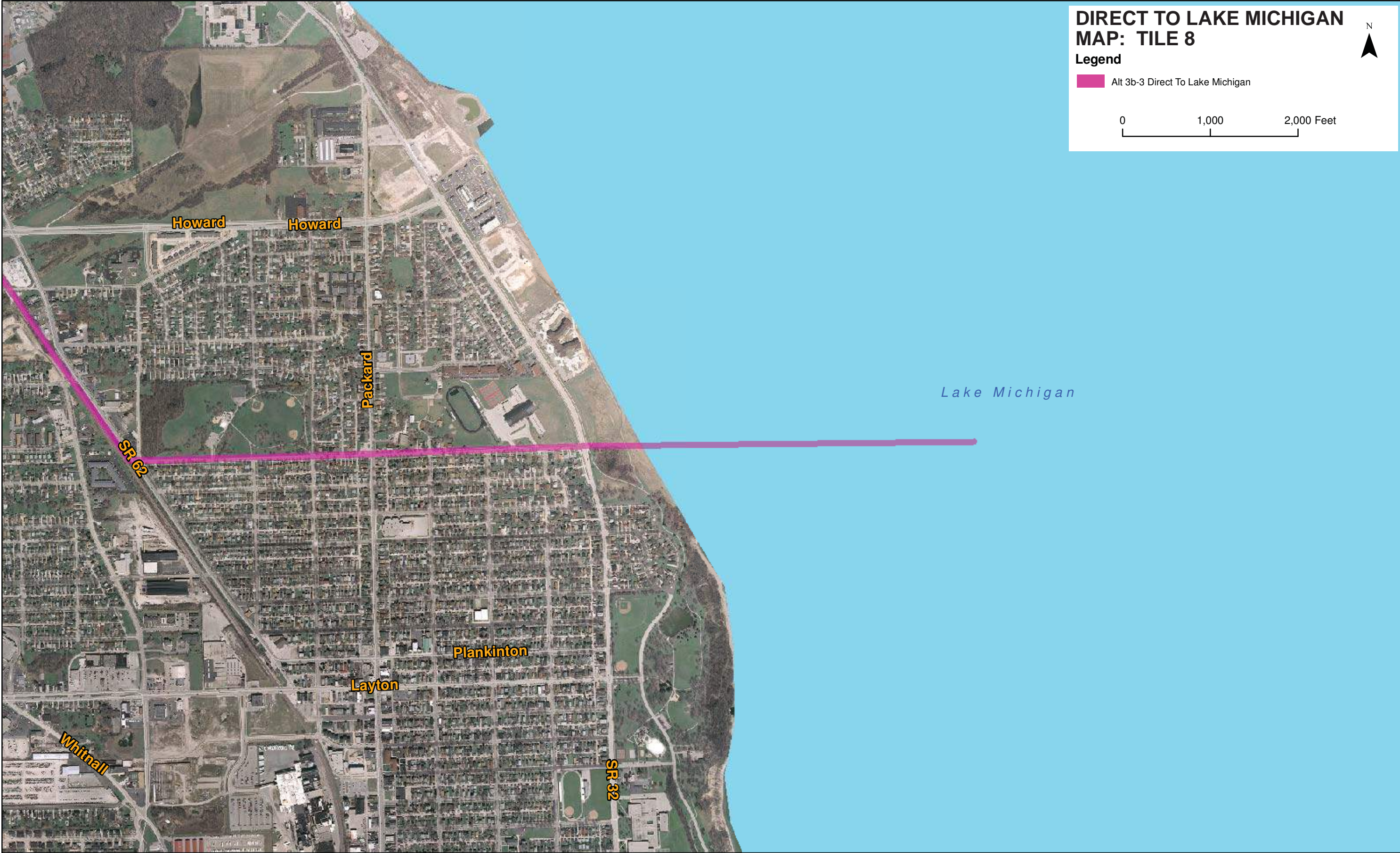


DIRECT TO LAKE MICHIGAN MAP: TILE 7

Legend

 Alt 3b-3 Direct To Lake Michigan

0 1,000 2,000 Feet



**DIRECT TO LAKE MICHIGAN
MAP: TILE 8**

Legend

 Alt 3b-3 Direct To Lake Michigan

0 1,000 2,000 Feet



Lake Michigan

Appendix 6-2
System Alternative Summary Tables –
Alternatives to the Proposed Project

System Alternative Summary Tables— Alternatives to the Proposed Project

This attachment contains system alternative tables that summarize impacts for various resource categories. The table numbers correspond to the table number in Section 6 with an “A” after the number. For example, the system alternative comparison table for “Table 6-7” in the ER Update Section 6 is listed as “Table 6-7A” in this attachment. This ER Update includes the addition of the proposed project, Lake Michigan (City of Oak Creek) Alignment 2 and Root River to Lake Michigan Alignment 2, to provide a side by side comparison. The proposed project is shaded grey in each of the tables below.

Water supply and return flow alternatives were developed individually, while return flow alternatives were developed considering the Lake Michigan supply source. These individual water supply and return flow alternatives are combined to create a “system alternative”. A system alternative adds together the impacts from both water supply and treated wastewater discharge to provide the sum of the impacts with respect to the environment. An example “system alternative” for a Mississippi River basin water supply includes using deep and shallow aquifers for the water supply with wastewater treatment at the existing WWTP. An example “system alternative” for a Lake Michigan basin water supply includes connecting to the City of Milwaukee’s Lake Michigan water supply with wastewater treatment at the City of Waukesha WWTP and return flow of treated wastewater to Lake Michigan via Underwood Creek.

Impacts from individual water supply and return flow alternatives were added together to determine the system alternative impacts. This is a conservative approach because for resource impacts associated with the pipeline routes, the water supply pipeline route and the return flow pipeline route overlap, which creates some double counting of impacts.

Where impact categories are compared, the most severe impact was selected for the system alternative. For example, if a water supply had a “moderate adverse impact” designation and the return flow had a “no adverse impact” designation, the “moderate adverse impact” designation was assigned to the system alternative.

The following is a table listing for this attachment. Not all tables are directly applicable to system alternatives comparison. Consequently, not all tables in Section 6 are included below.

Tables

6-7A	System Alternatives Environmental Impact Comparison Summary – Lake Michigan Water Quality	2
6-9A	System Alternatives Environmental Impact Comparison Summary – Lake Michigan Geomorphology and Sediments	3
6-12A	System Alternatives Environmental Impact Comparison Summary – Lake Michigan Aquatic Habitat	3

6-15A	System Alternatives Environmental Impact Comparison Summary – Number of Water Body Crossings.....	4
6-17A	System Alternatives Environmental Impact Comparison Summary – Inland Waterway Aquatic Habitat and Flooding.....	5
6-28A	System Alternatives Environmental Impact Comparison Summary – Inland Waterway Water Quality	6
6-30A	System Alternatives Environmental Impact Comparison Summary – Inland Waterways Geomorphology and Sediments.....	7
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For Table 6-7A, the more conservative of the water supply alternative and water return alternative designations was used to define the system alternative impact.

TABLE 6-7A

System Alternatives Environmental Impact Comparison Summary: Lake Michigan Water Quality

Water Supply Alternative	Water Return Alternative	Water Quality
Deep and Shallow Aquifers	Discharge to Fox River	Not Applicable
Shallow Aquifer and Fox River Alluvium	Discharge to Fox River	Not Applicable
Lake Michigan (City of Milwaukee)	Underwood Creek to Lake Michigan	No adverse impact
Lake Michigan (City of Milwaukee)	Root River to Lake Michigan Alignment 1	No adverse impact
Lake Michigan (City of Milwaukee)	Direct to Lake Michigan	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 1	Underwood Creek to Lake Michigan	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 1	Root River to Lake Michigan Alignment 1	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 1	Direct to Lake Michigan	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 2	Root River to Lake Michigan Alignment 2	No adverse impact
Lake Michigan (City of Racine)	Underwood Creek to Lake Michigan	No adverse impact
Lake Michigan (City of Racine)	Root River to Lake Michigan Alignment 1	No adverse impact
Lake Michigan (City of Racine)	Direct to Lake Michigan	No adverse impact

For Table 6-9A, the more conservative of the water supply alternative and water return alternative designations was used to define the system alternative impact.

TABLE 6-9A

System Alternatives Environmental Impact Comparison Summary: Lake Michigan Geomorphology and Sediments

Water Supply Alternative	Water Return Alternative	Geomorphology and Sediments
Deep and Shallow Aquifers	Discharge to Fox River	No adverse impact
Shallow Aquifer and Fox River Alluvium	Discharge to Fox River	No adverse impact
Lake Michigan (City of Milwaukee)	Underwood Creek to Lake Michigan	No adverse impact
Lake Michigan (City of Milwaukee)	Root River to Lake Michigan Alignment 1	No adverse impact
Lake Michigan (City of Milwaukee)	Direct to Lake Michigan	Minor adverse impact
Lake Michigan (City of Oak Creek) Alignment 1	Underwood Creek to Lake Michigan	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 1	Root River to Lake Michigan Alignment 1	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 1	Direct to Lake Michigan	Minor adverse impact
Lake Michigan (City of Oak Creek) Alignment 2	Root River to Lake Michigan Alignment 2	No adverse impact
Lake Michigan (City of Racine)	Underwood Creek to Lake Michigan	No adverse impact
Lake Michigan (City of Racine)	Root River to Lake Michigan Alignment 1	No adverse impact
Lake Michigan (City of Racine)	Direct to Lake Michigan	Minor adverse impact

For Table 6-12A, the more conservative of the water supply alternative and water return alternative designations was used to define the system alternative impact.

TABLE 6-12A

System Alternatives Environmental Impact Comparison Summary: Lake Michigan Aquatic Habitat

Water Supply Alternative	Water Return Alternative	Aquatic Habitat
Deep and Shallow Aquifers	Discharge to Fox River	Not applicable
Shallow Aquifer and Fox River Alluvium	Discharge to Fox River	Not applicable
Lake Michigan (City of Milwaukee)	Underwood Creek to Lake Michigan	No adverse impact
Lake Michigan (City of Milwaukee)	Root River to Lake Michigan Alignment 1	No adverse impact
Lake Michigan (City of Milwaukee)	Direct to Lake Michigan	Minor adverse impact
Lake Michigan (City of Oak Creek) Alignment 1	Underwood Creek to Lake Michigan	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 1	Root River to Lake Michigan Alignment 1	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 1	Direct to Lake Michigan	Minor adverse impact
Lake Michigan (City of Oak Creek) Alignment 2	Root River to Lake Michigan Alignment 2	No adverse impact
Lake Michigan (City of Racine)	Underwood Creek to Lake Michigan	No adverse impact
Lake Michigan (City of Racine)	Root River to Lake Michigan Alignment 1	No adverse impact
Lake Michigan (City of Racine)	Direct to Lake Michigan	Minor adverse impact

For Table 6-15A, the number of water body crossings of the water supply alternative was added to the number of water body crossings for the water return alternative to define the system alternative impact.

TABLE 6-15A

System Alternatives Environmental Impact Comparison Summary: Number of Water Body Crossings

Water Supply Alternative	Water Return Alternative	Number of Water Body Crossings
Deep and Shallow Aquifers	Discharge to Fox River	4
Shallow Aquifer and Fox River Alluvium	Discharge to Fox River	4
Lake Michigan (City of Milwaukee)	Underwood Creek to Lake Michigan	17
Lake Michigan (City of Milwaukee)	Root River to Lake Michigan Alignment 1	18
Lake Michigan (City of Milwaukee)	Direct to Lake Michigan	16
Lake Michigan (City of Oak Creek) Alignment 1	Underwood Creek to Lake Michigan	18
Lake Michigan (City of Oak Creek) Alignment 1	Root River to Lake Michigan Alignment 1	21
Lake Michigan (City of Oak Creek) Alignment 1	Direct to Lake Michigan	19
Lake Michigan (City of Oak Creek) Alignment 2	Root River to Lake Michigan Alignment 2	7
Lake Michigan (City of Racine)	Underwood Creek to Lake Michigan	24
Lake Michigan (City of Racine)	Root River to Lake Michigan Alignment 1	27
Lake Michigan (City of Racine)	Direct to Lake Michigan	25

For Table 6-17A, the more conservative of the water supply alternative and water return alternative designations was used to define the system alternative impact.

Since the completion of the February 2012 ER, the Return Flow Management Plan has changed. The Return Flow Management Plan is described in Appendix C of the Application. This change caused the impact to inland waterway flooding for all return flow alternatives except direct to Lake Michigan to increase from no adverse impact to minor adverse impact. For more information on the change in flooding impact refer to Section 5 and Section 6 of this ER Update.

TABLE 6-17A

System Alternatives Environmental Impact Comparison Summary: Inland Waterway Aquatic Habitat and Flooding

Water Supply Alternative	Water Return Alternative	Aquatic Habitat	Flooding
Deep and Shallow Aquifers	Discharge to Fox River	Significant adverse impact	No adverse impact
Shallow Aquifer and Fox River Alluvium	Discharge to Fox River	Significant adverse impact	No adverse impact
Lake Michigan (City of Milwaukee)	Underwood Creek to Lake Michigan	Minor adverse impact	Minor adverse impact
Lake Michigan (City of Milwaukee)	Root River to Lake Michigan Alignment 1	Minor adverse impact	Minor adverse impact
Lake Michigan (City of Milwaukee)	Direct to Lake Michigan	Minor adverse impact	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 1	Underwood Creek to Lake Michigan	Minor adverse impact	Minor adverse impact
Lake Michigan (City of Oak Creek) Alignment 1	Root River to Lake Michigan Alignment 1	Minor adverse impact	Minor adverse impact
Lake Michigan (City of Oak Creek) Alignment 1	Direct to Lake Michigan	Minor adverse impact	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 2	Root River to Lake Michigan Alignment 2	Minor adverse impact	Minor adverse impact
Lake Michigan (City of Racine)	Underwood Creek to Lake Michigan	Minor adverse impact	Minor adverse impact
Lake Michigan (City of Racine)	Root River to Lake Michigan Alignment 1	Minor adverse impact	Minor adverse impact
Lake Michigan (City of Racine)	Direct to Lake Michigan	Minor adverse impact	No adverse impact

For Table 6-28A, the more conservative of the water supply alternative and water return alternative designations was used to define the system alternative impact.

TABLE 6-28A
System Alternatives Environmental Impact Comparison Summary: Inland Waterway Water Quality

Water Supply Alternative	Water Return Alternative	Water Quality
Deep and Shallow Aquifers	Discharge to Fox River	Minor adverse impact
Shallow Aquifer and Fox River Alluvium	Discharge to Fox River	No adverse impact
Lake Michigan (City of Milwaukee)	Underwood Creek to Lake Michigan	No adverse impact
Lake Michigan (City of Milwaukee)	Root River to Lake Michigan Alignment 1	No adverse impact
Lake Michigan (City of Milwaukee)	Direct to Lake Michigan	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 1	Underwood Creek to Lake Michigan	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 1	Root River to Lake Michigan Alignment 1	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 1	Direct to Lake Michigan	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 2	Root River to Lake Michigan Alignment 2	No adverse impact
Lake Michigan (City of Racine)	Underwood Creek to Lake Michigan	No adverse impact
Lake Michigan (City of Racine)	Root River to Lake Michigan Alignment 1	No adverse impact
Lake Michigan (City of Racine)	Direct to Lake Michigan	No adverse impact

For Table 6-30A, the more conservative of the water supply alternative and water return alternative designations was used to define the system alternative impact.

TABLE 6-30A

System Alternatives Environmental Impact Comparison Summary: Inland Waterways Geomorphology and Sediments

Water Supply Alternative	Water Return Alternative	Geomorphology and Sediments
Deep and Shallow Aquifers	Discharge to Fox River	No adverse impact
Shallow Aquifer and Fox River Alluvium	Discharge to Fox River	No adverse impact
Lake Michigan (City of Milwaukee)	Underwood Creek to Lake Michigan	No adverse impact
Lake Michigan (City of Milwaukee)	Root River to Lake Michigan Alignment 1	No adverse impact
Lake Michigan (City of Milwaukee)	Direct to Lake Michigan	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 1	Underwood Creek to Lake Michigan	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 1	Root River to Lake Michigan Alignment 1	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 1	Direct to Lake Michigan	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 2	Root River to Lake Michigan Alignment 2	No adverse impact
Lake Michigan (City of Racine)	Underwood Creek to Lake Michigan	No adverse impact
Lake Michigan (City of Racine)	Root River to Lake Michigan Alignment 1	No adverse impact
Lake Michigan (City of Racine)	Direct to Lake Michigan	No adverse impact

For Table 6-43A, the number of temporary and permanent wetland acres from the water supply alternative was added to the number of temporary and permanent wetland acres from the water return alternative to define the system alternative impact. This is a conservative approach because water supply and return flow routes share some common corridors, which would cause actual impacts to be less. Slight variations exist between alternatives due to rounding.

TABLE 6-43A

System Alternatives Environmental Impact Comparison Summary: Wetlands Crossed by the Alternatives (acres)

Water Supply Alternative	Return Flow Alternative	Temporary Wetland Impacts (ac)	Permanent Wetland Impacts (ac)
Deep and Shallow Aquifers	Discharge to Fox River	3,099	3,091
Shallow Aquifer and Fox River Alluvium	Discharge to Fox River	4,129	4,113
Lake Michigan (City of Milwaukee)	Underwood Creek to Lake Michigan	16	2
Lake Michigan (City of Milwaukee)	Root River to Lake Michigan Alignment 1	19	2
Lake Michigan (City of Milwaukee)	Direct to Lake Michigan	12	1
Lake Michigan (City of Oak Creek) Alignment 1	Underwood Creek to Lake Michigan	23	2
Lake Michigan (City of Oak Creek) Alignment 1	Root River to Lake Michigan Alignment 1	26	3
Lake Michigan (City of Oak Creek) Alignment 1	Direct to Lake Michigan	19	2
Lake Michigan (City of Oak Creek) Alignment 2	Root River to Lake Michigan Alignment 2	1	<1
Lake Michigan (City of Racine)	Underwood Creek to Lake Michigan	61	7
Lake Michigan (City of Racine)	Root River to Lake Michigan Alignment 1	64	7
Lake Michigan (City of Racine)	Direct to Lake Michigan	57	6

For Table 6-45A, the more conservative of the water supply alternative and water return alternative designations was used to define the system alternative impact.

TABLE 6-45A
System Alternatives Environmental Impact Comparison Summary: Wetlands

Water Supply Alternative	Water Return Alternative	Temporary and Permanent Wetland Impacts
Deep and Shallow Aquifers	Discharge to Fox River	Significant adverse impact
Shallow Aquifer and Fox River Alluvium	Discharge to Fox River	Significant adverse impact
Lake Michigan (City of Milwaukee)	Underwood Creek to Lake Michigan	Minor adverse impact
Lake Michigan (City of Milwaukee)	Root River to Lake Michigan Alignment 1	Minor adverse impact
Lake Michigan (City of Milwaukee)	Direct to Lake Michigan	Minor adverse impact
Lake Michigan (City of Oak Creek) Alignment 1	Underwood Creek to Lake Michigan	Minor adverse impact
Lake Michigan (City of Oak Creek) Alignment 1	Root River to Lake Michigan Alignment 1	Minor adverse impact
Lake Michigan (City of Oak Creek) Alignment 1	Direct to Lake Michigan	Minor adverse impact
Lake Michigan (City of Oak Creek) Alignment 2	Root River to Lake Michigan Alignment 2	Minor adverse impact
Lake Michigan (City of Racine)	Underwood Creek to Lake Michigan	Moderate adverse impact
Lake Michigan (City of Racine)	Root River to Lake Michigan Alignment 1	Moderate adverse impact
Lake Michigan (City of Racine)	Direct to Lake Michigan	Moderate adverse impact

For Table 6-46A, the number of high suitability ratings from the water supply alternative was added to the number of high suitability ratings from the water return alternative to define the system alternative impact.

TABLE 6-46A

System Alternatives Environmental Impact Comparison Summary: Natural Community High Suitability Ratings

Water Supply Alternative	Water Return Alternative	Number of High Natural Community Suitability Ratings (out of 16)
Deep and Shallow Aquifers	Discharge to Fox River	7
Shallow Aquifer and Fox River Alluvium	Discharge to Fox River	7
Lake Michigan (City of Milwaukee)	Underwood Creek to Lake Michigan	0
Lake Michigan (City of Milwaukee)	Root River to Lake Michigan Alignment 1	0
Lake Michigan (City of Milwaukee)	Direct to Lake Michigan	0
Lake Michigan (City of Oak Creek) Alignment 1	Underwood Creek to Lake Michigan	1
Lake Michigan (City of Oak Creek) Alignment 1	Root River to Lake Michigan Alignment 1	1
Lake Michigan (City of Oak Creek) Alignment 1	Direct to Lake Michigan	1
Lake Michigan (City of Oak Creek) Alignment 2	Root River to Lake Michigan Alignment 2	0
Lake Michigan (City of Racine)	Underwood Creek to Lake Michigan	3
Lake Michigan (City of Racine)	Root River to Lake Michigan Alignment 1	3
Lake Michigan (City of Racine)	Direct to Lake Michigan	3

For Table 6-50A, the more conservative of the water supply alternative and water return alternative designations was used to define the system alternative impact.

TABLE 6-50A

System Alternatives Environmental Impact Comparison Summary: Groundwater Resources

Water Supply Alternative	Water Return Alternative	Groundwater Resources
Deep and Shallow Aquifers	Discharge to Fox River	Significant adverse impact
Shallow Aquifer and Fox River Alluvium	Discharge to Fox River	Significant adverse impact
Lake Michigan (City of Milwaukee)	Underwood Creek to Lake Michigan	No adverse impact
Lake Michigan (City of Milwaukee)	Root River to Lake Michigan Alignment 1	No adverse impact
Lake Michigan (City of Milwaukee)	Direct to Lake Michigan	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 1	Underwood Creek to Lake Michigan	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 1	Root River to Lake Michigan Alignment 1	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 1	Direct to Lake Michigan	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 2	Root River to Lake Michigan Alignment 2	No adverse impact
Lake Michigan (City of Racine)	Underwood Creek to Lake Michigan	No adverse impact
Lake Michigan (City of Racine)	Root River to Lake Michigan Alignment 1	No adverse impact
Lake Michigan (City of Racine)	Direct to Lake Michigan	No adverse impact

For Table 6-56A, the acres of land affected from the water supply alternative was added to the acres of affected by the water return alternative to define the system alternative impact.

TABLE 6-56A

System Alternatives Environmental Impact Comparison Summary: Public or Conservation Lands within or Adjacent to the Alternatives

Water Supply Alternative	Water Return Alternative	Number of Properties	Acres within Proposed 75ft Construction Workspace
Deep and Shallow Aquifers	Discharge to Fox River	5	3.53
Shallow Aquifer and Fox River Alluvium	Discharge to Fox River	5	3.53
Lake Michigan (City of Milwaukee)	Underwood Creek to Lake Michigan	10	32.07
Lake Michigan (City of Milwaukee)	Root River to Lake Michigan Alignment 1	10	72.34
Lake Michigan (City of Milwaukee)	Direct to Lake Michigan	13	30.17
Lake Michigan (City of Oak Creek) Alignment 1	Underwood Creek to Lake Michigan	15	66.67
Lake Michigan (City of Oak Creek) Alignment 1	Root River to Lake Michigan Alignment 1	15	106.94
Lake Michigan (City of Oak Creek) Alignment 1	Direct to Lake Michigan	18	64.77
Lake Michigan (City of Oak Creek) Alignment 2	Root River to Lake Michigan Alignment 2	15	4.34
Lake Michigan (City of Racine)	Underwood Creek to Lake Michigan	11	28.34
Lake Michigan (City of Racine)	Root River to Lake Michigan Alignment 1	11	68.61
Lake Michigan (City of Racine)	Direct to Lake Michigan	14	26.44

For Table 6-58A and Table 6-70A, the more conservative of the water supply alternative and water return alternative designations was used to define the system alternative impact.

TABLE 6-58A

System Alternatives Environmental Impact Comparison Summary: Land Use

Water Supply Alternative	Water Return Alternative	Land Use
Deep and Shallow Aquifers	Discharge to Fox River	No adverse impact
Shallow Aquifer and Fox River Alluvium	Discharge to Fox River	No adverse impact
Lake Michigan (City of Milwaukee)	Underwood Creek to Lake Michigan	No adverse impact
Lake Michigan (City of Milwaukee)	Root River to Lake Michigan Alignment 1	No adverse impact
Lake Michigan (City of Milwaukee)	Direct to Lake Michigan	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 1	Underwood Creek to Lake Michigan	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 1	Root River to Lake Michigan Alignment 1	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 1	Direct to Lake Michigan	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 2	Root River to Lake Michigan Alignment 2	No adverse impact
Lake Michigan (City of Racine)	Underwood Creek to Lake Michigan	No adverse impact
Lake Michigan (City of Racine)	Root River to Lake Michigan Alignment 1	No adverse impact
Lake Michigan (City of Racine)	Direct to Lake Michigan	No adverse impact

TABLE 6-70A
System Alternatives Environmental Impact Comparison Summary: Soils

Water Supply Alternative	Water Return Alternative	Soils
Deep and Shallow Aquifers	Discharge to Fox River	Minor adverse impact
Shallow Aquifer and Fox River Alluvium	Discharge to Fox River	Minor adverse impact
Lake Michigan (City of Milwaukee)	Underwood Creek to Lake Michigan	No adverse impact
Lake Michigan (City of Milwaukee)	Root River to Lake Michigan Alignment 1	No adverse impact
Lake Michigan (City of Milwaukee)	Direct to Lake Michigan	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 1	Underwood Creek to Lake Michigan	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 1	Root River to Lake Michigan Alignment 1	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 1	Direct to Lake Michigan	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 2	Root River to Lake Michigan Alignment 2	No adverse impact
Lake Michigan (City of Racine)	Underwood Creek to Lake Michigan	No adverse impact
Lake Michigan (City of Racine)	Root River to Lake Michigan Alignment 1	No adverse impact
Lake Michigan (City of Racine)	Direct to Lake Michigan	No adverse impact

For Table 6-71A, the water supply alternative and water return alternative values were added together to define the system alternative impact.

TABLE 6-71A

System Alternatives Environmental Impact Comparison Summary: Estimated Energy Use and GHG Emissions

Water Supply Alternative	Water Return Alternative	Estimated Annual Energy Usage (MWh)	Estimated Annual GHG Emissions (tons CO ₂)
Deep and Shallow Aquifers	Discharge to Fox River	26,500	24,600
Shallow Aquifer and Fox River Alluvium	Discharge to Fox River	24,100	22,400
Lake Michigan (City of Milwaukee)	Underwood Creek to Lake Michigan	14,200	15,700
Lake Michigan (City of Milwaukee)	Root River to Lake Michigan Alignment 1	15,900	17,300
Lake Michigan (City of Milwaukee)	Direct to Lake Michigan	16,100	17,500
Lake Michigan (City of Oak Creek) Alignment 1	Underwood Creek to Lake Michigan	18,700	19,800
Lake Michigan (City of Oak Creek) Alignment 1	Root River to Lake Michigan Alignment 1	20,400	21,400
Lake Michigan (City of Oak Creek) Alignment 1	Direct to Lake Michigan	20,600	21,600
Lake Michigan (City of Oak Creek) Alignment 2	Root River to Lake Michigan Alignment 2	21,500	22,500
Lake Michigan (City of Racine)	Underwood Creek to Lake Michigan	18,800	20,000
Lake Michigan (City of Racine)	Root River to Lake Michigan Alignment 1	20,500	21,600
Lake Michigan (City of Racine)	Direct to Lake Michigan	20,800	21,800

For Table 6-72A, the more conservative of the water supply alternative and water return alternative designations was used to define the system alternative impact.

TABLE 6-80A
Water Supply and Return Flow Alternative Environmental Impact Comparison Summary

Water Supply Alternative	Water Return Alternative	Groundwater Resources	Geomorphology and Sediments	Flooding	Aquatic Habitat	Water Quality	Wetlands	Soils	Land Use
Deep and Shallow Aquifers	Discharge to Fox River	Significant adverse impact	No adverse impact	No adverse impact	Significant adverse impact	Minor adverse impact	Significant adverse impact	Minor adverse impact	No adverse impact
Shallow Aquifer and Fox River Alluvium	Discharge to Fox River	Significant adverse impact	No adverse impact	No adverse impact	Significant adverse impact	No adverse impact	Significant adverse impact	Minor adverse impact	No adverse impact
Lake Michigan (City of Milwaukee)	Underwood Creek to Lake Michigan	No adverse impact	No adverse impact	Minor adverse impact	Minor adverse impact	No adverse impact	Minor adverse impact	No adverse impact	No adverse impact
Lake Michigan (City of Milwaukee)	Root River to Lake Michigan Alignment 1	No adverse impact	No adverse impact	Minor adverse impact	Minor adverse impact	No adverse impact	Minor adverse impact	No adverse impact	No adverse impact
Lake Michigan (City of Milwaukee)	Direct to Lake Michigan	No adverse impact	Minor adverse impact	No adverse impact	Minor adverse impact	No adverse impact	Minor adverse impact	No adverse impact	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 1	Underwood Creek to Lake Michigan	No adverse impact	No adverse impact	Minor adverse impact	Minor adverse impact	No adverse impact	Minor adverse impact	No adverse impact	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 1	Root River to Lake Michigan Alignment 1	No adverse impact	No adverse impact	Minor adverse impact	Minor adverse impact	No adverse impact	Minor adverse impact	No adverse impact	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 1	Direct to Lake Michigan	No adverse impact	Minor adverse impact	No adverse impact	Minor adverse impact	No adverse impact	Minor adverse impact	No adverse impact	No adverse impact
Lake Michigan (City of Oak Creek) Alignment 2	Root River to Lake Michigan Alignment 2	No adverse impact	No adverse impact	Minor adverse impact	Minor adverse impact	No adverse impact	Minor adverse impact	No adverse impact	No adverse impact
Lake Michigan (City of Racine)	Underwood Creek to Lake Michigan	No adverse impact	No adverse impact	Minor adverse impact	Minor adverse impact	No adverse impact	Moderate adverse impact	No adverse impact	No adverse impact
Lake Michigan (City of Racine)	Root River to Lake Michigan Alignment 1	No adverse impact	No adverse impact	Minor adverse impact	Minor adverse impact	No adverse impact	Moderate adverse impact	No adverse impact	No adverse impact
Lake Michigan (City of Racine)	Direct to Lake Michigan	No adverse impact	Minor adverse impact	No adverse impact	Minor adverse impact	No adverse impact	Moderate adverse impact	No adverse impact	No adverse impact

TABLE 6-63A

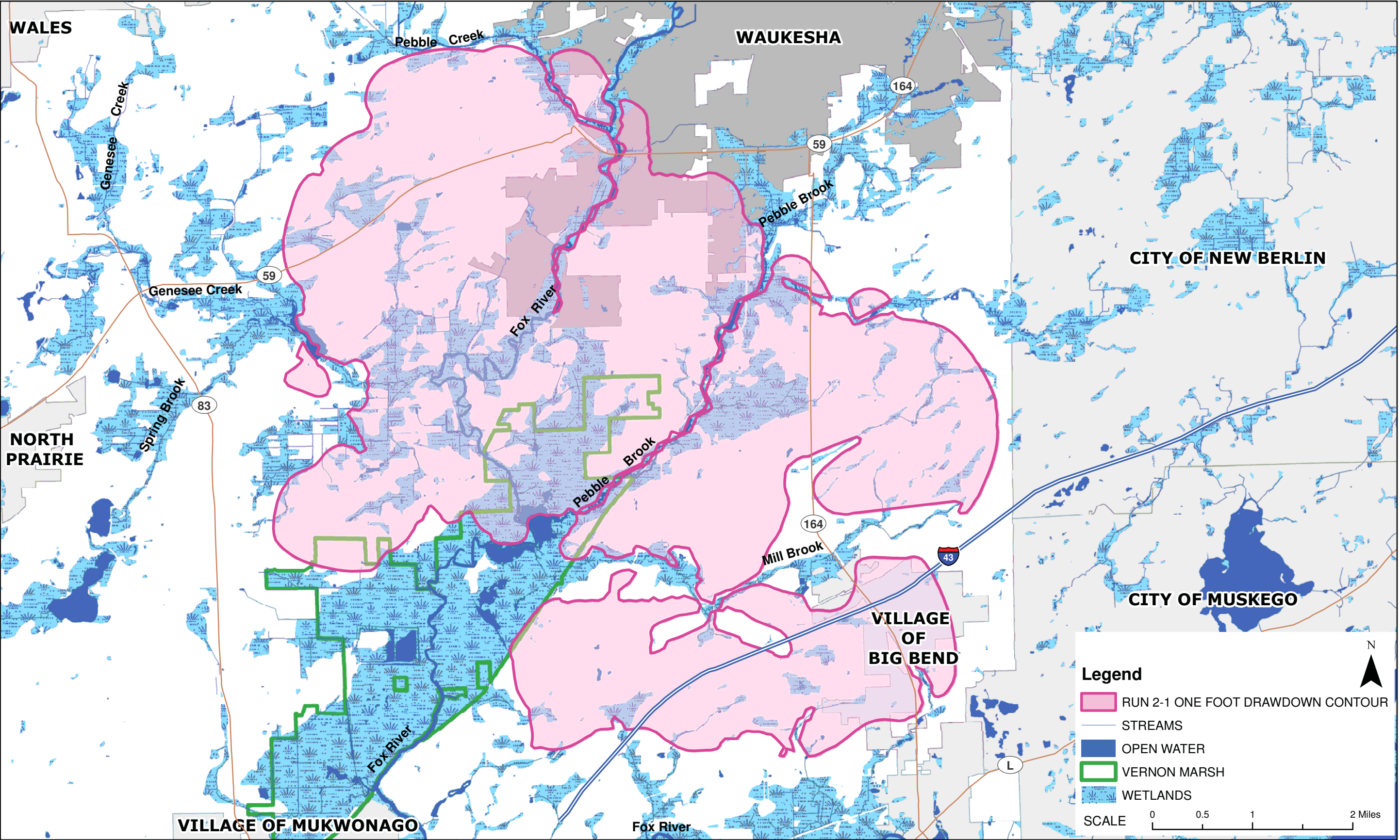
System Alternatives Environmental Impact Comparison Summary: Estimated Energy Use and GHG Emissions

Water Supply Alternative	Water Return Alternative	Estimated Annual Energy Usage (MWh)	Estimated Annual GHG Emissions (tons CO₂)	Annual Energy Usage (MWh)	Estimated Annual GHG Emissions (tons CO₂)
Deep and Shallow Aquifer	Discharge to Fox River	26,471	24,605	26,500	24,600
Shallow Aquifer and Fox River Alluvium	Discharge to Fox River	24,103	22,404	24,100	22,400
Lake Michigan (City of Milwaukee)	Underwood Creek to Lake Michigan	14,188	15,676	14,200	15,700
Lake Michigan (City of Milwaukee)	Root River to Lake Michigan Alignment 1	15,887	17,256	15,900	17,300
Lake Michigan (City of Milwaukee)	Direct to Lake Michigan	16,098	17,451	16,100	17,500
Lake Michigan (City of Oak Creek) Alignment 1	Underwood Creek to Lake Michigan	18,671	19,843	18,700	19,800
Lake Michigan (City of Oak Creek) Alignment 1	Root River to Lake Michigan Alignment 1	20,370	21,423	20,400	21,400
Lake Michigan (City of Oak Creek) Alignment 1	Direct to Lake Michigan	20,581	21,618	20,600	21,600
Lake Michigan (City of Oak Creek) Alignment 2	Root River to Lake Michigan Alignment 2	21,488	22,461	21,500	22,500
Lake Michigan (City of Racine)	Underwood Creek to Lake Michigan	18,848	20,007	18,800	20,000
Lake Michigan (City of Racine)	Root River to Lake Michigan Alignment 1	20,547	21,587	20,500	21,600
Lake Michigan (City of Racine)	Direct to Lake Michigan	20,758	21,782	20,800	21,800

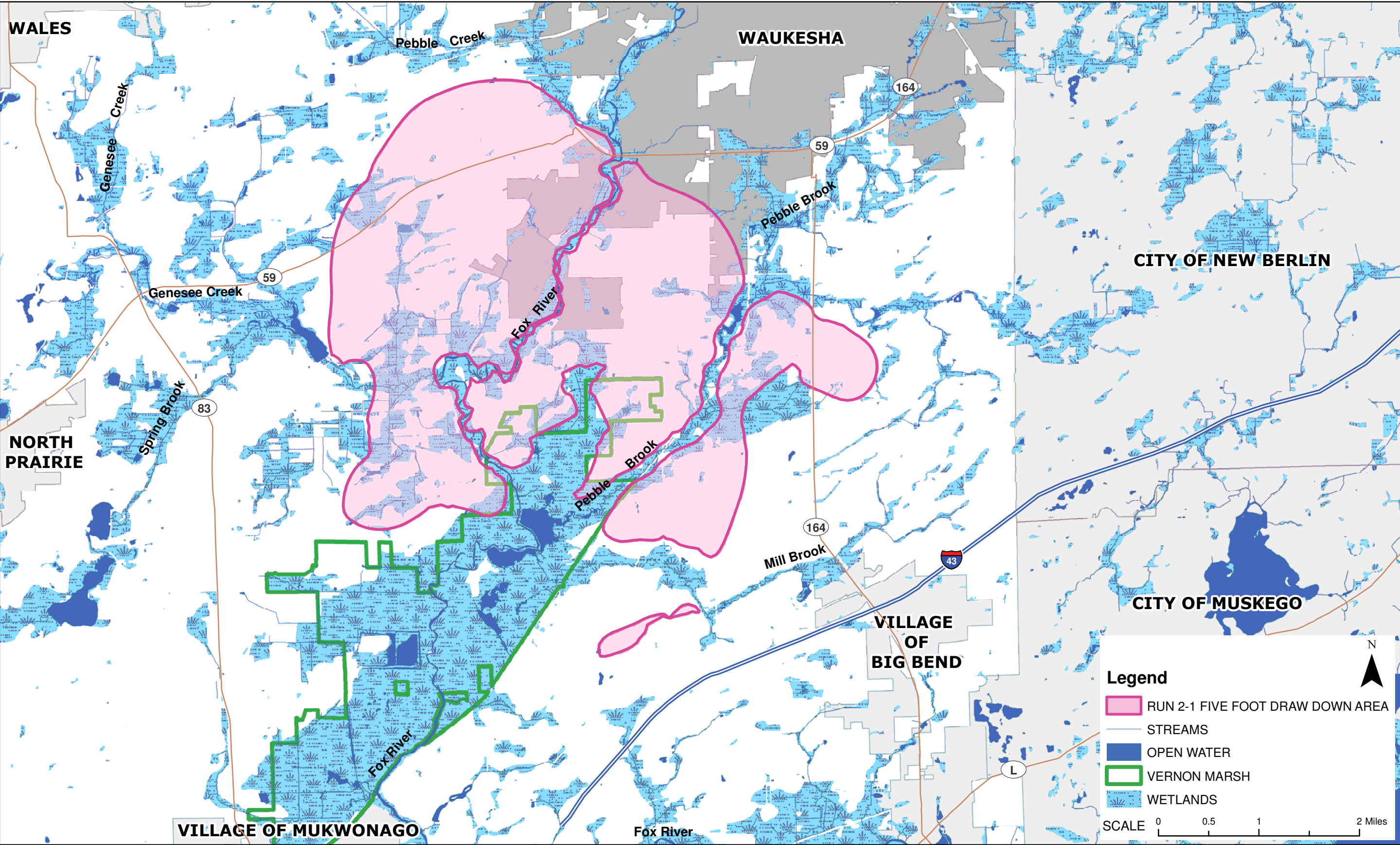
Numbers rounded to the nearest 100

Appendix 6-3
Groundwater Drawdown Maps

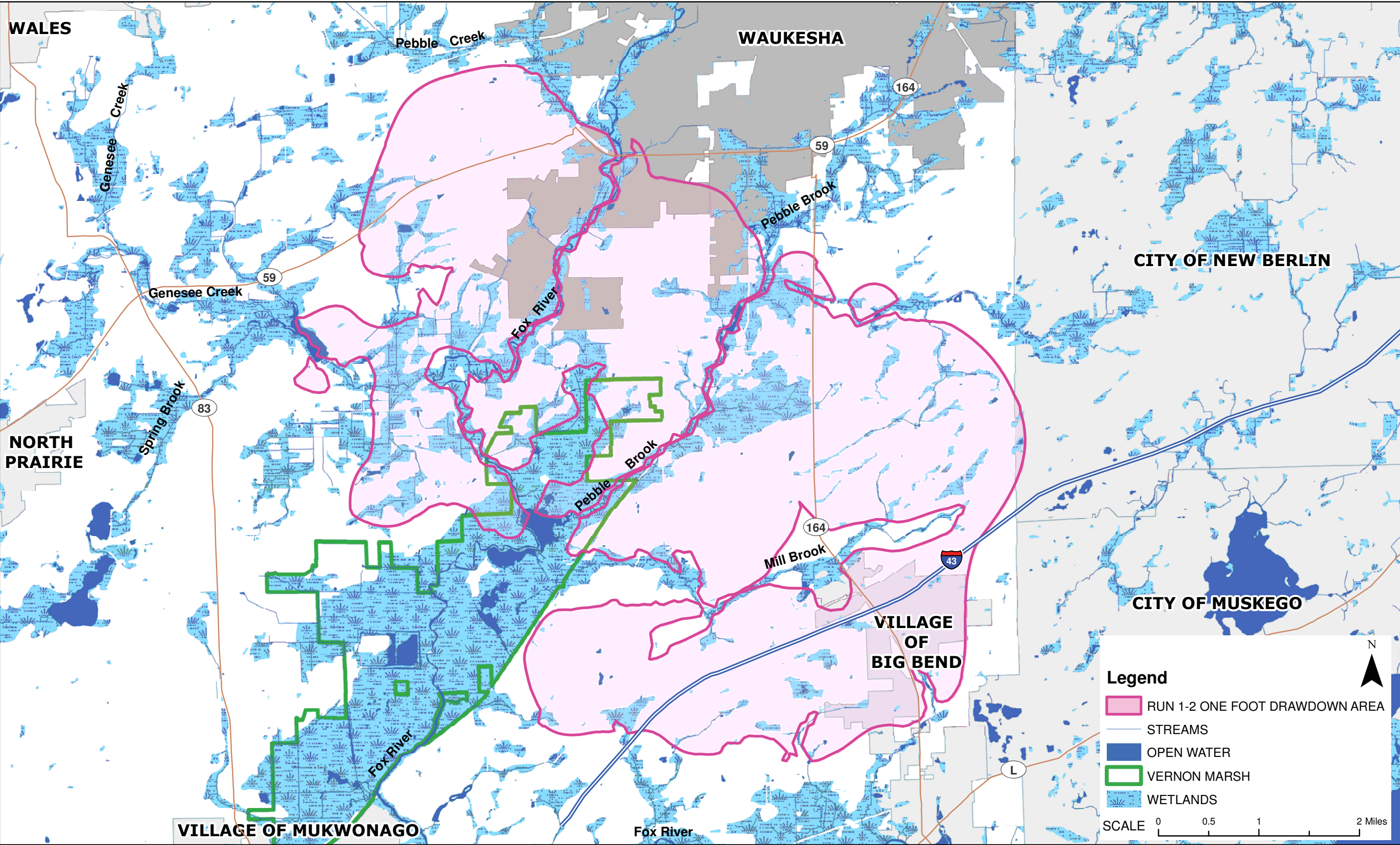
SHALLOW AQUIFER WITH FOX RIVER ALLUVIUM ONE FOOT DRAWDOWN AREA



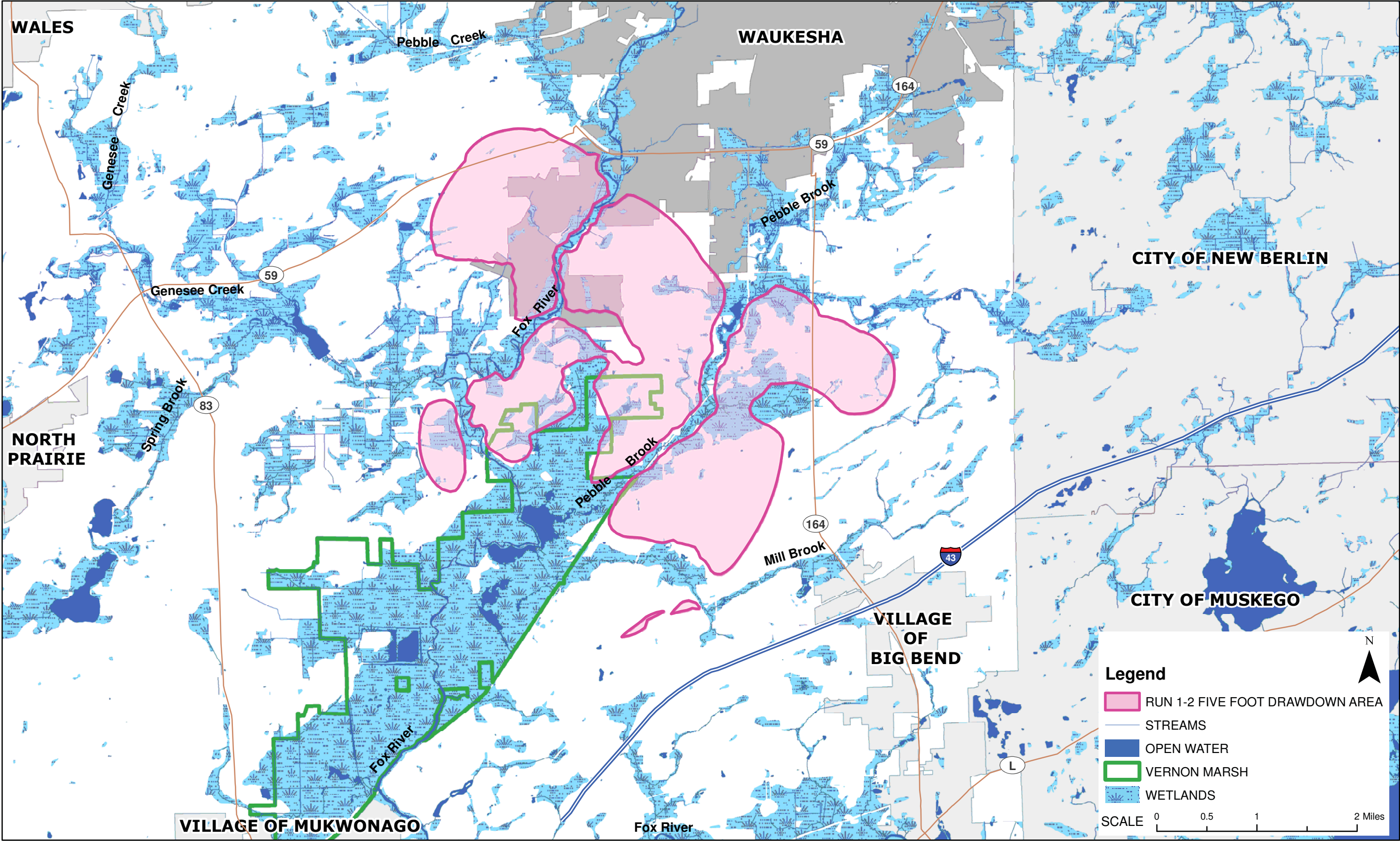
SHALLOW AQUIFER WITH FOX RIVER ALLUVIUM FIVE FOOT DRAWDOWN AREA



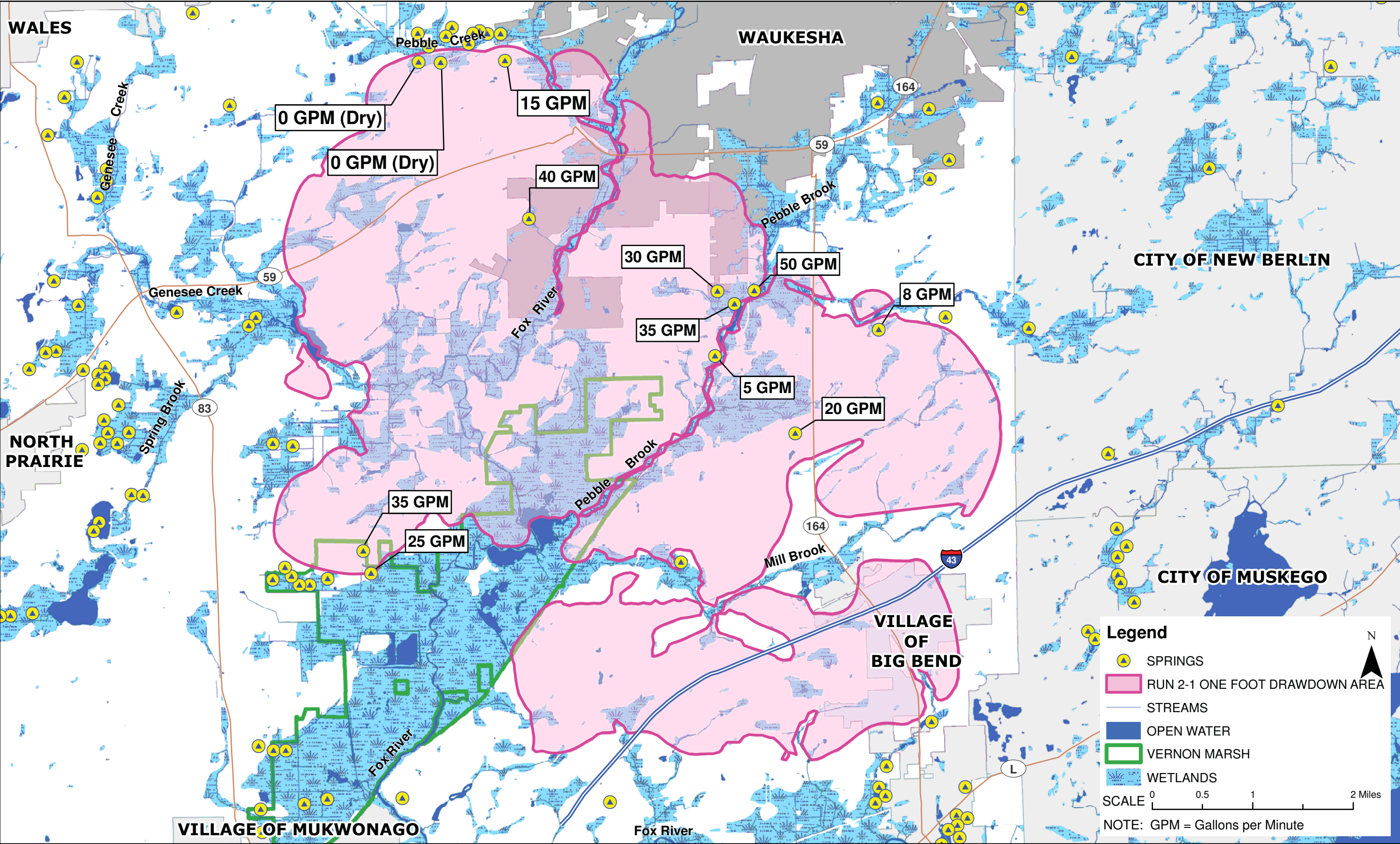
DEEP AND SHALLOW AQUIFERS ONE FOOT DRAWDOWN AREA



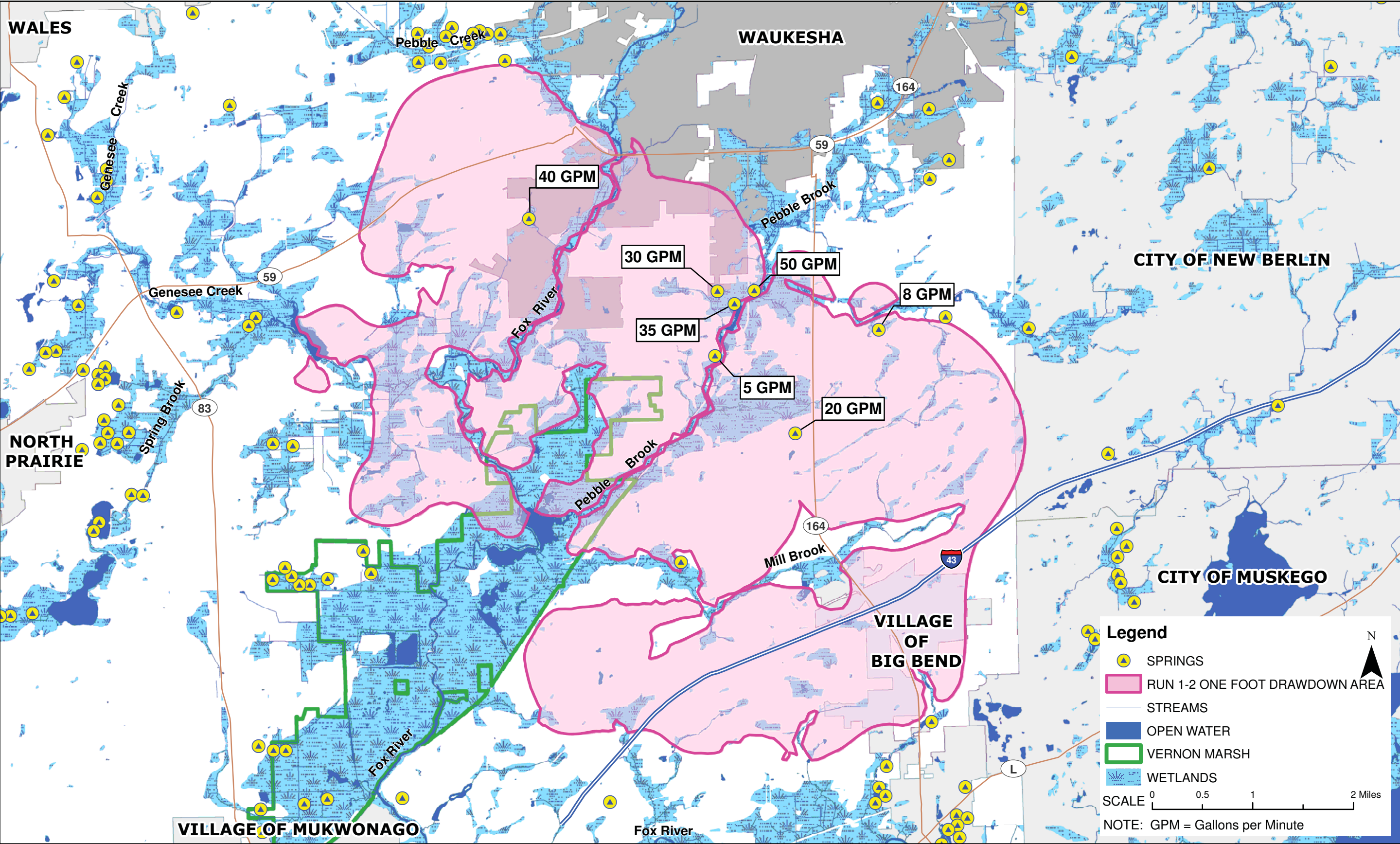
DEEP AND SHALLOW AQUIFERS
FIVE FOOT DRAWDOWN AREA



SHALLOW AQUIFER WITH FOX RIVER ALLUVIUM ONE FOOT DRAWDOWN AREA AND SPRINGS



DEEP AND SHALLOW AQUIFERS ONE FOOT DRAWDOWN AREA AND SPRINGS



Appendix 6-4
Vernon Marsh Wetland Impact Analysis
Technical Memorandum

Wetland Habitat Impact Analysis: Vernon Marsh Wildlife Area

PREPARED FOR: Waukesha Water Utility

PREPARED BY: CH2M HILL

DATE: March 8, 2011

This memorandum provides an analysis of potential impacts to wetland habitat in the Vernon Marsh Wildlife Area due to withdrawals of groundwater for a City of Waukesha water supply. This memorandum discusses how these anticipated hydrologic changes may affect wetland functions, vegetation, and wildlife and evaluates potential mitigation measures that could lessen impacts to the Vernon Marsh Wildlife Area.

Groundwater Drawdown Effects on Wetland Hydrology

In an unconfined shallow aquifer like that within the Vernon Marsh Wildlife Area, groundwater pumping causes the groundwater levels to drop. When the shallow groundwater reaches (or exceeds) the ground surface, as it does in wetland areas, changes in the wetland's hydrologic system can occur if significant water withdrawal demands are placed on the aquifer. Depending on the duration and extent of the aquifer drawdown, these changes in wetland hydrology can be short or long term, minor or severe.

As described in *Results of Groundwater Modeling Study: Shallow Groundwater Source – Fox River & Vernon Marsh Area*, an attachment to the Water Supply Service Area Plan, the groundwater model¹ simulates average annual conditions and clearly demonstrates a hydrologic relationship between the regional shallow aquifers and the groundwater level. Therefore, drawdown in the aquifer will influence the ground surface saturation and standing water in wetlands, as well as base flows in Pebble Brook, Pebble Creek, Mill Brook, and the Fox River. Groundwater drawdown and their influence on surface hydrology could be more significant during summer periods, when groundwater levels are naturally lower and municipal water demand is greatest.

The number of wetland acres potentially affected will vary according to the degree of drawdown and the proximity of the wetland to the well's zone of influence. For the purpose of comparing alternatives, the estimated impacts were quantified using a greater-than-1-foot-drawdown extent and a greater-than-5-foot-drawdown extent.

Potential Effects of Hydrologic Change to Wetland Habitat

Processes, functions, and parameters of wetland systems that may be affected by changes in hydrology include vegetative cover, fisheries, benthic macroinvertebrates, soil condition, food chain links/sources, wildlife use, water treatment, water storage, and fire risk.

¹ *Results of Groundwater Modeling Study: Shallow Groundwater Source – Fox River & Vernon Marsh Area*

For the purpose of estimating and predicting impacts, it was assumed that no surface water would be present in wetlands anytime in the year within the 5-foot *and greater* drawdown contour. This is a reasonable assumption because the shallow aquifer is unconfined and previous modeling demonstrated that there was clear relationship between surface water and ground water resources. Also, it was assumed that no appreciable ground surface saturation would occur at the 5-foot and greater drawdown. Therefore total wetland loss within areas of 5-foot or greater drawdown (as predicted by the groundwater model) would occur.

The U.S. Army Corps of Engineers (USACE) in their *Manual for Wetland Delineations* and the *Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Midwest Region* generally defines wetlands as having soil saturation starting at a depth of 1 foot or less during the growing season (USACE 1987, 2010). Consequently, a groundwater drawdown of 1 foot or more would have impacts upon wetland hydrology. A groundwater drawdown of less than 1 foot would not have the degree of negative impacts to wetland hydrology associated with greater drawdowns if the surface soil is saturated. For wetland impact analysis purposes, it has been conservatively assumed that a 1-foot annual average drawdown *or less* will have no appreciable loss of wetland function. This is reasoned because it is possible that significant rainfall events could temporarily replenish groundwater levels to pre-drawdown conditions. If this happens in the growing season, the wetland could show less appreciable negative impact. If replenishment happens regularly, the wetland may retain many of its functions and characteristics.

It follows that the area *between* the 1-foot drawdown and the 5-foot drawdown represents a potential gradient for changing from one wetland type to another. Where deep-water wetlands currently exist, such as open water and aquatic bed habitats, a 2-, 3-, or 4-foot drawdown would shift the wetland vegetation to a more shallow emergent marsh or wet meadow. This would not be a total loss of wetland, but it would be a change in wetland type, and cause negative impacts to natural communities. However, where an existing shallow or ephemeral wetland occurs (such as emergent or wet meadow, seeps, forested wetland), a small decrease in surface water level or prolonged dry periods may result in lost wetland functions and a gradual shift toward an upland community.

Wetland types and water resources present in the geographic area of the Vernon Marsh Wildlife Area include:

- Calcareous fen
- Emergent or wet meadow
- Filled or drained wetland
- Flats or unvegetated wet soil
- Forested swamp
- Fox River
- Groundwater seeps
- Open water and aquatic bed
- Scrub shrub

The wetland types and the effects of groundwater drawdown on the habitat they provide are described below.

Calcareous Fen

Calcareous fen is a rare wet meadow type that is sustained by natural springs or groundwater seeps that make it to the surface. These springs and seeps bring specific water chemistry and hydrologic conditions that sustain some rare and specialized plant species

(WDNR, 2006). The groundwater that reaches the surface is rich with calcium and magnesium bicarbonates (or sulfates), which creates a strong alkaline soil condition, in which only a few, rare calcium-tolerant plants can thrive (Miner and Ketterling, 2003). Prolonged interruption of this hydrologic process sustained by consistent groundwater expression may result in loss of these certain rare resources. Calcareous fen occurs in the southern end of the Vernon Marsh Wildlife Area, in an area not included in the model's predicted area of drawdown. Consequently, no known calcareous fens will be impacted by the drawdown. However, plant species that require calcareous fen habitat or similar conditions were retained in the threatened and endangered species evaluation for the groundwater alternatives that have the potential to affect the Vernon Marsh Wildlife Area, since similar groundwater seepage conditions, even though they might not be a calcareous fen, could exist in the groundwater drawdown influence area. Additional information on the impacts the shallow groundwater water supply alternatives may have on unique species is found in the response to the WDNR question RF18 from December 2, 2010, and is found in the Environmental Report.

Shallow Wetlands

Shallow wetland types, such as the emergent or wet meadow, flats or unvegetated wet soil, forested swamps or alluvium, seeps, and scrub shrub are wet only part of the year, as these wetland types have short and shallow hydroperiods. A prolonged or permanent decrease in groundwater levels of 1 foot or greater could lower the surface water level and soil saturation within these wetland types to such a degree that detrimental impacts to wildlife, endangered resources, and vegetative cover may occur. impacts might include loss of habitat for invertebrates, fish, amphibians, or wading birds. Other impacts might be seen as a change in wildlife species that use the wetland, that is, with fewer wetland-dependent species present, more terrestrial species move in. Changes in herbaceous groundcover species would be observed first, followed by growth of a shrub layer.

Changes in groundcover could include a shift toward upland species, and upland shrubs could invade, resulting in a shift from herbaceous wetland to herbaceous/shrubby upland. In many stressed wetlands, invasive plants become established and out-compete native vegetation. Invasive exotics can include reed canary grass (*Phalaris arundinacea*), giant reed (*Phragmites communis*), and purple loosestrife (*Lythrum salicaria*).

A permanent loss of surface water would most certainly preclude fish habitat and amphibian habitat, which likely would degrade the potential for the wetland to support other wildlife that feed on fish or amphibians.

Forested Wetlands

Wetland trees have a morphological adaptation to survive in wet soil conditions. When wet soils are exposed to air for several years, the result can be a loss of hydric indicators in the soil through oxidation, and subsidence can occur. The tree subcanopy and canopy would show signs of stress, the soil can subside, and trees topple as a result of reduced soil strength. With the loss of trees, the habitat is less suitable for nesting and denning, and food sources change (different plant seeds/berries), which may result in a loss of habitat for mammals, birds, or reptiles.

Drained or Filled Wetlands

Previously impacted (drained or filled) wetlands are likely to have diminished wetland functions and characteristics. Further and prolonged reductions in surface hydrology would in most situations result in complete loss of remaining functions.

Open Water Wetlands

Open water and aquatic bed wetland systems, which have much deeper water and are typically a permanent year-round flooded wetland type, can retain many of the functions associated with wetlands depending on the severity with which the hydrology has been affected. Aquatic beds along open-water areas could adapt to lowered water levels by extending runners and rhizomes farther into the deeper water zones as they drain or by a change in vegetation composition, where more drought-tolerant wetland plants become established. Within the predicted 1-to-5-foot drawdown range, the deeper systems might lose some deep-water wetland characteristics, such as waterfowl habitat, but may transition to a wet meadow or marsh habitat, which is more suitable to wading birds.

Summary of Potential Wetland Impacts

As stated previously, the degree of impacts observed in any given wetland will vary depending on wetland type, proximity to the zone of drawdown, the severity of depressed water table, frequency and amount of rainfall, etc. Also, impacts will vary from one extreme, such as a total loss of all wetland functions, to a shift from one wetland type to another.

The estimated areas (acreage) of impact that may occur between the 1-foot drawdown and the 5-foot drawdown under the Deep and Shallow Aquifer Mix scenario and under the Shallow Aquifer and Fox River Alluvium scenario are presented in Table 1. As previously stated, for analysis purposes, a groundwater drawdown of less than 1 foot has been assumed to have no appreciable loss of wetland function. Groundwater drawdown less than 1-foot could also impact wetland hydrology and function depending upon the existing groundwater level relative to the ground surface. This analysis however focuses in on the 1-foot or greater groundwater drawdown depths which would be expected to have the most significant impact to wetland hydrology.

TABLE 1
Area of Wetland Types

	Acres within Drawdown Area			
	Drawdown between 1 and 5 Feet		Drawdown 5 Feet and Greater	
	Deep and Shallow Aquifer Mix	Shallow Aquifer and Fox River Alluvium	Deep and Shallow Aquifer Mix	Shallow Aquifer and Fox River Alluvium
Emergent or wet meadow	469.6	604.2	240.6	475
Filled or drained wetland	9.5	10.2	1.8	2.4
Flats or unvegetated wet soil	38.4	44.1	12.1	30.4
Forested	624.7	730.8	307.5	547.9
Open water and aquatic bed	77.5	66.4	11.1	37
Scrub/ shrub	875.4	686.9	419	871.3
Total	2,095.10	2,142.60	992.1	1,964.00

The estimated areas of impact that may occur at the 5-foot drawdown and greater under the Deep and Shallow Aquifer Mix scenario and under the Shallow Aquifer and Fox River Alluvium scenario are presented in Table 1.

Potential Mitigation Action Analysis

Based upon the groundwater modeling results, there will be impacts to wetlands from groundwater drawdown for the shallow groundwater supply alternatives, and not all of these impacts can be offset or reduced to insignificant levels. Consequently, activities or actions that could partially minimize, restore, reduce, or reverse the adverse effects of groundwater drawdown include:

- Flow augmentation with groundwater
- Control of surface water outfall
- Well field pump rotation
- Mitigation bank credit purchase

The first three of the four potential mitigation methods listed below could be targeted to reduce impacts on selected wetlands if particularly rare or locally important resources were threatened.

Augmentation with Groundwater

Augmentation with groundwater could be used as a water supplement to, in part, offset the loss of groundwater seepage to the wetland resulting from the groundwater drawdown. Under this mitigation measure, groundwater would be withdrawn from a local source, such as a groundwater well, and piped to a wetland area for surface discharge during certain critical times of the growing season. This approach has been used in Florida to reduce adverse effects and to avoid predicted adverse effects on wellfields (SJRWMD, 2009).

Potential disadvantages of this approach include that additional groundwater pumping will cause additional groundwater drawdown and consequently affect more wetlands. This is contrary to the goal of reducing the acreage of wetlands impacted by groundwater drawdown. The applicability of wetland flow augmentation from groundwater also faces limitations of location and topography.

Augmentation with groundwater is most applicable to certain wetland areas that are hydrologically isolated from other wetlands, have relatively flat topography, and are within manageable proximity to a groundwater source. These characteristics allow the flow augmentation to be distributed across the wetland in close to a uniform manner allowing ground saturation to occur over as broad of an area as possible. Also, plant species adapted to niche habitat conditions, for example, groundwater seeps (which are prevalent at the Vernon Marsh Wildlife Area), would be less likely to benefit unless the augmentation input was designed to recharge local groundwater in a specific area. Delivering water to the wetland requires active operational management and regular monitoring. Because of these limitations the applicability of this mitigation alternative is limited to small targeted areas, which makes application impractical to address all impacts.

Control of Surface Water

This strategy is intended to reverse hydrologic changes brought about by ditching and draining a wetland's surface water. Wetlands that have been previously altered through ditching can be further impacted by groundwater drawdown. This approach calls for a

control structure to be constructed in an outfall ditch draining a part of the wetland, with the top of the weir set to match the wetland's seasonal high-water level, thereby allowing rainfall and groundwater to accumulate in the wetland. The goal of backing up the water is to restore the saturated conditions in the surface soils. This in-stream dam is designed to back up and divert outflows up to a certain level, but in doing so would raise flooding levels on streams by backing up water. Consequently, the control structures can themselves have unintended effects upstream and downstream including changing the hydrology of downstream aquatic resources, causing upstream surface flooding, potentially causing less downstream soil saturation, and creating barriers to aquatic species. As a result, it will not be practical in many circumstances, including the use of it on the Fox River and main Fox River tributaries.

Control structures could be used in wetlands where flowing surface water is available and could be used to hold back the flow and allow some flow augmentation in the wetland. Benefits to some wetlands may be achieved with the construction of small dams or ditch blocks (within the Vernon Marsh Wildlife Area Property boundary) to hold back base flow, which could recharge, or flood, wetland areas in the Vernon Marsh Wildlife Area. If base flow in a ditch were held back in certain locations, the water level might recharge enough to benefit nearby wetlands. Wetlands near the structure would benefit the most; conversely, wetlands farther away would benefit less.

The benefits realized from a surface water control structure are limited by regional weather conditions; in times of drought the structure would have no effect because the measure is rainfall dependent and a base-flow control weir will have no beneficial effect if there is no surface water outflow from the wetland. Targeting specific resources, for example, plant species adapted to niche habitat conditions (groundwater seeps), would be difficult. The applicability of this mitigation alternative is consequently limited seasonally and to specific locations and topography, and it is not practicable for large areas with diverse habitat types, such as those affected by the groundwater drawdown, and is better suited for wetlands that have been previously altered through ditching. This mitigation alternative is impractical to address all impacts.

Well Field Pump Rotation

A potential mitigation option could be to increase the number of wells to spread the groundwater drawdown impact over a larger area and implement a pump operation rotation schedule. Depending on the zone of influence that each well would have on the local groundwater, an "on-off" pumping schedule might provide the supply water needed and still give temporary relief, or a "rest period," of groundwater drawdown to certain areas. The strategy calls for strategic wells to be shut off for a period of time, thereby allowing the groundwater to rebound. The intent is for the groundwater to recharge enough to reach the ground surface in the wetland. This rest period for the wetland may be enough for wetlands experiencing slight groundwater drawdown to retain functions, support desirable vegetation, and support wetland dependant wildlife.

Where specific wetlands have been identified as providing significant habitat to threatened or endangered species, or if the wetland type (e.g., wet meadow, calcareous fen) is particularly vulnerable to prolonged drawdown, pumping rotation may result in successful minimization of impacts.

Potential limitations of this approach are varied. The 1-foot or greater drawdown area already affects over 2,000 wetland acres; consequently, expanding the drawdown area would impact even more wetland acres. In addition to potential environmental impacts, such a mitigation option would require active operational management, additional pipelines, wells, and property acquisition, all of which would add significant cost to the alternative. This approach would be less practical to implement by requiring more property owners to sell land for well sites. As a result, the applicability of this mitigation alternative may be undesirable due to implementation difficulties and additional cost. Further, this mitigation alternative is impractical to address all impacts.

Wetland Mitigation Bank Credit Purchase

Another mitigation option is to purchase wetland credits from a wetland mitigation bank. Purchasing wetland mitigation bank credits is not preferential, however when the wetland purchase transfers wetland resources out of the source watershed. According to the multi-agency publication *Guidelines for Wetland Compensation Mitigation in Wisconsin* (WDNR et al., 2002) onsite mitigation is preferable when practicable and if site conditions are acceptable. The preference stated in the guidelines is to keep mitigation within the “same sub-watershed or one-half mile of the wetland impact.” The goal of these preferences is to replace lost wetland acreage nearest the impact area as possible. For impacts to wetlands in the Vernon Marsh Wildlife Area, mitigation beyond the preferred mitigation distance would have to be considered.

At this time, the State of Wisconsin does not have an in-lieu-fee wetland credit purchase program (ELI, 2011a). However, wetland mitigation credits can be purchased from a permitted mitigation bank subject to coordination and approval from the U.S. Army Corps of Engineers. Upon final approval, some of the project’s impacts could be offset through purchase of credits from mitigation banks. One criterion for approval is location of the impact relative to the bank’s permitted service area. In Wisconsin, there is only one available commercial mitigation bank with credits remaining, located in Wood County near Wisconsin Rapids (WDNR, 2008). The wetland mitigation bank in Wood County has only 65 credits remaining (O’Leary, 2011).

Potential limitations of this approach include an insufficient number of credits available at the approved bank to offset wetland impacts to the Vernon Marsh Wildlife Area and the wetland resources being transferred over 100 miles to a different watershed. As a result, the applicability of this mitigation alternative is inadequate to compensate for predicted impacts at the Vernon Marsh Wildlife Area.

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Appendix 6-5

**Relative Comparison of Wildlife,
Natural Community, and Endangered Resources
Impacts for City of Waukesha Water Supply and
Return Flow Alternatives**

Relative Comparison of Wildlife, Natural Community, and Endangered Resources Impacts for City of Waukesha Water Supply and Return Flow Alternatives

PREPARED FOR: Waukesha Water Utility

PREPARED BY: CH2M HILL

DATE: March 8, 2011
Updated July 8, 2013

2013 ER: This attachment to the ER contains updated Exhibits 1-9 and descriptions of two new natural communities (Oak Openings and Wet-Mesic Prairie) that were identified specifically for the proposed project (water supply from Lake Michigan (City of Oak Creek) Alignment 2 with return flow following Root River to Lake Michigan Return Flow Alignment 2). No other changes have been made to this evaluation.

Introduction

The wildlife, natural communities, and endangered resources along each City of Waukesha water supply and return flow alternative corridor as documented in the Environmental Report (ER) were reviewed to develop a relative comparison of impacts. The wildlife, natural communities, and endangered resources potentially affected by each of the water supply and return flow alternative corridors were identified through a Wisconsin Natural Heritage Inventory (NHI) database query submitted to the Wisconsin Department of Natural Resources (WDNR) in January 2010 and additional information received from the WDNR in January 2011. Existing geographical information system (GIS) data sets containing information on land use, wetlands, floodplains, springs, and other information were used to evaluate potential occurrences of each of these resources. The GIS data was supplemented by a habitat analysis that included field observations in key areas along the alignments during the summer of 2010, which was documented in the memorandum *City of Waukesha Water Supply – Habitat Assessment* (CH2M HILL, 2010).

Types of Impacts

Potential impacts to wildlife, natural community, and endangered resources fall into two categories:

Temporary: Temporary impacts are those that result only from construction. Through the use of construction techniques that minimize impacts, along with techniques that restore the construction area, temporary impacts are expected to be limited to the duration of the construction period (typically less than a year). An example of temporary impacts is provided by pipeline construction projects – the surface impacts are restored to the same or better condition than what existed prior to construction. Temporary impacts would occur for all water supply and return flow alternatives.

Permanent: Permanent impacts fall into two categories:

Permanent impacts associated with any long-term groundwater drawdown that results in habitat-type changes. An example of such an impact would be groundwater drawdown in an emergent marsh, which could cause the marsh habitat to decrease in areal extent and at least partially transition to upland habitat. Groundwater drawdown impacts are applicable only to the Deep and Shallow Well water supply alternative, and the Shallow Aquifer and Fox River Alluvium water supply alternative.

Permanent impacts associated with new aboveground infrastructure or aboveground pipeline maintenance. Aboveground infrastructure includes access roads and other aboveground structures. Pipeline corridor maintenance is applicable as a long-term impact in areas where routine mowing may result in a permanent habitat type change. Habitat type changes could occur in areas of natural vegetation where no current active maintenance is occurring. Aboveground structures having new impacts to undisturbed area are only associated with the Deep and Shallow Well water supply alternative and the Shallow Aquifer and Fox River Alluvium water supply alternative. An evaluation of potential mitigation options for the major permanent impacts are discussed the March 8, 2011 memorandum *Wetland Habitat Impact Analysis: Vernon Marsh Wildlife Area* found as an attachment to the ER.

Natural Community-Specific Analysis

A natural community is an assemblage of different plants and animal species within a specific habitat. The WDNR description of each of the natural communities identified by the NHI inventory that have the potential to be in the vicinity of the project and therefore potentially affected by the water supply and return flow alternatives is provided in Exhibit 1. Exhibit 1 is provided separately due to the sensitive nature of the potential habitat locations for threatened and endangered species.

An analysis of the NHI GIS data received from the WDNR, and supplemented by the findings from the 2010 field observations, was conducted for each of the natural communities to produce a relative comparison of impacts for each water supply and return flow alternative. The analysis evaluates impacts based on the assumption of a conventional excavation installation technique and does not consider construction best management practices (BMPs) techniques such as direction drilling for pipelines that could further minimize impacts. The City of Waukesha will work with the WDNR and other resource agencies to minimize natural community impacts with the approved alternative. The evaluation process for each natural community is described below with the relative comparison for each alternative presented in Exhibits 2 through 5.

Relative Comparison Method

Because natural community-specific data in acres were not directly available in GIS data sets for all of the natural communities, general habitat information was used to generate a relative comparison of the potential impact of an alternative. For example, no GIS layer specific for the bird rookery was available; consequently, a relative comparison was conducted using other habitat-type information. Conversely, the estimated acreage impact to the emergent marsh natural community was available from the Wisconsin Wetland Inventory (WWI) GIS layer and these specific data were used for the analysis. Additional information on the procedure for evaluating each natural community is described below.

The following suitability rating scale is meant to provide a measurement of the potential of a given route to contain any of the natural communities listed by the WDNR. Potential suitability rankings were defined as absent, low, moderate, or high:

- Absent – habitat is not present
- Low Potential Suitability – Up to 10 acres
- Moderate Potential Suitability – 10 to 20 acres
- High Potential Suitability – More than 20 acres

Bird Rookery. Bird rookeries require trees in or adjacent to open water or wetlands. Consequently, the relative potential occurrence of bird rookery habitat was compared by determining the total of all wetlands and all woodlands adjacent to bodies of water affected by the alternative. With the absence of a GIS data set specific to bird rookeries, the relative ranking of low/moderate/high potential suitability was used. There has been no confirmed presence of a bird rookery for any of the alternatives. The relative comparison of potential bird rookery impacts is listed in Exhibit 2.

Wet Prairie. Wet prairie shares characteristics with emergent aquatic communities. Thus, the relative occurrence of potential wet prairie impacts utilized the WWI emergent marsh GIS data set to evaluate potential wet prairie impacts. With the absence of a GIS data set specific to a wet prairie, the relative ranking of low/moderate/high potential suitability was used. There has been no confirmed presence of wet prairie for any of the alternatives. The relative comparison of potential wet prairie impacts is listed in Exhibit 2.

Springs and Spring Runs. The Wisconsin Geological and Natural History Survey (WGNHS) maintains an inventory of springs, which was consulted to determine potential impacts to springs. Several springs exist near the groundwater alternative areas (shallow wells in the deep and shallow wells alternative, and all wells in the shallow aquifer and Fox River alluvium alternative)(WGNHS, 2010) but none were found to be within the construction footprint of either the Lake Michigan water supply alternatives or the return flow alternatives. An analysis of potential springs affected by groundwater drawdown was previously conducted and shown in maps in the ER. An additional analysis was conducted to determine the number of WGNHS-documented springs within the project area for all alternatives. With the availability of a specific GIS data set addressing springs, a comparison to the WGNHS data set was conducted. The relative ranking of low/moderate/high potential suitability was developed utilizing the number of springs affected instead of acres affected. Springs and spring runs have been confirmed based upon literature documentation for the groundwater supply alternatives within the groundwater drawdown areas. The relative comparison of potential springs and spring run impacts is listed in Exhibit 2.

Streams. Stream data are available through GIS data sets. A comparison was conducted using the data, and the relative ranking of low/moderate/high potential suitability based upon acres impacted was used to evaluate impacts to streams listed as (slow, hard warm) by the WDNR. There has been no confirmed presence of a slow, hard warm stream within any of the alternatives. The relative comparison of potential stream impacts is listed in Exhibit 2.

Oxbow Lake. No GIS data were available for oxbow lakes. The analysis for the potential of an oxbow lake was conducted by observing the location of bodies of water on aerial maps

and through the habitat field survey conducted in 2010. There has been no confirmed presence of an oxbow lake within any of the alternatives. The relative comparison of potential oxbow lake impacts is listed in Exhibit 2.

Emergent Marsh. Information on the presence and extent of emergent marshes was available through the WWI. The relative comparison of the potential for an alternative to impact emergent marsh habitat was conducted using GIS analysis. With the availability of a specific GIS data set a numeric comparison of acres was made. The relative comparison of potential emergent marsh impacts is listed in Exhibit 3.

Shrub-Carr Wetlands. Information on the presence and extent of the shrub-carr natural community is available through the WWI which identifies shrub-carr as “scrub-shrub” wetland. The relative comparison of the potential for an alternative to impact scrub-carr wetlands was conducted using GIS analysis. With the availability of a GIS data set specific to shrub-carr communities, a numeric comparison of acres impacted was made to conduct the relative comparison. The relative comparison of potential shrub-carr impacts is listed in Exhibit 3.

Forested Floodplain. Information on the potential location of the forested floodplain natural community was analyzed using available GIS data sets for SEWRPC woodlands, WWI forested wetlands, and Federal Emergency Management Agency (FEMA) floodplains. All areas of woodlands and forested wetlands located within the mapped 100 year floodplain were assumed to represent forested floodplain. These calculated numeric acreages were used as the basis for comparison of a potential alternative to impact forested floodplain. The relative comparison of potential forested floodplain impacts is listed in Exhibit 3.

Mesic Prairie. A mesic prairie is an open grassland habitat. Because a mesic prairie GIS data set was unavailable, information on the potential location of the mesic prairie natural community was analyzed using available GIS data sets for the SEWRPC open lands and observations made during the summer 2010 habitat assessment. The presence of open lands does not necessarily mean mesic prairie would exist but using the SEWRPC open lands data set provides insight into the potential existence for this habitat type. With the absence of a GIS data set specific to the mesic prairie, the relative ranking of low/moderate/high potential suitability based on open lands acreage and field observations was used. There has been no confirmed presence of a mesic prairie for any of the alternatives. The relative comparison of potential mesic prairie impacts is listed in Exhibit 2.

Southern Sedge Meadow. A southern sedge meadow is an open wetland community. Because a southern sedge meadow GIS data set was unavailable, information on the potential location of the southern sedge meadow natural community was analyzed using available GIS data sets for WWI emergent marsh. Southern sedge meadow is often found adjacent to emergent marsh; consequently, emergent marsh is a good indicator of the potential presence of southern sedge meadow. With the absence of a GIS data set specific to southern sedge meadow, the relative ranking of low/moderate/high potential suitability based on emergent marsh acreage was used. There has been no confirmed presence of a southern sedge meadow for any of the alternatives. The relative comparison of potential southern sedge meadow impacts is listed in Exhibit 4.

Calcareous Fen. Calcareous fens occur in areas receiving carbonate-enriched groundwater. Because a GIS data set for calcareous fen was unavailable, information on the potential location

of the calcareous fen natural community was analyzed using available GIS data sets for WWI emergent marsh supplemented with 2010 field observations and communication with the Vernon Marsh Wildlife Area manager, who is aware of known calcareous fen locations in the Vernon Marsh Wildlife Area. Calcareous fen is often found adjacent to emergent marsh; consequently, emergent marsh is a good indicator of potential calcareous fen presence. With the absence of a GIS data set specific to calcareous fen, the relative ranking of low/moderate/high potential suitability based on emergent marsh acreage and field observations was used. There has been no confirmed presence of a calcareous fen for any of the alternatives. The relative comparison of potential calcareous fen impacts is listed in Exhibit 4.

Northern Wet Forest. The potential presence of northern wet forest was analyzed using WWI forested wetlands because a GIS data set specific to northern wet forest was unavailable. The presence of forested wetlands does not necessarily mean a northern wet forest would exist but using the WWI forested wetlands data set provides insight into the potential existence of this habitat type. With the absence of a community-specific specific GIS data set, the relative ranking of low/moderate/high potential suitability based on forested wetlands acreage was used. There has been no confirmed presence of a northern wet forest for any of the alternatives. The relative comparison of potential northern wet forest impacts is listed in Exhibit 5.

Southern Dry Forest. The potential presence of southern dry forest was analyzed using SEWRPC woodlands because a GIS data set specific to southern dry forest was unavailable. The presence of woodlands does not necessarily mean a southern dry forest would exist but using the SEWRPC woodlands data set provides insight into the potential existence for this habitat type. With the absence of a GIS data set specific to southern dry forest, the relative ranking of low/moderate/high potential suitability based on woodlands acreage was used. There has been no confirmed presence of a southern dry forest for any of the alternatives. The relative comparison of potential southern dry forest impacts is listed in Exhibit 5.

Southern Dry Mesic Forest. The potential presence of southern dry mesic forest was analyzed using SEWRPC woodlands because a GIS data set specific to southern dry mesic forest was unavailable. The presence of woodlands does not necessarily mean a southern dry mesic forest would exist but using the SEWRPC woodlands data set provides insight into the potential existence for this habitat type. With the absence of a GIS data set specific to southern dry mesic forest, the relative ranking of low/moderate/high potential suitability based on woodlands acreage was used. There has been no confirmed presence of a southern dry mesic forest for any of the alternatives. The relative comparison of potential southern dry mesic forest impacts is listed in Exhibit 5.

Southern Mesic Forest. The potential presence of southern mesic forest was analyzed using SEWRPC woodlands because a GIS data set specific to a southern mesic forest was unavailable. The presence of woodlands does not necessarily mean a southern mesic forest would exist but using the SEWRPC woodlands data set provides insight into the potential existence for this habitat type. With the absence of a GIS data set specific to southern mesic forest, relative ranking of low/moderate/high potential suitability based on woodland acreage was used. There has been no confirmed presence of a southern mesic forest for any of the alternatives. The relative comparison of potential southern mesic forest impacts is listed in Exhibit 5.

Southern Tamarack Swamp. The potential presence of southern tamarack swamp was analyzed using WWI forested wetlands because a GIS data set specific to southern tamarack swamp was unavailable. The presence of forested wetlands does not necessarily mean a southern tamarack swamp would be present but using the WWI forested wetlands data set provides insight into the potential existence for this habitat type. With the absence of a community-specific GIS data set, the relative ranking of low/moderate/high potential suitability based on forested wetland acreage was used. There has been no confirmed presence of a southern tamarack swamp for any of the alternatives. The relative comparison of potential southern tamarack swamp impacts is listed in Exhibit 5.

Oak Opening. An oak opening is an oak dominated savanna community in which there is less than 50 percent tree canopy. The potential presence of an oak opening community was analyzed using SEWRPC open lands, because a GIS data set specific to an oak opening was unavailable. The presence of open lands does not necessarily mean an oak opening would exist but using the SEWRPC open lands data set provides insight into the potential existence for this habitat type. With the absence of a GIS data set specific to oak opening, relative ranking of low, moderate, or high potential suitability based on open lands acreage was used. There has been no confirmed presence of an oak opening for any of the alternatives. Exhibit 5 compares potential oak opening impacts.

Wet-Mesic Prairie. Wet-mesic prairie shares characteristics with emergent aquatic communities. Thus, the relative occurrence of potential wet-mesic prairie impacts utilized the WWI emergent marsh GIS data set to evaluate potential wet prairie impacts. With the absence of a GIS data set specific to a wet-mesic prairie, the relative ranking of low, moderate, or high potential suitability was used. There has been no confirmed presence of wet-mesic prairie for any of the alternatives. Exhibit 2 compares potential wet-mesic prairie impacts.

Summary of Natural Community Relative Comparisons

An evaluation of Exhibits 2 through 5 indicates the groundwater supply alternatives have the highest overall potential impact to natural communities. The most significant impacts to natural communities are the potential permanent habitat type changes to wetland areas that may result from the groundwater drawdown associated with the groundwater supply alternatives. Impacts to wetland areas and other natural communities from the Lake Michigan water supply and return flow alternatives are largely temporary and/or are several orders of magnitude less than those associated with the groundwater supply alternatives.

The actual impacts to natural communities may vary from those presented here depending upon the final selected alternative, field verification of natural resources, and efforts to avoid, minimize, and mitigate impacts to natural communities. However the analysis conducted does accurately depict the relative impacts of the alternatives. The City of Waukesha will work with the WDNR and resource agencies to avoid, minimize, and mitigate impacts resulting from the final selected alternative.

Relative Comparison of Endangered Species Impacts

The water supply and return flow alternatives were analyzed for the relative impacts they each could have on preferred habitat for threatened, endangered, or species of special concern.

Habitat Comparison

The preferred habitat for threatened species, endangered species, and species of special concern affected by each alternative was summarized, including temporary impacts that would occur during construction and permanent impacts associated with pipeline maintenance, aboveground structures, access roads, and groundwater drawdown impacts. SEWRPC land use data were used to document habitat affected by each alternative.

Temporary impacts for pipelines assumed a larger impact area to compensate for machinery and material staging for installing the pipeline. After construction is completed the pipeline construction area will be restored to a condition similar or better to what existed prior to construction in accordance with recommendations from the WDNR and other applicable resource agencies. Because the pipeline construction corridor will be restored, permanent impacts for pipelines exist only where long-term pipeline maintenance requires a change in land use. For example, existing transportation and utility corridors are already routinely maintained and no additional maintenance would need to be performed to the transportation and utility corridors for the pipelines. Consequently, the potential for long-term impacts from pipeline corridors are mainly associated with forest and scrub-shrub habitat areas where new tree growth would be inconsistent with maintenance goals.

The estimated temporary and permanent impacts of each alternative are shown in Exhibit 6. The tabulated data indicate that the dominant land use affected by the Lake Michigan water supply and return flow alternatives includes utility corridors, transportation land uses, and agriculture. The dominant land use affected by the groundwater alternatives, including the groundwater drawdown area, consists of agricultural, residential, and wetlands.

Endangered Resource Inventory

Preferred habitat requirements for each of the threatened, endangered, and species of special concern, based upon NHI information, was summarized and correlated with SEWRPC land use types present along the various alternatives. For example, species listed by NHI as requiring forest habitat were categorized as woodland species according to the SEWRPC land use designations. It should be noted, that depending upon NHI habitat requirements, a particular species may be associated with multiple SEWRPC land use designations. The list of species, their habitat preferences, and the corresponding SEWRPC land use designation assignments are included in Exhibits 7 and 8. Exhibits 7 and 8 are provided separately due to the sensitive nature of the potential habitat locations for threatened and endangered species. Each water supply and return flow alternative has a separate list of species, with the exception of the two groundwater alternatives that share one list of species because the area they affect overlaps.

Once each listed species was assigned to a SEWRPC land use(s), the total number of occurrences for each land use type was calculated and used to determine which land use types are more likely to represent habitat for listed species. Exhibit 9 contains the relative comparison of rare species habitat occurrences by land use type. While individual wetlands types (emergent marsh, forested wetland, etc.) were used to designate habitat requirements for individual species, all types of wetlands were added together to simplify the comparison process.

Summary of Potential Listed Species Impacts

A review of Exhibit 9 shows that wetlands habitat is needed for more than half of all listed species habitat requirements along the supply and return flow alternatives. Consequently, it stands to reason that of all habitats affected by the supply and return flow alternatives, wetlands have the greatest potential to provide habitat for listed species. A comparison of the amount of wetland habitat acres affected by each alternative, as shown in Exhibit 6, indicates that the groundwater supply alternatives would result in permanent groundwater drawdown impacts to thousands of acres of wetland habitat. Conversely, the Lake Michigan water supply and return flow alternatives have only several acres of potential permanent wetland impacts. As such, the groundwater supply alternatives are expected to have significant adverse impacts to listed species whereas the Lake Michigan water supply alternatives are expected to have minor adverse impacts.

References

CH2M HILL. 2010. *Technical Memorandum: City of Waukesha Water Supply – Habitat Assessment*.

CH2M HILL. 2011, March 8. Technical Memorandum Relative Comparison of Wildlife, Natural Community, and Endangered Resources Impacts for City of Waukesha Water Supply for City of Waukesha Water Supply and Return Flow Alternatives..

Wisconsin Department of Natural Resources (WDNR) website (accessed February 28, 2011): <http://dnr.wi.gov/org/land/er/communities>.

WDNR (Wisconsin Department of Natural Resources). 2013. Correspondence from WDNR to Mark Mittag/CH2M HILL. January 3.

Wisconsin Geological and Natural History Survey (WGNHS). 2010. Spring Inventory provided March 9, 2010.

Exhibit 1 is provided separately due to the sensitive nature of the potential habitat locations for threatened and endangered species.

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EXHIBIT 2
Potential Suitability for Natural Communities - Others
Relative Comparison of Wildlife, Natural Community, and Endangered Resources

Alternative Name	Bird Rookery		Wet Prairie		Springs & Spring Runs		Streams		Oxbow Lake		Mesic Prairie		Wet-Mesic Prairie	
	Relative Suitability ³	Type Of Impact ^{3,4}	Relative Suitability ³	Type Of Impact ^{3,4}	Relative Suitability ³	Type Of Impact ^{3,4}	Relative ³	Type Of Impact ^{3,4}	Relative Suitability ³	Type Of Impact ^{3,4}	Relative Suitability ³	Type Of Impact ^{3,4}	Relative Suitability ^{3,6}	Type Of Impact ^{3,4,6}
Water Supply Alternative														
Deep and Shallow Wells														
Pipeline & Aboveground Structures ¹	Moderate	Temporary and permanent	N/A	N/A	Low	Temporary	N/A	N/A	N/A	N/A	Low	Temporary and permanent	N/A	N/A
Areas of 1-Foot or Greater Groundwater Drawdown	High	Permanent	N/A	N/A	Moderate	Permanent	N/A	N/A	N/A	N/A	High	No impacts will occur ⁵	N/A	N/A
Areas of 5-Foot or Greater Groundwater Drawdown ²	High	Permanent	N/A	N/A	Moderate	Permanent	N/A	N/A	N/A	N/A	High	No impacts will occur ⁵	N/A	N/A
Shallow Aquifer and Fox River Alluvium														
Pipeline & Aboveground Structures ¹	High	Temporary and permanent	N/A	N/A	Low	Temporary	N/A	N/A	N/A	N/A	Low	Temporary and permanent	N/A	N/A
Areas of 1-Foot or Greater Groundwater Drawdown	High	Permanent	N/A	N/A	Moderate	Permanent	N/A	N/A	N/A	N/A	High	No impacts will occur ⁵	N/A	N/A
Areas of 5-Foot or Greater Groundwater Drawdown ²	High	Permanent	N/A	N/A	Moderate	Permanent	N/A	N/A	N/A	N/A	High	No impacts will occur ⁵	N/A	N/A
Lake Michigan Supply Alternatives														
Lake Michigan-Milwaukee Supply	Low	Temporary and permanent	N/A	N/A	Absent	None	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Lake Michigan-Oak Creek Supply Alignment 1	N/A	N/A	Low	Temporary	Absent	None	N/A	N/A	N/A	N/A	High	Temporary	N/A	N/A
Lake Michigan-Oak Creek Supply Alignment 2	Low	Temporary	Low	Temporary	Absent	None	N/A	N/A	N/A	N/A	Low	Temporary	Low	Temporary
Lake Michigan-Racine Supply	High	Temporary and permanent	N/A	N/A	Absent	None	Low	Temporary	Absent	None	High	Temporary	N/A	N/A
Return Flow Alternatives														
Underwood Creek to Lake Michigan	N/A	N/A	N/A	N/A	Absent	None	N/A	N/A	N/A	N/A	Low	Temporary	N/A	N/A
Root River to Lake Michigan Alignment 1	N/A	N/A	N/A	N/A	Absent	None	N/A	N/A	N/A	N/A	Moderate	Temporary	N/A	N/A
Root River to Lake Michigan Alignment 2	Low	Temporary and permanent	Low	Temporary	Absent	None	N/A	N/A	N/A	N/A	Low	Temporary	Low	Temporary
Direct to Lake Michigan	N/A	N/A	N/A	N/A	Absent	None	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

¹Includes pipeline alignment, new access roads (15 feet wide), well houses, and WTP.
²The Areas of the 5-Foot or Greater Groundwater Drawdown is contained within the Areas of the 1-Foot or Greater Groundwater Drawdown.
³N/A is used when the natural community was not listed by the WDNR NHI results for the alternative, and was not observed during the 2010 Habitat Surveys.

⁴**Deep and Shallow Wells & Shallow Aquifer and Fox River Alluvium**
Groundwater Drawdowns: All impacts associated with the long-term groundwater drawdown and subsequent habitat type changes will be permanent. These permanent impacts will occur only to bodies of water and all wetlands types.
Pipeline and Aboveground Structures: “Temporary” impacts are those only associated with construction. While “Temporary and Permanent” impacts include temporary impacts from construction, in addition to the permanent impacts from access roads and aboveground structures, and the pipeline maintenance corridors. The permanent impacts for the pipeline maintenance corridors are only a small subset of the “Temporary and Permanent” total. To be conservative, it is assumed that the temporary impacts occur.

Lake Michigan Water Supply Alternatives
“Temporary” impacts are those only associated with construction. While “Temporary and Permanent” impacts include temporary impacts from construction, in addition to the permanent impacts from the pipeline maintenance corridors. The permanent impacts for the pipeline maintenance corridors are only a small subset of the “Temporary and Permanent” total. To be conservative, it is assumed that the temporary impacts occur.
Return Flow Alternatives
“Temporary” impacts are those only associated with construction. While “Temporary and Permanent” impacts include temporary impacts from construction, in addition to the permanent impacts from the pipeline maintenance corridors. The permanent impacts for the pipeline maintenance corridors are only a small subset of the “Temporary and Permanent” total. To be conservative, it is assumed that the temporary impacts occur.

⁵No impacts are likely to occur to upland prairie habitats as a result of the groundwater drawdowns.
Data Sources: Wisconsin Geological and Natural History Survey 2010 Spring Inventory, SEWRPC Land Use Data, and 2010 Habitat Surveys

Wet-Mesic Prairie
⁶ NHI investigation identified natural community only for Oak Creek Alignment 2 and Root River Alignment 2.

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EXHIBIT 3
Potential Occurrence of Natural Communities - Wetlands
Relative Comparison of Wildlife, Natural Community, and Endangered Resources

Alternative Name	Emergent Marsh		Shrub-Carr		Floodplain Forest	
	Relative Occurrence	Type Of Impact ⁴	Relative Occurrence	Type Of Impact ⁴	Relative Occurrence	Type Of Impact ⁴
Water Supply Alternatives						
Deep and Shallow Wells						
Pipeline & Aboveground Structures ¹	4 acres	Temporary and Permanent	5 acres	Temporary and permanent	2 acres	Temporary and permanent
Areas of 1-Foot or Greater Groundwater Drawdown	710 acres	Permanent	1,294 acres	Permanent	438 acres	Permanent
Areas of 5-Foot or Greater Groundwater Drawdown ²	241 acres	Permanent	419 acres	Permanent	138 acres	Permanent
Deep and Shallow Wells Total ³	714 acres		1,299 acres		440 acres	
Shallow Aquifer and Fox River Alluvium						
Pipeline & Aboveground Structures ¹	4 acres	Temporary and Permanent	7 acres	Temporary and permanent	8 acres	Temporary and permanent
Areas of 1-Foot or Greater Groundwater Drawdown	1,079 acres	Permanent	1,558 acres	Permanent	676 acres	Permanent
Areas of 5-Foot or Greater Groundwater Drawdown ²	475 acres	Permanent	871 acres	Permanent	290 acres	Permanent
Shallow Aquifer and Fox River Alluvium Total ³	1,083 acres		1,565 acres		684 acres	
Lake Michigan Supply Alternatives						
Lake Michigan-Milwaukee Supply	1 acre	Temporary	2 acres	Temporary and permanent	3 acres	Temporary and permanent
Lake Michigan-Oak Creek Supply Alignment 1	3 acres	Temporary	4 acres	Temporary and permanent	4 acres	Temporary and permanent
Lake Michigan-Oak Creek Supply Alignment 2	<0.1 acre	Temporary	<0.1 acre	Temporary	<0.1 acre	Temporary
Lake Michigan-Racine Supply	16 acres	Temporary	22 acres	Temporary and permanent	4 acres	Temporary and permanent
Return Flow Alternatives						
Underwood Creek to Lake Michigan	2 acres	Temporary	2 acres	Temporary and permanent	0.5 acres	Temporary and permanent
Root River to Lake Michigan Alignment 1	2 acres	Temporary	3 acres	Temporary and permanent	7 acres	Temporary and permanent
Root River to Lake Michigan Alignment 2	<0.1 acre	Temporary	<0.1 acre	Temporary	<1 acre	Temporary and permanent
Direct to Lake Michigan	2 acres	Temporary	2 acres	Temporary and permanent	Absent	Not applicable

¹ Includes pipeline alignment, new access roads (15 feet wide), well houses, and WTP.
²The Areas of the 5-Foot or Greater Groundwater Drawdown is contained within the Areas of the 1-Foot or Greater Groundwater Drawdown.
³Includes Pipeline & Aboveground Structures and Areas of 1-Foot or Greater Groundwater Drawdown.

⁴**Deep and Shallow Wells & Shallow Aquifer and Fox River Alluvium**
Groundwater Drawdowns: All impacts associated with the long-term groundwater drawdown and subsequent habitat type changes will be permanent. These permanent impacts will occur only to bodies of water and all wetlands types.
Pipeline and Aboveground Structures: “Temporary” impacts are those only associated with construction. While “Temporary and Permanent” impacts include temporary impacts from construction, in addition to the permanent impacts from access roads and aboveground structures, and the pipeline maintenance corridors. The permanent impacts for the pipeline maintenance corridors are only a small subset of the “Temporary and Permanent” total. To be conservative, it is assumed that the temporary impacts occur.
Lake Michigan Water Supply Alternatives
“Temporary” impacts are those only associated with construction. While “Temporary and Permanent” impacts include temporary impacts from construction, in addition to the permanent impacts from the pipeline maintenance corridors. The permanent impacts for the pipeline maintenance corridors are only a small subset of the “Temporary and Permanent” total. To be conservative, it is assumed that the temporary impacts occur.
Return Flow Alternatives
“Temporary” impacts are those only associated with construction. While “Temporary and Permanent” impacts include temporary impacts from construction, in addition to the permanent impacts from the pipeline maintenance corridors. The permanent impacts for the pipeline maintenance corridors are only a small subset of the “Temporary and Permanent” total. To be conservative, it is assumed that the temporary impacts occur.
Sources: SEWRPC Land Use Data, FEMA Firmette Mapping Database, & 2010 Habitat Surveys.

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EXHIBIT 4
Potential Suitability for Natural Communities - Special Wetland Types
Relative Comparison of Wildlife, Natural Community, and Endangered Resources

Alternative Name	Southern sedge meadow		Calcareous fen		Comments
	Relative Suitability ³	Type Of Impact ^{3,4}	Relative Suitability ³	Type Of Impact ^{3,4}	
Water Supply Alternatives					
Deep and Shallow Wells					
Pipeline & Aboveground Structures ¹	Low	Temporary and permanent	Low	Temporary and permanent	
Areas of 1-Foot or Greater Groundwater Drawdown	High	Permanent	N/A ⁵	N/A ⁵	
Areas of 5-Foot or Greater Groundwater Drawdown ²	High	Permanent	N/A ⁵	N/A ⁵	
Shallow Aquifer and Fox River Alluvium					
Pipeline & Aboveground Structures ¹	Low	Temporary and permanent	Low	Temporary and permanent	
Areas of 1-Foot or Greater Groundwater Drawdown	High	Permanent	N/A ⁵	N/A ⁵	
Areas of 5-Foot or Greater Groundwater Drawdown ²	High	Permanent	N/A ⁵	N/A ⁵	
Lake Michigan Supply Alternatives					
Lake Michigan-Milwaukee Supply	Low	Temporary	N/A	N/A	Southern Sedge Meadow: Although southern sedge meadow was not listed as occurring along this alternative by the WDNR NHI results, PEM wetlands that contain sedge species, joe-pye weed, swamp milkweed, and reed canary grass are located along bodies of water and were observed along this alternative during the July 2010 surveys.
Lake Michigan-Oak Creek Supply Alignment 1	Low	Temporary	Low	Temporary	
Lake Michigan-Oak Creek Supply Alignment 2	Low	Temporary	N/A	N/A	
Lake Michigan-Racine Supply	Moderate	Temporary	Moderate	Temporary	Southern Sedge Meadow: Although southern sedge meadow was not listed as occurring along this alternative by the WDNR NHI results, PEM wetlands that contain sedge species, joe-pye weed, swamp milkweed, and reed canary grass are located along bodies of water and were observed along this alternative during the July 2010 surveys. Calcareous Fen: Although no calcareous bog or fen areas were observed during the July 2010 habitat surveys, there were areas that the biologists were not able to observe.
Return Flow Alternatives					
Underwood Creek to Lake Michigan	Low	Temporary	N/A	N/A	
Root River to Lake Michigan Alignment 1	Low	Temporary	N/A	N/A	Southern Sedge Meadow: Although southern sedge meadow was not listed as occurring along this alternative by the WDNR NHI results, PEM wetlands that contain sedge species, joe-pye weed, swamp milkweed, and reed canary grass are located along bodies of water and were observed along this alternative during the July 2010 surveys.
Root River to Lake Michigan Alignment 2	Low	Temporary	N/A	N/A	
Direct to Lake Michigan	Low	Temporary	Low	Temporary	Southern Sedge Meadow: Although southern sedge meadow was not listed as occurring along this alternative by the WDNR NHI results, PEM wetlands that contain sedge species, joe-pye weed, swamp milkweed, and reed canary grass are located along bodies of water and were observed along this alternative during the July 2010 surveys.

¹Includes pipeline alignment, new access roads (15 feet wide), well houses, and WTP.
²The Areas of the 5-Foot or Greater Groundwater Drawdown is contained within the Areas of the 1-Foot or Greater Groundwater Drawdown.
³N/A is used when the natural community was not listed by the WDNR NHI results for the alternative.

⁴**Deep and Shallow Wells & Shallow Aquifer and Fox River Alluvium**
Groundwater Drawdowns: All impacts associated with the long-term groundwater drawdown and subsequent habitat type changes will be permanent. These permanent impacts will occur only to bodies of water and all wetlands types.
Pipeline and Aboveground Structures: “Temporary” impacts are those only associated with construction. While “Temporary and Permanent” impacts include temporary impacts from construction, in addition to the permanent impacts from access roads and aboveground structures, and the pipeline maintenance corridors. The permanent impacts for the pipeline maintenance corridors are only a small subset of the “Temporary and Permanent” total. To be conservative, it is assumed that the temporary impacts occur.

EXHIBIT 4
Potential Suitability for Natural Communities - Special Wetland Types
Relative Comparison of Wildlife, Natural Community, and Endangered Resources

Alternative Name	Southern sedge meadow		Calcareous fen		Comments
	Relative Suitability ³	Type Of Impact ^{3,4}	Relative Suitability ³	Type Of Impact ^{3,4}	

Lake Michigan Water Supply Alternatives

“Temporary” impacts are those only associated with construction. While “Temporary and Permanent” impacts include temporary impacts from construction, in addition to the permanent impacts from the pipeline maintenance corridors. The permanent impacts for the pipeline maintenance corridors are only a small subset of the “Temporary and Permanent” total. To be conservative, it is assumed that the temporary impacts occur.

Return Flow Alternatives

“Temporary” impacts are those only associated with construction. While “Temporary and Permanent” impacts include temporary impacts from construction, in addition to the permanent impacts from the pipeline maintenance corridors. The permanent impacts for the pipeline maintenance corridors are only a small subset of the “Temporary and Permanent” total. To be conservative, it is assumed that the temporary impacts occur.

⁵ N/A is used because based on communications from the Vernon Marsh Wildlife Manager no known calcareous fens occur within the groundwater drawdown areas.

Source: SEWRPC Land Use Data & 2010 Habitat Surveys.

EXHIBIT 5
Potential Suitability for Natural Communities – Forests
Relative Comparison of Wildlife, Natural Community, and Endangered Resources

Alternative Name	Northern Wet Forest		Southern Dry Forest		Southern Dry-Mesic Forest		Southern Mesic Forest		Southern Tamarack Swamp		Oak Opening	
	Relative Suitability ³	Type Of Impact ^{3,4}	Relative Suitability ³	Type Of Impact ^{3,4}	Relative Suitability ³	Type Of Impact ^{3,4}	Relative Suitability ³	Type Of Impact ^{3,4}	Relative Suitability ³	Type Of Impact ^{3,4}	Relative Suitability ^{3,6}	Type Of Impact ^{3,4,6}
Water Supply Alternatives												
Deep and Shallow Wells												
Pipeline & Aboveground Structures ¹	N/A	N/A	Absent	None	Absent	None	Absent	None	Low	Temporary and permanent	N/A	N/A
Areas of 1-Foot or Greater Groundwater Drawdown	N/A	N/A	High	No impacts will occur ⁵	High	No impacts will occur ⁵	High	No impacts will occur ⁵	High	Permanent	N/A	N/A
Areas of 5-Foot or Greater Groundwater Drawdown ²	N/A	N/A	High	No impacts will occur ⁵	High	No impacts will occur ⁵	High	No impacts will occur ⁵	High	Permanent	N/A	N/A
Shallow Aquifer and Fox River Alluvium												
Pipeline & Aboveground Structures ¹	N/A	N/A	Absent	None	Absent	None	Absent	None	Moderate	Temporary and permanent	N/A	N/A
Areas of 1-Foot or Greater Groundwater Drawdown	N/A	N/A	High	No impacts will occur ⁵	High	No impacts will occur ⁵	High	No impacts will occur ⁵	High	Permanent	N/A	N/A
Areas of 5-Foot or Greater Groundwater Drawdown ²	N/A	N/A	High	No impacts will occur ⁵	High	No impacts will occur ⁵	High	No impacts will occur ⁵	High	Permanent	N/A	N/A
Lake Michigan Supply Alternatives												
Lake Michigan-Milwaukee Supply	N/A	N/A	N/A	N/A	Low	Temporary and permanent	Low	Temporary and permanent	N/A	N/A	N/A	N/A
Lake Michigan-Oak Creek Supply Alignment 1	Low	Temporary and permanent	N/A	N/A	Low	Temporary and permanent	Low	Temporary and permanent	N/A	N/A	N/A	N/A
Lake Michigan-Oak Creek Supply Alignment 2	Low	Temporary	N/A	N/A	Low	Temporary	Low	Temporary	N/A	N/A	Low	Temporary
Lake Michigan-Racine Supply	Low	Temporary and permanent	Low	Temporary and permanent	Low	Temporary and permanent	Low	Temporary and permanent	N/A	N/A	N/A	N/A
Return Flow Alternatives												
Underwood Creek to Lake Michigan	N/A	N/A	N/A	N/A	Absent	None	Absent	None	N/A	N/A	N/A	N/A
Root River to Lake Michigan Alignment 1	N/A	N/A	N/A	N/A	Low	Temporary and permanent	Low	Temporary and permanent	N/A	N/A	N/A	N/A
Root River to Lake Michigan Alignment 2	Low	Temporary	N/A	N/A	Low	Temporary	Low	Temporary	N/A	N/A	Low	Temporary
Direct to Lake Michigan	N/A	N/A	N/A	N/A	Low	Temporary and permanent (Impacts are unlikely)	Low	Temporary and permanent (Impacts are unlikely)	N/A	N/A	N/A	N/A

¹ Includes pipeline alignment, new access roads (15 feet wide), well houses, and WTP.
²The Areas of the 5-Foot or Greater Groundwater Drawdown is contained within the Areas of the 1-Foot or Greater Groundwater Drawdown.
³N/A is used when the natural community was not listed by the WDNR NHI results for the alternative, and was not observed during the 2010 Habitat Surveys.

⁴**Deep and Shallow Wells & Shallow Aquifer and Fox River Alluvium**
Groundwater Drawdowns: All impacts associated with the long-term groundwater drawdown and subsequent habitat type changes will be permanent. These permanent impacts will occur only to bodies of water and all wetlands types.
Pipeline and Aboveground Structures: “Temporary” impacts are those only associated with construction. While “Temporary and Permanent” impacts include temporary impacts from construction, in addition to the permanent impacts from access roads and aboveground structures, and the pipeline maintenance corridors. The permanent impacts for the pipeline maintenance corridors are only a small subset of the “Temporary and Permanent” total. To be conservative, it is assumed that the temporary impacts occur.

Lake Michigan Water Supply Alternatives
“Temporary” impacts are those only associated with construction. While “Temporary and Permanent” impacts include temporary impacts from construction, in addition to the permanent impacts from the pipeline maintenance corridors. The permanent impacts for the pipeline maintenance corridors are only a small subset of the “Temporary and Permanent” total. To be conservative, it is assumed that the temporary impacts occur.

Return Flow Alternatives
“Temporary” impacts are those only associated with construction. While “Temporary and Permanent” impacts include temporary impacts from construction, in addition to the permanent impacts from the pipeline maintenance corridors. The permanent impacts for the pipeline maintenance corridors are only a small subset of the “Temporary and Permanent” total. To be conservative, it is assumed that the temporary impacts occur.

⁵ No impacts are likely to occur to upland forested habitats as a result of the groundwater drawdowns.

Source: Vernon Marsh Wildlife Manager, SEWRPC Land Use Data & 2010 Habitat Surveys.

Oak Opening

⁶ NHI investigation identified this natural community only for Oak Creek Alignment 2 and Root River Alignment 2.

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EXHIBIT 6
Estimated Land Uses Crossed by the Proposed Alternatives (Acres)
Relative Comparison of Wildlife, Natural Community, and Endangered Resources

Alternative Name	Residential		Commercial & Industrial		Transportation		Utilities (Power & Comm.)		Government & Institutional		Recreational Areas		Agricultural Lands		Open Lands		Woodlands		Surface Water		
	Temporary Land Affected ¹ (ac)	Permanent Land Affected ² (ac)	Temporary Land Affected ¹ (ac)	Permanent Land Affected ² (ac)	Temporary Land Affected ¹ (ac)	Permanent Land Affected ² (ac)	Temporary Land Affected ¹ (ac)	Permanent Land Affected ² (ac)	Temporary Land Affected ¹ (ac)	Permane nt Land Affected ² (ac)	Temporary Land Affected ¹ (ac)	Permanent Land Affected ² (ac)	Temporary Land Affected ¹ (ac)	Permanent Land Affected ² (ac)	Temporary Land Affected ¹ (ac)	Permanent Land Affected ² (ac)	Temporary Land Affected ¹ (ac)	Permanent Land Affected ² (ac)	Temporary Land Affected ¹ (ac)	Permanent Land Affected ² (ac)	
Water Supply Alternatives																					
Deep and Shallow Wells																					
Pipeline & Aboveground Structures ⁴	11	<0.1	2	0	76	<1	1	0	1	0	1	0	47	27	6	<0.1	0	0	<1	0	
Areas of 1-Foot or Greater Groundwater Drawdown	3,996	0	150	0	1,341	0	5	0	98	0	226	0	6,183	0	1,252	0	1,079	0	79	79	
Areas of 5-Foot or Greater Groundwater Drawdown ⁵	1,616	0	74	0	419	0	4	0	81	0	32	0	1,977	0	387	0	338	0	7	7	
Deep and Shallow Wells Total ⁶	4,007	<0.1	152	0	1,417	<1	6	0	99	0	227	0	6,230	27	1,258	<0.1	1,079	0	80	79	
Shallow Aquifer and Fox River Alluvium																					
Pipeline & Aboveground Structures ⁴	11	<0.1	2	0	76	1	1	0	1	0	1	0	74	47	6	<0.1	0	0	1	0	
Areas of 1-Foot or Greater Groundwater Drawdown	4,216	0	176	0	1,419	0	12	0	99	0	256	0	6,968	0	1,339	0	1,211	0	122	122	
Areas of 5-Foot or Greater Groundwater Drawdown ⁵	2,114	0	91	0	604	0	7	0	84	0	149	0	3,342	0	610	0	583	0	38	38	
Shallow Aquifer and Fox River Alluvium Total ⁶	4,227	<0.1	178	0	1,495	1	13	0	100	0	257	0	7,042	47	1,345	<0.1	1,211	0	123	122	
Lake Michigan Supply Alternatives																					
Lake Michigan-Milwaukee Supply	3	0	3	0	67	0	31	0	<1	0	2	0	0	0	8	0	1	0	0	0	
Lake Michigan-Oak Creek Supply Alignment 1	10	0	3	0	101	0	59	0	1	0	5	0	4	0	31	0	2	<0.1	<1	0	
Lake Michigan-Oak Creek Supply Alignment 2	6	0	<1	0	166	0	<0.1	0	<1	0	<1	0	3	0	1	0	<1	0	0	0	
Lake Michigan-Racine Supply	9	0	4	0	26	0	8	0	<1	0	4	0	213	0	31	0	8	1	<1	0	
Return Flow Alternatives																					
Underwood Creek to Lake Michigan	2	0	4	0	24	0	51	0	1	0	3	0	0	0	6	0	0	0	<1	0	
Root River to Lake Michigan Alignment 1	2	0	2	0	41	0	51	0	1	0	9	0	0	0	20	0	1	<1	<1	0	
Root River to Lake Michigan Alignment 2	6	0	<1	0	167	0	<1	0	1	0	<1	0	4	0	4	0	<0.1	0	<0.1	0	
Direct to Lake Michigan	5	0	10	0	92	0	63	0	4	0	5	0	0	0	11	0	<1	0	<1	0	

¹ Includes all areas being temporarily impacted by the construction of the supply and return flow alternatives.
² Includes all land being disturbed permanently for groundwater drawdowns and the operation of the alternatives, which includes new access roads, new aboveground structures, and pipeline maintenance corridors.
³ Includes filled/drained wetlands, and flats/unvegetated wet soil areas.
⁴ Includes pipeline alignment, new access roads (15 feet wide), well houses, and WTP.
⁵The Areas of the 5-Foot or Greater Groundwater Drawdown is contained within the Areas of the 1-Foot or Greater Groundwater Drawdown.
⁶Includes Pipeline & Aboveground Structures and Areas of 1-Foot or Greater Groundwater Drawdown.
Source: SEWRPC Land Use Data

EXHIBIT 6 (CONTINUED)
Land Uses Crossed by the Proposed Alternatives (Acres)
Relative Comparison of Wildlife, Natural Community, and Endangered Resources

Alternative Name	Wetlands (acres)											
	Emergent/Wet Meadow		Scrub/Shrub		Forested		Open Water		Other ³		Total	
	Temporary Land Affected ¹	Permanent Land Affected ²	Temporary Land Affected ¹	Permanent Land Affected ²	Temporary Land Affected ¹	Permanent Land Affected ²	Temporary Land Affected ¹	Permanent Land Affected ²	Temporary Land Affected ¹	Permanent Land Affected ²	Temporary Land Affected ¹	Permanent Land Affected ²
Water Supply Alternatives												
Deep and Shallow Wells												
Pipeline & Aboveground Structures ⁴	4	2	5	1	2	1	0	0	<1	0	156	31
Areas of 1-Foot or Greater Groundwater Drawdown	710	710	1,294	1,294	932	932	89	89	62	62	17,496	4,098
Areas of 5-Foot or Greater Groundwater Drawdown ⁵	241	241	419	419	307	307	11	11	14	14	5,927	1,306
Deep and Shallow Wells Total ⁶	714	712	1,299	1,295	934	933	89	89	63	62	17,652	4,129
Shallow Aquifer and Fox River Alluvium												
Pipeline & Aboveground Structures ⁴	4	2	7	2	11	3	0	0	<1	0	195	55
Areas of 1-Foot or Greater Groundwater Drawdown	1,079	1,079	1,558	1,558	1,279	1,279	103	103	87	87	19,924	5,507
Areas of 5-Foot or Greater Groundwater Drawdown ⁵	475	475	871	871	548	548	37	37	33	33	9,586	2,550
Shallow Aquifer and Fox River Alluvium Total ⁶	1,083	1,081	1,565	1,560	1,290	1,282	103	103	88	87	20,119	5,562
Lake Michigan Supply Alternatives												
Lake Michigan-Milwaukee Supply ⁷	1	0	2	<1	4	1	<1	0	0	0	123	2
Lake Michigan-Oak Creek Supply Alignment 1 ⁷	3	0	4	1	6	1	<1	0	0	0	230	2
Lake Michigan-Oak Creek Supply Alignment 2 ⁷	<0.1	0	<1	0	<1	0	0	0	0	0	178	0
Lake Michigan-Racine Supply ⁷	16	0	22	4	7	1	2	0	6	0	357	6
Return Flow Alternatives												
Underwood Creek to Lake Michigan ⁷	2	0	2	0	5	1	<1	0	0	0	101	1
Root River to Lake Michigan Alignment 1 ⁷	2	0	3	<0.1	7	1	<1	0	0	0	140	2
Root River to Lake Michigan Alignment 2 ⁷	<0.1	0	<1	0	<1	<1	0	0	<0.1	0	184	<1
Direct to Lake Michigan ⁷	2	0	2	0	1	<1	<1	0	<1	0	196	1

¹ Includes all areas being temporarily impacted by the construction of the supply and return flow alternatives.
² Includes all land being disturbed permanently for groundwater drawdowns and the operation of the alternatives, which includes new access roads, new aboveground structures, and pipeline maintenance corridors.
³ Includes filled/drained wetlands, and flats/unvegetated wet soil areas.
⁴ Includes pipeline alignment, new access roads (15 feet wide), well houses, and WTP.
⁵The Areas of the 5-Foot or Greater Groundwater Drawdown is contained within the Areas of the 1-Foot or Greater Groundwater Drawdown.
⁶Includes Pipeline & Aboveground Structures and Areas of 1-Foot or Greater Groundwater Drawdown.
⁷The majority of pipeline alignments follow previously disturbed areas and maintained utility corridors. Forested wetlands are generally not present in maintained utility corridors. Potential permanent wetland impacts are consequently conservative. Permanent wetland impacts incorporated in the Environmental Report are consequently estimated to be less than 5 acres, minor adverse impact.
Source: SEWRPC Land Use Data, WWI

Exhibit 7 is provided separately due to the sensitive nature of the potential habitat locations for threatened and endangered species.

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Exhibit 8 is provided separately due to the sensitive nature of the potential habitat locations for threatened and endangered species.

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EXHIBIT 9
Relative Occurrence of State- and Federally-Listed Species per Land Use for Each Proposed Alternative
Relative Comparison of Wildlife, Natural Community, and Endangered Resources

Alternative Name	Residential	Commercial & Industrial	Transportation	Utilities (Power & Communication)	Government & Institutional	Recreational Areas	Agricultural Lands	Open Lands	Woodlands	Surface Water	Wetlands ¹	Total Listed Species Per Route
Water Supply Alternatives												
Deep and Shallow Wells ²	0%	0%	2%	0%	0%	0%	2%	9%	8%	19%	61%	60
Shallow Aquifer and Fox River Alluvium ²	0%	0%	2%	0%	0%	0%	2%	9%	8%	19%	61%	60
Lake Michigan-Milwaukee Supply	0%	0%	2%	0%	0%	0%	3%	10%	14%	14%	57%	36
Lake Michigan-Oak Creek Supply Alignment 1	0%	0%	1%	<1%	0%	0%	3%	11%	14%	14%	57%	53
Lake Michigan-Oak Creek Supply Alignment 2	0%	0%	2%	0%	0%	0%	4%	11%	20%	20%	45%	31
Lake Michigan-Racine Supply	0%	0%	3%	0%	0%	0%	1%	11%	17%	13%	55%	62
Return Flow Alternatives												
Underwood Creek to Lake Michigan	0%	0%	3%	0%	0%	0%	3%	12%	15%	14%	52%	38
Root River to Lake Michigan Alignment 1	0%	0%	2%	0%	0%	0%	4%	12%	15%	13%	54%	35
Root River to Lake Michigan Alignment 2	0%	0%	2%	0%	0%	0%	4%	12%	21%	19%	42%	29
Direct to Lake Michigan	0%	1%	3%	1%	0%	0%	3%	13%	13%	13%	52%	43

¹ Includes all wetland types, including, emergent/wet meadow, scrub-shrub, forested, open water, and other. See Exhibit 6.
² Includes pipeline, access roads, wells, and WTP, as well as the areas of 1-foot and greater, and areas of 5-foot and greater groundwater drawdown areas.
Sources: SEWRPC Land Use Data and Wisconsin Dept. of Natural Resources, Natural Heritage Inventory Results

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Appendix 6-6
Wildlife Resources

Wildlife Resources

Attachments

- A Volume 1: Public Agency Correspondence
- B Volume 2: Confidential Agency Correspondence

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References

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TABLE 1
 Deep and Shallow Wells & Shallow Aquifer and Fox River Alluvium Supply: State-Listed Endangered and Threatened
 Species and Communities
City of Waukesha Water Supply

Species Group	Scientific Name	Common Name	State Status ^a	Federal Status ^a	Date Last Observed
Habitat/Other	—	Bird Rookery	N/A	—	1994 6/25/2010 9/10/1992 7/29/1993
	—	Calcerous Fen	N/A	—	9/24/1993 9/18/1991 9/16/1993 5/30/1992
	—	Emergent Marsh	N/A	—	7/28/1993 10/28/1992
	—	Floodplain Forest	N/A	—	1981
	—	Mesic Prairie	N/A	—	7/26/2002
	—	Southern dry forest	N/A	—	4/30/1992
	—	Southern dry-mesic forest	N/A	—	4/30/1992 4/29/1992
	—	Southern mesic forest	N/A	—	3/30/2006 4/28/1992 10/13/1993
	—	Southern sedge meadow	N/A	—	9/25/1992 7/29/1993 9/16/1993
	—	Southern tamarack swamp	N/A	—	6/1963 7/29/1993
	—	Springs and Spring Runs	N/A	—	7/1976 5/1977
Plants	<i>Agrimonia parviflora</i>	Swamp Agrimony	SC	—	6/3/1882 1999 5/21/2010
	<i>Asclepias Purpurascens</i>	Purple Milkweed	E	—	4/7/1928
	<i>Aster furcatus</i>	Forked aster	T	—	8/6/1999 8/18/1998
	<i>Cacalia tuberosa</i>	Prairie Indian plantain	T	—	7/25/1925
	<i>Carex Crawei</i>	Crawe Sedge	SC	—	1852 8/14/1992 6/9/1997 6/10/1898
	<i>Cypripedium candidum</i>	Small White Lady's Slipper	T	—	5/31/1948 5/25/1994 5/21/2010 8/11/1982
	<i>Cypripedium parviflorum</i>	Northern yellow lady's slipper	SC	—	5/7/1938 5/25/2010
	<i>Gentiana alba</i>	Yellow Gentian	T	—	8/30/1938 9/10/1992 9/25/1995
	<i>Gentianopsis procera</i>	Lesser Fringed Gentian	SC	—	5/25/1994 10/13/1993 6/21/1905 1852
	<i>Jeffersonia diphylla</i>	Twinleaf	SC	—	6/24/1930 8/7/1933
	<i>Liatriis spicata</i>	Marsh blazing star	SC	—	8/10/1897
	<i>Myriophyllum faewellii</i>	Farwell's Water-milfoil	SC	—	5/31/1931
	<i>Polygala cruciata</i>	Crossleaf Milkwort	SC	—	8/1875
	<i>Prenanthes aspera</i>	Rough rattlesnake root	E	—	1845
	<i>Ptelea trifoliata</i>	Wafer-ash	SC	—	9/10/1992

TABLE 1

Deep and Shallow Wells & Shallow Aquifer and Fox River Alluvium Supply: State-Listed Endangered and Threatened Species and Communities
City of Waukesha Water Supply

Species Group	Scientific Name	Common Name	State Status ^a	Federal Status ^a	Date Last Observed
	<i>Solidago ohioensis</i>	Ohio Goldenrod	SC	—	8/30/1928
					9/10/1992
					6/9/1997
					7/11/1956
					3/16/2000
					6/21/1905
					5/25/1994
	<i>Thaspium trifoliatum</i> var. <i>flavum</i>	Purple Meadow-Parsnip	SC	—	6/22/1905
					5/30/1930
	<i>Tofieldia glutinosa</i>	Sticky false-asphodel	T	—	7/5/1915
					9/24/1993
					5/24/2010
	<i>Epilobium strictum</i>	Downy willow-herb	SC	—	8/24/1983
	<i>Trillium recurvatum</i>	Reflexed Trillium	SC	—	4/28/1992
	<i>Eleocharis rostellata</i>	Beaked Spikerush	T	—	5/25/1994
					5/24/2010
	<i>Scirpus cespitosus</i>	Tufted Bulrush	T	—	5/27/1970
					5/24/2010
	<i>Triglochin maritime</i>	Common Bog Arrow-grass	SC	—	9/24/1993
	<i>Triglochin palustris</i>	Slender Bog Arrow-grass	SC	—	5/24/2010
	<i>Cardamine pratensis</i>	Cuckooflower	SC	—	9/13/1991
	<i>Eleocharis quinqueflora</i>	Few-flower Spikerush	SC	—	7/1/1993
	<i>Scleria verticillata</i>	Low nutrush	SC		9/2/1996
					6/1995
Reptiles & Amphibians	<i>Acris crepitans</i>	Northern cricket frog	E	—	5/1/1955
					5/1993
	<i>Emydoidea blandingii</i>	Blanding's turtle	T	—	8/28/2005
					5/2009
					7/7/2008
					4/5/1955
					4/17/1998
					6/7/2007
	<i>Thamnophis butleri</i>	Butler's gartersnake	T	—	2/10/2007
					Oct-07
					2004
					2003
Fish and Mussels	<i>Alasmodonta marginata</i>	Elktoe	SC	—	10/2/2007
					9/2008
	<i>Alasmodonta virdis</i>	Slippershell Mussel	T	—	2006
					8/15/2001
					9/10/1996
	<i>Erimyzon sucetta</i>	Lake chubsucker	SC	—	8/15/2001
					9/10/1006
	<i>Lepomis megalotis</i>	Longear Sunfish	T	—	6/29/2006
					11/7/1978
	<i>Luxilus chrysocephalus</i>	Striped shiner	E	—	7/13/1978
					9/11/2008

TABLE 1
 Deep and Shallow Wells & Shallow Aquifer and Fox River Alluvium Supply: State-Listed Endangered and Threatened
 Species and Communities
City of Waukesha Water Supply

Species Group	Scientific Name	Common Name	State Status ^a	Federal Status ^a	Date Last Observed
	<i>Fundulus diaphanous</i>	Banded Killfish	SC	—	9/3/2008 6/28/1978 11/9/1978
	<i>Fundulus dispar</i>	Starhead Topminnow	E	—	9/9/2008 11/9/1978
	<i>Pleurobema sintoxia</i>	Round Pigtoe	SC	—	6/26/2006
	<i>Venustacocha ellipiformis</i>	Ellipse	T	—	6/26/2001 9/5/2001
	<i>Villosa iris</i>	Rainbow Shell	E	—	6/26/2006 6/28/2006 6/28/1978
	<i>Notropis anogenus</i>	Pugnose Shiner	SC	—	9/18/2003 6/26/2006 10/8/1971
	<i>Moxostoma valenciennesi</i>	Greater redhorse	T	—	9/3/2008
	<i>Notropis texanus</i>	Weed Shiner	SC	—	8/5/1928
	<i>Noturus exilis</i>	Slender madtom	E	—	1/1/1923
	<i>Etheostoma microperca</i>	Least Darter	SC	—	6/14/1978 7/10/1978
	<i>Moxostoma carinatum</i>	River Redhorse	T	—	5/26/1994
Birds	<i>Anas Acuta</i>	Northern pintail	SC	—	7/10/1992
	<i>Chlidonias niger</i>	Black tern	SC	—	5/30/1992 7/10/2010 6/12/2009
	<i>Gallinula Chloropus</i>	Common Moorhen	SC	—	5/30/1992 6/6/2006
	<i>Ixobrychus exilis</i>	Least bittern	SC	—	7/10/2010
Insects	<i>Calephelis muticum</i>	Swamp Metalmark	E	—	7/24/1973
	<i>Engallagnma basidens</i>	Double-striped Bluet	SC	—	6/27/1990
	<i>Euphyes bimacula</i>	Two-spotted Skipper	SC	—	6/27/1977
	<i>Ischnura posita</i>	Fragile Forktail	SC	—	7/22/1990
	<i>Nannothemis bella</i>	Elfin Skimmer	SC	—	7/5/2006
	<i>Papaipema beeriana</i>	Liatris borer moth	SC	—	9/16/1994
	<i>Papaipema silphii</i>	Silphium Borer Moth	E	—	9/10/1994
	<i>Poanes viator</i>	Broad-winged Skipper	SC	—	8/12/1993
Crustacean	<i>Procambarus gracilis</i>	Prairie Crayfish	SC	—	6/6/1984
Mammals	<i>Spermophilus franklinii</i>	Franklin's ground Squirrel	SC	—	1980

^aE, Endangered; T, Threatened; SC, Species of Concern (not legally protected).

TABLE 2

Lake Michigan—Milwaukee Supply: State-Listed Endangered and Threatened Species and Communities
City of Waukesha Water Supply

Species Group	Scientific Name	Common Name	State Status ^a	Federal Status ^a	Date Last Observed
Habitat	—	Southern dry-mesic forest	N/A	—	5/1/1992 9/3/1997 5/23/2002
	—	Bird Rookery	NA	—	NA
	—	Southern mesic forest	N/A	—	2/8/1988
Plants	<i>Asclepias purpurascens</i>	Purple milkweed	E	—	7/13/1912
	<i>Astragalus neglectus</i>	Cooper's milkvetch	E	—	6/22/1939
	<i>Carex crus-corvi</i>	Ravenfoot sedge	E	—	6/22/1988
	<i>Carex lupuliformis</i>	False hop sedge	E	—	7/22/1988 1995
	<i>Conioselinum chinense</i>	Hemlock parsley	E	—	8/25/1897
	<i>Platanthera leucophaea</i>	Prairie white-fringed orchid	E	T	7/9/1890
	<i>Erigenia bulbosa</i>	Harbinger-of-spring	E	—	4/25/1897
	<i>Prenanthes aspera</i>	Rough rattlesnake root	E	—	1845
	<i>Cypripedium arietinum</i>	Ram's-head lady's slipper	T	—	6/1897
	<i>Cypripedium candidum</i>	Small white lady's slipper	T	—	1850
	<i>Aster furcatus</i>	Forked aster	T	—	6/7/1999
	<i>Cacalia muehlenbergii</i>	Great Indian plantain	SC	—	7/1/1937
	<i>Lithospermum latifolium</i>	American gromwell	SC	—	5/29/1976 4/30/1992 5/11/1992
	<i>Platanthera hookeri</i>	Hooker orchid	SC	—	7/9/1899
	<i>Scutellaria ovata</i>	Heart-leaved skullcap	SC	—	5/12/1980 8/1/2000
	<i>Trillium recurvatum</i>	Reflexed trillium	SC	—	5/28/2000 5/23/2002
	<i>Calamagrostis stricta</i>	Slim-stem small reedgrass	SC	—	6/30/1940
	<i>Carex tenuiflora</i>	Sparse-flowered sedge	SC	—	6/3/1882
	<i>Cypripedium parviflorum</i>	Northern yellow lady's slipper	SC	—	6/3/1932
	<i>Liatris spicata</i>	Marsh blazing star	SC	—	9/1875
	<i>Thalictrum revolutum</i>	Waxleaf meadowrue	SC	—	8/8/1933 6/30/1940
	<i>Triglochin maritime</i>	Common bog arrow-grass	SC	—	1800s
	<i>Ptelea trifoliata</i>	Wafer-ash	SC	—	10/3/2000
	<i>Viburnum prunifolium</i>	Smooth black-haw	SC	—	12/2/1999
	<i>Platanthera dilatata</i>	Leafy white orchid	SC	—	7/1884

TABLE 2
 Lake Michigan—Milwaukee Supply: State-Listed Endangered and Threatened Species and Communities
City of Waukesha Water Supply

Species Group	Scientific Name	Common Name	State Status ^a	Federal Status ^a	Date Last Observed
Reptiles & Amphibians	<i>Acris crepitans</i>	Northern cricket frog	E	—	5/10/1946 5/1/1955
	<i>Thamnophis butleri</i>	Butler's gartersnake	T	—	7/13/2007 10/23/2007 6/2008 10/23/2008
	<i>Emydoidea blandingii</i>	Blanding's turtle	T	—	5/3/1988 6/26/1996 2002
	<i>Lithobates catesbeianus</i>	American bullfrog	SC	—	7/20/1988
Fish	<i>Luxilus chrysocephalus</i>	Striped shiner	E	—	1920
	<i>Lythrurus umbratilis</i>	Redfin shiner	T	—	7/11/1924
	<i>Clinostomus elongates</i>	Redside dace	SC	—	3/20/1910
	<i>Erimyzon sucetta</i>	Lake chubsucker	SC	—	3/29/1977 5/10/1979
Insects	<i>Pompeius verna</i>	Little glassy wing	SC	—	7/12/1988
	<i>Archilestes grandis</i>	Great spreadwing	SC	—	9/20/1984
Crustaceans	<i>Procambarus gracilis</i>	Prairie crayfish	SC	—	3/28/1910 5/11/1970

^aE, Endangered; T, Threatened; SC, Species of Concern (not legally protected).

TABLE 3

Lake Michigan—Oak Creek Supply Alignment 1: State-Listed Endangered and Threatened Species and Communities
City of Waukesha Water Supply

Species Group	Scientific Name	Common Name	State Status ^a	Federal Status ^a	Date Last Observed
Habitat	—	Southern dry mesic forest	N/A	—	6/11/1991 5/1/1992 9/30/1997 7/24/2001 5/23/2002 5/1/2003
	—	Southern mesic forest	N/A	—	2/8/1988 6/16/1991 6/22/1995 7/29/1999
	—	Mesic prairie	N/A	—	8/17/1992
	—	Wet prairie	N/A	—	7/1985
	—	Emergent marsh	N/A	—	7/1985
	—	Southern sedge meadow	N/A	—	7/1985
	—	Calcareous fen	N/A	—	9/9/1991
	—	Shrub-carr	N/A	—	7/1985
	—	Northern wet forest	N/A	—	7/1985
	—	Floodplain forest	N/A	—	6/2/1995
	—	Springs and spring runs (hard)	N/A	—	7/1985
Plants	<i>Asclepias purpurascens</i>	Purple milkweed	E	—	8/20/1905 7/13/1912 7/4/1928
	<i>Solidago caesia</i>	Bluestem goldenrod	E	—	9/16/1991 8/30/2000 6/4/2003 9/20/2003
	<i>Platanthera leucophaea</i>	Prairie white-fringed orchid	E	T	7/9/1890
	<i>Carex lupuliformis</i>	False hop sedge	E	—	1995 5/1/2003
	<i>Carex crus-corvi</i>	Ravenfoot sedge	E	—	6/22/1988
	<i>Trisetum melicoides</i>	Purple false oats	E	—	8/4/1940
	<i>Astragalus neglectus</i>	Cooper's milkvetch	E	—	6/22/1939
	<i>Conioselinum chinense</i>	Hemlock parsley	E	—	8/25/1897
	<i>Erigenia bulbosa</i>	Harbinger-of-spring	E	—	4/25/1897
	<i>Prenanthes aspera</i>	Rough rattlesnake root	E	—	1845
	<i>Aster furcatus</i>	Forked aster	T	—	5/1/1992 1997
	<i>Tofieldia glutinosa</i>	Sticky false-asphodel	T	—	7/31/2003
	<i>Cypripedium arietinum</i>	Ram's-head lady's slipper	T	—	6/1897

TABLE 3
 Lake Michigan—Oak Creek Supply Alignment 1: State-Listed Endangered and Threatened Species and Communities
City of Waukesha Water Supply

Species Group	Scientific Name	Common Name	State Status ^a	Federal Status ^a	Date Last Observed
	<i>Cypripedium candidum</i>	Small white lady's slipper	T	—	1850
	<i>Scutellaria ovata</i>	Heart-leaved skullcap	SC	—	5/12/1980 8/1/2000
	<i>Carex tenuiflora</i>	Sparse-flowered sedge	SC	—	6/3/1882
	<i>Cacalia muehlenbergii</i>	Great Indian plantain	SC	—	7/1/1937
	<i>Medeola virginiana</i>	Indian cucumber-root	SC	—	6/6/1908
	<i>Platanthera hookeri</i>	Hooker orchid	SC	—	7/9/1899
	<i>Trillium recurvatum</i>	Reflexed trillium	SC	—	5/18/1941 5/11/1992 4/30/1999 5/28/2000 7/11/2000 5/23/2002 5/1/2003
	<i>Viburnum prunifolium</i>	Smooth black-haw	SC	—	9/16/1991 4/26/2000 7/11/2000 5/1/2003
	<i>Cypripedium parviflorum</i>	Northern yellow lady's slipper	SC	—	5/30/1889 7/9/1890 6/3/1932
	<i>Liatris spicata</i>	Marsh blazing star	SC	—	9/1875
	<i>Epilobium strictum</i>	Downy willow-herb	SC	—	8/19/1983
	<i>Triglochin maritima</i>	Common bog arrow-grass	SC	—	1800s
	<i>Platanthera dilatata</i>	Leafy white orchid	SC	—	7/1884
	<i>Glycyrrhiza lepidota</i>	Wild licorice	SC	—	8/13/1940
	<i>Thalictrum revolutum</i>	Waxleaf meadowrue	SC	—	6/30/1940 7/5/1963 6/15/2000
	<i>Lithospermum latifolium</i>	American gromwell	SC	—	5/27/1897 5/29/1976 4/30/1992 5/11/1992 10/19/2005
	<i>Calamagrostis stricta</i>	Slim-stem small reedgrass	SC	—	6/30/1940
	<i>Cakile lacustris</i>	American sea-rocket	SC	—	7/26/1975
	<i>Cypripedium reginae</i>	Showy lady's slipper	SC	—	6/17/1939
	<i>Equisetum variegatum</i>	Variegated horsetail	SC	—	6/30/1995
	<i>Gentianopsis procera</i>	Lesser fringed gentian	SC	—	9/22/2000

TABLE 3

Lake Michigan—Oak Creek Supply Alignment 1: State-Listed Endangered and Threatened Species and Communities
City of Waukesha Water Supply

Species Group	Scientific Name	Common Name	State Status ^a	Federal Status ^a	Date Last Observed
	<i>Solidago ohioensis</i>	Ohio goldenrod	SC	—	10/20/2000
	<i>Triglochin palustris</i>	Slender bog arrow-grass	SC	—	8/11/1981
	<i>Ptelea trifoliata</i>	Wafer-ash	SC	—	10/3/2000
Birds	<i>Sterna forsteri</i>	Forster's tern	E	—	2004
	<i>Nycticorax nycticorax</i>	Black-crowned night heron	SC	—	1962
	<i>Pandion haliaetus</i>	Osprey	SC	—	5/2008
	<i>Spiza Americana</i>	Dickissel	SC	—	7/7/2000
Reptiles & Amphibians	<i>Acris crepitans</i>	Northern cricket frog	E	—	5/10/1946 5/1/1955
	<i>Thamnophis butleri</i>	Butler's gartersnake	T	—	7/14/2006 5/14/2007 7/13/2007 10/23/2007 4/2008 6/2008 10/23/2008
	<i>Emydoidea blandingii</i>	Blanding's turtle	T	—	5/3/1988 6/4/1996 5/9/2000 2002
	<i>Lithobates catesbeianus</i>	American bullfrog	SC	—	7/20/1988
Fish	<i>Luxilus chrysocephalus</i>	Striped shiner	E	—	1920
	<i>Lythrurus umbratilis</i>	Redfin shiner	T	—	7/11/1974
	<i>Lepomis megalotis</i>	Longear sunfish	T	—	4/4/2000
	<i>Etheostoma microperca</i>	Least darter	SC	—	7/11/1924
	<i>Erimyzon sucetta</i>	Lake chubsucker	SC	—	3/29/1977 5/10/1979
Insects	<i>Somatochlora ensigera</i>	Lemon-faced emerald	SC	—	6/25/1978
	<i>Pompeius verna</i>	Little glassy wing	SC	—	7/12/1988
Crustaceans	<i>Procambarus gracilis</i>	Prairie crayfish	SC	—	5/11/1970 8/7/1982

^aE, Endangered; T, Threatened; SC, Species of Concern (not legally protected).

TABLE 4

Lake Michigan—Oak Creek Supply Alignment 2: State-Listed Endangered and Threatened Species and Communities
 City of Waukesha Water Supply

Species Group	Scientific Name	Common Name	State Status ^a	Federal Status ^a	Date Last Observed	Within 75' Corridor
Habitat	—	Mesic Prairie	N/A	—	7/26/2002	x
					8/17/1992	
					April 1999	x
					March 1992	x
	—	Southern dry-mesic forest	N/A	—	9/30/1997	
					6/11/1991	
					6/6/1992	
					7/24/2001	
	—	Floodplain Forest	N/A	—	July 1876	x
					June 1995	
	—	Emergent Marsh	N/A	—	July 1985	x
	—	Northern Wet Forest	N/A	—	July 1985	x
	—	Shurb-carr	N/A	—	July 1985	x
	—	Southern Sedge Meadow	NA	—	July 1985	x
	—	Wet Prairie	N/A	—	July 1985	
	—	Oak Opening	N/A	—	8/17/1992	
	—	Wet Mesic Prairie	N/A	—	9/7/1993	
	—	Bird Rookery	N/A	—	1995	
	—	Southern Mesic Forest	N/A	—	6/22/1995	
Plants	<i>Prenanthes aspera</i>	Rough rattlesnake root	E	—	1845	x
	<i>Asclepias purpurascens</i>	Purple milkweed	E	—	7/4/1928	x
	<i>Carex crus-corvi</i>	Ravenfoot sedge	E	—	9/9/1996	x
					7/27/1994	
	<i>Solidago caesia</i>	Bluestem Goldenrod	E	—	9/20/2003	
					10/3/2000	
	<i>Platanthera leucophaea</i>	Prairie White-fringed Orchid	E	T	7/9/1890	
	<i>Carex lupuliformis</i>	False Hop Sedge	E	—	1991	
	<i>Aster furcatus</i>	Forked Aster	T	—	5/1/1992	
	<i>Fraxinus quadrangulata</i>	Blue Ash	T	—	8/5/2009	x
	<i>Cacalia tuberosa</i>	Prairie Indian-Plantain	T	—	6/24/1939	
	<i>Carex formosa</i>	Handsome Sedge	T	—	5/20/1993	
	<i>Aplectrum hyemale</i>	Putty Root	SC	—	1967	x
	<i>Platanthera hookeri</i>	Hooker orchid	SC	—	7/9/1899	x
	<i>Viburnum prunifolium</i>	Smooth black-haw	SC	—	6/11/1991	x
					7/11/2002	
	<i>Jeffersonia diphylla</i>	Twinleaf	SC	—	6/24/1930	
	<i>Scutellaria ovata ssp. ovata</i>	Heart-leaved Skullcap	SC	—	7/11/2002	

TABLE 4

Lake Michigan—Oak Creek Supply Alignment 2: State-Listed Endangered and Threatened Species and Communities
City of Waukesha Water Supply

Birds	<i>Sterna forsteri</i>	Forster's Tern	E	—	6/19/2009	
	<i>Aythya americana</i>	Redhead	SC	—	6/22/2005	
	<i>Chlidonias niger</i>	Black Tern	SC	—	6/27/2009	
	<i>Ixobrychus exilis</i>	Least Bittern	SC	—	5/18/2010	
	<i>Xanthocephalus xanthocephalus</i>	Yellow-headed Blackbird	SC	—	5/18/2010	
	<i>Nycticorax nycticorax</i>	Black-crowned Night-Heron	SC	—	5/15/1905	
Reptiles & Amphibians	<i>Acris crepitans</i>	Northern cricket frog	E	—	5/1/1955	x
		Butler's gartersnake				
	<i>Thamnophis butleri</i>		T	—	2004	x
					2010	x
	<i>Emydoidea blandingii</i>	Blanding's Turtle	T	—	5/9/2000	
	<i>Thamnophis radix</i>	Plains Gartersnake	SC	—	2009	
Fish	<i>Luxilus chrysocephalus</i>	Striped Shiner	E	—	4/3/1905	
	<i>Lythrurus umbratilis</i>	Redfin Shiner	T	—	10/16/1972	
	<i>Lepomis megalotis</i>	Longear Sunfish	T	—	4/4/2004	
					5/10/1979	x
	<i>Erimyzon sucetta</i>	Lake chubsucker	SC	—	5/5/2008	
					3/29/1977	
	<i>Etheostoma microperca</i>	Least Darter	SC	—	7/11/1974	
Crustacean	<i>Procambarus gracilis</i>	Prairie Crayfish	SC	—	5/1/2003	

^aE, Endangered; T, Threatened; SC, Species of Concern (not legally protected).

TABLE 5
 Lake Michigan - Racine; State-Listed Endangered and Threatened Species and Communities
City of Waukesha Water Supply

Species Group	Scientific Name	Common Name	State Status ^a	Federal Status ^a	Date Last Observed
Habitat		Bird Rookery	SC	—	10/18/1991 6/16/1905
		Calcareous Fen	NA	—	8/11/1993 10/2/1992
		Emergent Marsh	NA	—	3/9/1985
		Floodplain Forest	NA	—	5/6/1993 7/22/1991 10/1/1991 12/11/1993 7/1985 7/10/1991 7/1976
		Lake--Oxbow	NA	—	7/1976
		Mesic Prairie	NA	—	7/19/1991
		Northern Wet Forest	NA	—	6/19/1992
		Southern Dry Forest	NA	—	4/30/1993
		Southern Dry-mesic Forest	NA	—	10/7/1991 10/2/1991 5/20/1991 4/1999 9/30/1997
		Southern Mesic Forest	NA	—	7/1976 10/7/1991 10/1/1991 5/8/1992 7/1976 5/20/1991 5/18/2004 4/29/1992 2/8/1988
		Stream--Slow, Hard, Warm	NA	—	7/1985
Plants	<i>Adlumia fungosa</i>	Climbing Fumitory	SC	—	1861?
	<i>Arethusa bulbosa</i>	Swamp-pink	SC	—	6/13/1888
	<i>Asclepias purpurascens</i>	Purple Milkweed	E	—	7/19/1879 7/4/1928 8/20/1905
	<i>Asclepias sullivantii</i>	Prairie Milkweed	T	—	6/14/1905 9/1880

TABLE 5

Lake Michigan - Racine; State-Listed Endangered and Threatened Species and Communities
City of Waukesha Water Supply

Species Group	Scientific Name	Common Name	State Status ^a	Federal Status ^a	Date Last Observed
	<i>Aster furcatus</i>	Forked Aster	T	—	6/12/1905 9/10/1992 8/29/1990
	<i>Cacalia muehlenbergii</i>	Great Indian-plantain	SC	—	6/16/1905
	<i>Cacalia tuberosa</i>	Prairie Indian Plantain	T	—	7/1995 7/30/1898
	<i>Calamintha arkansana</i>	Low Calamint	SC	—	10/3/1891
	<i>Carex crawei</i>	Crawe Sedge	SC	—	6/15/1901 1/25/1905
	<i>Carex crus-corvi</i>	Ravenfoot Sedge	E	—	9/9/1996
	<i>Carex formosa</i>	Handsome Sedge	T	—	1980s
	<i>Carex lupuliformis</i>	False Hop Sedge	E	—	6/12/1905
	<i>Carex richardsonii</i>	Richardson Sedge	SC	—	6/12/1901
	<i>Carex tenuiflora</i>	Sparse-flowered Sedge	SC	—	7/1/1932
	<i>Cirsium hillii</i>	Hill's Thistle	T	—	8/17/1897
	<i>Cypripedium candidum</i>	Small White Lady's-slipper	T	—	6/1876
	<i>Cypripedium parviflorum</i> var. <i>makasin</i>	Northern Yellow Lady's-slipper	SC	—	5/23/1897 3/14/1905 5/30/1889 5/7/1938 6/3/1932
	<i>Cypripedium reginae</i>	Showy Lady's-slipper	SC	—	3/17/1905
	<i>Deschampsia cespitosa</i>	Tufted Hairgrass	SC	—	6/30/1900
	<i>Echinacea pallida</i>	Pale-purple Coneflower	T	—	6/9/1905
	<i>Etheostoma microperca</i>	Least Darter	SC	—	7/10/1924
	<i>Festuca paradoxa</i>	Cluster Fescue	SC	—	1930s?
	<i>Fraxinus quadrangulata</i>	Blue Ash	T	—	7/9/1995
	<i>Gentiana alba</i>	Yellow Gentian	T	—	8/1992
	<i>Gentianopsis procera</i>	Lesser Fringed Gentian	SC	—	5/9/1897 9/28/1968

TABLE 5
 Lake Michigan - Racine; State-Listed Endangered and Threatened Species and Communities
 City of Waukesha Water Supply

Species Group	Scientific Name	Common Name	State Status ^a	Federal Status ^a	Date Last Observed
	<i>Jeffersonia diphylla</i>	Twinleaf	SC	—	6/24/1930
	<i>Liatris spicata</i>	Marsh Blazing Star	SC	—	9/5/1990 6/12/1905
	<i>Lithospermum latifolium</i>	American Gromwell	SC	—	5/8/1992 10/2/1991 5/29/1976 10/21/2000 12/11/1993
	<i>Medeola virginiana</i>	Indian Cucumber-root	SC	—	6/6/1908
	<i>Pandion haliaetus</i>	Osprey	SC	—	6/30/1905
	<i>Panicum wilcoxianum</i>	Wilcox Panic Grass	SC	—	7/23/1944
	<i>Parthenium integrifolium</i>	American Fever-few	T	—	9/25/1900 6/12/1905
	<i>Plantago cordata</i>	Heart-leaved Plantain	E	—	7/17/2002
	<i>Platanthera leucophaea</i>	Prairie White-fringed Orchid	E	—	7/9/1980
	<i>Polystichum acrostichoides</i>	Christmas Fern	SC	—	1861?
	<i>Prenanthes aspera</i>	Rough Rattlesnake-root	E	—	1/18/1905
	<i>Ptelea trifoliata</i>	Wafer-ash	SC	—	10/17/ 1940 7/6/1966
	<i>Ranunculus cymbalaria</i>	Seaside Crowfoot	T	—	7/1/1898 8/1878
	<i>Scutellaria ovata</i>	Heart-leaved Skullcap	SC	—	5/24/2000
	<i>Solidago caesia</i>	Bluestem Goldenrod	E	—	10/21/2000 10/18/1991 9/10/1992 9/25/2001
	<i>Solidago ohioensis</i>	Ohio Goldenrod	SC	—	9/5/1990 6/12/1905 9/13/1991 10/2/1992 8/30/1928 9/13/1991 10/2/1992

TABLE 5

Lake Michigan - Racine; State-Listed Endangered and Threatened Species and Communities
 City of Waukesha Water Supply

Species Group	Scientific Name	Common Name	State Status ^a	Federal Status ^a	Date Last Observed
					9/10/1992
	<i>Thalictrum revolutum</i>	Waxleaf Meadowrue	SC	—	7/6/1906 9/5/1990 6/12/1905
	<i>Tofieldia glutinosa</i>	Sticky False-asphodel	T	—	7/2/1898
	<i>Tomanthera auriculata</i>	Earleaf Foxglove	SC	—	8/18/1900
	<i>Triglochin maritima</i>	Common Bog Arrow-grass	SC	—	1800s
	<i>Trillium recurvatum</i>	Reflexed Trillium	SC	—	5/6/1993 6/3/1991 5/24/2000 6/6/1991 10/1/1991 4/6/1962 5/20/1991 8/18/2004 5/14/1933 5/12/1980 5/10/1988 5/15/2001 5/20/1990 6/15/1960 4/28/1998
	<i>Viburnum prunifolium</i>	Smooth Black-haw	SC	—	5/6/1993 5/8/1992 12/11/1993 5/24/2000 10/2/1991 9/1/1985 10/1/1991 5/25/1992 10/7/1991 7/22/1998
Reptiles & Amphibians	<i>Emydoidea blandingii</i>	Blanding's Turtle	T	—	7/1/1989 5/3/2006
	<i>Thamnophis butleri</i>	Butler's Gartersnake	T	—	6/26/1905 10/2/2010 4/5/1955 6/7/2005 7/2007 6/13/2006 6/30/2003 4/5/1955 7/13/2007
	<i>Regina septemvittata</i>	Queensnake	E	—	8/21/1971

TABLE 5
 Lake Michigan - Racine; State-Listed Endangered and Threatened Species and Communities
City of Waukesha Water Supply

Species Group	Scientific Name	Common Name	State Status ^a	Federal Status ^a	Date Last Observed
	<i>Acris crepitans</i>	Northern Cricket Frog	E	—	5/1/1955
Birds	<i>Haliaeetus leucocephalus</i>	Bald Eagle	SC	R	5/2008
	<i>Nycticorax nycticorax</i>	Black-crowned Night-heron	SC	—	1950s 5/15/1905
	<i>Buteo lineatus</i>	Red-shouldered Hawk	T	—	4/1982
	<i>Bartramia longicauda</i>	Upland Sandpiper	SC		6/10/1987
Fish and Mussels	<i>Fundulus diaphanus</i>	Banded Killifish	SC	—	6/20/1995 7/11/1978 11/9/1978
				—	
	<i>Opsopoeodus emiliae</i>	Pugnose Minnow	SC	—	6/26/1995
	<i>Notropis anogenus</i>	Pugnose Shiner	T	—	10/8/1971
	<i>Luxilus chrysocephalus</i>	Striped Shiner	E	—	7/12/1978
	<i>Erimyzon sucetta</i>	Lake Chubsucker	SC	—	7/11/1978 3/29/1977
	<i>Lythrurus umbratilis</i>	Redfin Shiner	T	—	7/11//1924 7/10/1924
	<i>Lepomis megalotis</i>	Longear Sunfish	T	—	1/9/1900 7/10/1924 11/9/1978

^aE, Endangered; T, Threatened; SC, Species of Concern (not legally protected); R, Recovery.

TABLE 6

Underwood Creek Return: State-Listed Endangered and Threatened Species, Natural Heritage Inventory Data—WDNR
City of Waukesha Water Supply

Species Group	Scientific Name	Common Name	State Status ^a	Federal Status ^a	Date Last Observed
Habitat	—	Southern dry-mesic forest	N/A	—	9/30/1997 10/9/1998 5/23/2002
	—	Southern mesic forest	N/A	—	2/8/1988 4/28/1993
	—	Floodplain forest	N/A	—	5/23/1992
	—	Southern sedge meadow	N/A	—	9/26/1990
	—	Mesic prairie	N/A	—	7/26/2002
Plants	<i>Asclepias purpurascens</i>	Purple milkweed	E	—	7/13/1912
	<i>Astragalus neglectus</i>	Cooper's milkvetch	E	—	6/22/1939
	<i>Carex crus-corvi</i>	Ravenfoot sedge	E	—	6/22/1988
	<i>Carex lupuliformis</i>	False hop sedge	E	—	1995
	<i>Conioselinum chinense</i>	Hemlock parsley	E	—	8/25/1897
	<i>Platanthera leucophaea</i>	Prairie white-fringed orchid	E	T	7/9/1890
	<i>Erigenia bulbosa</i>	Harbinger-of-spring	E	—	4/25/1897
	<i>Prenanthes aspera</i>	Rough rattlesnake root	E	—	1845
	<i>Cypripedium arietinum</i>	Ram's-head lady's slipper	T	—	6/1897
	<i>Aster furcatus</i>	Forked aster	T	—	1997
	<i>Cypripedium candidum</i>	Small white lady's slipper	T	—	1850
	<i>Cacalia muehlenbergii</i>	Great Indian plantain	SC	—	7/1/1937
	<i>Lithospermum latifolium</i>	American gromwell	SC	—	5/27/1897 5/29/1976 4/30/1992 4/28/1993
	<i>Platanthera hookeri</i>	Hooker orchid	SC	—	7/9/1899
	<i>Scutellaria ovata</i>	Heart-leaved skullcap	SC	—	5/12/1980 8/1/2000
	<i>Trillium recurvatum</i>	Reflexed trillium	SC	—	5/12/2002 5/23/2002
	<i>Calamagrostis stricta</i>	Slim-stem small reedgrass	SC	—	6/30/1940
	<i>Carex tenuiflora</i>	Sparse-flowered sedge	SC	—	6/3/1882
	<i>Cypripedium parviflorum</i>	Northern yellow lady's slipper	SC	—	6/3/1932 8/11/1992
	<i>Liatris spicata</i>	Marsh blazing star	SC	—	9/1875
	<i>Thalictrum revolutum</i>	Waxleaf meadowrue	SC	—	6/30/1940
	<i>Triglochin maritime</i>	Common bog arrow-grass	SC	—	1800s
	<i>Platanthera dilatata</i>	Leafy white orchid	SC	—	7/1884

TABLE 6
 Underwood Creek Return: State-Listed Endangered and Threatened Species, Natural Heritage Inventory Data—WDNR
City of Waukesha Water Supply

Species Group	Scientific Name	Common Name	State Status^a	Federal Status^a	Date Last Observed
	<i>Calylophus serrulatus</i>	Yellow evening primrose	SC	—	7/26/2002
	<i>Thaspium trifoliatum</i>	Purple meadow parsnip	SC	—	5/30/1930
	<i>Jeffersonia diphylla</i>	Twinleaf	SC	—	4/28/1993
Birds	<i>Nycticorax nycticorax</i>	Black-crowned night heron	SC	—	1974
Reptiles & Amphibians	<i>Acris crepitans</i>	Northern cricket frog	E	—	5/10/1946 5/1/1955
	<i>Thamnophis butleri</i>	Butler's gartersnake	T	—	7/2007 10/23/2007 2008
	<i>Emydoidea blandingii</i>	Blanding's turtle	T	—	5/3/1988 6/26/1996
	<i>Lithobates catesbeianus</i>	American bullfrog	SC	—	7/20/1988
Fish	<i>Luxilus chrysocephalus</i>	Stride shiner	E	—	1920
	<i>Lythrurus umbratilis</i>	Redfin shiner	T	—	7/11/1924
	<i>Etheostoma microperca</i>	Least darter	SC	—	11/17/1901
	<i>Erimyzon sucetta</i>	Lake chubsucker	SC	—	3/29/1977
	<i>Clinostomus elongates</i>	Redside dace	SC	—	11/17/1901
Insects	<i>Pompeius verna</i>	Little glassy wing	SC	—	7/12/1988
Crustaceans	<i>Procambarus gracilis</i>	Prairie crayfish	SC	—	5/11/1970

^aE, Endangered; T, Threatened; SC, Species of Concern (not legally protected).

TABLE 7

Root River to Lake Michigan Return Flow Alignment 1: State-Listed Endangered and Threatened Species and Communities
 City of Waukesha Water Supply

Species Group	Scientific Name	Common Name	State Status ^a	Federal Status ^a	Date Last Observed
Habitat	—	Mesic Prairie	N/A	—	7/26/2002
	—	Southern Dry Mesic Forest	N/A	—	5/14/1991 6/11/1991 5/1/1992 5/23/2002
	—	Southern Mesic Forest	N/A	—	2/8/1988
Plants	<i>Asclepias purpurascens</i>	Purple Milkweed	E	—	8/20/1905 7/13/1912
	<i>Aster furcatus</i>	Forked Aster	T	—	5/1/1992
	<i>Astragalus neglectus</i>	Cooper's Milkvetch	E	—	6/22/1939
	<i>Cacalia muehlenbergii</i>	Great Indian Plantain	SC	—	7/1/1937
	<i>Calamagrostis stricta</i>	Slim-stem Small reedgrass	SC	—	6/30/1940
	<i>Carex lupuliformis</i>	False Hop Sedge	E	—	1995
	<i>Carex tenuiflora</i>	Sparse-flowered Sedge	SC	—	6/3/1882
	<i>Conioselinum chinense</i>	Hemlock parsley	E	—	8/25/1897
	<i>Cypripedium arietinum</i>	Ram's-head Lady's slipper	T	—	6/1897
	<i>Cypripedium parviflorum</i>	Northern Yellow Lady's slipper	SC	—	6/3/1932 8/11/1992
	<i>Liatris spicata</i>	Marsh Blazing Star	SC	—	9/1875
	<i>Lithospermum latifolium</i>	American Gromwell	SC	—	5/27/1897 6/11/1991 4/30/1992 5/11/1992
	<i>Platanthera dilatata</i>	Leafy white orchid	SC	—	7/1884
	<i>Platanthera hookeri</i>	Hooker orchid	SC	—	7/9/1899
	<i>Platanthera leucophaea</i>	Prairie white-fringed orchid	E	T	7/9/1890
	<i>Prenanthes aspera</i>	Rough Rattlesnake-root	E	—	1845
	<i>Ptelea trifoliata</i>	Wafer-ash	SC	—	10/3/2000
	<i>Scutellaria ovata</i>	Heart-leaved skullcap	SC	—	8/1/2000
	<i>Solidago caesia</i>	Bluestem goldenrod	E	—	9/20/2003
	<i>Thalictrum revolutum</i>	Waxleaf Meadowrue	SC	—	8/8/1933 6/30/1940
	<i>Triglochin maritime</i>	Common Bog Arrow-grass	SC	—	1800s
	<i>Trillium recurvatum</i>	Reflexed Trillium	SC	—	1846 5/18/1941 5/23/1944 5/23/1945 5/14/1991 5/1/1992 5/28/2000 5/12/2002

TABLE 7

Root River to Lake Michigan Return Flow Alignment 1: State-Listed Endangered and Threatened Species and Communities
City of Waukesha Water Supply

Species Group	Scientific Name	Common Name	State Status ^a	Federal Status ^a	Date Last Observed
					5/23/2002
	<i>Viburnum prunifolium</i>	Smooth black-haw	SC	—	6/11/1991
Birds	<i>Spiza Americana</i>	Dickcissel	SC	—	7/7/2000
Reptiles & Amphibians	<i>Acris crepitans</i>	Northern Cricket Frog	E	—	5/10/1946 5/1/1955
	<i>Emydoidea blandingii</i>	Blanding's Turtle	T	—	5/3/1988 5/9/2000
	<i>Lithobates catesbeianus</i>	American Bullfrog	SC	—	7/20/1988
	<i>Thamnophis butleri</i>	Butler's Gartersnake	T	—	4/5/1955 2003 6/30/2003 10/2003 2004 7/13/2006 7/18/2006 5/14/2007 6/7/2007 6/13/2007 7/2007 10/2/2007 2008 6/2008
Fish	<i>Luxilus chrysocephalus</i>	Striped shiner	E	—	1920
	<i>Lythrurus umbratilis</i>	Redfin shiner	T	—	7/11/1924
	<i>Lepomis megalotis</i>	Longear sunfish	T	—	4/4/2000
	<i>Etheostoma microperca</i>	Least darter	SC	—	7/11/1924
	<i>Erimyzon sucetta</i>	Lake chubsucker	SC	—	5/10/1979
Insects	<i>Pompeius verna</i>	Little Glassy Wing	SC	—	7/12/1988
Crustaceans	<i>Procambarus gracilis</i>	Prairie Crayfish	SC	—	3/28/1910 5/11/1970

^aE, Endangered; T, Threatened; SC, Species of Concern (not legally protected).

TABLE 8

Root River to Lake Michigan Return Flow Alignment 2: State-Listed Endangered and Threatened Species and Communities

City of Waukesha Water Supply

Species Group	Scientific Name	Common Name	State Status ^a	Federal Status ^a	Date Last Observed	Within 75' Corridor
Habitat	—	Mesic forest	N/A	—	7/26/2002	x
					8/17/1992	x
		Southern dry-mesic forest	N/A	—	Apr-99	x
					5/1/1992	x
					6/6/1992	x
	—				9/30/1997	
					6/11/1991	
					10/7/1991	
					Jul-76	x
	—	Floodplain Forest	NA	—	Jul-91	
	—	Emergent Marsh	NA	—	Jul-85	x
	—	Northern Wet Forest	NA	—	Jul-85	x
	—	Shurb-carr	NA	—	Jul-85	x
	—	Southern Sedge Meadow	NA	—	Jul-85	x
	—	Wet Prairie	NA	—	Jul-85	x
Plants	—	Oak Opening	NA	—	Aug-92	
	—	Wet Mesic Prairie	NA	—	9/7/1993	
	-	Bird Rookery	NA	—	1995	
	—	Southern Mesic Forest	NA	—	Oct-91	
	Prenanthes aspera	Rough rattlesnake root	E	—	1845	x
	Asclepias purpurascens	Purple milkweed	E	—	7/4/1928	x
					8/20/1905	x
	Carex crus-corvi	Ravenfoot sedge	E	—	9/9/1996	x
	Solidago caesia	Bluestem Goldenrod	E	—	9/20/2003	
	Fraxinus quadrangulata	Blue Ash	T	—	10/3/2000	
	Aster furcatus	Forked Aster	T	—	8/5/2009	x
	Cacalia tuberosa	Prairie Indian-Plantain	T	—	5/1/1992	
	Aplectrum hyemale	Putty Root	SC		6/24/1939	
	Platanthera hookeri	Hooker orchid	SC	—	1967	x
					7/9/1899	x
Birds	Viburnum prunifolium	Smooth black-haw	SC	—	6/11/1991	x
					8/18/2005	
	Scutellaria ovata ssp. ovata	Heart-leaved Skullcap	SC	—	7/7/1977	x
	Jeffersonia diphylla	Twinleaf	SC	—		
					6/24/1930	
		Yellow Evening Primrose	SC	—	7/26/2002	
	Calylophus serrulatus					
Birds	Sterna forsteri	Forster's Tern	E	—	6/19/2009	

TABLE 8

Root River to Lake Michigan Return Flow Alignment 2: State-Listed Endangered and Threatened Species and Communities

City of Waukesha Water Supply

Species Group	Scientific Name	Common Name	State Status ^a	Federal Status ^a	Date Last Observed	Within 75' Corridor
	<i>Aythya americana</i>	Redhead	SC	—	6/22/2005	
	<i>Chlidonias niger</i>	Black Tern	SC	—	6/27/2009	
	<i>Ixobrychus exilis</i>	Least Bittern	SC	—	5/18/2010	
	<i>Xanthocephalus xanthocephalus</i>	Yellow-headed Blackbird	SC	—	5/18/2010	
Reptiles & Amphibians	<i>Acris crepitans</i>	Northern cricket frog	E	—	5/1/1955	x
	<i>Thamnophis butleri</i>	Butler's gartersnake	T	—	2010	x
	<i>Emydoidea blandingii</i>	Blanding's Turtle	T	—	5/9/2000	
	<i>Thamnophis radix</i>	Plains Gartersnake	SC	—	2009	
Fish	<i>Lythrurus umbratilis</i>	Redfin Shiner	T	—	7/11/1924 10/16/1972	x
	<i>Erimyzon sucetta</i>	Lake chubsucker	SC	—	5/10/1979	x
	<i>Etheostoma microperca</i>	Least Darter	SC	—	5/5/2008 7/11/1974	
	<i>Lepomis megalotis</i>	Longear Sunfish	T	—	4/4/2004 6/1/2007	
	<i>Fundulus dispar</i>	Starhead Topminnow	E	—	10/1/2008	
	<i>Luxilus chrysocephalus</i>	Striped Shiner	E	—	4/3/1905	
	<i>Procambarus gracilis</i>	Prairie Crayfish	SC	—	Mar-03	

^aE, Endangered; T, Threatened; SC, Species of Concern (not legally protected).

TABLE 9

Direct to Lake Michigan: State-Listed Endangered and Threatened Species and Communities
City of Waukesha Water Supply

Species Group	Scientific Name	Common Name	State Status ^a	Federal Status ^a	Date Last Observed
Habitat	—	Calcareous fen	NA		9/9/1991
	—	Southern dry mesic forest	N/A	—	5/14/1991
	—	Southern mesic forest	N/A	—	9/9/1991
	—	Springs and spring runs (hard)	N/A	—	7/1985
Plants	<i>Asclepias purpurascens</i>	Purple milkweed	E	—	8/20/1905 7/13/1912 7/4/1928
	<i>Aster furcatus</i>	Forked aster	T	—	8/19/2001 1997
	<i>Astragalus neglectus</i>	Cooper's milkvetch	E	—	6/22/1939
	<i>Cacalia muehlenbergii</i>	Great Indian plantain	SC	—	7/1/1937
	<i>Cakile lacustris</i>	American sea-rocket	SC	—	1950s?
	<i>Calamagrostis stricta</i>	Slim-stem small reedgrass	SC	—	6/30/1940
	<i>Carex tenuiflora</i>	Sparse-flowered sedge	SC	—	6/3/1882
	<i>Conioselinum chinense</i>	Hemlock parsley	E	—	8/25/1897
	<i>Cypripedium arietinum</i>	Ram's-head lady's slipper	T	—	6/1897
	<i>Cypripedium candidum</i>	Small white lady's slipper	T	—	1850
	<i>Cypripedium parviflorum</i>	Northern yellow lady's slipper	SC	—	5/30/1889 7/9/1890 6/3/1932
	<i>Cypripedium reginae</i>	Showy lady's slipper	SC	—	6/17/1939
	<i>Equisetum variegatum</i>	Variegated horsetail	SC	—	6/30/1995
	<i>Erigenia bulbosa</i>	Harbinger-of-spring	E	—	1850 1920
	<i>Euphorbia polygonifolia</i>	Seaside Spurge	SC		1872
	<i>Gentianopsis procera</i>	Lesser fringed gentian	SC	—	9/9/1991
	<i>Glycyrrhiza lepidota</i>	Wild licorice	SC	—	8/19/1940
	<i>Liatris spicata</i>	Marsh blazing star	SC	—	9/1875 1872
	<i>Lithospermum latifolium</i>	American gromwell	SC	—	5/27/1897
	<i>Medeola virginiana</i>	Indian cucumber-root	SC	—	6/6/1908
	<i>Penstemon hirsutus</i>	Hairy Beardtongue	SC		6/18/1939
	<i>Platanthera dilatata</i>	Leafy white orchis	SC	—	7/1884
	<i>Platanthera hookeri</i>	Hooker orchis	SC	—	7/9/1899
	<i>Platanthera leucophaea</i>	Prairie white-fringed orchid	E	T	7/9/1890

TABLE 9
 Direct to Lake Michigan: State-Listed Endangered and Threatened Species and Communities
City of Waukesha Water Supply

Species Group	Scientific Name	Common Name	State Status ^a	Federal Status ^a	Date Last Observed
	<i>Solidago caesia</i>	Bluestem goldenrod	E	—	9/20/1872 9/25/2001 12/10/2000
	<i>Solidago ohioensis</i>	Ohio goldenrod	SC	—	9/20/1975 9/9/1991
	<i>Thalictrum revolutum</i>	Waxleaf meadowrue	SC	—	8/8/1933 6/30/1940
	<i>Tofieldia glutinosa</i>	Sticky false-asphodel	T	—	6/30/1995
	<i>Triglochin maritime</i>	Common bog arrow-grass	SC	—	1800s
	<i>Triglochin palustris</i>	Slender bog arrow-grass	SC	—	8/11/1981
	<i>Trillium recurvatum</i>	Reflexed trillium	SC	—	5/14/1991 1846 5/23/1945 5/17/1963 5/28/2000 5/11/1938
	<i>Trisetum melicoides</i>	Purple false oats	E	—	8/4/1940
Birds	<i>Spiza Americana</i>	Dickissel	SC	—	2/8/2000
Reptiles & Amphibians	<i>Acris crepitans</i>	Northern cricket frog	E	—	5/10/1946 5/1/1955
	<i>Thamnophis butleri</i>	Butler's gartersnake	T	—	10/25/1915 4/14/1910 2003 5/14/2007 10/10/1938 10/18/1987
	<i>Emydoidea blandingii</i>	Blanding's turtle	T	—	5/3/1988 6/4/1996 5/9/2000 2002
	<i>Lithobates catesbeianus</i>	American bullfrog	SC	—	7/20/1988
Fish	<i>Luxilus chrysocephalus</i>	Striped shiner	E	—	3/2/1910
	<i>Lythrurus umbratilis</i>	Redfin shiner	T	—	7/11/1974
	<i>Moxostoma valenciennesi</i>	Greater Redhorse	T		9/13/1996
	<i>Fundulus diaphanus</i>	Banded Killfish	SC	—	4/20/1902
	<i>Pompeius verna</i>	Little glassy wing	SC	—	7/12/1988
Crustaceans	<i>Procambarus gracilis</i>	Prairie crayfish	SC	—	3/28/1910 5/2/1910 7/9/1983 2/7/1982 7/11/1982 7/8/1982

^aE, Endangered; T, Threatened; SC, Species of Concern (not legally protected).

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Attachment A

Volume 1: Public Agency Correspondence

City of Waukesha Water Supply Attachment 6-6 A: Public Agency Correspondence

Prepared for
City of Waukesha

February 2013

CH2MHILL

CH2MHILL TRANSMITTAL

To: Wisconsin Dept. of Natural Resources
Office of Energy, OE/7
101 S. Webster S., P.O. Box 7921
Madison, WI 53707-7921

From: Mark Mittag
CH2M HILL
135 South 84th Street, Suite 400
Milwaukee, WI 53076

Attn: Shari Koslowsky

Date: December 12, 2012

Re: City of Waukesha, Wisconsin – Application for Lake Michigan Water Supply Supplement

We Are Sending You:

x	Attached	Under separate cover via	
	Shop Drawings	Documents	Tracings
	Prints	Specifications	Catalogs
	Copy of letter	x	Other: CD

Quantity	Description
1	Endangered Resources Review Request
1	Affected Quarter Sections List
1	Map of the two alignments and intersecting quarter sections
1	Aerial maps of the two alignments (also provided on CD)
1	CD containing: <ul style="list-style-type: none">• Shapefiles of the two alignments• Maps of project area• Correspondance between CH2M Hill and WDNR from January 12, 2010

*If material received is not as listed, please notify us at once.

Shari,

As we discussed on the phone on Friday, December 7, we would like your help evaluating T/E concerns along the proposed water supply and return options included in the CD for a supplemental report. We completed an Endangered Resources Review Request (Attachment 1) for your documentation purposes. Attachment 2 provides the township, range and section data for the proposed alignments in tabular format. Attachment 3 is a map depicting the quarter sections from Attachment 2 that intersect the alterntatives.

We are planning on completing the supplemental report by mid-January 2013. We would prefer your review and comment on the two alignments by December 21.

If you have any questions regarding this request or need additional information, please do not hesitate to contact me at (312) 348-5046.

Thank you,

Anjulie Cheema

cc:

Mark Mittag/CH2M Hill
Brent Brown/ CH2M Hill

Endangered Resources Review Request

Form 1700-047 (R 2/11)

Page 1 of 2

Notice: An Endangered Resources (ER) Review of a proposed land development, management, planning, or similar type of project provides the requester with information from Wisconsin's Natural Heritage Inventory (NHI) database and other sources on rare plants and animals, high quality natural communities, and other endangered resources that may be impacted by the proposed project. The ER Review will also include specific recommendations to help projects comply with Wisconsin's Endangered Species Law (s. 29.604, Wis. Stats.) and other laws and regulations protecting endangered resources. Personal information collected will be used for administrative purposes and may be provided to requesters to the extent required by Wisconsin's Open Records Law (ss. 19.31-19.39, Wis. Stats.).

Instructions: The following materials are required to process this request. Submit all materials by mail to the address above or by fax (608-266-2925) or email (DNRERReview@wisconsin.gov). Do not include payment with this form.

- ☐ Completed, signed form
- ☐ Map(s) delineating the project area, preferably a topographic map and digital orthophoto (aerial photo)

Submission of the following materials are strongly encouraged and will facilitate review of your project:

- ☐ Photographs that clearly show the project area, including natural features and vegetation present on site
- ☐ Additional relevant information and reports (e.g., detailed project and habitat descriptions, wetland delineation, and site plans)

Section 1: Requester Information (ER Review, correspondence and invoice will be sent to this person)

Name Mark Mittag		Organization CH2M Hill	
Mailing Address 135 South 84th Street, Suite 400		City Waukesha	State WI
Telephone Number (414) 847-0536		FAX Number	Email Address mark.mittag@ch2m.com
ZIP Code 53214			

Section 2: Landowner Information (if different than Section 1)

Name Varies		Organization	
Mailing Address		City	State ZIP Code
Telephone Number		FAX Number	Email Address

Section 3: Project Information

Project Name Environmental Report - City of Waukesha Water Supply	Project Address (if applicable)
Project Types: <input type="radio"/> Residential <input type="radio"/> Commercial <input type="radio"/> Industrial <input checked="" type="radio"/> Utility <input type="radio"/> Transportation (roads, railroads, trails) <input type="radio"/> Other: _____	

Start Date (on-site disturbance) To be determined	End Date (on-site disturbance) To be determined	Total Acreage To be determined
--	--	-----------------------------------

County Waukesha	<input checked="" type="radio"/> City <input type="radio"/> Town <input type="radio"/> Village of: Waukesha
--------------------	---

Township	Range	Direction	Section	Quarter Section	Quarter-Quarter Section	Additional Comments on TRS Location (attach additional information if necessary)
05 N	21	<input checked="" type="checkbox"/> E <input type="checkbox"/> W		<input type="checkbox"/> NW <input type="checkbox"/> NE <input type="checkbox"/> SW <input type="checkbox"/> SE	<input type="checkbox"/> NW <input type="checkbox"/> NE <input type="checkbox"/> SW <input type="checkbox"/> SE	Project includes 4 TR locations.
N		<input type="checkbox"/> E <input type="checkbox"/> W		<input type="checkbox"/> NW <input type="checkbox"/> NE <input type="checkbox"/> SW <input type="checkbox"/> SE	<input type="checkbox"/> NW <input type="checkbox"/> NE <input type="checkbox"/> SW <input type="checkbox"/> SE	Refer to attached Quarter Section map.

Provide a detailed description of the proposed project and associated disturbance, including acres to be disturbed. Attach additional pages as needed.

The City of Waukesha is creating a supplemental report to an environmental report completed in February 2012. The environmental report evaluated the impacts of several alternatives to meet the current and future water supply needs of the City. The supplement includes a new water supply alternative (Oak Creek Supply Alignment 2) and a new water return alternative (Root River Return Flow Alignment 2).

Endangered Resources Review Request

Form 1700-047 (R 2/11)

Page 2 of 2

Section 3: Project Information, *continued*

Provide a detailed description of the habitat types and current land use within the project area (e.g., 50% in active agriculture-currently corn, 20% floodplain forest, 15% industrial area, 10% hardwood swamp dominated by black ash, 5% fallow field - in active agriculture until one year ago). Attach additional pages as needed.

The proposed alignments are within the right-of-way.

List all wetlands and waterbodies (e.g., rivers, intermittent streams, lakes, marshes) within one mile of the project area. List any known or suspected impacts of the proposed project to these wetlands and waterbodies. Indicate the location(s) of any point source discharge(s) into wetlands or waterbodies.

Not available.

List any reports that have been prepared to describe habitat that may be impacted by the proposed project (e.g., wetland delineation, habitat assessments, and rare species surveys). Attach copies if available.

Not available.

List any other project reports or correspondence concerning endangered resources. Include endangered resources reviews conducted by this or another agency (list log # and/or date issued) for this or a different phase of or alternative to the proposed project. Attach copies if available.

See attached correspondence between CH2M Hill and Shari Koslowsky.

Section 4: Related Permits, Licenses or Regulatory Approvals

Permit, License or Approval	Issuing Agency, Program or Municipality	Contact Person	Status
			<input type="checkbox"/> will be applying for <input type="checkbox"/> have applied for <input type="checkbox"/> have received
			<input type="checkbox"/> will be applying for <input type="checkbox"/> have applied for <input type="checkbox"/> have received
			<input type="checkbox"/> will be applying for <input type="checkbox"/> have applied for <input type="checkbox"/> have received

Section 5: Certification by Requester

I am the owner, authorized representative of the owner, or utility representative of the property for which I am requesting an Endangered Resources (ER) Review. To the best of my knowledge, the information I have provided is complete and accurate.

I understand that the requested ER Review may contain NHI data and information (including specific locations of endangered resources) which are considered sensitive and are not subject to Wisconsin's Open Records Law (per s. 23.27, Wis. Stats.). I agree to use the information contained in the ER Review solely for planning and implementation of the proposed project. As such, I agree to share information contained in the ER Review only with individuals who need this information to carry out specific roles in planning and implementation of the proposed project. I agree to not reproduce or disseminate the ER Review or the specific locations of endangered resources contained in the ER Review to any other parties or individuals without prior written permission from the Bureau of Endangered Resources. (Please contact the Endangered Resources Review Program at 608-264-6057 if you have any questions about sharing information contained in the ER Review.)

I agree to pay, within 30 days of receipt of an invoice, the fee charged by the Department for this ER Review (see Page 1 for details).

Signature of Requester	Date Signed	Name of Requester (Please Print)
------------------------	-------------	----------------------------------



January 11, 2013

Mr. Peter Fasbender
Ecological Services Office – Green Bay
U.S. Fish and Wildlife Service
2661 Scott Tower Drive
New Franken, WI 54229

Subject: Environmental Review: City of Waukesha Municipal Water Supply – Lake Michigan
Diversion

Dear Mr. Fasbender:

This letter is a follow-up to the threatened and endangered (T&E) species review request letters sent on February 2, 2010 and January 13, 2010 regarding several alternatives being considered to meet future water supply needs of the City of Waukesha (City). As the project has progressed, two new alternatives have been added.

On behalf of the City, CH2M HILL is requesting a detailed environmental impact review for the locations where the two new alternatives are proposed to further identify and evaluate any potential impacts the alternatives may have federal-managed lands, and/or sensitive habitats. The township, range and section data for each proposed alternative is provided in a map and tabular format (Attachment 1 and 2), which is included with this letter for your convenience. Attachment 3 includes the prior correspondence with the USFWS. Attachment 4 is detailed aerial maps of the two proposed alignments and the 75-foot-wide construction workspace. Additionally, Attachment 5 contains a CD with GIS shapefiles of the two alignments and the 75-foot-wide construction workspace.

The WDNR has been contacted to review Natural Heritage Inventory (NHI) species. The WDNR identified one federally-listed species within 1 mile of the project area. The federally threatened species is the prairie white-fringed orchid. Please provide any additional information on the species that is of relevance to the project.

Due to the need to compare each of the alternatives, we would appreciate if you would provide a separate review and analysis of the potential impacts for each alternative name and which section / quarter section (s) the resource may be present.

If you have any questions regarding this request or need additional information, please do not hesitate to contact me at (312) 348-5046. Thank you.

Sincerely,
CH2M HILL

Anjulie Cheema
Water Engineer

Attachments:

1. Map with quarter sections listed in Attachment 2 intersecting the alignments
2. Quarter Section List
3. Prior USFWS Correspondence

4. Aerial Maps
5. CD with the GIS shape files of the two alignments and the 75-foot-wide construction workspace

cc: Mark Mittag/CH2M Hill
Brent Brown/CH2M Hill

Attachment 2: Quarter Section List

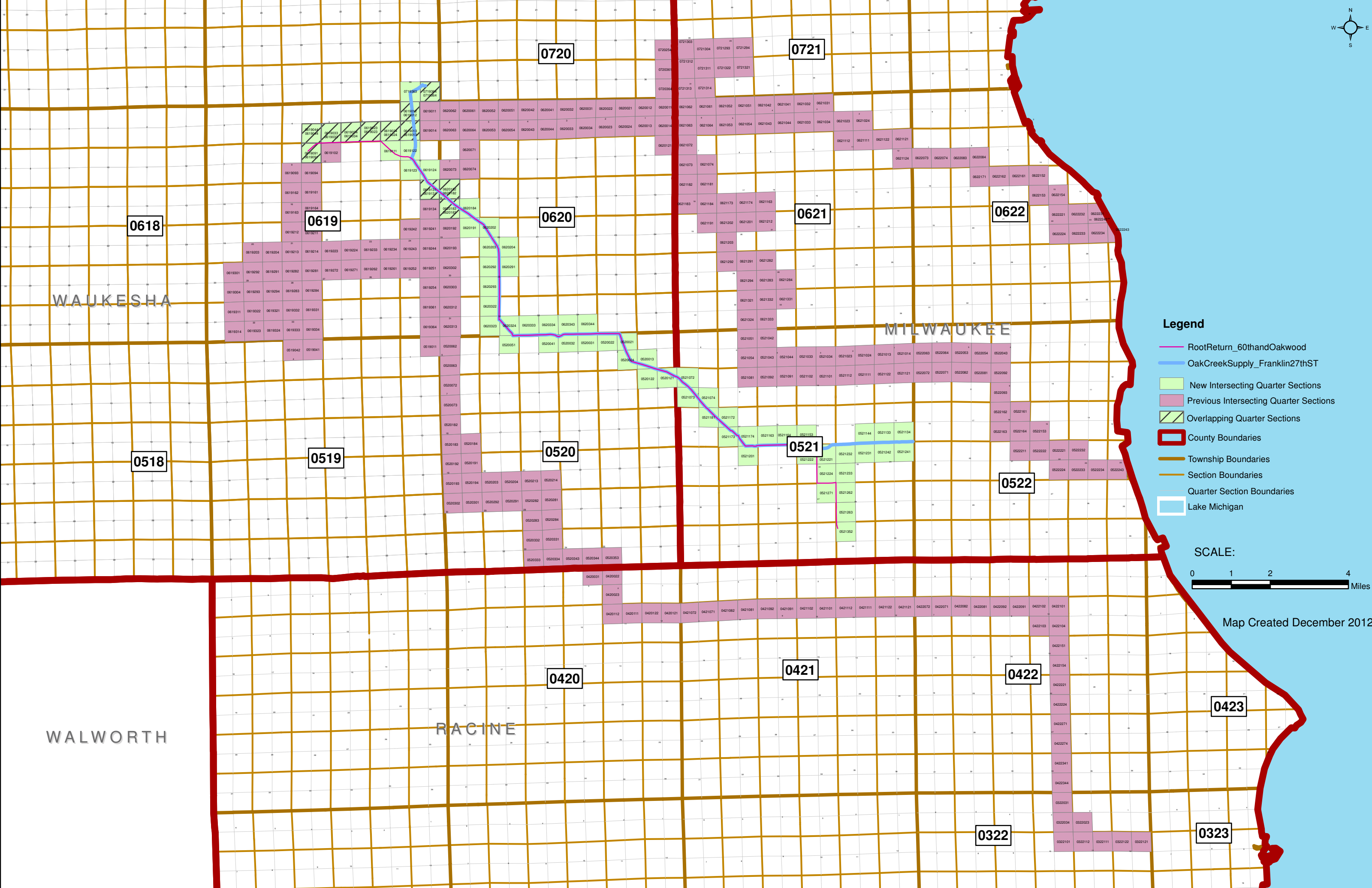
ALIGNMENT	TWN	RNG	SEC	QUARTER_SEC	QUARTER_SEC_ID
Oak Creek Supply Alignment 2	5	21	07	2	521072
Oak Creek Supply Alignment 2	5	21	07	3	521073
Oak Creek Supply Alignment 2	5	21	07	4	521074
Oak Creek Supply Alignment 2	5	21	13	3	521133
Oak Creek Supply Alignment 2	5	21	13	4	521134
Oak Creek Supply Alignment 2	5	21	14	4	521144
Oak Creek Supply Alignment 2	5	21	15	3	521153
Oak Creek Supply Alignment 2	5	21	16	3	521163
Oak Creek Supply Alignment 2	5	21	16	4	521164
Oak Creek Supply Alignment 2	5	21	17	2	521172
Oak Creek Supply Alignment 2	5	21	17	3	521173
Oak Creek Supply Alignment 2	5	21	17	4	521174
Oak Creek Supply Alignment 2	5	21	18	1	521181
Oak Creek Supply Alignment 2	5	21	20	1	521201
Oak Creek Supply Alignment 2	5	21	22	1	521221
Oak Creek Supply Alignment 2	5	21	22	2	521222
Oak Creek Supply Alignment 2	5	21	23	1	521231
Oak Creek Supply Alignment 2	5	21	23	2	521232
Oak Creek Supply Alignment 2	5	21	24	1	521241
Oak Creek Supply Alignment 2	5	21	24	2	521242
Oak Creek Supply Alignment 2	6	19	13	1	619131
Oak Creek Supply Alignment 2	6	20	18	2	620182
Oak Creek Supply Alignment 2	6	19	01	3	619013
Oak Creek Supply Alignment 2	7	19	36	3	719363
Oak Creek Supply Alignment 2	7	19	36	4	719364
Oak Creek Supply Alignment 2	6	19	12	3	619123
Oak Creek Supply Alignment 2	6	19	12	4	619124
Oak Creek Supply Alignment 2	6	19	12	2	619122
Oak Creek Supply Alignment 2	6	19	01	2	619012
Oak Creek Supply Alignment 2	5	20	12	2	520122
Oak Creek Supply Alignment 2	5	20	12	1	520121
Oak Creek Supply Alignment 2	6	20	32	2	620322
Oak Creek Supply Alignment 2	5	20	02	4	520024
Oak Creek Supply Alignment 2	5	20	01	3	520013
Oak Creek Supply Alignment 2	5	20	05	1	520051
Oak Creek Supply Alignment 2	5	20	04	1	520041
Oak Creek Supply Alignment 2	5	20	03	2	520032
Oak Creek Supply Alignment 2	5	20	03	1	520031
Oak Creek Supply Alignment 2	5	20	02	2	520022
Oak Creek Supply Alignment 2	5	20	02	1	520021
Oak Creek Supply Alignment 2	6	20	32	3	620323
Oak Creek Supply Alignment 2	6	20	32	4	620324
Oak Creek Supply Alignment 2	6	20	33	3	620333
Oak Creek Supply Alignment 2	6	20	33	4	620334
Oak Creek Supply Alignment 2	6	20	34	3	620343
Oak Creek Supply Alignment 2	6	20	34	4	620344

Attachment 2: Quarter Section List

Oak Creek Supply Alignment 2	6	20	29	3	620293
Oak Creek Supply Alignment 2	6	20	29	2	620292
Oak Creek Supply Alignment 2	6	20	29	1	620291
Oak Creek Supply Alignment 2	6	20	20	3	620203
Oak Creek Supply Alignment 2	6	20	20	4	620204
Oak Creek Supply Alignment 2	6	20	19	1	620191
Oak Creek Supply Alignment 2	6	20	20	2	620202
Oak Creek Supply Alignment 2	6	20	18	3	620183
Oak Creek Supply Alignment 2	6	20	18	4	620184
Root River Return Flow Alignment 2	5	21	07	2	521072
Root River Return Flow Alignment 2	5	21	07	3	521073
Root River Return Flow Alignment 2	5	21	07	4	521074
Root River Return Flow Alignment 2	5	21	15	3	521153
Root River Return Flow Alignment 2	5	21	16	3	521163
Root River Return Flow Alignment 2	5	21	16	4	521164
Root River Return Flow Alignment 2	5	21	17	2	521172
Root River Return Flow Alignment 2	5	21	17	3	521173
Root River Return Flow Alignment 2	5	21	17	4	521174
Root River Return Flow Alignment 2	5	21	18	1	521181
Root River Return Flow Alignment 2	5	21	20	1	521201
Root River Return Flow Alignment 2	5	21	22	1	521221
Root River Return Flow Alignment 2	5	21	22	2	521222
Root River Return Flow Alignment 2	5	21	22	4	521224
Root River Return Flow Alignment 2	5	21	23	3	521233
Root River Return Flow Alignment 2	5	21	26	2	521262
Root River Return Flow Alignment 2	5	21	26	3	521263
Root River Return Flow Alignment 2	5	21	27	1	521271
Root River Return Flow Alignment 2	5	21	35	2	521352
Root River Return Flow Alignment 2	6	19	13	1	619131
Root River Return Flow Alignment 2	6	20	18	2	620182
Root River Return Flow Alignment 2	6	19	04	4	619044
Root River Return Flow Alignment 2	6	19	03	3	619033
Root River Return Flow Alignment 2	6	19	03	4	619034
Root River Return Flow Alignment 2	6	19	02	3	619023
Root River Return Flow Alignment 2	6	19	02	4	619024
Root River Return Flow Alignment 2	6	19	12	3	619123
Root River Return Flow Alignment 2	6	19	12	4	619124
Root River Return Flow Alignment 2	6	19	09	1	619091
Root River Return Flow Alignment 2	6	19	11	1	619111
Root River Return Flow Alignment 2	6	19	12	2	619122
Root River Return Flow Alignment 2	5	20	12	2	520122
Root River Return Flow Alignment 2	5	20	12	1	520121
Root River Return Flow Alignment 2	6	20	32	2	620322
Root River Return Flow Alignment 2	5	20	02	4	520024
Root River Return Flow Alignment 2	5	20	01	3	520013
Root River Return Flow Alignment 2	5	20	05	1	520051
Root River Return Flow Alignment 2	5	20	04	1	520041

Attachment 2: Quarter Section List

Root River Return Flow Alignment 2	5	20	03	2	520032
Root River Return Flow Alignment 2	5	20	03	1	520031
Root River Return Flow Alignment 2	5	20	02	2	520022
Root River Return Flow Alignment 2	5	20	02	1	520021
Root River Return Flow Alignment 2	6	20	32	3	620323
Root River Return Flow Alignment 2	6	20	32	4	620324
Root River Return Flow Alignment 2	6	20	33	3	620333
Root River Return Flow Alignment 2	6	20	33	4	620334
Root River Return Flow Alignment 2	6	20	34	3	620343
Root River Return Flow Alignment 2	6	20	34	4	620344
Root River Return Flow Alignment 2	6	20	29	3	620293
Root River Return Flow Alignment 2	6	20	29	2	620292
Root River Return Flow Alignment 2	6	20	29	1	620291
Root River Return Flow Alignment 2	6	20	20	3	620203
Root River Return Flow Alignment 2	6	20	20	4	620204
Root River Return Flow Alignment 2	6	20	19	1	620191
Root River Return Flow Alignment 2	6	20	20	2	620202
Root River Return Flow Alignment 2	6	20	18	3	620183
Root River Return Flow Alignment 2	6	20	18	4	620184





CH2M HILL
135 S. 84th Street
Suite 325
Milwaukee, WI 53214
Tel 414-272-2426
Fax 414-272-4408

January 12, 2010

Shari Koslowsky
Office of Energy SS/7
Wisconsin Department of Natural Resources
P.O. Box 7921
Madison, WI 53707-7921
Phone: (608) 261-4382

Subject: Threatened and Endangered Species Review Request
City of Waukesha Municipal Water Supply – Lake Michigan Diversion

Dear Ms. Koslowsky:

On behalf of the City of Waukesha (the City), CH2M HILL is requesting your verification that no threatened, endangered, proposed or candidate species, and/or unique habitats or natural areas exist in locations where infrastructure associated with obtaining a new water source for the City may be located. As requested by the Wisconsin DNR, the City is completing an environmental report that is evaluating the impacts of several alternatives to meet the current and future water supply needs of the City. These water supply alternatives include expanding existing groundwater sources, developing new groundwater sources, and obtaining and returning Lake Michigan water. This review will assist the City with evaluating the impacts of each alternative.

All of the proposed areas that may be impacted by water supply alternatives are located in the Counties of Waukesha, Milwaukee, or Racine, Wisconsin. The township, range, and section data for each proposed route is provided in tabular format in Attachment 1, which is included with this letter for your convenience. Attachment 2 is a map depicting the quarter sections from Attachment 1 that intersect with the alternatives.

CH2M HILL is requesting your concurrence that no state protected resources will be affected by or is located within one (1) mile of the water supply alternatives described above.


Because we are evaluating and comparing the alternatives, it is important that the potential impacts be identified for each alternative. We respectfully request that if potential impacts are identified in your review, that you please indicate which alignment ID and quarter section is impacted.

If you have any questions regarding this request or need additional information, please do not hesitate to contact me at (414) 272-2426, ext. 40356. Thank you.

Sincerely,

Ms. Shari Koslowsky
Page 2
January 12, 2010

CH2M HILL

A handwritten signature in cursive script that reads "Corey Wilcox".

Corey Wilcox
Associate Scientist

Attachments:

- (1) Tables 1 - 3. Township, Range, and Section Data for Water Supply Alternatives
- (2) Map Depicting Quarter-Sections Impacted by Proposed Water Supply Alternatives

Cc: Mark Mittag/CH2M HILL
Brent Brown/CH2M HILL

TABLE 2A – 2D – TRS Data

TABLE 2A

ALIGNMENT	TWN	RNG	SEC	QUARTER_SEC_ID
RB	06	19	01	2
RB	06	19	01	3
RB	06	19	02	3
RB	06	19	02	4
RB	06	19	03	3
RB	06	19	03	4
RB	06	19	04	4
RB	06	19	09	1
RB	06	19	01	1
RB	06	19	01	4
RB	06	20	01	1
RB	06	20	01	2
RB	06	20	01	3
RB	06	20	01	4
RB	06	20	02	1
RB	06	20	02	2
RB	06	20	02	3
RB	06	20	02	4
RB	06	20	03	1
RB	06	20	03	2
RB	06	20	03	3
RB	06	20	03	4
RB	06	20	04	1
RB	06	20	04	2
RB	06	20	04	3
RB	06	20	04	4
RB	06	20	05	1
RB	06	20	05	2
RB	06	20	05	3
RB	06	20	05	4
RB	06	20	06	1
RB	06	20	06	2

TABLE 2A

ALIGNMENT	TWN	RNG	SEC	QUARTER_SEC_ID
RB	06	20	06	3
RB	06	20	06	4

TABLE 2B

ALIGNMENT	TWN	RNG	SEC	QUARTER_SEC_ID
RLM	06	21	02	3
RLM	06	21	02	4
RLM	06	21	03	1
RLM	06	21	03	2
RLM	06	21	03	3
RLM	06	21	03	4
RLM	06	21	04	1
RLM	06	21	04	2
RLM	06	21	04	3
RLM	06	21	04	4
RLM	06	21	05	1
RLM	06	21	05	2
RLM	06	21	05	3
RLM	06	21	05	4
RLM	06	21	06	1
RLM	06	21	06	4
RLM	06	21	11	1
RLM	06	21	12	1
RLM	06	21	12	2
RLM	06	21	12	4
RLM	06	22	07	3
RLM	06	22	07	4
RLM	06	22	08	3
RLM	06	22	08	4
RLM	06	22	15	2
RLM	06	22	15	3

TABLE 2B

ALIGNMENT	TWN	RNG	SEC	QUARTER_SEC_ID
RLM	06	22	15	4
RLM	06	22	16	1
RLM	06	22	16	2
RLM	06	22	17	1
RLM	06	22	22	1
RLM	06	22	23	1
RLM	06	22	23	2
RLM	06	22	23	3
RLM	06	22	23	4
RLM	06	22	24	2
RLM	06	22	24	3
RLM	06	20	01	1
RLM	06	20	01	4
RLM	06	21	06	2
RLM	06	21	06	3

TABLE 2C

ALIGNMENT	TWN	RNG	SEC	QUARTER_SEC_ID
RRG	06	20	12	1
RRG	06	21	06	3
RRG	06	21	07	2
RRG	06	21	07	3
RRG	06	21	07	4
RRG	06	21	18	1
RRG	06	21	18	2
RRG	06	21	18	3
RRG	06	21	18	4
RRG	06	21	19	1
RRG	06	21	20	2
RRG	06	21	20	3
RRG	06	21	28	2

TABLE 2C

ALIGNMENT	TWN	RNG	SEC	QUARTER_SEC_ID
RRG	06	21	28	3
RRG	06	21	28	4
RRG	06	21	29	1
RRG	06	21	29	2
RRG	06	21	29	4
RRG	06	20	01	4

TABLE 2D

ALIGNMENT	TWN	RNG	SEC	QUARTER_SEC_ID
RUB	06	21	06	2
RUB	07	20	25	4
RUB	07	20	36	1
RUB	07	20	36	4
RUB	07	21	31	2
RUB	07	21	31	3
RUB	06	20	01	1

TABLE 3A – 3F – TRS Data**TABLE 3A**

ALIGNMENT	TWN	RNG	SEC	QUARTER_SEC_ID
SSWF	05	19	04	1
SSWF	05	19	04	2
SSWF	06	19	28	3
SSWF	06	19	28	4
SSWF	06	19	33	1
SSWF	06	19	33	2
SSWF	06	19	33	3
SSWF	06	19	33	4

TABLE 3B

ALIGNMENT	TWN	RNG	SEC	QUARTER_SEC_ID
SAWTP	06	19	29	3
SAWTP	06	19	32	2

TABLE 3C

ALIGNMENT	TWN	RNG	SEC	QUARTER_SEC_ID
VMWTPHR	06	19	01	1
VMWTPHR	06	19	01	4
VMWTPHR	06	19	13	1
VMWTPHR	06	19	13	4
VMWTPHR	06	19	20	3
VMWTPHR	06	19	20	4
VMWTPHR	06	19	21	3
VMWTPHR	06	19	21	4
VMWTPHR	06	19	22	3
VMWTPHR	06	19	22	4
VMWTPHR	06	19	23	3
VMWTPHR	06	19	23	4

TABLE 3C

ALIGNMENT	TWN	RNG	SEC	QUARTER_SEC_ID
VMWTPHR	06	19	24	1
VMWTPHR	06	19	24	2
VMWTPHR	06	19	24	3
VMWTPHR	06	19	24	4
VMWTPHR	06	19	25	1
VMWTPHR	06	19	25	2
VMWTPHR	06	19	26	1
VMWTPHR	06	19	26	2
VMWTPHR	06	19	27	1
VMWTPHR	06	19	27	2
VMWTPHR	06	19	28	1
VMWTPHR	06	19	28	2
VMWTPHR	06	19	29	1
VMWTPHR	06	19	29	2
VMWTPHR	06	19	29	3
VMWTPHR	06	20	06	1
VMWTPHR	06	20	06	2
VMWTPHR	06	20	06	3
VMWTPHR	06	20	06	4
VMWTPHR	06	20	07	1
VMWTPHR	06	20	07	3
VMWTPHR	06	20	07	4
VMWTPHR	06	20	18	2
VMWTPHR	06	20	18	3
VMWTPHR	06	19	36	4

TABLE 3D

ALIGNMENT	TWN	RNG	SEC	QUARTER_SEC_ID
SWSWF	06	19	29	1
SWSWF	06	19	29	2

TABLE 3D

ALIGNMENT	TWN	RNG	SEC	QUARTER_SEC_ID
SWSWF	06	19	29	3
SWSWF	06	19	29	4
SWSWF	06	19	30	1
SWSWF	06	19	30	4
SWSWF	06	19	31	1
SWSWF	06	19	32	1
SWSWF	06	19	32	2

TABLE 3E

ALIGNMENT	TWN	RNG	SEC	QUARTER_SEC_ID
WTPSWWTP	06	19	09	1
WTPSWWTP	06	19	09	3
WTPSWWTP	06	19	09	4
WTPSWWTP	06	19	10	2
WTPSWWTP	06	19	16	1
WTPSWWTP	06	19	16	2
WTPSWWTP	06	19	16	3
WTPSWWTP	06	19	16	4
WTPSWWTP	06	19	20	3
WTPSWWTP	06	19	20	4
WTPSWWTP	06	19	21	1
WTPSWWTP	06	19	21	2
WTPSWWTP	06	19	21	3
WTPSWWTP	06	19	21	4
WTPSWWTP	06	19	28	1
WTPSWWTP	06	19	28	2
WTPSWWTP	06	19	29	1
WTPSWWTP	06	19	29	2
WTPSWWTP	06	19	29	3

TABLE 3F

ALIGNMENT	TWN	RNG	SEC	QUARTER_SEC_ID
WWURLLS	06	19	29	3
WWURLLS	06	19	29	4
WWURLLS	06	19	30	4
WWURLLS	06	19	31	1
WWURLLS	06	19	31	4
WWURLLS	06	19	32	1
WWURLLS	06	19	32	2
WWURLLS	06	19	32	3
WWURLLS	06	19	32	4



CH2M HILL
135 S. 84th Street
Suite 325
Milwaukee, WI 53214
Tel 414-272-2426
Fax 414-272-4408

January 13, 2010

Ms. Louise Clemency
Ecological Services Office – Green Bay
U.S. Fish and Wildlife Service
2661 Scott Tower Drive
New Franken, WI 54229
Phone: (920) 866-1717

Subject: Threatened and Endangered Species Review Request
City of Waukesha, Wisconsin Application for Lake Michigan Water Supply

Dear Ms. Clemency:

On behalf of the City of Waukesha (the City), CH2M HILL is requesting your verification that no threatened, endangered, proposed or candidate species, and/or unique habitats or natural areas exist in locations where infrastructure associated with obtaining a new water source for the City may be located. As requested by the Wisconsin DNR, the City is completing an environmental report that is evaluating the impacts of several alternatives to meet the current and future water supply needs of the City. These water supply alternatives include expanding existing groundwater sources, developing new groundwater sources, and obtaining and returning Lake Michigan water. This review will assist the City with evaluating the impacts of each alternative.

All of the proposed areas that may be impacted by water supply alternatives are located in the Counties of Waukesha, Milwaukee, or Racine, Wisconsin. The township, range, and section data for each proposed route is provided in tabular format in Attachment 1, which is included with this letter for your convenience. Attachment 2 is a map depicting the quarter sections from Attachment 1 that intersect with the alternatives.

CH2M HILL reviewed the online U.S. Fish and Wildlife Service (USFWS), Midwest Region's *County Distribution of Federally-listed Endangered, Threatened, Proposed, and Candidate Species* list for the state of Wisconsin, and found that no species are listed for either Milwaukee or Racine County. However, there is one threatened species listed for Waukesha County: the eastern prairie fringed orchid (*Platanthera leucophaea*). According to the USFWS, the eastern prairie fringed orchid typically occurs in wet grassland habitats.

CH2M HILL is requesting your concurrence that no federally protected resources will be affected by or is located within one (1) mile of the water supply alternatives described above.

Because we are evaluating and comparing the alternatives, it is important that the potential impacts be identified for each alternative. We respectfully request that if potential impacts are identified in your review, that you please indicate which alignment ID and quarter section is impacted.

Ms. Louise Clemency
Page 2
January 13, 2010

If you have any questions regarding this request or need additional information, please do not hesitate to contact me at (414) 272-2426, ext. 40356. Thank you.

Sincerely,

CH2M HILL

A handwritten signature in cursive script that reads "Corey Wilcox".

Corey Wilcox
Associate Scientist

Attachments:

- (1) Tables 1 - 3. Township, Range, and Section Data for Water Supply Alternatives
- (2) Map Depicting Quarter-Sections Impacted by Proposed Water Supply Alternatives

Cc: Mark Mittag/CH2M HILL
Brent Brown/CH2M HILL

TABLE 1A – 1H – TRS Data**TABLE 1A**

ALIGNMENT	TWN	RNG	SEC	QUARTER_SEC_ID
MS	06	21	17	3
MS	06	21	17	4
MS	06	21	20	1
MS	06	20	01	4
MS	06	20	12	1
MS	06	21	06	3
MS	06	21	07	2
MS	06	21	07	3
MS	06	21	18	1
MS	06	21	18	2
MS	06	21	18	3
MS	06	21	18	4
MS	06	21	19	1
MS	06	21	20	2

TABLE 1B

ALIGNMENT	TWN	RNG	SEC	QUARTER_SEC_ID
OCS	05	21	01	3
OCS	05	21	01	4
OCS	05	21	02	3
OCS	05	21	02	4
OCS	05	21	03	3
OCS	05	21	03	4
OCS	05	21	04	2
OCS	05	21	04	3
OCS	05	21	04	4
OCS	05	21	05	1
OCS	05	21	05	4
OCS	05	21	08	1
OCS	05	21	09	1

TABLE 1B

ALIGNMENT	TWN	RNG	SEC	QUARTER_SEC_ID
OCS	05	21	09	2
OCS	05	21	10	1
OCS	05	21	10	2
OCS	05	21	11	1
OCS	05	21	11	2
OCS	05	21	12	1
OCS	05	21	12	2
OCS	05	22	04	3
OCS	05	22	05	3
OCS	05	22	05	4
OCS	05	22	06	3
OCS	05	22	06	4
OCS	05	22	07	1
OCS	05	22	07	2
OCS	05	22	08	1
OCS	05	22	08	2
OCS	05	22	09	2
OCS	05	22	09	3
OCS	05	22	15	3
OCS	05	22	16	1
OCS	05	22	16	2
OCS	05	22	16	4
OCS	05	22	21	1
OCS	05	22	22	1
OCS	05	22	22	2
OCS	05	22	22	4
OCS	05	22	23	2
OCS	05	22	23	3
OCS	05	22	23	4
OCS	06	21	32	1
OCS	06	21	32	4
OCS	06	21	33	2
OCS	06	21	33	3

TABLE 1B

ALIGNMENT	TWN	RNG	SEC	QUARTER_SEC_ID
OCS	06	20	01	4
OCS	06	20	12	1
OCS	06	21	06	3
OCS	06	21	07	2
OCS	06	21	07	3
OCS	06	21	18	1
OCS	06	21	18	2
OCS	06	21	18	3
OCS	06	21	18	4
OCS	06	21	19	1
OCS	06	21	20	2
OCS	06	21	20	3
OCS	06	21	28	3
OCS	06	21	29	1
OCS	06	21	29	2
OCS	06	21	29	4

TABLE 1C

ALIGNMENT	TWN	RNG	SEC	QUARTER_SEC_ID
RS	03	22	03	1
RS	03	22	03	4
RS	03	22	10	1
RS	03	22	11	1
RS	03	22	11	2
RS	03	22	12	1
RS	03	22	12	2
RS	04	20	02	2
RS	04	20	02	3
RS	04	20	03	1
RS	04	20	11	1
RS	04	20	11	2

TABLE 1C

ALIGNMENT	TWN	RNG	SEC	QUARTER_SEC_ID
RS	04	20	12	1
RS	04	20	12	2
RS	04	21	07	1
RS	04	21	07	2
RS	04	21	08	1
RS	04	21	08	2
RS	04	21	09	1
RS	04	21	09	2
RS	04	21	10	1
RS	04	21	10	2
RS	04	21	11	1
RS	04	21	11	2
RS	04	21	12	1
RS	04	21	12	2
RS	04	22	07	1
RS	04	22	07	2
RS	04	22	08	1
RS	04	22	08	2
RS	04	22	09	1
RS	04	22	09	2
RS	04	22	10	1
RS	04	22	10	2
RS	04	22	10	4
RS	04	22	15	1
RS	04	22	15	4
RS	04	22	22	1
RS	04	22	22	4
RS	04	22	27	1
RS	04	22	27	4
RS	04	22	34	1
RS	04	22	34	4
RS	05	19	01	1
RS	05	20	06	2

TABLE 1C

ALIGNMENT	TWN	RNG	SEC	QUARTER_SEC_ID
RS	05	20	06	3
RS	05	20	07	2
RS	05	20	07	3
RS	05	20	18	2
RS	05	20	18	3
RS	05	20	18	4
RS	05	20	19	1
RS	05	20	19	2
RS	05	20	19	3
RS	05	20	19	4
RS	05	20	20	3
RS	05	20	20	4
RS	05	20	21	3
RS	05	20	21	4
RS	05	20	28	1
RS	05	20	28	2
RS	05	20	28	3
RS	05	20	28	4
RS	05	20	29	1
RS	05	20	29	2
RS	05	20	30	1
RS	05	20	30	2
RS	05	20	33	1
RS	05	20	33	2
RS	05	20	33	3
RS	05	20	33	4
RS	05	20	34	3
RS	05	20	34	4
RS	05	20	35	3
RS	06	19	24	1
RS	06	19	24	4
RS	06	19	25	1
RS	06	19	25	4

TABLE 1C

ALIGNMENT	TWN	RNG	SEC	QUARTER_SEC_ID
RS	06	19	36	1
RS	06	19	36	4
RS	06	20	19	2
RS	06	20	19	3
RS	06	20	30	2
RS	06	20	30	3
RS	06	20	31	2
RS	06	20	31	3

TABLE 1D

ALIGNMENT	TWN	RNG	SEC	QUARTER_SEC_ID
SB	06	20	01	1
SB	06	20	01	2
SB	06	20	01	3
SB	06	20	01	4
SB	06	20	02	1
SB	06	20	02	2
SB	06	20	02	3
SB	06	20	02	4
SB	06	20	03	1
SB	06	20	03	2
SB	06	20	03	3
SB	06	20	03	4
SB	06	20	04	1
SB	06	20	04	2
SB	06	20	04	3
SB	06	20	04	4
SB	06	20	05	1
SB	06	20	05	2
SB	06	20	05	3
SB	06	20	05	4

TABLE 1D

ALIGNMENT	TWN	RNG	SEC	QUARTER_SEC_ID
SB	06	20	06	1
SB	06	20	06	4

TABLE 1E

ALIGNMENT	TWN	RNG	SEC	QUARTER_SEC_ID
SNEWHR	06	19	01	1
SNEWHR	06	19	01	4
SNEWHR	06	20	06	1
SNEWHR	06	20	06	2
SNEWHR	06	20	06	3
SNEWHR	07	19	36	4
SNEWHR	06	20	06	4

TABLE 1F

ALIGNMENT	TWN	RNG	SEC	QUARTER_SEC_ID
SSEWHT	06	19	13	4
SSEWHT	06	20	06	4
SSEWHT	06	20	07	1
SSEWHT	06	20	07	3
SSEWHT	06	20	07	4
SSEWHT	06	20	18	2
SSEWHT	06	20	18	3

TABLE 1G

ALIGNMENT	TWN	RNG	SEC	QUARTER_SEC_ID
EVSWs	06	19	28	3
EVSWs	06	19	28	4

TABLE 1G

ALIGNMENT	TWN	RNG	SEC	QUARTER_SEC_ID
EVSWs	06	19	29	3
EVSWs	06	19	29	4
EVSWs	06	19	32	1
EVSWs	06	19	32	2
EVSWs	06	19	33	1
EVSWs	06	19	33	2

TABLE 1H

ALIGNMENT	TWN	RNG	SEC	QUARTER_SEC_ID
MSZ	06	21	06	2
MSZ	07	21	29	3
MSZ	07	21	29	4
MSZ	07	21	30	4
MSZ	07	21	31	1
MSZ	07	21	31	2
MSZ	07	21	31	3
MSZ	07	21	31	4
MSZ	07	21	32	1
MSZ	07	21	32	2



CH2M HILL
135 S. 84th Street
Suite 325
Milwaukee, WI 53214
Tel 414-272-2426
Fax 414-272-4408

February 2, 2010

Ms. Jill Utrupp
Ecological Services Office – Green Bay
U.S. Fish and Wildlife Service
2661 Scott Tower Drive
New Franken, WI 54229

Subject: Environmental Review
City of Waukesha Municipal Water Supply – Lake Michigan Diversion

Dear Ms. Utrupp:

This letter is a follow-up to the initial threatened and endangered (T&E) species review request letter sent on January 13, 2010, and subsequent phone and email correspondence on January 21 and 26, 2010 regarding several alternatives being considered to meet future water supply needs of the City of Waukesha (City).

On behalf of the City, CH2M HILL is requesting a more detailed environmental impact review for the locations where the alternatives are proposed, to further identify and evaluate any potential impacts the alternatives may have on federal-listed species, federal-managed lands, and/or sensitive habitats. The township, range, and section data for each proposed alternative is provided in tabular format in Attachment 1, which is included with this letter for your convenience. In addition, a copy of the Draft Application for Lake Michigan Water Supply, which provides a explanation of the nature, location, and general impacts resulting from the proposed project, has been included (Attachment 2) to provide you with more detailed information regarding the proposed alternatives.

Due to the need to compare each of the alternatives, we would appreciate if you would provide a separate review and analysis of the potential impacts for each alternative. Accordingly, we respectfully request that you please indicate the corresponding alternative name and which section / quarter section(s) the resource may be present.

If you have any questions regarding this request or need additional information, please do not hesitate to contact me at (414) 272-2426, ext. 40356. Thank you.

Sincerely,

CH2M HILL

A handwritten signature in cursive script that reads "Corey Wilcox".

Corey Wilcox
Associate Scientist

Ms. Jill Utrupp
Page 2
February 2, 2010

Attachments:

Tables 1 – 8. Township, Range, and Section Data for Proposed Water Supply and Return Alternatives

DRAFT Application Lake Michigan Water Supply

Cc: Mark Mittag/CH2M HILL
Brent Brown/CH2M HILL



CH2M HILL
135 S. 84th Street
Suite 325
Milwaukee, WI 53214
Tel 414-272-2426
Fax 414-272-4408

February 2, 2010

Shari Koslowsky
Office of Energy SS/7
Wisconsin Department of Natural Resources
P.O. Box 7921
Madison, WI 53707-7921

Subject: Environmental Review
City of Waukesha Municipal Water Supply – Lake Michigan Diversion

Dear Ms. Koslowsky:

This letter is a follow-up to the initial threatened and endangered (T&E) species review request letter sent on January 13, 2010, and subsequent phone and email correspondence on January 19, 2010 regarding several alternatives being considered to meet future water supply needs of the City of Waukesha (City).

On behalf of the City, CH2M HILL is requesting a more detailed environmental impact review for the locations where the alternatives are proposed, to further identify and evaluate any potential impacts the alternatives may have on state-listed species, state-managed lands, and/or sensitive habitats. The township, range, and section data for each proposed alternative is provided in tabular format in Attachment 1, which is included with this letter for your convenience. In addition, a copy of the Draft Application for Lake Michigan Water Supply, which provides a explanation of the nature, location, and general impacts resulting from the proposed project, has been included (Attachment 2) to provide you with more detailed information regarding the proposed alternatives.

Due to the need to compare each of the alternatives, we would appreciate if you would provide a separate review and analysis of the potential impacts for each alternative. Accordingly, we respectfully request that you please indicate the corresponding alternative name and which section / quarter section(s) the resource may be present.

If you have any questions regarding this request or need additional information, please do not hesitate to contact me at (414) 272-2426, ext. 40356. Thank you.

Sincerely,

CH2M HILL

A handwritten signature in black ink that reads "Corey Wilcox".

Corey Wilcox
Associate Scientist

Ms. Shari Koslowsky
Page 2
February 2, 2010

Attachments:

Tables 1 – 8. Township, Range, and Section Data for Proposed Water Supply and Return Alternatives

DRAFT Application Lake Michigan Water Supply

Cc: Mark Mittag/CH2M HILL
Brent Brown/CH2M HILL

TRS Data for Proposed Supply and Return Routes

TABLE 1
Alternative 1
Deep and Shallow Wells (Supply)

TWN	RNG	SEC	QUARTER_SEC_ID
06	19	16	2
06	19	16	1
06	19	15	2
06	19	15	1
06	19	16	3
06	19	16	4
06	19	30	4
06	19	29	3
06	19	29	4
06	19	28	3
06	19	28	4
06	19	03	3
06	19	03	4
07	19	35	3
07	19	35	4
07	19	36	3
07	19	36	4
06	19	09	3
06	19	09	4
06	19	10	3
06	19	10	4
06	19	09	1
06	19	10	2
06	19	10	1
06	19	03	2
06	19	03	1
06	19	02	2
06	19	02	1
06	19	31	1
06	19	32	2
06	19	32	1

TABLE 1
Alternative 1
Deep and Shallow Wells (Supply)

TWN	RNG	SEC	QUARTER_SEC_ID
06	19	33	2
06	19	33	1
06	19	31	4
06	19	32	3
06	19	32	4
06	19	33	3
06	19	33	4
06	19	29	2
06	19	29	1
06	19	28	2
06	19	28	1
06	19	20	3
06	19	20	4
06	19	21	3
06	19	21	4
06	19	21	2
06	19	21	1

TABLE 2
Alternative 2
Shallow Aquifer and Fox River Alluvium (Supply)

TWN	RNG	SEC	QUARTER_SEC_ID
06	19	16	2
06	19	16	1
06	19	15	2
06	19	15	1
06	19	16	3
06	19	16	4
06	19	30	4
06	19	29	3
06	19	29	4
06	19	28	3
06	19	28	4
06	19	03	3
06	19	03	4
07	19	35	3
07	19	35	4
07	19	36	3
07	19	36	4
06	19	09	3
06	19	09	4
06	19	10	3
06	19	10	4
06	19	09	1
06	19	10	2
06	19	10	1
06	19	03	2
06	19	03	1
06	19	02	2
06	19	02	1
06	19	31	1
06	19	32	2
06	19	32	1
06	19	33	2

TABLE 2
Alternative 2
Shallow Aquifer and Fox River Alluvium (Supply)

TWN	RNG	SEC	QUARTER_SEC_ID
06	19	33	1
06	19	31	4
06	19	32	3
06	19	32	4
06	19	33	3
06	19	33	4
06	19	30	1
06	19	29	2
06	19	29	1
06	19	28	2
06	19	28	1
06	19	20	3
06	19	20	4
06	19	21	3
06	19	21	4
06	19	21	2
06	19	21	1

TABLE 3
Alternative 3a-1
Milwaukee Supply

TWN	RNG	SEC	QUARTER_SEC_ID
06	21	06	2
06	21	06	3
06	21	07	1
06	21	07	2
06	21	07	3
06	21	07	4
06	21	14	3
06	21	15	3
06	21	15	4
06	21	16	3
06	21	16	4
06	21	17	3
06	21	17	4
06	21	18	1
06	21	18	2
06	21	18	3
06	21	18	4
06	21	19	1
06	21	19	2
06	21	20	1
06	21	20	2
06	21	21	1
06	21	21	2
06	21	22	1
06	21	22	2
06	21	23	2
06	20	06	3
06	20	06	4
06	20	05	3
06	20	05	4
06	20	04	3
06	20	04	4

TABLE 3
Alternative 3a-1
Milwaukee Supply

TWN	RNG	SEC	QUARTER_SEC_ID
06	20	03	3
06	20	03	4
06	20	02	3
06	20	02	4
06	20	01	3
06	20	01	4
06	19	01	4
07	19	36	4
06	20	10	1
06	20	11	2
06	20	11	1
06	20	12	2
06	20	12	1
06	19	01	1
06	20	06	2
06	20	06	1
06	20	05	2
06	20	05	1
06	20	04	2
06	20	04	1
06	20	03	2
06	20	03	1
06	20	02	2
06	20	02	1
06	20	01	2
06	20	01	1

TABLE 4
Alternative 3a-2
Oak Creek (Supply)

TWN	RNG	SEC	QUARTER_SEC_ID
05	21	01	3
05	21	01	4
05	21	02	3
05	21	02	4
05	21	03	3
05	21	03	4
05	21	04	2
05	21	04	3
05	21	04	4
05	21	05	1
05	21	05	4
05	21	08	1
05	21	09	1
05	21	09	2
05	21	10	1
05	21	10	2
05	21	11	1
05	21	11	2
05	21	12	1
05	21	12	2
05	22	04	3
05	22	05	3
05	22	05	4
05	22	06	3
05	22	06	4
05	22	07	1
05	22	07	2
05	22	08	1
05	22	08	2
05	22	09	2
05	22	09	3
05	22	15	3

TABLE 4
Alternative 3a-2
Oak Creek (Supply)

TWN	RNG	SEC	QUARTER_SEC_ID
05	22	16	1
05	22	16	2
05	22	16	3
05	22	16	4
05	22	21	1
05	22	22	1
05	22	22	2
05	22	22	4
05	22	23	2
05	22	23	3
05	22	23	4
05	22	24	3
06	20	01	4
06	20	12	1
06	21	06	3
06	21	07	2
06	21	07	3
06	21	18	1
06	21	18	2
06	21	18	3
06	21	18	4
06	21	19	1
06	21	20	2
06	21	20	3
06	21	28	3
06	21	29	1
06	21	29	2
06	21	29	4
06	21	32	1
06	21	32	4
06	21	33	2
06	21	33	3

TABLE 4
Alternative 3a-2
Oak Creek (Supply)

TWN	RNG	SEC	QUARTER_SEC_ID
06	20	01	1
06	20	01	2
06	20	01	3
06	20	01	4
06	20	02	1
06	20	02	2
06	20	02	3
06	20	02	4
06	20	03	1
06	20	03	2
06	20	03	3
06	20	03	4
06	20	04	1
06	20	04	2
06	20	04	3
06	20	04	4
06	20	05	1
06	20	05	2
06	20	05	3
06	20	05	4
06	20	06	1
06	20	06	4
06	19	01	1
06	19	01	4
06	20	06	1
06	20	06	2
06	20	06	3
06	20	06	4
07	19	36	4

TABLE 5
Alternative 3a-3
Racine (Supply)

TWN	RNG	SEC	QUARTER_SEC_ID
03	22	02	3
03	22	03	1
03	22	03	4
03	22	10	1
03	22	11	1
03	22	11	2
03	22	12	1
03	22	12	2
04	20	02	2
04	20	02	3
04	20	03	1
04	20	11	1
04	20	11	2
04	20	12	1
04	20	12	2
04	21	07	1
04	21	07	2
04	21	08	1
04	21	08	2
04	21	09	1
04	21	09	2
04	21	10	1
04	21	10	2
04	21	11	1
04	21	11	2
04	21	12	1
04	21	12	2
04	22	07	1
04	22	07	2
04	22	08	1
04	22	08	2
04	22	09	1

TABLE 5
Alternative 3a-3
Racine (Supply)

TWN	RNG	SEC	QUARTER_SEC_ID
04	22	09	2
04	22	10	1
04	22	10	2
04	22	10	3
04	22	10	4
04	22	15	1
04	22	15	4
04	22	22	1
04	22	22	4
04	22	27	1
04	22	27	4
04	22	34	1
04	22	34	4
05	19	01	1
05	20	06	2
05	20	06	3
05	20	07	2
05	20	07	3
05	20	18	2
05	20	18	3
05	20	18	4
05	20	19	1
05	20	19	2
05	20	19	3
05	20	19	4
05	20	20	3
05	20	20	4
05	20	21	3
05	20	21	4
05	20	28	1
05	20	28	2
05	20	28	3

TABLE 5
Alternative 3a-3
Racine (Supply)

TWN	RNG	SEC	QUARTER_SEC_ID
05	20	28	4
05	20	29	1
05	20	29	2
05	20	30	1
05	20	30	2
05	20	33	1
05	20	33	2
05	20	33	3
05	20	33	4
05	20	34	3
05	20	34	4
05	20	35	3
06	19	24	1
06	19	24	4
06	19	25	1
06	19	25	4
06	19	36	1
06	19	36	4
06	20	19	2
06	20	19	3
06	20	30	2
06	20	30	3
06	20	31	2
06	20	31	3
06	19	01	1
06	19	01	4
06	20	06	1
06	20	06	2
06	20	06	3
06	20	06	4
07	19	36	4
06	19	13	1

TABLE 5
Alternative 3a-3
Racine (Supply)

TWN	RNG	SEC	QUARTER_SEC_ID
06	19	13	4
06	20	06	4
06	20	07	1
06	20	07	3
06	20	07	4
06	20	18	2
06	20	18	3

TABLE 6
Alternative 3b-1
Underwood Creek (Return Route)

TWN	RNG	SEC	QUARTER_SEC_ID
06	19	01	1
06	19	01	2
06	19	01	3
06	19	01	4
06	19	02	3
06	19	02	4
06	19	03	3
06	19	03	4
06	19	04	4
06	19	09	1
06	19	10	2
06	20	01	1
06	20	01	2
06	20	01	3
06	20	01	4
06	20	02	1
06	20	02	2
06	20	02	3
06	20	02	4
06	20	03	1
06	20	03	2
06	20	03	3
06	20	03	4
06	20	04	1
06	20	04	2
06	20	04	3
06	20	04	4
06	20	05	1
06	20	05	2
06	20	05	3
06	20	05	4
06	20	06	1

TABLE 6
Alternative 3b-1
Underwood Creek (Return Route)

TWN	RNG	SEC	QUARTER_SEC_ID
06	20	06	2
06	20	06	3
06	20	06	4
06	20	01	1
06	21	06	2
07	20	25	4
07	20	36	1
07	20	36	4
07	21	30	3
07	21	31	2
07	21	31	3

TABLE 7
Alternative 3b-2
Root River (Return)

TWN	RNG	SEC	QUARTER_SEC_ID
06	19	01	1
06	19	01	2
06	19	01	3
06	19	01	4
06	19	02	3
06	19	02	4
06	19	03	3
06	19	03	4
06	19	04	4
06	19	09	1
06	19	10	2
06	20	01	1
06	20	01	2
06	20	01	3
06	20	01	4
06	20	02	1
06	20	02	2
06	20	02	3
06	20	02	4
06	20	03	1
06	20	03	2
06	20	03	3
06	20	03	4
06	20	04	1
06	20	04	2
06	20	04	3
06	20	04	4
06	20	05	1
06	20	05	2
06	20	05	3
06	20	05	4
06	20	06	1

TABLE 7
Alternative 3b-2
Root River (Return)

TWN	RNG	SEC	QUARTER_SEC_ID
06	20	06	2
06	20	06	3
06	20	06	4
06	20	01	4
06	20	12	1
06	21	06	3
06	21	07	2
06	21	07	3
06	21	07	4
06	21	18	1
06	21	18	2
06	21	18	3
06	21	18	4
06	21	19	1
06	21	20	2
06	21	20	3
06	21	28	2
06	21	28	3
06	21	28	4
06	21	29	1
06	21	29	2
06	21	29	4
06	21	33	1

TABLE 8
Alternative 3b-3
Direct to Lake Michigan (Return)

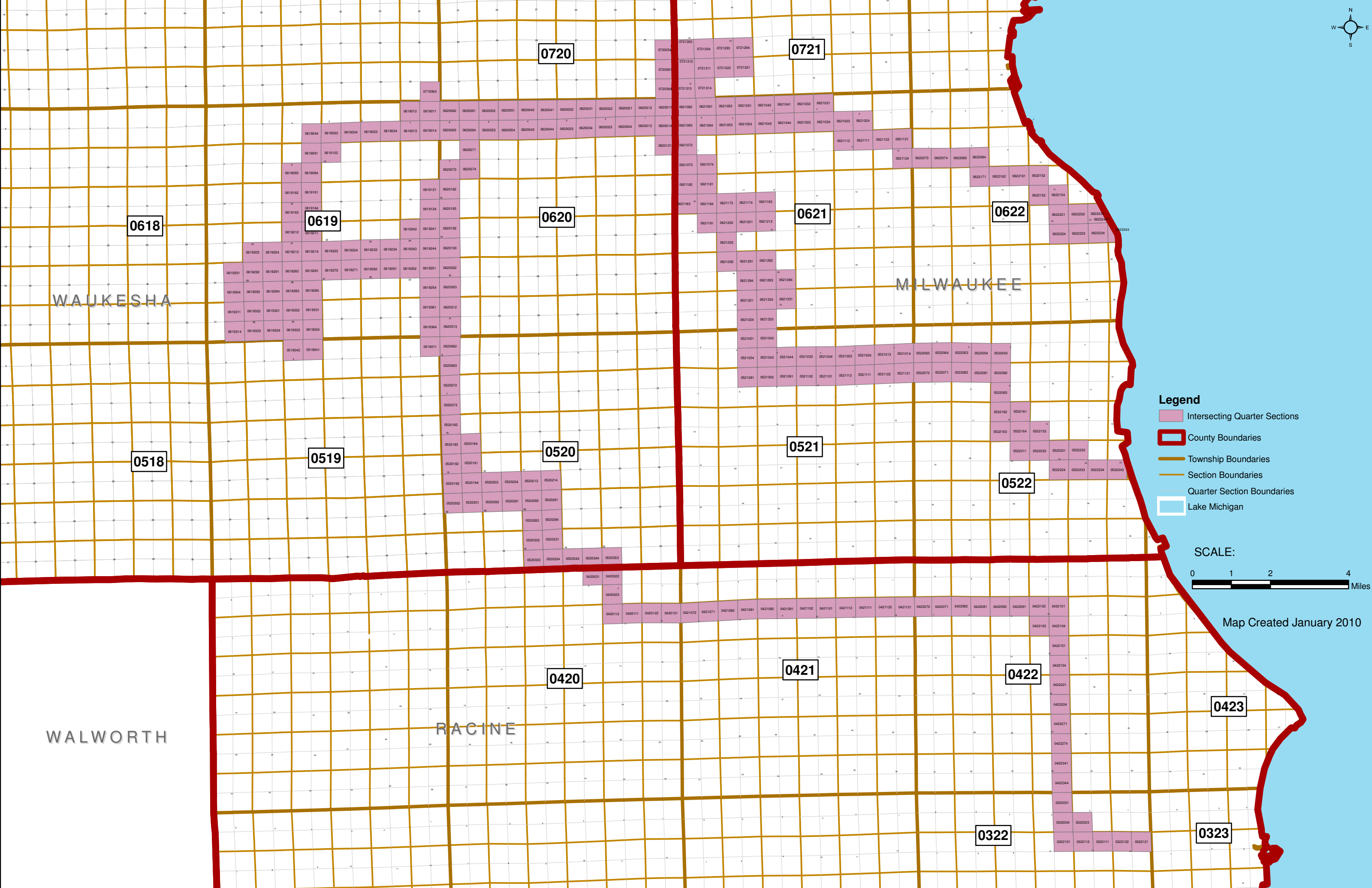
TWN	RNG	SEC	QUARTER_SEC_ID
06	19	01	1
06	19	01	2
06	19	01	3
06	19	01	4
06	19	02	3
06	19	02	4
06	19	03	3
06	19	03	4
06	19	04	4
06	19	09	1
06	19	10	2
06	20	01	1
06	20	01	2
06	20	01	3
06	20	01	4
06	20	02	1
06	20	02	2
06	20	02	3
06	20	02	4
06	20	03	1
06	20	03	2
06	20	03	3
06	20	03	4
06	20	04	1
06	20	04	2
06	20	04	3
06	20	04	4
06	20	05	1
06	20	05	2
06	20	05	3
06	20	05	4
06	20	06	1

TABLE 8
Alternative 3b-3
Direct to Lake Michigan (Return)

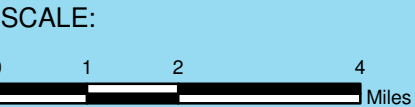
TWN	RNG	SEC	QUARTER_SEC_ID
06	20	06	2
06	20	06	3
06	20	06	4
06	20	01	1
06	20	01	4
06	21	02	3
06	21	02	4
06	21	03	1
06	21	03	2
06	21	03	3
06	21	03	4
06	21	04	1
06	21	04	2
06	21	04	3
06	21	04	4
06	21	05	1
06	21	05	2
06	21	05	3
06	21	05	4
06	21	06	1
06	21	06	2
06	21	06	3
06	21	06	4
06	21	11	1
06	21	11	2
06	21	12	1
06	21	12	2
06	21	12	4
06	22	07	3
06	22	07	4
06	22	08	3
06	22	08	4

TABLE 8
Alternative 3b-3
Direct to Lake Michigan (Return)

TWN	RNG	SEC	QUARTER_SEC_ID
06	22	15	2
06	22	15	3
06	22	15	4
06	22	16	1
06	22	16	2
06	22	17	1
06	22	22	1
06	22	22	4
06	22	23	1
06	22	23	2
06	22	23	3
06	22	23	4
06	22	24	2
06	22	24	3



- Legend**
- Intersecting Quarter Sections
 - County Boundaries
 - Township Boundaries
 - Section Boundaries
 - Quarter Section Boundaries
 - Lake Michigan



Map Created January 2010

Appendix 6-7
Habitat Assessment

City of Waukesha Water Supply - Habitat Assessment

PREPARED FOR: Dan Duchniak/Waukesha Water Utility

PREPARED BY: CH2M HILL

ATTACHMENTS: Preferred Habitat for State-Listed Species
Habitat Survey Results Tables
Habitat Survey Location Aerial Maps (Confidential)
Photographic Documentation of Habitat Surveys (Confidential)

DATE: August 19, 2010

As part of the environmental resource review associated with the Environmental Report supporting the City of Waukesha's Water Supply Application the Wisconsin Department of Natural Resources (WDNR) requested additional information regarding the type and distribution of habitats along the water supply and return flow alternative routes being evaluated. The WDNR requested an assessment of the habitats to aid in their review of impacts to state-listed species that have the potential to occur along the routes. In support of this request CH2M HILL conducted habitat assessment activities along the water supply and return flow alternative routes from July 6 to July 9, 2010.

Prior to conducting the habitat surveys along each route, CH2M HILL utilized information received from the WDNR Bureau of Endangered Resources (BER) to summarize the preferred habitat for each of the state-listed species having the potential to be present along the routes. The preferred habitat for each species is provided in tabular format in the Preferred Habitat for State-Listed Species table (attached).

Locations and data parameters for the habitat assessment were identified during a May 10, 2010 meeting between the Waukesha Water Utility, CH2M HILL, and the WDNR. Based on a review of aerial photography a total of 41 individual locations which had the potential to contain higher quality habitat were selected for onsite review. It was assumed that higher quality habitats also represented increased potential for state-listed species habitat. Due to the overlap in alignment of some of the supply and return flow routes, several of the routes share the same survey locations. Aerial maps of each route showing the selected survey locations were produced prior to completing the habitat assessment and are provided with this memorandum, but under separate cover. These maps and photographic documentation of the habitat surveys include information regarding potential habitat locations of state-listed species and therefore will be submitted as confidential items. Data parameters for the survey include the following information:

- Site number
- Type of habitat
- Dominant species in the three main vegetative layers (overstory, understory, and herbaceous)

- Presence and percentage of invasive species
- Maintenance status
- Observation access type (direct or indirect/restricted)
- Wildlife observed
- Wetlands/waterbodies present
- Stream conditions (width, depth, potential quality)
- Photo numbers
- Determination of potential state-listed species habitat
- General site comments

A two-person CH2M HILL field team conducted habitat surveys at each of the 41 pre-determined locations from July 6 through July 9, 2010. Of the 41 pre-determined locations, 15 exhibited potential state-listed species habitat based on vegetation diversity and vigor, presence of wetlands/waterbodies present, the overall size of the habitat, and/or lack of invasive species. Additional habitat review should be considered in conjunction with the selected alternative design to identify site specific habitat features and to further inform construction technique selection that can avoid, minimize, and mitigate potential impacts within any of these 15 locations. Table 1 on the following page provides the identification numbers of the 15 survey locations with potential state-listed species habitat.

The remaining 26 locations surveyed did not have significant potential to support preferred habitat for state-listed species. This was typically due to lack of vegetation diversity, or monotypic stands of a specific species, dominance of invasive species (both native and non-native), evidence of herbicide application, previous disturbance, or that the location was maintained. Further details regarding each of the sites surveyed are provided in tabular format in the Habitat Survey Results tables for each individual route (attached).

TABLE 1
City of Waukesha Water Supply Habitat Assessment

Route Name	Number of Sites with Potential State-Listed Species Habitat	Site No.
Alt 1 (Deep and Shallow Wells)	1	Site 1
Alt 2 (Shallow Aquifer & Fox River Alluvium)	2	Site 1 (Same site as Alt 1, Site 1) Site 4B
Alt 3A-1 (Milwaukee Supply)	3	Site 1 Site 2C Site 4C
Alt 3A-3 (Oak Creek Supply)	7	Site 1 (Same site as Alt 3A-1, Site 1) Site 3 (Same site as Alt 3A-1, Site 2C) Site 4 (Same site as Alt 3A-1, Site 4C) Site 7 Site 8 (Potential habitat could occur directly adjacent to the site to the north) Site 10 Site 12 ^a
Alt 3A-4 (Racine Supply)	8	Site 1 (Same site as Alt 3A-1, Site 1) Site 7 ^a Site 10 ^a Site 12 ^a Site 13 ^a Site 14 ^a Site 15 ^a Site 16
Alt 3B-1 (Underwood Creek)	1	Site 1C (Same site as Alt 3A-1, Site 2C)
Alt 3B-2 (Root River)	2	Site 1C (Same site as Alt 3A-1, Site 2C) Site 3C (Same site as Alt 3A-1, Site 4C)
Alt 3B-3 (Direct to Lake Michigan)	1	Site 1C (Same site as Alt 3A-1, Site 2C)

^a No direct access to site; potential habitat determination made from aerial photos

PREFERRED HABITAT FOR STATE-LISTED SPECIES					
Alternative 1 (Deep and Shallow Wells) & Alternative 2 (Shallow Aquifer and Fox River Alluvium)					
City of Waukesha Water Supply					
Species Group	Scientific Name	Common Name	State Status ^a	Federal Status ^a	Habitat Description
Habitat	—	Bird rookery	SC	—	A bird rookery is an area where more than one pair of birds nest in a group. The number of nests can vary from just a few to hundreds, and can include a single to many different species of birds. Sites can include rare and non-rare species. The breeding time will vary based on the species present at the site. Rookeries are typically located in inaccessible locations including forests, shrub communities, wetlands adjacent to water (lakes, rivers or streams), and islands. These sites are important as large numbers of breeding individuals can be found in a single place.
	—	Calcareous fen	N/A	—	Calcareous fens occur mostly in southern Wisconsin, on sites that are fed by carbonate-enriched groundwater. Most fens are small, covering no more than a few acres, and are often associated and can intergrade with more abundant and widespread wetland communities such as southern sedge meadow, wet prairie, shrub-carr, emergent marsh, and southern tamarack swamp. An accumulation of peat can raise the fen surface to a height of several meters above the adjoining lands. Common or representative plants include sedges, marsh fern, shrubby cinquefoil, shrubby St. John's wort, Ohio goldenrod, grass-of-parnassus, twig-rush, brook lobelia, boneset, swamp thistle, and asters. Many fens have a significant number of prairie or sedge meadow components, and some contain plants often associated with bogs, such as tamarack, bog birch and pitcher plant. Fens occur in several landscape settings, including the bases of morainal slopes, on sloping deposits of glacial outwash, in the headwaters regions of spring runs and small streams, and on the shores of alkaline drainage lakes.
	—	Emergent marsh	N/A	—	These open, marsh, lake, riverine and estuarine communities with permanent standing water are dominated by robust emergent macrophytes, in pure stands of single species or in various mixtures. Dominants include cattails, bulrushes (particularly <i>Scirpus acutus</i> , <i>S. fluviatilis</i> , and <i>S. validus</i>), bur-reeds, giant reed, pickerel-weed, water-plantains, arrowheads, the larger species of spikerush (such as <i>Eleocharis smallii</i>), and wild rice.
	—	Mesic prairie	N/A	—	This grassland community occurs on rich, moist, well-drained sites, usually on level or gently rolling glacial topography. The dominant plant is the tall grass big bluestem. The grasses little bluestem, Indian grass, needle grass, prairie dropseed, and switch grass are also frequent. The forb layer is diverse in the number, size, and physiognomy of the species. Common taxa include the prairie docks, lead plant, heath and smooth asters, prairie coreopsis, prairie sunflower, rattlesnake-master, flowering spurge, bee-balm, prairie coneflower, and spiderwort.
	—	Southern dry forest	N/A	—	Oaks (<i>Quercus</i> spp.) are the dominant species in this upland forest community of dry sites. White oak and black oak are dominant, often with admixtures of northern red and bur oaks and black cherry. In the well-developed shrub layer, brambles (<i>Rubus</i> spp.), gray dogwood, and American hazelnut are common. Frequent herbaceous species are wild geranium, false Solomon's-seal, hog-peanut, and rough-leaved sunflower. This community type intergrades to oak woodland, which has similar canopy composition but a more open forest floor due to relatively frequent ground fires and possibly also due to grazing by elk, bison, or deer prior to EuroAmerican settlement.
	—	Southern dry-mesic forest	N/A	—	Southern dry-mesic forests occur on loamy soils of glacial till plains and moraines, and on erosional topography with a loess cap, south of the tension zone. Red oak is a common dominant tree of this upland forest community type. White oak, basswood, sugar and red maples, white ash, shagbark hickory, and black cherry are also important. The herbaceous understory flora is diverse and includes many species listed under southern dry forest plus jack-in-the-pulpit, enchanter's-nightshade, large-flowered bellwort, interrupted fern, lady fern, tick-trefoils, and hog peanut.
	—	Southern mesic forest	N/A	—	Oaks are the dominant species in this upland forest community of dry sites. White oak and black oak are dominant, often with admixtures of northern red and bur oaks and black cherry. In the well-developed shrub layer, brambles (<i>Rubus</i> spp.), gray dogwood, and American hazelnut are common. Frequent herbaceous species are wild geranium, false Solomon's-seal, hog-peanut, and rough-leaved sunflower.
Plants	<i>Agrimonia parviflora</i>	Swamp agrimony	SC	—	Found in wet woodland patches and ditches, oak-hickory forests, southern mesic forests, wet prairies, and margins of calcareous marshes. Blooming occurs throughout July; fruiting occurs early August through early September. The optimal identification period for this species is early August through early September.
	<i>Asclepias Purpurascens</i>	Purple milkweed	E	—	Found in open oak forest (i.e. southern dry mesic forests) margins and roadsides; it has wide soil moisture tolerances. Pink/purple flowers at flat top. Blooming occurs early June through late July; fruiting occurs early July through late August. The optimal identification period for this species is late June through late July.
	<i>Aster furcatus</i>	Forked aster	T	—	Found in dry to mesic hardwoods (i.e. southern wet and wet mesic forests), often on stream-sides or slopes with dolomite near the surface. White flowers, clustered at the very top of stem. Blooming occurs early August through early October; fruiting occurs late August through early October. The optimal identification period for this species is late August through late September.
	<i>Cacalia tuberosa</i>	Prairie Indian plantain	T	—	Found in a variety of deep-soiled prairies (i.e. wet, wet mesic and dry prairies) with moist soils. Blooming occurs early May through late June; fruiting occurs late June through late July. The optimal identification period for this species is late May through late July.
	<i>Carex Crawei</i>	Crawe sedge	SC	—	Found in calcareous wetlands and dolomitic pavement, often near Lake Michigan, as well as fens, moist calcareous prairies, and northern wet forests with moist, calcareous soils. Blooming occurs late April through late May; fruiting occurs late May through late June. The optimal identification period for this species is throughout May.
	<i>Cypripedium candidum</i>	Small white lady's slipper	T	—	Found in calcareous fens, and wet and mesic prairies with wet or moist soils. Blooming occurs late May through early June; fruiting occurs throughout September. The optimal identification period for this species is late May through early June.
	<i>Cypripedium parviflorum</i>	Northern yellow lady's slipper	SC	—	Found in fens, calcareous swales, and rich springy forest edges (i.e. southern or northern wet mesic forests) with moist to wet soils. Blooming occurs late May through late June; fruiting occurs late June through late July. The optimal identification period for this species is late May through early July.
	<i>Gentiana alba</i>	Yellow gentian	T	—	Found in thin soil in dry, open woodlands (i.e. oak openings), ridges and bluffs (often with dolomite near the surface), as well as moist sand prairies (mesic to dry mesic prairies) and roadside ditches. Blooming occurs late August through early October; fruiting occurs early September through early October. The optimal identification period for this species is throughout September.

City of Waukesha Water Supply

Species Group	Scientific Name	Common Name	State Status ^a	Federal Status ^a	Habitat Description
Plants (cont.)	<i>Gentianopsis procera</i>	Lesser fringed gentian	SC	—	Found on wet dolomite pavement near Lake Michigan, as well as cold fens, seeps, and meadows (i.e. northern sedge meadows) with wet, calcareous soils. Deep blue flowers with fringed edges. Blooming occurs late August through early October; fruiting occurs early September through early October. The optimal identification period for this species is late August through early October.
	<i>Jeffersonia diphylla</i>	Twinleaf	SC	—	Found in very rich hardwood forests (i.e. southern mesic forests), often with dolomite near the surface. White cupped flower with leaves comprised of 2 symmetrical parts. Blooming occurs throughout May; fruiting occurs early July through early September. The optimal identification period for this species is early May through early June.
	<i>Liatris spicata</i>	Marsh blazing star	SC	—	Found in moist, sandy calcareous prairies (i.e. dry to wet mesic prairies) with moist to wet soils. Deep purple flowers with wispy petals. Blooming occurs late July through early August; fruiting occurs throughout August. The optimal identification period for this species is early August through early September.
	<i>Myriophyllum farewellii</i>	Farwell's water-milfoil	SC	—	A submergent aquatic, native-invasive plant found in lakes, streams, and ponds. It is especially common in small shallow reservoirs in the bed of glacial Lake Wisconsin. Blooming occurs from mid June-mid August mid July-mid October. The optimal identification period for this species is mid July through late September.
	<i>Polygala cruciata</i>	Crossleaf milkwort	SC	—	Found in moist acidic peaty ditches, oak and pine barrens, and bogs in the bed of glacial Lake Wisconsin. Occurs in moist to wet, acidic, peaty soils and has tiered purple flowers at the top of the stem (ground cover). Blooming occurs early July through early September; fruiting occurs late August through late September. The optimal identification period for this species is early July through early August.
	<i>Prenanthes aspera</i>	Rough rattlesnake root	E	—	Found in dryish prairies (i.e. dry mesic prairies), usually on the lower slopes of hills. White flowers clustered at top of plant. Blooming occurs late August through early October; fruiting occurs throughout September. The optimal identification period for this species is late August through early October.
	<i>Ptelea trifoliata</i>	Wafer ash	SC	—	Found on dry dolomite ledges in oak forests (i.e. southern dry and wet mesic forests). Blooming occurs late May through early June; fruiting occurs throughout July. The optimal identification period for this species is late May through late September.
	<i>Solidago ohioensis</i>	Ohio goldenrod	SC	—	Found most commonly on wet dolomite lake flats in Door County, and in fens, moist calcareous prairies, and sedge meadows in the southeast portion of the state with moist soils. Yellow, flat-topped flowers. Blooming occurs early August through late September; fruiting occurs throughout September. The optimal identification period for this species is late August through early September.
	<i>Thaspium trifoliatum</i> var. <i>flavum</i>	Purple meadow-parsnip	SC	—	Found in moist prairies (wet mesic and mesic prairies) and woodlands (including oak openings); it is also naturalized on roadsides and embankments. Yellow flowers clustered at the flat top. Blooming occurs late May through late June; fruiting occurs early July through early October. The optimal identification period for this species is early July through late September.
Reptiles & Amphibians	<i>Acris crepitans</i>	Northern cricket frog	E	—	Prefer ponds, lakes, and a variety of habitats along and adjacent to streams and rivers including, marshes, fens, sedge meadows, low prairies, and exposed mud flats. The species tends to breed in quiet water (no or low flow) and may also move from streams and rivers to adjacent wetlands and ponds. Cricket frogs are active from late-March through November. Breeding occurs from mid-May through mid-August, with some larvae not transforming until late September.
	<i>Emydoidea blandingii</i>	Blanding's turtle	T	—	Utilize a wide variety of aquatic habitats including deep and shallow marshes, shallow bays of lakes and impoundments where areas of dense emergent and submergent vegetation exists, sluggish streams, oxbows and other backwaters of rivers, drainage ditches (usually where wetlands have been drained), and sedge meadows and wet meadows adjacent to these habitats. This species is semi-terrestrial and individuals may spend a good deal of time on land. They often move between a variety of wetland types during the active season, which can extend from early March to mid-October. Blanding's generally breed in spring, late summer or fall. Nesting occurs from about mid-May through June depending on spring temperatures. They strongly prefer to nest in sandy soils and may travel well over a mile from preferred habitat to find suitable soils. Hatching occurs from early August through early September but hatchlings can successfully overwinter in the nest, emerging the following late April or May.
	<i>Thamnophis butleri</i>	Butler's gartersnake	T	—	Prefer almost any open-canopy wetland type (not open water) and adjacent open to semi-open canopy upland, including prairies, old fields and weedy vacant lots. They also prefer low-canopy vegetation (<24"), although they will occupy habitats with taller vegetation, such as reed canary grass. Butler's gartersnakes can be active from mid-March through early November, usually emerging shortly after frost-out and remaining active until daytime temperatures fall consistently below 50 deg. F. Breeding usually occurs in April and early May, but can occur in the fall, in which case live young are born between mid-July and mid-August.
Fish and Mussels	<i>Alasmidonta marginata</i>	Elktoe	SC	—	Found in various-sized streams with flowing water and sand, gravel, or rock substrates that are stable. The known host fishes include widespread species including redborse, sucker species and rockbass.
	<i>Alasmidonta viridis</i>	Slippershell mussel	T	—	Found buried in the sandy or fine gravelly bottoms of shallow, small to medium-sized streams with flowing hard water. Also occurs along lakeshores on a sand bottom. It is presently found only in the eastern and southern parts of Wisconsin. The known hosts are banded and mottled sculpins and johnny darter. They are probably infested from February through April.
	<i>Erimyzon sucetta</i>	Lake chubsucker	SC	—	Prefers moderately clear lakes, oxbow lakes, sloughs of weedy lakes and their associated marshy streams that are dense with organic debris over bottoms of cobble, sand, boulders, mud or silt. Spawning occurs from mid May through early July.
	<i>Lepomis megalotis</i>	Longear sunfish	T	—	Prefers clear, shallow, moderately warm, still waters of streams, rivers or occasionally lakes over rubble, gravel and sand with moderate aquatic vegetation present. Found in or near vegetation. Spawning occurs from late May through mid-July, sporadic to August.

PREFERRED HABITAT FOR STATE-LISTED SPECIES

Alternative 1 (Deep and Shallow Wells) & Alternative 2 (Shallow Aquifer and Fox River Alluvium)

City of Waukesha Water Supply

Species Group	Scientific Name	Common Name	State Status ^a	Federal Status ^a	Habitat Description
Fish and Mussels (cont.)	<i>Luxilus chrysocephalus</i>	Striped shiner	E	—	Prefers clear to slightly turbid waters of runs and shallow pools of the lower Milwaukee River, with dense aquatic vegetation over substrates of cobble, boulders, silt, sand, mud or bedrock. Sometimes present in large schools at the foot of riffles and shallow, hard-bottomed pools with some flow. Spawning occurs from late May through June.
Birds	<i>Chlidonias niger</i>	Black tern	SC	—	Prefers large, shallow marshes with abundant vegetation adjacent to open water. Black body with white on the tail and wings. Nesting occurs from May through the end of July.
	<i>Gallinula Chloropus</i>	Common moorhen	SC	—	Prefers shallow marshes (freshwater and brackish), especially where shallow lakes are rimmed with dense, emergent marsh vegetation and interspersed with open water. Black and gray colored body with a red beak piece. The breeding season extends from mid-May to late July.
Mammals	<i>Spermophilus franklinii</i>	Franklin's ground squirrel	SC	—	A semi-colonial species that prefers brushy and partly wooded areas, dense grassy, shrubby marshland, as well as prairie edges, rather than open prairie. Mating occurs from the late April to mid-May and young are born between late May to mid-June.

^aE, Endangered; T, Threatened; SC, Species of Concern (not legally protected).

PREFERRED HABITAT FOR STATE-LISTED SPECIES Alternative 3A-1 (Milwaukee Supply) City of Waukesha Water Supply					
Species Group	Scientific Name	Common Name	State Status ^a	Federal Status ^a	Habitat Description
Habitat	—	Southern dry-mesic forest	N/A	—	Southern dry-mesic forests occur on loamy soils of glacial till plains and moraines, and on erosional topography with a loess cap, south of the tension zone. Red oak is a common dominant tree of this upland forest community type. White oak, basswood, sugar and red maples, white ash, shagbark hickory, and black cherry are also important. The herbaceous understory flora is diverse and includes many species listed under southern dry forest plus jack-in-the-pulpit, enchanter's-nightshade, large-flowered bellwort, interrupted fern, lady fern, tick-trefoils, and hog peanut.
	—	Bird rookery	N/A	—	A bird rookery is an area where more than one pair of birds nest in a group. The number of nests can vary from just a few to hundreds and can include one to many different species of birds. Sites can include rare and non-rare species. The breeding time will vary based on the species present at the site. Rookeries are typically located in inaccessible locations including forests, shrub communities, wetlands adjacent to water (lakes, rivers or streams), and islands. These sites are important as large numbers of breeding individuals can be found in a single place.
	—	Southern mesic forest	N/A	—	Oaks are the dominant species in this upland forest community of dry sites. White oak and black oak are dominant, often with admixtures of northern red and bur oaks and black cherry. In the well-developed shrub layer, brambles (<i>Rubus</i> spp.), gray dogwood, and American hazelnut are common. Frequent herbaceous species are wild geranium, false Solomon's-seal, hog-peanut, and rough-leaved sunflower.
Plants	<i>Asclepias purpurascens</i>	Purple milkweed	E	—	Found in open oak forest (i.e. southern dry mesic forests) margins and roadsides; it has wide soil moisture tolerances. Pink/purple flowers at flat top. Blooming occurs early June through late July; fruiting occurs early July through late August. The optimal identification period for this species is late June through late July.
	<i>Astragalus neglectus</i>	Cooper's milkvetch	E	—	Found on riverbanks, ravines, and lakeshores, especially on dolomite near Lake Michigan, with calcareous soils. It can also be found in old fields and mesic forests. White flowers at top of stem, with alternate leaves. Blooming occurs throughout June; fruiting occurs throughout July. The optimal identification period for this species is early June through late July.
	<i>Carex crus-corvi</i>	Ravenfoot sedge	E	—	Found along ephemeral woodland (i.e. southern wet forests with moist soils) ponds. Blooms are clustered at the top. Blooming occurs throughout June; fruiting occurs throughout July. The optimal identification period for this species is late June through early July.
	<i>Carex lupuliformis</i>	False hop sedge	E	—	Found in floodplain forests (i.e. southern wet and mesic wet forests) and ephemeral woodland ponds, and have wet soils. Blooming occurs early June through early October; fruiting occurs late July through early October. The optimal identification period for this species is early August through late September.
	<i>Conioselinum chinense</i>	Hemlock parsley	E	—	Found in discharge areas in forested seeps, calcareous fens, and tamarack swamps (including northern wet forests) with wet soils. Blooming occurs late August through late September; fruiting occurs throughout September. The optimal identification period for this species is late August through late September.
	<i>Platanthera leucophaea</i>	Prairie white-fringed orchid	E	T	Found in moist, undisturbed, deep-soiled and/or calcareous prairies (i.e. mesic and wet mesic prairies) and rarely in tamarack fens with wet and moist soils. White flowers with large fringed petals at the bottom of the bloom. Blooming occurs early June through early August; fruiting occurs throughout August. The optimal identification period for this species is late June through late July.
	<i>Erigenia bulbosa</i>	Harbinger-of-spring	E	—	Found in rich hardwoods (i.e. southern mesic forests) with rich soils. White flower clustered at the top of the stems. Blooming occurs late April through early May; fruiting occurs throughout May. The optimal identification period for this species is late April through early May.
	<i>Prenanthes aspera</i>	Rough rattlesnake root	E	—	Found in dryish prairies (i.e. dry mesic prairies), usually on the lower slopes of hills. White flowers clustered at top of plant. Blooming occurs late August through early October; fruiting occurs throughout September. The optimal identification period for this species is late August through early October.
	<i>Cypripedium arietinum</i>	Ram's-head lady's slipper	T	—	Found on basic substrates in various habitats (including northern dry mesic to mesic forests), but it is most characteristic of conifer swamps with moist, acidic soils. Blooming occurs late May through early June; fruiting occurs late June through late July. The optimal identification period for this species is late May through early June.
	<i>Cypripedium candidum</i>	Small white lady's slipper	T	—	Found in calcareous fens, and wet and mesic prairies with wet or moist soils. Blooming occurs late May through early June; fruiting occurs throughout September. The optimal identification period for this species is late May through early June.
	<i>Aster furcatus</i>	Forked aster	T	—	Found in dry to mesic hardwoods (i.e. southern wet and wet mesic forests), often on stream-sides or slopes with dolomite near the surface. White flowers, clustered at the very top of plant. Blooming occurs early August through early October; fruiting occurs late August through early October. The optimal identification period for this species is late August through late September.
	<i>Cacalia muehlenbergii</i>	Great Indian plantain	SC	—	Found in mesic hardwood forests (i.e. southern wet and wet mesic forests) and adjacent mesic prairies, often with dolomite near the surface. Blooming occurs late June through late July; fruiting occurs late July through late August. The optimal identification period for this species is early June through late September.
	<i>Lithospermum latifolium</i>	American gromwell	SC	—	Found in upland hardwood forests (southern wet mesic forests), often with dolomite near the surface, and dry, calcareous soils. Small yellow flowers with 5 petals at top of plant. Blooming occurs throughout June; fruiting occurs early July through late August. The optimal identification period for this species is early June through late August.
	<i>Platanthera hookeri</i>	Hooker orchis	SC	—	Found in a variety of dry to moist, mostly mixed coniferous-hardwood forests (i.e. southern and northern dry mesic forests). Blooming occurs late May through late July; fruiting occurs early July through late August. The optimal identification period for this species is early June through early September.

PREFERRED HABITAT FOR STATE-LISTED SPECIES					
Alternative 3A-1 (Milwaukee Supply)					
City of Waukesha Water Supply					
Species Group	Scientific Name	Common Name	State Status ^a	Federal Status ^a	Habitat Description
Plants (cont.)	<i>Scutellaria ovata</i>	Heart-leaved skullcap	SC	—	Found in dry-mesic forests. Purple flowers in rows along the upper portions of the stem (above the leaves). Blooming occurs early June through late July; fruiting occurs late July through late August. The optimal identification period for this species is early June through late July.
	<i>Trillium recurvatum</i>	Reflexed trillium	SC	—	Found in rich hardwood forests (i.e. southern mesic and dry mesic forests), with rich, moist soils. Blooming occurs late April through early May; fruiting occurs throughout June. The optimal identification period for this species is late April through late May.
	<i>Calamagrostis stricta</i>	Slim-stem small reedgrass	SC	—	Found on dry to moist dunes, barrens, and dolomite or sandstone ledges, mostly near the Great Lakes, as well as calcareous wetlands, southern sedge meadows, and occasionally pine barrens. Occurs in wet, sandy soils. Blooming occurs throughout June; fruiting occurs early July through late August. The optimal identification period for this species is early July through late August.
	<i>Carex tenuiflora</i>	Sparse-flowered sedge	SC	—	Found in open- to closed canopy cold, wet, coniferous forests (northern wet mesic and mesic forests), usually on neutral to calcareous substrates. Blooming occurs late May through early June; fruiting occurs late June through late July. The optimal identification period for this species is early June through late July.
	<i>Cypripedium parviflorum</i>	Northern yellow lady's slipper	SC	—	Found in fens, calcareous swales, and rich springy forest edges (i.e. southern or northern wet mesic forests) with moist to wet soils. Blooming occurs late May through late June; fruiting occurs late June through late July. The optimal identification period for this species is late May through early July.
	<i>Liatris spicata</i>	Marsh blazing star	SC	—	Found in moist, sandy calcareous prairies (i.e. dry to wet mesic prairies) with moist to wet soils. Deep purple flowers with wispy petals. Blooming occurs late July through early August; fruiting occurs throughout August. The optimal identification period for this species is early August through early September.
	<i>Thalictrum revolutum</i>	Waxleaf meadowrue	SC	—	Found in moist, often calcareous meadows (i.e. southern sedge meadows) and mesic prairies. It is also naturalized on railroad embankments. Blooming occurs throughout June; fruiting occurs throughout July. The optimal identification period for this species is throughout June.
	<i>Triglochin maritime</i>	Common bog arrow-grass	SC	—	Found on fen mats, calcareous fens, bogs, open neutral to calcareous conifers swamps, northern wet forests, and Great Lakes swales with wet soils. Blooming occurs late June through early August; fruiting occurs late July through early September. The optimal identification period for this species is early July through late August.
	<i>Ptelea trifoliata</i>	Wafer-ash	SC	—	Found on dry dolomite ledges in oak forests (i.e. southern dry and wet mesic forests). Blooming occurs late May through early June; fruiting occurs throughout July. The optimal identification period for this species is late May through late September.
	<i>Viburnum prunifolium</i>	Smooth black-haw	SC	—	Found in rich hardwood forests (i.e. southern wet mesic and mesic forests), often with dolomite near the surface. Blooming occurs late May through late June; fruiting occurs early July through early September. The optimal identification period for this species is late May through early September.
	<i>Platanthera dilatata</i>	Leafy white orchis	SC	—	Found on neutral to calcareous bog and fen mats (or calcareous fens), or northern wet forests (sometimes with scattered tamarack and white cedar) with wet, neutral to calcareous soils. White flowers down the length of the stem. Blooming occurs early June through early July; fruiting occurs throughout July. The optimal identification period for this species is early June through early July.
Reptiles & Amphibians	<i>Acris crepitans</i>	Northern cricket frog	E	—	Prefer ponds, lakes, and a variety of habitats along and adjacent to streams and rivers including, marshes, fens, sedge meadows, low prairies, and exposed mud flats. The species tends to breed in quiet water (no or low flow) and may also move from streams and rivers to adjacent wetlands and ponds. Cricket frogs are active from late-March through November. Breeding occurs from mid-May through mid-August, with some larvae not transforming until late September.
	<i>Thamnophis butleri</i>	Butler's gartersnake	T	—	Prefer almost any open-canopy wetland type (not open water) and adjacent open to semi-open canopy upland, including prairies, old fields and weedy vacant lots. They also prefer low-canopy vegetation (<24"), although they will occupy habitats with taller vegetation, such as reed canary grass. Butler's gartersnakes can be active from mid-March through early November, usually emerging shortly after frost-out and remaining active until daytime temperatures fall consistently below 50 deg. F. Breeding usually occurs in April and early May, but can occur in the fall, in which case live young are born between mid-July and mid-August.
	<i>Emydoidea blandingii</i>	Blanding's turtle	T	—	Utilize a wide variety of aquatic habitats including deep and shallow marshes, shallow bays of lakes and impoundments where areas of dense emergent and submergent vegetation exists, sluggish streams, oxbows and other backwaters of rivers, drainage ditches (usually where wetlands have been drained), and sedge meadows and wet meadows adjacent to these habitats. This species is semi-terrestrial and individuals may spend a good deal of time on land. They often move between a variety of wetland types during the active season, which can extend from early March to mid-October. Blanding's generally breed in spring, late summer or fall. Nesting occurs from about mid-May through June depending on spring temperatures. They strongly prefer to nest in sandy soils and may travel well over a mile from preferred habitat to find suitable soils. Hatching occurs from early August through early September but hatchlings can successfully overwinter in the nest, emerging the following late April or May.
	<i>Lithobates catesbeianus</i>	American bullfrog	SC	—	Found throughout Wisconsin in any permanent body of water - lakes, ponds, rivers, and creeks. They have a very patchy distribution. In Wisconsin, bullfrogs typically favor oligotrophic (waters with low algal production; thus very clear) to mesotrophic (generally clear water with beds of submerged plants) waters; tend to breed where dense submergent vegetation filters out the majority of the suspended solids. Bullfrogs are active from April through mid-October. They breed from mid-May through late July or later.

Alternative 3A-1 (Milwaukee Supply)
City of Waukesha Water Supply

Species Group	Scientific Name	Common Name	State Status ^a	Federal Status ^a	Habitat Description
Fish	<i>Luxilus chrysocephalus</i>	Striped shiner	E	—	Prefers clear to slightly turbid waters of runs and shallow pools of the lower Milwaukee River, with dense aquatic vegetation over substrates of cobble, boulders, silt, sand, mud or bedrock. Sometimes present in large schools at the foot of riffles and shallow, hard-bottomed pools with some flow. Spawning occurs from late May through June.
	<i>Lythrurus umbratilis</i>	Redfin shiner	T	—	Prefers turbid waters of pools in low-gradient streams over substrates of boulders, cobble, sand, silt or detritus. Spawning occurs from early June through mid-August in sunfish nests.
	<i>Clinostomus elongates</i>	Redside dace	SC	—	Prefers cool water pools and quiet riffles of small streams (usually adjacent to meadows or pastures) with substrate of cobble, sand, clay silt or bedrock. Spawning occurs from May to early June.
	<i>Erimyzon sucetta</i>	Lake chubsucker	SC	—	Prefers moderately clear lakes, oxbow lakes, sloughs of weedy lakes and their associated marshy streams that are dense with organic debris over bottoms of cobble, sand, boulders, mud or silt. Spawning occurs from mid May through early July.
Insects	<i>Pompeius verna</i>	Little glassy wing	SC	—	Found in grassy openings in wooded areas near swamps, streams, bogs. Host plants appear to include grasses, especially purple top grass (<i>Tridens flavus</i>). Flight period is from late June-July.
	<i>Archilestes grandis</i>	Great spreadwing	SC	—	This dragonfly prefers slow, small streams (with alder or willows present along banks), wetlands, ponds and temporary pools. The typical flight season extends from early August to mid-October.
Crustaceans	<i>Procambarus gracilis</i>	Prairie crayfish	SC	—	Typically restricted to prairie regions of southeastern Wisconsin and is the rarest crayfish in Wisconsin. This species frequents burrows in banks of ponds, roadside ditches, small sluggish creeks, marshes, swamps, and small artificial lakes, as well as wet pastures and flat fields in prairies. The burrows can be quite deep and branching, with a characteristic mud chimney. Breeding occurs and young hatch in early spring, as early as March, with juveniles occurring through spring and summer. Females move to open water for a relatively short period in the summer where the newly hatched young are released.

^a E, Endangered; T, Threatened; SC, Species of Concern (not legally protected).

PREFERRED HABITAT FOR STATE-LISTED SPECIES					
Alternative 3A-3 (Oak Creek Supply)					
City of Waukesha Water Supply					
Species Group	Scientific Name	Common Name	State Status ^a	Federal Status ^a	Habitat Description
Habitat	—	Southern dry-mesic forest	N/A	—	Southern dry-mesic forests occur on loamy soils of glacial till plains and moraines, and on erosional topography with a loess cap, south of the tension zone. Red oak is a common dominant tree of this upland forest community type. White oak, basswood, sugar and red maples, white ash, shagbark hickory, and black cherry are also important. The herbaceous understory flora is diverse and includes many species listed under southern dry forest plus jack-in-the-pulpit, enchanter's-nightshade, large-flowered bellwort, interrupted fern, lady fern, tick-trefoils, and hog peanut.
	—	Southern mesic forest	N/A	—	Oaks are the dominant species in this upland forest community of dry sites. White oak and black oak are dominant, often with admixtures of northern red and bur oaks and black cherry. In the well-developed shrub layer, brambles (<i>Rubus</i> spp.), gray dogwood, and American hazelnut are common. Frequent herbaceous species are wild geranium, false Solomon's-seal, hog-peanut, and rough-leaved sunflower.
	—	Mesic prairie	N/A	—	This grassland community occurs on rich, moist, well-drained sites, usually on level or gently rolling glacial topography. The dominant plant is the tall grass big bluestem. The grasses little bluestem, Indian grass, needle grass, prairie dropseed, and switch grass are also frequent. The forb layer is diverse in the number, size, and physiognomy of the species. Common taxa include the prairie docks, lead plant, heath and smooth asters, prairie coreopsis, prairie sunflower, rattlesnake-master, flowering spurge, bee-balm, prairie coneflower, and spiderwort.
	—	Wet prairie	N/A	—	This is a rather variable tall grassland community that shares characteristics of prairies, southern sedge meadow, calcareous fen and even emergent aquatic communities. The wet prairies' more wetland-like character can mean that sometimes very few obligate prairie species are present. In wet prairie, the dominant grass species may include Canada bluejoint grass, cordgrass, and marsh wild-timothy, plus several sedge species including lake sedge, water sedge, and woolly sedge. Many of the herbs are shared with the wet-mesic prairies, but the following species are often prevalent: New England aster, swamp thistle, northern bedstraw, yellow stargrass, cowbane, tall meadow-rue, golden alexander, and mountain-mint.
	—	Emergent marsh	N/A	—	These open, marsh, lake, riverine and estuarine communities with permanent standing water are dominated by robust emergent macrophytes, in pure stands of single species or in various mixtures. Dominants include cattails, bulrushes (particularly <i>Scirpus acutus</i> , <i>S. fluviatilis</i> , and <i>S. validus</i>), bur-reeds, giant reed, pickerel-weed, water-plantains, arrowheads, the larger species of spikerush (such as <i>Eleocharis smallii</i>), and wild rice.
	—	Southern sedge meadow	N/A	—	Widespread in southern Wisconsin, this open wetland community is most typically dominated by tussock sedge and Canada bluejoint grass. Common associates of relatively undisturbed sedge meadows are other sedges (<i>Carex diandra</i> , <i>C. sartwellii</i>), marsh bellflower, marsh wild-timothy, water horehound, panicked aster, swamp aster, blue flag, spotted Joe-Pye weed, marsh fern, and swamp milkweed. Reed canary grass may be dominant in grazed and/or ditched stands, sometimes to the exclusion of virtually all other species. Sedge meadows are most common in glaciated landscapes, where they often border streams or drainage lakes. Many sedge meadows in southeastern Wisconsin are influenced by alkaline groundwater, and occur in complexes with emergent marsh, calcareous fen, wet prairie, wet-mesic prairie, and shrub-carr.
	—	Calcareous fen	N/A	—	Calcareous fens occur mostly in southern Wisconsin, on sites that are fed by carbonate-enriched groundwater. Most fens are small, covering no more than a few acres, and are often associated and can intergrade with more abundant and widespread wetland communities such as southern sedge meadow, wet prairie, shrub-carr, emergent marsh, and southern tamarack swamp. An accumulation of peat can raise the fen surface to a height of several meters above the adjoining lands. Common or representative plants include sedges, marsh fern, shrubby cinquefoil, shrubby St. John's wort, Ohio goldenrod, grass-of-parnassus, twig-rush, brook lobelia, boneset, swamp thistle, and asters. Many fens have a significant number of prairie or sedge meadow components, and some contain plants often associated with bogs, such as tamarack, bog birch and pitcher plant. Fens occur in several landscape settings, including the bases of morainal slopes, on sloping deposits of glacial outwash, in the headwaters regions of spring runs and small streams, and on the shores of alkaline drainage lakes.
	—	Shrub-carr	N/A	—	This wetland community is dominated by tall shrubs such as red-osier dogwood, silky dogwood, meadowsweet, and various willows. Canada bluejoint grass is often very common. This type occupies areas that are transitional between open wetlands such as wet prairie, calcareous fen, or southern sedge meadow, and forested wetlands such as floodplain forest or southern hardwood swamp. This type often occurs in bands around lakes or ponds, on the margins of river floodplains, or, more extensively, in glacial lakebeds. It is common and widespread in southern Wisconsin but also occurs in the north.
	—	Northern wet forest	N/A	—	Northern wet forest encompasses a group of weakly minerotrophic, conifer-dominated, acid peatlands located mostly north of the Tension Zone. The dominant trees are black spruce and tamarack. Jack pine is a significant component in parts of the type's range. This community is found primarily in kettle depressions or partially filled basins, on glacial outwash landforms, moraines, and till plains, where the water table is near the surface or where drainage is somewhat impeded. The community also occurs along the margins of lakes and low-gradient streams. On the wetter side of the moisture gradient, this community tends to grade into muskeg, open bog, or poor fen. On the drier side, the spruce-tamarack swamps may grade into "rich" swamp forests of northern white cedar or black ash, if a source of nutrient-enriched groundwater is present.
	—	Floodplain forest	N/A	—	This lowland hardwood forest community type occurs along large rivers, usually of Stream Order 3 or higher. Canopy dominants vary, but may include silver maple, river birch, green and black ashes, hackberry, swamp white oak, and eastern cottonwood. Black willow, basswood, red oak, and red maple are associated tree species found in these forests. Understory composition is also quite variable, and follows the pattern exhibited by the canopy species, with the most extensive stands and highest plant species diversity occurring in southwestern Wisconsin. Buttonbush is a locally dominant shrub that may form dense thickets on the margins of oxbow lakes, sloughs and ponds, which are often important aquatic habitats within these forests. Wood nettle, stinging nettle, sedges (e.g., <i>Carex grayii</i> , <i>C. lupulina</i> , <i>C. hystericina</i> , <i>C. tuckermanii</i>), native grasses (e.g., <i>Cinna arundinacea</i> , <i>Elymus villosus</i> , <i>Leersia virginica</i>), ostrich fern and green-headed coneflower are important understory herbs, and lianas such as Virginia creepers, grapes, Canada moonseed, and poison-ivy are often common. Among the more striking herbs of this community are cardinal flower, fringed loosestrife, and green dragon.
	—	Springs and spring runs (hard)	N/A	—	A water source from the ground.
Plants	<i>Asclepias purpurascens</i>	Purple milkweed	E	—	Found in open oak forest (i.e. southern dry mesic forests) margins and roadsides; it has wide soil moisture tolerances. Pink/purple flowers at flat top. Blooming occurs early June through late July; fruiting occurs early July through late August. The optimal identification period for this species is late June through late July.

PREFERRED HABITAT FOR STATE-LISTED SPECIES					
Alternative 3A-3 (Oak Creek Supply)					
City of Waukesha Water Supply					
Species Group	Scientific Name	Common Name	State Status ^a	Federal Status ^a	Habitat Description
Plants cont.	<i>Solidago caesia</i>	Bluestem goldenrod	E	—	Found in open forests, forest edges, clearings, and/or thickets. Occur on level ground, side slopes and protected ravine environments generally associated with Lake Michigan. Yellow clusters of flowers along the majority of the mid to upper portion of the stem. Blooming occurs from August to October.
	<i>Platanthera leucophaea</i>	Prairie white-fringed orchid	E	T	Found in moist, undisturbed, deep-soiled and/or calcareous prairies (i.e. mesic and wet mesic prairies) and rarely in tamarack fens with wet and moist soils. White flowers with large fringed petals at the bottom of the bloom. Blooming occurs early June through early August; fruiting occurs throughout August. The optimal identification period for this species is late June through late July.
	<i>Carex lupuliformis</i>	False hop sedge	E	—	Found in floodplain forests (i.e. southern wet and mesic wet forests) and ephemeral woodland ponds, and have wet soils. Blooming occurs early June through early October; fruiting occurs late July through early October. The optimal identification period for this species is early August through late September.
	<i>Carex crus-corvi</i>	Ravenfoot sedge	E	—	Found along ephemeral woodland (i.e. southern wet forests with moist soils) ponds. Blooms are clustered at the top. Blooming occurs throughout June; fruiting occurs throughout July. The optimal identification period for this species is late June through early July.
	<i>Trisetum melicoides</i>	Purple false oats	E	—	Found in rich hardwood or mixed forests (i.e. northern mesic or boreal forests) near Lake Michigan, as well as shoreline dolomite and in swales, with gravelly and rocky soils. Blooming occurs from June. The optimal identification period for this species is mid-July to late August.
	<i>Astragalus neglectus</i>	Cooper's milkvetch	E	—	Found on riverbanks, ravines, and lakeshores, especially on dolomite near Lake Michigan, with calcareous soils. It can also be found in old fields and mesic forests. White flowers at top of stem, with alternate leaves. Blooming occurs throughout June; fruiting occurs throughout July. The optimal identification period for this species is early June through late July.
	<i>Conioselinum chinense</i>	Hemlock parsley	E	—	Found in discharge areas in forested seeps, calcareous fens, and tamarack swamps (including northern wet forests) with wet soils. Blooming occurs late August through late September; fruiting occurs throughout September. The optimal identification period for this species is late August through late September.
	<i>Erigenia bulbosa</i>	Harbinger-of-spring	E	—	Found in rich hardwoods (i.e. southern mesic forests) with rich soils. White flower clustered at the top of the stems. Blooming occurs late April through early May; fruiting occurs throughout May. The optimal identification period for this species is late April through early May.
	<i>Prenanthes aspera</i>	Rough rattlesnake root	E	—	Found in dryish prairies (i.e. dry mesic prairies), usually on the lower slopes of hills. White flowers clustered at top of plant. Blooming occurs late August through early October; fruiting occurs throughout September. The optimal identification period for this species is late August through early October.
	<i>Tofieldia glutinosa</i>	Sticky false-asphodel	T	—	Found in moist calcareous bogs, fens and wet locations. White flowers clustered at the top of the plant with reddish/purple anthers. Blooming occurs between June and August.
	<i>Cypripedium arietinum</i>	Ram's-head lady's slipper	T	—	Found on basic substrates in various habitats (including northern dry mesic to mesic forests), but it is most characteristic of conifer swamps with moist, acidic soils. Blooming occurs late May through early June; fruiting occurs late June through late July. The optimal identification period for this species is late May through early June.
	<i>Cypripedium candidum</i>	Small white lady's slipper	T	—	Found in calcareous fens, and wet and mesic prairies with wet or moist soils. Blooming occurs late May through early June; fruiting occurs throughout September. The optimal identification period for this species is late May through early June.
	<i>Scutellaria ovata</i>	Heart-leaved skullcap	SC	—	Found in dry-mesic forests. Purple flowers in rows along the upper portions of the stem (above the leaves). Blooming occurs early June through late July; fruiting occurs late July through late August. The optimal identification period for this species is early June through late July.
	<i>Carex tenuiflora</i>	Sparse-flowered sedge	SC	—	Found in open- to closed canopy cold, wet, coniferous forests (northern wet mesic and mesic forests), usually on neutral to calcareous substrates. Blooming occurs late May through early June; fruiting occurs late June through late July. The optimal identification period for this species is early June through late July.
	<i>Cacalia muehlenbergii</i>	Great Indian plantain	SC	—	Found in mesic hardwood forests (i.e. southern wet and wet mesic forests) and adjacent mesic prairies, often with dolomite near the surface. Blooming occurs late June through late July; fruiting occurs late July through late August. The optimal identification period for this species is early June through late September.
	<i>Medeola virginiana</i>	Indian cucumber-root	SC	—	Found in rich hardwood or mixed conifer-hardwood forests (i.e. northern mesic or dry mesic forests). Leaves occur in a star pattern where yellowish whitish flower extends out of. Blooming occurs early May through late June; fruiting occurs late July through late August. The optimal identification period for this species is early May through late August.
	<i>Platanthera hookeri</i>	Hooker orchis	SC	—	Found in a variety of dry to moist, mostly mixed coniferous-hardwood forests (i.e. southern and northern dry mesic forests). Blooming occurs late May through late July; fruiting occurs early July through late August. The optimal identification period for this species is early June through early September.
	<i>Trillium recurvatum</i>	Reflexed trillium	SC	—	Found in rich hardwood forests (i.e. southern mesic and dry mesic forests), with rich, moist soils. Blooming occurs late April through early May; fruiting occurs throughout June. The optimal identification period for this species is late April through late May.
	<i>Viburnum prunifolium</i>	Smooth black-haw	SC	—	Found in rich hardwood forests (i.e. southern wet mesic and mesic forests), often with dolomite near the surface. Blooming occurs late May through late June; fruiting occurs early July through early September. The optimal identification period for this species is late May through early September.
	<i>Cypripedium parviflorum</i>	Northern yellow lady's slipper	SC	—	Found in fens, calcareous swales, and rich springy forest edges (i.e. southern or northern wet mesic forests) with moist to wet soils. Blooming occurs late May through late June; fruiting occurs late June through late July. The optimal identification period for this species is late May through early July.

PREFERRED HABITAT FOR STATE-LISTED SPECIES
Alternative 3A-3 (Oak Creek Supply)
City of Waukesha Water Supply

Species Group	Scientific Name	Common Name	State Status ^a	Federal Status ^a	Habitat Description
Plants (cont.)	<i>Liatris spicata</i>	Marsh blazing star	SC	—	Found in moist, sandy calcareous prairies (i.e. dry to wet mesic prairies) with moist to wet soils. Deep purple flowers with wispy petals. Blooming occurs late July through early August; fruiting occurs throughout August. The optimal identification period for this species is early August through early September.
	<i>Epilobium strictum</i>	Downy willow-herb	SC	—	Found in fens (i.e. calcareous fens), marshes, and sedge meadows with wet soils. Purple flowers at the top of the plant. Blooming occurs late July through early September; fruiting occurs late July through early October. The optimal identification period for this species is late July through late September.
	<i>Triglochin maritime</i>	Common bog arrow-grass	SC	—	Found on fen mats, calcareous fens, bogs, open neutral to calcareous conifers swamps, northern wet forests, and Great Lakes swales with wet soils. Blooming occurs late June through early August; fruiting occurs late July through early September. The optimal identification period for this species is early July through late August.
	<i>Platanthera dilatata</i>	Leafy white orchis	SC	—	Found on neutral to calcareous bog and fen mats (or calcareous fens), or northern wet forests (sometimes with scattered tamarack and white cedar) with wet, neutral to calcareous soils. White flowers down the length of the stem. Blooming occurs early June through early July; fruiting occurs throughout July. The optimal identification period for this species is early June through early July.
	<i>Glycyrrhiza lepidota</i>	Wild licorice	SC	—	Found in moist prairies and other grasslands and stream banks. It has been found naturalized on cinders of railroads and other disturbed areas. Blooming occurs throughout July; fruiting occurs early August through late October. The optimal identification period for this species is early August through late October.
	<i>Thalictrum revolutum</i>	Waxleaf meadowrue	SC	—	Found in moist, often calcareous meadows (i.e. southern sedge meadows) and mesic prairies. It is also naturalized on railroad embankments. Blooming occurs throughout June; fruiting occurs throughout July. The optimal identification period for this species is throughout June.
	<i>Lithospermum latifolium</i>	American gromwell	SC	—	Found in upland hardwood forests (southern wet mesic forests), often with dolomite near the surface, and dry, calcareous soils. Small yellow flowers with 5 petals at top of plant. Blooming occurs throughout June; fruiting occurs early July through late August. The optimal identification period for this species is early June through late August.
	<i>Calamagrostis stricta</i>	Slim-stem small reedgrass	SC	—	Found on dry to moist dunes, barrens, and dolomite or sandstone ledges, mostly near the Great Lakes, as well as calcareous wetlands, southern sedge meadows, and occasionally pine barrens. Occurs in wet, sandy soils. Blooming occurs throughout June; fruiting occurs early July through late August. The optimal identification period for this species is early July through late August.
	<i>Cakile lacustris</i>	American sea-rocket	SC	—	Found on Lake Michigan beaches or, less commonly, on dunes (sandy soils). Small white, 4-petal flowers at top of plant. Blooming occurs early July through early September; fruiting occurs late July through late September. The optimal identification period for this species is early July through late September.
	<i>Cypripedium reginae</i>	Showy lady's slipper	SC	—	Found in neutral to alkaline forested wetlands (i.e. southern mesic and northern wet mesic forests); it is also found in rich upland forests in seeps and moist to dry clay bluffs with moist, neutral to calcareous soils. White and purple/pinkish flower. Blooming occurs late June through late July; fruiting occurs late July through late August. The optimal identification period for this species is late June through early August.
	<i>Equisetum variegatum</i>	Variegated horsetail	SC	—	Found most characteristically on wet dolomite flats and gravelly swales near Lake Michigan but also in other wet, open, neutral to calcareous wetlands (i.e. lake dunes, beach, and northern sedge meadows). The optimal identification period for this species is late May through late September.
	<i>Gentianopsis procera</i>	Lesser fringed gentian	SC	—	Found on wet dolomite pavement near Lake Michigan, as well as cold fens, seeps, and meadows (i.e. northern sedge meadows) with wet, calcareous soils. Deep blue flowers with fringed edges. Blooming occurs late August through early October; fruiting occurs early September through early October. The optimal identification period for this species is late August through early October.
	<i>Solidago ohioensis</i>	Ohio goldenrod	SC	—	Found most commonly on wet dolomite lake flats in Door County, and in fens, moist calcareous prairies, and sedge meadows in the southeast portion of the state with moist soils. Yellow, flat-topped flowers. Blooming occurs early August through late September; fruiting occurs throughout September. The optimal identification period for this species is late August through early September.
	<i>Triglochin palustris</i>	Slender bog arrow-grass	SC	—	Found on muddy to marly fen and bog edges, as well as calcareous sedge meadows and northern wet forests. Blooming occurs throughout July; fruiting occurs throughout August. The optimal identification period for this species is early July through late August.
	<i>Ptelea trifoliata</i>	Wafer-ash	SC	—	Found on dry dolomite ledges in oak forests (i.e. southern dry and wet mesic forests). Blooming occurs late May through early June; fruiting occurs throughout July. The optimal identification period for this species is late May through late September.
Birds	<i>Sterna forsteri</i>	Forster's tern	E	—	Prefers large semi-permanent and permanently flooded wetlands (i.e. marshes) that support extensive growths of cattail and hardstem bulrush, estuaries, and lake islands. These habitats are also common for breeding. White and light gray body with a black colored cap on head. The breeding season extends from mid May to late July.
	<i>Nycticorax nycticorax</i>	Black-crowned night heron	SC	—	Prefers freshwater wetlands dominated by bulrush and cattail with small groves of alder, willow, or other brush. Their breeding season occurs from mid-April through mid-September.
	<i>Pandion haliaetus</i>	Osprey	SC	—	Prefer large trees in isolated areas in proximity to large areas of surface water, large complexes of deciduous forest, coniferous forest, wetland, and shrub communities. Areas are usually forested with second growth pine, aspen, and hardwood forests. Breed mainly in forested lake regions of northwest and north central Wisconsin. A few nest along the Wisconsin River, in swamps and inland lakes in the central part of the state. Large lakes and rivers with nearby tall pine trees are preferred for nesting. Most frequent nest sites are super-canopy snags and dead-topped pines located along lake and stream shoreline, in recent clear-cut areas near water, in swamp conifer stands, and on snags in marshes and bogs. The breeding season extends from late April through August.

<div><div>PREFERRED HABITAT FOR STATE-LISTED SPECIES</div><div>Alternative 3A-3 (Oak Creek Supply)</div><div>City of Waukesha Water Supply</div></div>					
Species Group	Scientific Name	Common Name	State Status ^a	Federal Status ^a	Habitat Description
Birds cont.	<i>Spiza Americana</i>	Dickissel	SC	—	Prefers open pasture and fields of clover and alfalfa. Grasslands, meadows, and savanna are also important nesting areas. This bird requires vegetation with medium to tall height-density and a significant component of forbs (i.e. herbaceous flowering plants that are not graminoids (grasses, sedges and rushes), some stiff-stemmed. Breeding occurs from late May to early August.
Reptiles & Amphibians	<i>Acris crepitans</i>	Northern cricket frog	E	—	Prefer ponds, lakes, and a variety of habitats along and adjacent to streams and rivers including, marshes, fens, sedge meadows, low prairies, and exposed mud flats. The species tends to breed in quiet water (no or low flow) and may also move from streams and rivers to adjacent wetlands and ponds. Cricket frogs are active from late-March through November. Breeding occurs from mid-May through mid-August, with some larvae not transforming until late September.
	<i>Thamnophis butleri</i>	Butler's gartersnake	T	—	Prefer almost any open-canopy wetland type (not open water) and adjacent open to semi-open canopy upland, including prairies, old fields and weedy vacant lots. They also prefer low-canopy vegetation (<24"), although they will occupy habitats with taller vegetation, such as reed canary grass. Butler's gartersnakes can be active from mid-March through early November, usually emerging shortly after frost-out and remaining active until daytime temperatures fall consistently below 50 deg. F. Breeding usually occurs in April and early May, but can occur in the fall, in which case live young are born between mid-July and mid-August.
	<i>Emydoidea blandingii</i>	Blanding's turtle	T	—	Utilize a wide variety of aquatic habitats including deep and shallow marshes, shallow bays of lakes and impoundments where areas of dense emergent and submergent vegetation exists, sluggish streams, oxbows and other backwaters of rivers, drainage ditches (usually where wetlands have been drained), and sedge meadows and wet meadows adjacent to these habitats. This species is semi-terrestrial and individuals may spend a good deal of time on land. They often move between a variety of wetland types during the active season, which can extend from early March to mid-October. Blanding's generally breed in spring, late summer or fall. Nesting occurs from about mid-May through June depending on spring temperatures. They strongly prefer to nest in sandy soils and may travel well over a mile from preferred habitat to find suitable soils. Hatching occurs from early August through early September but hatchlings can successfully overwinter in the nest, emerging the following late April or May.
	<i>Lithobates catesbeianus</i>	American bullfrog	SC	—	Found throughout Wisconsin in any permanent body of water - lakes, ponds, rivers, and creeks. They have a very patchy distribution. In Wisconsin, bullfrogs typically favor oligotrophic (waters with low algal production; thus very clear) to mesotrophic (generally clear water with beds of submerged plants) waters; tend to breed where dense submergent vegetation filters out the majority of the suspended solids. Bullfrogs are active from April through mid-October. They breed from mid-May through late July or later.
Fish	<i>Luxilus chrysocephalus</i>	Striped shiner	E	—	Prefers clear to slightly turbid waters of runs and shallow pools of the lower Milwaukee River, with dense aquatic vegetation over substrates of cobble, boulders, silt, sand, mud or bedrock. Sometimes present in large schools at the foot of riffles and shallow, hard-bottomed pools with some flow. Spawning occurs from late May through June.
	<i>Lythrurus umbratilis</i>	Redfin shiner	T	—	Prefers turbid waters of pools in low-gradient streams over substrates of boulders, cobble, sand, silt or detritus. Spawning occurs from early June through mid-August in sunfish nests.
	<i>Lepomis megalotis</i>	Longear sunfish	T	—	Prefers clear, shallow, moderately warm, still waters of streams, rivers or occasionally lakes over rubble, gravel and sand with moderate aquatic vegetation present. Found in or near vegetation. Spawning occurs from late May through mid-July, sporadic to August.
	<i>Etheostoma microperca</i>	Least darter	SC	—	Prefers clear, warm, quiet waters of overflow ponds, pools, lakes and streams over substrates of gravel, silt, sand, boulders, mud or clay with dense vegetation or filamentous algal beds. Spawning occurs from late April into July.
	<i>Erimyzon sucetta</i>	Lake chubsucker	SC	—	Prefers moderately clear lakes, oxbow lakes, sloughs of weedy lakes and their associated marshy streams that are dense with organic debris over bottoms of cobble, sand, boulders, mud or silt. Spawning occurs from mid May through early July.
Insects	<i>Somatochlora ensigera</i>	Lemon-faced emerald	SC	—	Found in small streams with forested riparian areas lining them. The flight period is in late June.
	<i>Pompeius verna</i>	Little glassy wing	SC	—	Found in grassy openings in wooded areas near swamps, streams, bogs. Host plants appear to include grasses, especially purple top grass (<i>Tridens flavus</i>). Flight period is from late June-July.
Crustaceans	<i>Procambarus gracilis</i>	Prairie crayfish	SC	—	Typically restricted to prairie regions of southeastern Wisconsin and is the rarest crayfish in Wisconsin. This species frequents burrows in banks of ponds, roadside ditches, small sluggish creeks, marshes, swamps, and small artificial lakes, as well as wet pastures and flat fields in prairies. The burrows can be quite deep and branching, with a characteristic mud chimney. Breeding occurs and young hatch in early spring, as early as March, with juveniles occurring through spring and summer. Females move to open water for a relatively short period in the summer where the newly hatched young are released.

^a E, Endangered; T, Threatened; SC, Species of Concern (not legally protected).

<div><div>PREFERRED HABITAT FOR STATE-LISTED SPECIES</div><div>Alternative 3A-4 (Racine Supply)</div><div>City of Waukesha Water Supply</div></div>					
Species Group	Scientific Name	Common Name	State Status ^a	Federal Status ^a	Habitat Description
Habitat		Bird rookery	SC	—	A bird rookery is an area where more than one pair of birds nest in a group. The number of nests can vary from just a few to hundreds, and can include a single to many different species of birds. Sites can include rare and non-rare species. The breeding time will vary based on the species present at the site. Rookeries are typically located in inaccessible locations including forests, shrub communities, wetlands adjacent to water (lakes, rivers or streams), and islands. These sites are important as large numbers of breeding individuals can be found in a single place.
		Calcareous fen	N/A	—	Calcareous fens occur mostly in southern Wisconsin, on sites that are fed by carbonate-enriched groundwater. Most fens are small, covering no more than a few acres, and are often associated and can intergrade with more abundant and widespread wetland communities such as southern sedge meadow, wet prairie, shrub-carr, emergent marsh, and southern tamarack swamp. An accumulation of peat can raise the fen surface to a height of several meters above the adjoining lands. Common or representative plants include sedges, marsh fern, shrubby cinquefoil, shrubby St. John's wort, Ohio goldenrod, grass-of-parnassus, twig-rush, brook lobelia, boneset, swamp thistle, and asters. Many fens have a significant number of prairie or sedge meadow components, and some contain plants often associated with bogs, such as tamarack, bog birch and pitcher plant. Fens occur in several landscape settings, including the bases of morainal slopes, on sloping deposits of glacial outwash, in the headwaters regions of spring runs and small streams, and on the shores of alkaline drainage lakes.
		Emergent marsh	N/A	—	These open, marsh, lake, riverine and estuarine communities with permanent standing water are dominated by robust emergent macrophytes, in pure stands of single species or in various mixtures. Dominants include cattails, bulrushes (particularly <i>Scirpus acutus</i> , <i>S. fluviatilis</i> , and <i>S. validus</i>), bur-reeds, giant reed, pickerel-weed, water-plantains, arrowheads, the larger species of spikerush (such as <i>Eleocharis smallii</i>), and wild rice.
		Floodplain forest	N/A	—	This lowland hardwood forest community type occurs along large rivers, usually of Stream Order 3 or higher. Canopy dominants vary, but may include silver maple, river birch, green and black ashes, hackberry, swamp white oak, and eastern cottonwood. Black willow, basswood, red oak, and red maple are associated tree species found in these forests. Understory composition is also quite variable, and follows the pattern exhibited by the canopy species, with the most extensive stands and highest plant species diversity occurring in southwestern Wisconsin. Buttonbush is a locally dominant shrub that may form dense thickets on the margins of oxbow lakes, sloughs and ponds, which are often important aquatic habitats within these forests. Wood nettle, stinging nettle, sedges (e.g., <i>Carex grayii</i> , <i>C. lupulina</i> , <i>C. hystericina</i> , <i>C. tuckermanii</i>), native grasses (e.g., <i>Cinna arundinacea</i> , <i>Elymus villosus</i> , <i>Leersia virginica</i>), ostrich fern and green-headed coneflower are important understory herbs, and lianas such as Virginia creepers, grapes, Canada moonseed, and poison-ivy are often common. Among the more striking herbs of this community are cardinal flower, fringed loosestrife, and green dragon.
		Lake-oxbow	N/A	—	An oxbow lake is a crescent shaped body of water formed along the side of a river when a wide meander from the main stem of the river is cut off to create a lake.
		Mesic prairie	N/A	—	This grassland community occurs on rich, moist, well-drained sites, usually on level or gently rolling glacial topography. The dominant plant is the tall grass big bluestem. The grasses little bluestem, Indian grass, needle grass, prairie dropseed, and switch grass are also frequent. The forb layer is diverse in the number, size, and physiognomy of the species. Common taxa include the prairie docks, lead plant, heath and smooth asters, prairie coreopsis, prairie sunflower, rattlesnake-master, flowering spurge, bee-balm, prairie coneflower, and spiderwort.
		Northern wet forest	N/A	—	Northern wet forest encompasses a group of weakly minerotrophic, conifer-dominated, acid peatlands located mostly north of the Tension Zone. The dominant trees are black spruce and tamarack. Jack pine is a significant component in parts of the type's range. This community is found primarily in kettle depressions or partially filled basins, on glacial outwash landforms, moraines, and till plains, where the water table is near the surface or where drainage is somewhat impeded. The community also occurs along the margins of lakes and low-gradient streams.
		Southern dry forest	N/A	—	Oaks (<i>Quercus</i> spp.) are the dominant species in this upland forest community of dry sites. White oak and black oak are dominant, often with admixtures of northern red and bur oaks and black cherry. In the well-developed shrub layer, brambles (<i>Rubus</i> spp.), gray dogwood, and American hazelnut are common. Frequent herbaceous species are wild geranium, false Solomon's-seal, hog-peanut, and rough-leaved sunflower. This community type intergrades to oak woodland, which has similar canopy composition but a more open forest floor due to relatively frequent ground fires and possibly also due to grazing by elk, bison, or deer prior to EuroAmerican settlement.
		Southern dry-mesic forest	N/A	—	Southern dry-mesic forests occur on loamy soils of glacial till plains and moraines, and on erosional topography with a loess cap, south of the tension zone. Red oak is a common dominant tree of this upland forest community type. White oak, basswood, sugar and red maples, white ash, shagbark hickory, and black cherry are also important. The herbaceous understory flora is diverse and includes many species listed under southern dry forest plus jack-in-the-pulpit, enchanter's-nightshade, large-flowered bellwort, interrupted fern, lady fern, tick-trefoils, and hog peanut.
		Southern mesic forest	N/A	—	Oaks are the dominant species in this upland forest community of dry sites. White oak and black oak are dominant, often with admixtures of northern red and bur oaks and black cherry. In the well-developed shrub layer, brambles (<i>Rubus</i> spp.), gray dogwood, and American hazelnut are common. Frequent herbaceous species are wild geranium, false Solomon's-seal, hog-peanut, and rough-leaved sunflower.
		Stream-slow, hard, warm	N/A	—	Warmwater streams are flowing waters with maximum water temperatures typically greater than 25 degrees Celsius. They usually have watershed areas less than 500 square miles and mean annual flow rates of less than 200 cubic feet per second. These streams are common statewide, particularly in southeastern and east-central Wisconsin. A rich fish fauna, dominated by warmwater species in the families Cyprinidae, Catostomidae, Centrarchidae, and Percidae can be found in warmwater streams.
Plants	<i>Adlumia fungosa</i>	Climbing fumitory	SC	—	Found in dry to moist hardwood or coniferous woods (i.e. boreal forests, northern mesic forests, or shaded cliffs), often with a history of burning; it is often found on dolomite and, less commonly, on basalt. Blooming occurs late June through late September; fruiting occurs late July through early October. The optimal identification period for this species is early July through early October.

PREFERRED HABITAT FOR STATE-LISTED SPECIES Alternative 3A-4 (Racine Supply) City of Waukesha Water Supply					
Species Group	Scientific Name	Common Name	State Status ^a	Federal Status ^a	Habitat Description
Plants (cont.)	<i>Arethusa bulbosa</i>	Swamp-pink	SC	—	Found on neutral bog and fen mats with a mix of sedges, Ericads, and Sphagnum (i.e. northern sedge meadows), along with northern wet forests. Purple/pinkish flowers that form an arrow shape at the top of the plant. Blooming occurs late May through early July; fruiting occurs throughout July. The optimal identification period for this species is early June through early July.
	<i>Asclepias purpurascens</i>	Purple milkweed	E	—	Found in open oak forest (i.e. southern dry mesic forests) margins and roadsides; it has wide soil moisture tolerances. Pink/purple flowers at flat top. Blooming occurs early June through late July; fruiting occurs early July through late August. The optimal identification period for this species is late June through late July.
	<i>Asclepias sullivantii</i>	Prairie milkweed	T	—	Found in moist prairies (i.e. mesic and wet mesic prairies). Purple to light pink flowers clustered at the top of the plant. Blooming occurs early June through early July; fruiting occurs throughout July. The optimal identification period for this species is early June through early July.
	<i>Aster furcatus</i>	Forked aster	T	—	Found in dry to mesic hardwoods (i.e. southern wet and wet mesic forests), often on stream-sides or slopes with dolomite near the surface. White flowers, clustered at the very top of stem. Blooming occurs early August through early October; fruiting occurs late August through early October. The optimal identification period for this species is late August through late September.
	<i>Cacalia muehlenbergii</i>	Great Indian plantain	SC	—	Found in mesic hardwood forests (i.e. southern wet and wet mesic forests) and adjacent mesic prairies, often with dolomite near the surface. Blooming occurs late June through late July; fruiting occurs late July through late August. The optimal identification period for this species is early June through late September.
	<i>Cacalia tuberosa</i>	Prairie Indian plantain	T	—	Found in a variety of deep-soiled prairies (i.e. wet, wet mesic and dry prairies) with moist soils. Blooming occurs early May through late June; fruiting occurs late June through late July. The optimal identification period for this species is late May through late July.
	<i>Calamintha arkansana</i>	Low calamint	SC	—	Found most typically on wet dolomite flats on Lake Michigan (Door County), as well as fens (calcareous), wet prairies, or sedge meadows. Blooming occurs late June through late September; fruiting occurs late July through late September. The optimal identification period for this species is early July through late August.
	<i>Carex crawei</i>	Crawe sedge	SC	—	Found in calcareous wetlands and dolomitic pavement, often near Lake Michigan, as well as fens, moist calcareous prairies, and northern wet forests with moist, calcareous soils. Blooming occurs late April through late May; fruiting occurs late May through late June. The optimal identification period for this species is throughout May.
	<i>Carex crus-corvi</i>	Ravenfoot sedge	E	—	Found along ephemeral woodland (i.e. southern wet forests with moist soils) ponds. Blooms are clustered at the top. Blooming occurs throughout June; fruiting occurs throughout July. The optimal identification period for this species is late June through early July.
	<i>Carex formosa</i>	Handsome sedge	T	—	Found in rich mesic woods (i.e. southern wet or wet mesic forests), often on alluvial terraces or where dolomite is near the surface, with rich, calcareous soils. Blooming occurs throughout June; fruiting occurs throughout July. The optimal identification period for this species is late June through early July.
	<i>Carex lupuliformis</i>	False hop sedge	E	—	Found in floodplain forests (i.e. southern wet and mesic wet forests) and ephemeral woodland ponds, and have wet soils. Blooming occurs early June through early October; fruiting occurs late July through early October. The optimal identification period for this species is early August through late September.
	<i>Carex richardsonii</i>	Richardson sedge	SC	—	Found in dry prairies and barrens (i.e. oak and pine) with dry, rocky, or sandy soils. Blooming occurs late April through early May; fruiting occurs throughout May. The optimal identification period for this species is late April through early May.
	<i>Carex tenuiflora</i>	Sparse-flowered sedge	SC	—	Found in open- to closed canopy cold, wet, coniferous forests (northern wet mesic and mesic forests), usually on neutral to calcareous substrates. Blooming occurs late May through early June; fruiting occurs late June through late July. The optimal identification period for this species is early June through late July.
	<i>Cirsium hillii</i>	Hill's thistle	T	—	Found in dry and mesic prairies, and pine and oak barrens with dry, sandy soils. Purple flower at top of plant. Blooming occurs late July through early August; fruiting occurs late July through late August. The optimal identification period for this species is late July through late August.
	<i>Cypripedium candidum</i>	Small white lady's-slipper	T	—	Found in calcareous fens, and wet and mesic prairies with wet or moist soils. Blooming occurs late May through early June; fruiting occurs throughout September. The optimal identification period for this species is late May through early June.
	<i>Cypripedium parviflorum</i> var. <i>makasin</i>	Northern yellow lady's-slipper	SC	—	Found in fens, calcareous swales, and rich springy forest edges (i.e. southern or northern wet mesic forests) with moist to wet soils. Blooming occurs late May through late June; fruiting occurs late June through late July. The optimal identification period for this species is late May through early July.
	<i>Cypripedium reginae</i>	Showy lady's-slipper	SC	—	Found in neutral to alkaline forested wetlands (i.e. southern mesic and northern wet mesic forests); it is also found in rich upland forests in seeps and moist to dry clay bluffs with moist, neutral to calcareous soils. White and purple/pinkish flower. Blooming occurs late June through late July; fruiting occurs late July through late August. The optimal identification period for this species is late June through early August.
	<i>Deschampsia cespitosa</i>	Tufted hairgrass	SC	—	Found in fens, sandstone and dolomite splash pools on the Great Lakes; it is also found in springs, marly bog pools, northern wet mesic forests, and cedar swamps. Blooming occurs late June through early July; fruiting occurs throughout July. The optimal identification period for this species is late June through late July.
	<i>Echinacea pallida</i>	Pale-purple coneflower	T	—	Found in prairies (i.e. dry to mesic prairies) and prairie remnants along roads and railroads. Blooming occurs early June through late July; fruiting occurs early July through late August. The optimal identification period for this species is early June through early August.

PREFERRED HABITAT FOR STATE-LISTED SPECIES Alternative 3A-4 (Racine Supply) City of Waukesha Water Supply					
Species Group	Scientific Name	Common Name	State Status ^a	Federal Status ^a	Habitat Description
Plants (cont.)	<i>Festuca paradoxa</i>	Cluster fescue	SC	—	Found in moist, sandy or peaty sedge meadows near the lower Wisconsin River (with moist, sandy or peaty soils). Blooming occurs throughout June; fruiting occurs early July through late August. The optimal identification period for this species is early July through late August.
	<i>Fraxinus quadrangulata</i>	Blue ash	T	—	Found in rich upland hardwoods (i.e. southern mesic forests), often with dolomite near the surface and moist, calcareous soils. Blooming occurs throughout June; fruiting occurs early July through late August. This species can be identified year-round.
	<i>Gentiana alba</i>	Yellow gentian	T	—	Found in thin soil in dry, open woodlands (i.e. oak openings), ridges and bluffs (often with dolomite near the surface), as well as moist sand prairies (mesic to dry mesic prairies) and roadside ditches. Blooming occurs late August through early October; fruiting occurs early September through early October. The optimal identification period for this species is throughout September.
	<i>Gentianopsis procera</i>	Lesser fringed gentian	SC	—	Found on wet dolomite pavement near Lake Michigan, as well as cold fens, seeps, and meadows (i.e. northern sedge meadows) with wet, calcareous soils. Deep blue flowers with fringed edges. Blooming occurs late August through early October; fruiting occurs early September through early October. The optimal identification period for this species is late August through early October.
	<i>Jeffersonia diphylla</i>	Twinleaf	SC	—	Found in very rich hardwood forests (i.e. southern mesic forests), often with dolomite near the surface. White cupped flower with leaves comprised of 2 symmetrical parts. Blooming occurs throughout May; fruiting occurs early July through early September. The optimal identification period for this species is early May through early June.
	<i>Liatris spicata</i>	Marsh blazing star	SC	—	Found in moist, sandy calcareous prairies (i.e. dry to wet mesic prairies) with moist to wet soils. Deep purple flowers with wispy petals. Blooming occurs late July through early August; fruiting occurs throughout August. The optimal identification period for this species is early August through early September.
	<i>Lithospermum latifolium</i>	American gromwell	SC	—	Found in upland hardwood forests (southern wet mesic forests), often with dolomite near the surface, and dry, calcareous soils. Small yellow flowers with 5 petals at top of plant. Blooming occurs throughout June; fruiting occurs early July through late August. The optimal identification period for this species is early June through late August.
	<i>Medeola virginiana</i>	Indian cucumber-root	SC	—	Found in rich hardwood or mixed conifer-hardwood forests (i.e. northern mesic or dry mesic forests). Leaves occur in a star pattern where yellowish whitish flower extends out of. Blooming occurs early May through late June; fruiting occurs late July through late August. The optimal identification period for this species is early May through late August.
	<i>Panicum wilcoxianum</i>	Wilcox panic grass	SC	—	Found in dry gravelly hillside prairies. Blooming occurs late May through early June; fruiting occurs late June through late July. The optimal identification period for this species is late June through late July.
	<i>Parthenium integrifolium</i>	American fever-few	T	—	Found in prairies (dry to wet mesic prairies) and remnants along roads and railroads with dry soils. It is sometimes planted and it can be difficult to tell whether a native plant is present. Small white flowers at top of plant (flat top) with large leaves. Blooming occurs late June through early September; fruiting occurs early August through early October. The optimal identification period for this species is late July through late September.
	<i>Plantago cordata</i>	Heart-leaved plantain	E	—	An emergent aquatic plant found on cold calcareous streambanks shaded by mesic hardwood forests with wet, calcareous soils. Blooming occurs early May through late June; fruiting occurs early June through early July. The optimal identification period for this species is late May through early July.
	<i>Platanthera leucophaea</i>	Prairie white-fringed orchid	E	—	Found in moist, undisturbed, deep-soiled and/or calcareous prairies (i.e. mesic and wet mesic prairies) and rarely in tamarack fens with wet and moist soils. White flowers with large fringed petals at the bottom of the bloom. Blooming occurs early June through early August; fruiting occurs throughout August. The optimal identification period for this species is late June through late July.
	<i>Polystichum acrostichoides</i>	Christmas fern	SC	—	Found in rich mesic woods (i.e. southern mesic forests), rocky upland woodlands (deciduous), bluffs, slopes of wooded ravines, and shaded cliffs. This fern is especially likely to be found where either limestone or sandstone comes close to the ground surface. Typically occur in well-drained, circumneutral to subacid soils. This species can be identified year-round.
	<i>Prenanthes aspera</i>	Rough rattlesnake-root	E	—	Found in dryish prairies (i.e. dry mesic prairies), usually on the lower slopes of hills. White flowers clustered at top of plant. Blooming occurs late August through early October; fruiting occurs throughout September. The optimal identification period for this species is late August through early October.
	<i>Ptelea trifoliata</i>	Wafer-ash	SC	—	Found on dry dolomite ledges in oak forests (i.e. southern dry and wet mesic forests). Blooming occurs late May through early June; fruiting occurs throughout July. The optimal identification period for this species is late May through late September.
	<i>Ranunculus cymbalaria</i>	Seaside crowfoot	T	—	An emergent aquatic plant found in sandy or muddy shores and marshes (i.e. northern sedge meadows), ditches and harbors along Lake Michigan, and salted roadsides near the city of Superior, with wet and sometimes sandy soils. Pale yellow flowers with cone in the middle of petals. Blooming occurs early June through late August; fruiting occurs late July through late August. The optimal identification period for this species is early June through late August.
	<i>Scutellaria ovata</i>	Heart-leaved skullcap	SC	—	Found in dry-mesic forests. Purple flowers in rows along the upper portions of the stem (above the leaves). Blooming occurs early June through late July; fruiting occurs late July through late August. The optimal identification period for this species is early June through late July.
	<i>Solidago caesia</i>	Bluestem goldenrod	E	—	Found in open forests, forest edges, clearings, and/or thickets. Occur on level ground, side slopes and protected ravine environments generally associated with Lake Michigan. Yellow clusters of flowers along the majority of the mid to upper portion of the stem. Blooming occurs from August to October.

<div> <div>PREFERRED HABITAT FOR STATE-LISTED SPECIES</div> <div> Alternative 3A-4 (Racine Supply) City of Waukesha Water Supply </div> </div>					
Species Group	Scientific Name	Common Name	State Status ^a	Federal Status ^a	Habitat Description
Plants (cont.)	<i>Solidago ohioensis</i>	Ohio goldenrod	SC	—	Found most commonly on wet dolomite lake flats in Door County, and in fens, moist calcareous prairies, and sedge meadows in the southeast portion of the state with moist soils. Yellow, flat-topped flowers. Blooming occurs early August through late September; fruiting occurs throughout September. The optimal identification period for this species is late August through early September.
	<i>Thalictrum revolutum</i>	Waxleaf meadowrue	SC	—	Found in moist, often calcareous meadows (i.e. southern sedge meadows) and mesic prairies. It is also naturalized on railroad embankments. Blooming occurs throughout June; fruiting occurs throughout July. The optimal identification period for this species is throughout June.
	<i>Tofieldia glutinosa</i>	Sticky false-asphodel	T	—	Found in moist calcareous bogs, fens and wet locations. White flowers clustered at the top of the plant with reddish/purple anthers. Blooming occurs between June and August.
	<i>Tomanthera auriculata</i>	Earleaf foxglove	SC	—	Found in prairies (i.e. wet mesic prairies) or open upland woods in or near serpentine soils (meaning (derived from serpentinite rock). Blooming occurs from late August through early September. The optimal identification period for this species is late August through early September.
	<i>Triglochin maritima</i>	Common bog arrow-grass	SC	—	Found on fen mats, calcareous fens, bogs, open neutral to calcareous conifers swamps, northern wet forests, and Great Lakes swales with wet soils. Blooming occurs late June through early August; fruiting occurs late July through early September. The optimal identification period for this species is early July through late August.
	<i>Trillium recurvatum</i>	Reflexed trillium	SC	—	Found in rich hardwood forests (i.e. southern mesic and dry mesic forests), with rich, moist soils. Blooming occurs late April through early May; fruiting occurs throughout June. The optimal identification period for this species is late April through late May.
	<i>Viburnum prunifolium</i>	Smooth black-haw	SC	—	Found in rich hardwood forests (i.e. southern wet mesic and mesic forests), often with dolomite near the surface. Blooming occurs late May through late June; fruiting occurs early July through early September. The optimal identification period for this species is late May through early September.
Reptiles & Amphibians	<i>Emydoidea blandingii</i>	Blanding's turtle	T	—	Utilize a wide variety of aquatic habitats including deep and shallow marshes, shallow bays of lakes and impoundments where areas of dense emergent and submergent vegetation exists, sluggish streams, oxbows and other backwaters of rivers, drainage ditches (usually where wetlands have been drained), and sedge meadows and wet meadows adjacent to these habitats. This species is semi-terrestrial and individuals may spend a good deal of time on land. They often move between a variety of wetland types during the active season, which can extend from early March to mid-October. Blanding's generally breed in spring, late summer or fall. Nesting occurs from about mid-May through June depending on spring temperatures. They strongly prefer to nest in sandy soils and may travel well over a mile from preferred habitat to find suitable soils. Hatching occurs from early August through early September but hatchlings can successfully overwinter in the nest, emerging the following late April or May.
	<i>Thamnophis butleri</i>	Butler's gartersnake	T	—	Prefer almost any open-canopy wetland type (not open water) and adjacent open to semi-open canopy upland, including prairies, old fields and weedy vacant lots. They also prefer low-canopy vegetation (<24"), although they will occupy habitats with taller vegetation, such as reed canary grass. Butler's gartersnakes can be active from mid-March through early November, usually emerging shortly after frost-out and remaining active until daytime temperatures fall consistently below 50 deg. F. Breeding usually occurs in April and early May, but can occur in the fall, in which case live young are born between mid-July and mid-August.
	<i>Regina septemvittata</i>	Queensnake	E	—	Prefer clear warm-water, spring-fed streams and small rivers in southern, lowland, hardwood forests and shrub carr communities. They are strongly associated with aquatic crayfish, and require both moderate to fast flows and rocky substrates. Queensnakes are rarely found far from their water habitat. They also prefer open-canopy habitats where they bask in grasses or in shoreline brush and foraging in water or along the shoreline. Queensnakes are active from late April through early October and breed mid-May through mid-June. Live young are born in August or early September.
	<i>Acris crepitans</i>	Northern cricket frog	E	—	Prefer ponds, lakes, and a variety of habitats along and adjacent to streams and rivers including, marshes, fens, sedge meadows, low prairies, and exposed mud flats. The species tends to breed in quiet water (no or low flow) and may also move from streams and rivers to adjacent wetlands and ponds. Cricket frogs are active from late-March through November. Breeding occurs from mid-May through mid-August, with some larvae not transforming until late September.
Birds	<i>Haliaeetus leucocephalus</i>	Bald eagle	SC	R	Prefers large trees in isolated areas, but in proximity to large areas of surface water, large complexes of deciduous forest, coniferous forest, wetland, and shrub communities. Large lakes and rivers with nearby tall pine trees are preferred for nesting. The breeding season extends from February through August. Favored roosting habitat includes wooded valleys near open water and major rivers from December through March.
	<i>Nycticorax nycticorax</i>	Black-crowned night-heron	SC	—	Prefers freshwater wetlands dominated by bulrush and cattail with small groves of alder, willow, or other brush. Their breeding season occurs from mid-April through mid-September.
	<i>Pandion haliaetus</i>	Osprey	SC	—	Prefers large trees in isolated areas in proximity to large areas of surface water, large complexes of deciduous forest, coniferous forest, wetland, and shrub communities. Areas are usually forested with second growth pine, aspen, and hardwood forests. Breed mainly in forested lake regions of northwest and north central Wisconsin. A few nest along the Wisconsin River, in swamps and inland lakes in the central part of the state. Large lakes and rivers with nearby tall pine trees are preferred for nesting. Most frequent nest sites are super canopy snags and dead-topped pines located along lake and stream shoreline, in recent clear-cut areas near water, in swamp conifer stands, and on snags in marshes and bogs. The breeding season extends from late April through August.
	<i>Buteo lineatus</i>	Red-shouldered hawk	T	—	Prefers larger stands of medium-aged to mature lowland deciduous forests, dry-mesic and mesic forest with small wetland pockets. Breeding habitat includes bottomland hardwoods, mesic deciduous or mixed deciduous-conifer forests, and wooded margins of marshes. Breeding occurs from mid-March through early August.

PREFERRED HABITAT FOR STATE-LISTED SPECIES

Alternative 3A-4 (Racine Supply)

City of Waukesha Water Supply

Species Group	Scientific Name	Common Name	State Status ^a	Federal Status ^a	Habitat Description
Birds (cont.)	<i>Bartramia longicauda</i>	Upland sandpiper	SC	—	Prefers tallgrass prairies, sedge meadows, unmowed alfalfa/timothy fields and scattered woodlands. The breeding season extends from early May through late September.
Fish and Mussels	<i>Fundulus diaphanus</i>	Banded killifish	SC	—	Prefers clear water of bays and quiet backwaters of large lakes and medium to large streams with sparse to no vegetation over gravel, sand, silt, marl, clay detritus or cobble. Spawning occurs from June through mid-August.
	<i>Opsopoeodus emiliae</i>	Pugnose minnow	SC	—	Prefers clear, quiet, weedy shoals of glacial lakes, sloughs, and low-gradient rivers/streams over bottoms of sand, mud, sand, rubble, silt, or clay. Characteristic vegetation includes pondweed, water milfoil, elodea, eelgrass, coontail, bullrush and filamentous algae. Spawning occurs from mid-June through mid-July.
	<i>Notropis anogenus</i>	Pugnose shiner	T	—	Prefers weedy shoals of glacial lakes and low-gradient streams over bottoms of mud, sand, cobble, silt, and clay. Spawning occurs from mid-June through mid-July.
	<i>Luxilus chrysocephalus</i>	Striped shiner	E	—	Prefers clear to slightly turbid waters of runs and shallow pools of the lower Milwaukee River, with dense aquatic vegetation over substrates of cobble, boulders, silt, sand, mud or bedrock. Sometimes present in large schools at the foot of riffles and shallow, hard-bottomed pools with some flow. Spawning occurs from late May through June.
	<i>Erimyzon sucetta</i>	Lake chubsucker	SC	—	Prefers moderately clear lakes, oxbow lakes, sloughs of weedy lakes and their associated marshy streams that are dense with organic debris over bottoms of cobble, sand, boulders, mud or silt. Spawning occurs from mid May through early July.
	<i>Etheostoma microperca</i>	Least darter	SC	—	Prefers clear, warm, quiet waters of overflow ponds, pools, lakes and streams over substrates of gravel, silt, sand, boulders, mud or clay with dense vegetation or filamentous algal beds. Spawning occurs from late April into July.
	<i>Lythrurus umbratilis</i>	Redfin shiner	T	—	Prefers turbid waters of pools in low-gradient streams over substrates of boulders, cobble, sand, silt or detritus. Spawning occurs from early June through mid-August in sunfish nests.
	<i>Lepomis megalotis</i>	Longear sunfish	T	—	Prefers clear, shallow, moderately warm, still waters of streams, rivers or occasionally lakes over rubble, gravel and sand with moderate aquatic vegetation present. Found in or near vegetation. Spawning occurs from late May through mid-July, sporadic to August.

^a E, Endangered; T, Threatened; SC, Species of Concern (not legally protected); R, Recovery

<div><div>PREFERRED HABITAT FOR STATE-LISTED SPECIES</div><div>Alternative 3B-1 (Underwood Creek)</div><div>City of Waukesha Water Supply</div></div>					
Species Group	Scientific Name	Common Name	State Status ^a	Federal Status ^a	Habitat Description
Habitat	—	Southern dry-mesic forest	N/A	—	Southern dry-mesic forests occur on loamy soils of glacial till plains and moraines, and on erosional topography with a loess cap, south of the tension zone. Red oak is a common dominant tree of this upland forest community type. White oak, basswood, sugar and red maples, white ash, shagbark hickory, and black cherry are also important. The herbaceous understory flora is diverse and includes many species listed under southern dry forest plus jack-in-the-pulpit, enchanter’s-nightshade, large-flowered bellwort, interrupted fern, lady fern, tick-trefoils, and hog peanut.
	—	Southern mesic forest	N/A	—	Oaks are the dominant species in this upland forest community of dry sites. White oak and black oak are dominant, often with admixtures of northern red and bur oaks and black cherry. In the well-developed shrub layer, brambles (<i>Rubus</i> spp.), gray dogwood, and American hazelnut are common. Frequent herbaceous species are wild geranium, false Solomon’s-seal, hog-peanut, and rough-leaved sunflower.
	—	Floodplain forest	N/A	—	This lowland hardwood forest community type occurs along large rivers, usually of Stream Order 3 or higher. Canopy dominants vary, but may include silver maple, river birch, green and black ashes, hackberry, swamp white oak, and eastern cottonwood. Black willow, basswood, red oak, and red maple are associated tree species found in these forests. Understory composition is also quite variable, and follows the pattern exhibited by the canopy species, with the most extensive stands and highest plant species diversity occurring in southwestern Wisconsin. Buttonbush is a locally dominant shrub that may form dense thickets on the margins of oxbow lakes, sloughs and ponds, which are often important aquatic habitats within these forests. Wood nettle, stinging nettle, sedges (e.g., <i>Carex grayii</i> , <i>C. lupulina</i> , <i>C. hystericina</i> , <i>C. tuckermanii</i>), native grasses (e.g., <i>Cinna arundinacea</i> , <i>Elymus villosus</i> , <i>Leersia virginica</i>), ostrich fern and green-headed coneflower are important understory herbs, and lianas such as Virginia creepers, grapes, Canada moonseed, and poison-ivy are often common. Among the more striking herbs of this community are cardinal flower, fringed loosestrife, and green dragon.
	—	Southern sedge meadow	N/A	—	Widespread in southern Wisconsin, this open wetland community is most typically dominated by tussock sedge and Canada bluejoint grass. Common associates of relatively undisturbed sedge meadows are other sedges (<i>Carex diandra</i> , <i>C. sartwellii</i>), marsh bellflower, marsh wild-timothy, water horehound, panicked aster, swamp aster, blue flag, spotted Joe-Pye weed, marsh fern, and swamp milkweed. Reed canary grass may be dominant in grazed and/or ditched stands, sometimes to the exclusion of virtually all other species. Sedge meadows are most common in glaciated landscapes, where they often border streams or drainage lakes. Many sedge meadows in southeastern Wisconsin are influenced by alkaline groundwater, and occur in complexes with emergent marsh, calcareous fen, wet prairie, wet-mesic prairie, and shrub-carr.
	—	Mesic prairie	N/A	—	This grassland community occurs on rich, moist, well-drained sites, usually on level or gently rolling glacial topography. The dominant plant is the tall grass big bluestem. The grasses little bluestem, Indian grass, needle grass, prairie dropseed, and switch grass are also frequent. The forb layer is diverse in the number, size, and physiognomy of the species. Common taxa include the prairie docks, lead plant, heath and smooth asters, prairie coreopsis, prairie sunflower, rattlesnake-master, flowering spurge, bee-balm, prairie coneflower, and spiderwort.
Plants	<i>Asclepias purpurascens</i>	Purple milkweed	E	—	Found in open oak forest (i.e. southern dry mesic forests) margins and roadsides; it has wide soil moisture tolerances. Pink/purple flowers at flat top. Blooming occurs early June through late July; fruiting occurs early July through late August. The optimal identification period for this species is late June through late July.
	<i>Astragalus neglectus</i>	Cooper’s milkvetch	E	—	Found on riverbanks, ravines, and lakeshores, especially on dolomite near Lake Michigan, with calcareous soils. It can also be found in old fields and mesic forests. White flowers at top of stem, with alternate leaves. Blooming occurs throughout June; fruiting occurs throughout July. The optimal identification period for this species is early June through late July.
	<i>Carex crus-corvi</i>	Ravenfoot sedge	E	—	Found along ephemeral woodland (i.e. southern wet forests with moist soils) ponds. Blooms are clustered at the top. Blooming occurs throughout June; fruiting occurs throughout July. The optimal identification period for this species is late June through early July.
	<i>Carex lupuliformis</i>	False hop sedge	E	—	Found in floodplain forests (i.e. southern wet and mesic wet forests) and ephemeral woodland ponds, and have wet soils. Blooming occurs early June through early October; fruiting occurs late July through early October. The optimal identification period for this species is early August through late September.
	<i>Conioselinum chinense</i>	Hemlock parsley	E	—	Found in discharge areas in forested seeps, calcareous fens, and tamarack swamps (including northern wet forests) with wet soils. Blooming occurs late August through late September; fruiting occurs throughout September. The optimal identification period for this species is late August through late September.
	<i>Platanthera leucophaea</i>	Prairie white-fringed orchid	E	T	Found in moist, undisturbed, deep-soiled and/or calcareous prairies (i.e. mesic and wet mesic prairies) and rarely in tamarack fens with wet and moist soils. White flowers with large fringed petals at the bottom of the bloom. Blooming occurs early June through early August; fruiting occurs throughout August. The optimal identification period for this species is late June through late July.
	<i>Erigenia bulbosa</i>	Harbinger-of-spring	E	—	Found in rich hardwoods (i.e. southern mesic forests) with rich soils. White flower clustered at the top of the stems. Blooming occurs late April through early May; fruiting occurs throughout May. The optimal identification period for this species is late April through early May.
	<i>Prenanthes aspera</i>	Rough rattlesnake root	E	—	Found in dryish prairies (i.e. dry mesic prairies), usually on the lower slopes of hills. White flowers clustered at top of plant. Blooming occurs late August through early October; fruiting occurs throughout September. The optimal identification period for this species is late August through early October.
	<i>Cypripedium arietinum</i>	Ram’s-head lady’s slipper	T	—	Found on basic substrates in various habitats (including northern dry mesic to mesic forests), but it is most characteristic of conifer swamps with moist, acidic soils. Blooming occurs late May through early June; fruiting occurs late June through late July. The optimal identification period for this species is late May through early June.
	<i>Aster furcatus</i>	Forked aster	T	—	Found in dry to mesic hardwoods (i.e. southern wet and wet mesic forests), often on stream-sides or slopes with dolomite near the surface. White flowers, clustered at the very top of stem. Blooming occurs early August through early October; fruiting occurs late August through early October. The optimal identification period for this species is late August through late September.

<div>PREFERRED HABITAT FOR STATE-LISTED SPECIES</div> <div>Alternative 3B-1 (Underwood Creek)</div> <div>City of Waukesha Water Supply</div>					
Species Group	Scientific Name	Common Name	State Status ^a	Federal Status ^a	Habitat Description
Plants (cont.)	<i>Cypripedium candidum</i>	Small white lady's slipper	T	—	Found in calcareous fens, and wet and mesic prairies with wet or moist soils. Blooming occurs late May through early June; fruiting occurs throughout September. The optimal identification period for this species is late May through early June.
	<i>Cacalia muehlenbergii</i>	Great Indian plantain	SC	—	Found in mesic hardwood forests (i.e. southern wet and wet mesic forests) and adjacent mesic prairies, often with dolomite near the surface. Blooming occurs late June through late July; fruiting occurs late July through late August. The optimal identification period for this species is early June through late September.
	<i>Lithospermum latifolium</i>	American gromwell	SC	—	Found in upland hardwood forests (southern wet mesic forests), often with dolomite near the surface, and dry, calcareous soils. Small yellow flowers with 5 petals at top of plant. Blooming occurs throughout June; fruiting occurs early July through late August. The optimal identification period for this species is early June through late August.
	<i>Platanthera hookeri</i>	Hooker orchis	SC	—	Found in a variety of dry to moist, mostly mixed coniferous-hardwood forests (i.e. southern and northern dry mesic forests). Blooming occurs late May through late July; fruiting occurs early July through late August. The optimal identification period for this species is early June through early September.
	<i>Scutellaria ovata</i>	Heart-leaved skullcap	SC	—	Found in dry-mesic forests. Purple flowers in rows along the upper portions of the stem (above the leaves). Blooming occurs early June through late July; fruiting occurs late July through late August. The optimal identification period for this species is early June through late July.
	<i>Trillium recurvatum</i>	Reflexed trillium	SC	—	Found in rich hardwood forests (i.e. southern mesic and dry mesic forests), with rich, moist soils. Blooming occurs late April through early May; fruiting occurs throughout June. The optimal identification period for this species is late April through late May.
	<i>Calamagrostis stricta</i>	Slim-stem small reedgrass	SC	—	Found on dry to moist dunes, barrens, and dolomite or sandstone ledges, mostly near the Great Lakes, as well as calcareous wetlands, southern sedge meadows, and occasionally pine barrens. Occurs in wet, sandy soils. Blooming occurs throughout June; fruiting occurs early July through late August. The optimal identification period for this species is early July through late August.
	<i>Carex tenuiflora</i>	Sparse-flowered sedge	SC	—	Found in open- to closed canopy cold, wet, coniferous forests (northern wet mesic and mesic forests), usually on neutral to calcareous substrates. Blooming occurs late May through early June; fruiting occurs late June through late July. The optimal identification period for this species is early June through late July.
	<i>Cypripedium parviflorum</i>	Northern yellow lady's slipper	SC	—	Found in fens, calcareous swales, and rich springy forest edges (i.e. southern or northern wet mesic forests) with moist to wet soils. Blooming occurs late May through late June; fruiting occurs late June through late July. The optimal identification period for this species is late May through early July.
	<i>Liatrix spicata</i>	Marsh blazing star	SC	—	Found in moist, sandy calcareous prairies (i.e. dry to wet mesic prairies) with moist to wet soils. Deep purple flowers with wispy petals. Blooming occurs late July through early August; fruiting occurs throughout August. The optimal identification period for this species is early August through early September.
	<i>Thalictrum revolutum</i>	Waxleaf meadowrue	SC	—	Found in moist, often calcareous meadows (i.e. southern sedge meadows) and mesic prairies. It is also naturalized on railroad embankments. Blooming occurs throughout June; fruiting occurs throughout July. The optimal identification period for this species is throughout June.
	<i>Triglochin maritime</i>	Common bog arrow-grass	SC	—	Found on fen mats, calcareous fens, bogs, open neutral to calcareous conifers swamps, northern wet forests, and Great Lakes swales with wet soils. Blooming occurs late June through early August; fruiting occurs late July through early September. The optimal identification period for this species is early July through late August.
	<i>Platanthera dilatata</i>	Leafy white orchis	SC	—	Found on neutral to calcareous bog and fen mats (or calcareous fens), or northern wet forests (sometimes with scattered tamarack and white cedar) with wet, neutral to calcareous soils. White flowers down the length of the stem. Blooming occurs early June through early July; fruiting occurs throughout July. The optimal identification period for this species is early June through early July.
	<i>Calylophus serrulatus</i>	Yellow evening primrose	SC	—	Found mostly on steep bluff prairies (dry to dry mesic prairies) along the Mississippi and lower St. Croix Rivers, as well as cedar glades and, occasionally, in moister prairies. Blooming occurs late June through early September; fruiting occurs early July through early October. The optimal identification period for this species is late June through early October.
	<i>Thaspium trifoliatum</i>	Purple meadow parsnip	SC	—	Found in moist prairies (wet mesic and mesic prairies) and woodlands (including oak openings); it is also naturalized on roadsides and embankments. Yellow flowers clustered at the flat top. Blooming occurs late May through late June; fruiting occurs early July through early October. The optimal identification period for this species is early July through late September.
	<i>Jeffersonia diphylla</i>	Twinleaf	SC	—	Found in very rich hardwood forests (i.e. southern mesic forests), often with dolomite near the surface. White cupped flower with leaves comprised of 2 symmetrical parts. Blooming occurs throughout May; fruiting occurs early July through early September. The optimal identification period for this species is early May through early June.
Birds	<i>Nycticorax nycticorax</i>	Black-crowned night heron	SC	—	Prefers freshwater wetlands dominated by bulrush and cattail with small groves of alder, willow, or other brush. Their breeding season occurs from mid-April through mid-September.
Reptiles & Amphibians	<i>Acris crepitans</i>	Northern cricket frog	E	—	Prefer ponds, lakes, and a variety of habitats along and adjacent to streams and rivers including, marshes, fens, sedge meadows, low prairies, and exposed mud flats. The species tends to breed in quiet water (no or low flow) and may also move from streams and rivers to adjacent wetlands and ponds. Cricket frogs are active from late-March through November. Breeding occurs from mid-May through mid-August, with some larvae not transforming until late September.

PREFERRED HABITAT FOR STATE-LISTED SPECIES					
Alternative 3B-1 (Underwood Creek)					
City of Waukesha Water Supply					
Species Group	Scientific Name	Common Name	State Status ^a	Federal Status ^a	Habitat Description
Reptiles & Amphibians (cont.)	<i>Thamnophis butleri</i>	Butler's gartersnake	T	—	Prefer almost any open-canopy wetland type (not open water) and adjacent open to semi-open canopy upland, including prairies, old fields and weedy vacant lots. They also prefer low-canopy vegetation (<24"), although they will occupy habitats with taller vegetation, such as reed canary grass. Butler's gartersnakes can be active from mid-March through early November, usually emerging shortly after frost-out and remaining active until daytime temperatures fall consistently below 50 deg. F. Breeding usually occurs in April and early May, but can occur in the fall, in which case live young are born between mid-July and mid-August.
	<i>Emydoidea blandingii</i>	Blanding's turtle	T	—	Utilize a wide variety of aquatic habitats including deep and shallow marshes, shallow bays of lakes and impoundments where areas of dense emergent and submergent vegetation exists, sluggish streams, oxbows and other backwaters of rivers, drainage ditches (usually where wetlands have been drained), and sedge meadows and wet meadows adjacent to these habitats. This species is semi-terrestrial and individuals may spend a good deal of time on land. They often move between a variety of wetland types during the active season, which can extend from early March to mid-October. Blanding's generally breed in spring, late summer or fall. Nesting occurs from about mid-May through June depending on spring temperatures. They strongly prefer to nest in sandy soils and may travel well over a mile from preferred habitat to find suitable soils. Hatching occurs from early August through early September but hatchlings can successfully overwinter in the nest, emerging the following late April or May.
	<i>Lithobates catesbeianus</i>	American bullfrog	SC	—	Found throughout Wisconsin in any permanent body of water - lakes, ponds, rivers, and creeks. They have a very patchy distribution. In Wisconsin, bullfrogs typically favor oligotrophic (waters with low algal production; thus very clear) to mesotrophic (generally clear water with beds of submerged plants) waters; tend to breed where dense submergent vegetation filters out the majority of the suspended solids. Bullfrogs are active from April through mid-October. They breed from mid-May through late July or later.
Fish	<i>Luxilus chrysocephalus</i>	Striped shiner	E	—	Prefers clear to slightly turbid waters of runs and shallow pools of the lower Milwaukee River, with dense aquatic vegetation over substrates of cobble, boulders, silt, sand, mud or bedrock. Sometimes present in large schools at the foot of riffles and shallow, hard-bottomed pools with some flow. Spawning occurs from late May through June.
	<i>Lythrurus umbratilis</i>	Redfin shiner	T	—	Prefers turbid waters of pools in low-gradient streams over substrates of boulders, cobble, sand, silt or detritus. Spawning occurs from early June through mid-August in sunfish nests.
	<i>Etheostoma microperca</i>	Least darter	SC	—	Prefers clear, warm, quiet waters of overflow ponds, pools, lakes and streams over substrates of gravel, silt, sand, boulders, mud or clay with dense vegetation or filamentous algal beds. Spawning occurs from late April into July.
	<i>Erimyzon sucetta</i>	Lake chubsucker	SC	—	Prefers moderately clear lakes, oxbow lakes, sloughs of weedy lakes and their associated marshy streams that are dense with organic debris over bottoms of cobble, sand, boulders, mud or silt. Spawning occurs from mid May through early July.
	<i>Clinostomus elongates</i>	Redside dace	SC	—	Prefers cool water pools and quiet riffles of small streams (usually adjacent to meadows or pastures) with substrate of cobble, sand, clay silt or bedrock. Spawning occurs from May to early June.
Insects	<i>Pompeius verna</i>	Little glassy wing	SC	—	Found in grassy openings in wooded areas near swamps, streams, bogs. Host plants appear to include grasses, especially purple top grass (<i>Tridens flavus</i>). Flight period is from late June-July.
Crustaceans	<i>Procambarus gracilis</i>	Prairie crayfish	SC	—	Typically restricted to prairie regions of southeastern Wisconsin and is the rarest crayfish in Wisconsin. This species frequents burrows in banks of ponds, roadside ditches, small sluggish creeks, marshes, swamps, and small artificial lakes, as well as wet pastures and flat fields in prairies. The burrows can be quite deep and branching, with a characteristic mud chimney. Breeding occurs and young hatch in early spring, as early as March, with juveniles occurring through spring and summer. Females move to open water for a relatively short period in the summer where the newly hatched young are released.

^a E, Endangered; T, Threatened; SC, Species of Concern (not legally protected).

PREFERRED HABITAT FOR STATE-LISTED SPECIES Alternative 3B-2 (Root River) City of Waukesha Water Supply					
Species Group	Scientific Name	Common Name	State Status ^a	Federal Status ^a	Habitat Description
Habitat	—	Mesic prairie	N/A	—	This grassland community occurs on rich, moist, well-drained sites, usually on level or gently rolling glacial topography. The dominant plant is the tall grass big bluestem. The grasses little bluestem, Indian grass, needle grass, prairie dropseed, and switch grass are also frequent. The forb layer is diverse in the number, size, and physiognomy of the species. Common taxa include the prairie docks, lead plant, heath and smooth asters, prairie coreopsis, prairie sunflower, rattlesnake-master, flowering spurge, bee-balm, prairie coneflower, and spiderwort.
	—	Southern dry-mesic forest	N/A	—	Southern dry-mesic forests occur on loamy soils of glacial till plains and moraines, and on erosional topography with a loess cap, south of the tension zone. Red oak is a common dominant tree of this upland forest community type. White oak, basswood, sugar and red maples, white ash, shagbark hickory, and black cherry are also important. The herbaceous understory flora is diverse and includes many species listed under southern dry forest plus jack-in-the-pulpit, enchanter's-nightshade, large-flowered bellwort, interrupted fern, lady fern, tick-trefoils, and hog peanut.
	—	Southern mesic forest	N/A	—	Oaks are the dominant species in this upland forest community of dry sites. White oak and black oak are dominant, often with admixtures of northern red and bur oaks and black cherry. In the well-developed shrub layer, brambles (<i>Rubus</i> spp.), gray dogwood, and American hazelnut are common. Frequent herbaceous species are wild geranium, false Solomon's-seal, hog-peanut, and rough-leaved sunflower.
Plants	<i>Asclepias purpurascens</i>	Purple milkweed	E	—	Found in open oak forest (i.e. southern dry mesic forests) margins and roadsides; it has wide soil moisture tolerances. Pink/purple flowers at flat top. Blooming occurs early June through late July; fruiting occurs early July through late August. The optimal identification period for this species is late June through late July.
	<i>Aster furcatus</i>	Forked aster	T	—	Found in dry to mesic hardwoods (i.e. southern wet and wet mesic forests), often on stream-sides or slopes with dolomite near the surface. White flowers, clustered at the very top of stem. Blooming occurs early August through early October; fruiting occurs late August through early October. The optimal identification period for this species is late August through late September.
	<i>Astragalus neglectus</i>	Cooper's milkvetch	E	—	Found on riverbanks, ravines, and lakeshores, especially on dolomite near Lake Michigan, with calcareous soils. It can also be found in old fields and mesic forests. White flowers at top of stem, with alternate leaves. Blooming occurs throughout June; fruiting occurs throughout July. The optimal identification period for this species is early June through late July.
	<i>Cacalia muehlenbergii</i>	Great Indian plantain	SC	—	Found in mesic hardwood forests (i.e. southern wet and wet mesic forests) and adjacent mesic prairies, often with dolomite near the surface. Blooming occurs late June through late July; fruiting occurs late July through late August. The optimal identification period for this species is early June through late September.
	<i>Calamagrostis stricta</i>	Slim-stem small reedgrass	SC	—	Found on dry to moist dunes, barrens, and dolomite or sandstone ledges, mostly near the Great Lakes, as well as calcareous wetlands, southern sedge meadows, and occasionally pine barrens. Occurs in wet, sandy soils. Blooming occurs throughout June; fruiting occurs early July through late August. The optimal identification period for this species is early July through late August.
	<i>Carex lupuliformis</i>	False hop sedge	E	—	Found in floodplain forests (i.e. southern wet and mesic wet forests) and ephemeral woodland ponds, and have wet soils. Blooming occurs early June through early October; fruiting occurs late July through early October. The optimal identification period for this species is early August through late September.
	<i>Carex tenuiflora</i>	Sparse-flowered sedge	SC	—	Found in open- to closed canopy cold, wet, coniferous forests (northern wet mesic and mesic forests), usually on neutral to calcareous substrates. Blooming occurs late May through early June; fruiting occurs late June through late July. The optimal identification period for this species is early June through late July.
	<i>Conioselinum chinense</i>	Hemlock parsley	E	—	Found in discharge areas in forested seeps, calcareous fens, and tamarack swamps (including northern wet forests) with wet soils. Blooming occurs late August through late September; fruiting occurs throughout September. The optimal identification period for this species is late August through late September.
	<i>Cypripedium arietinum</i>	Ram's-head lady's slipper	T	—	Found on basic substrates in various habitats (including northern dry mesic to mesic forests), but it is most characteristic of conifer swamps with moist, acidic soils. Blooming occurs late May through early June; fruiting occurs late June through late July. The optimal identification period for this species is late May through early June.
	<i>Cypripedium parviflorum</i>	Northern yellow lady's slipper	SC	—	Found in fens, calcareous swales, and rich springy forest edges (i.e. southern or northern wet mesic forests) with moist to wet soils. Blooming occurs late May through late June; fruiting occurs late June through late July. The optimal identification period for this species is late May through early July.
	<i>Liatris spicata</i>	Marsh blazing star	SC	—	Found in moist, sandy calcareous prairies (i.e. dry to wet mesic prairies) with moist to wet soils. Deep purple flowers with wispy petals. Blooming occurs late July through early August; fruiting occurs throughout August. The optimal identification period for this species is early August through early September.
	<i>Lithospermum latifolium</i>	American gromwell	SC	—	Found in upland hardwood forests (southern wet mesic forests), often with dolomite near the surface, and dry, calcareous soils. Small yellow flowers with 5 petals at top of plant. Blooming occurs throughout June; fruiting occurs early July through late August. The optimal identification period for this species is early June through late August.
	<i>Platanthera dilatata</i>	Leafy white orchis	SC	—	Found on neutral to calcareous bog and fen mats (or calcareous fens), or northern wet forests (sometimes with scattered tamarack and white cedar) with wet, neutral to calcareous soils. White flowers down the length of the stem. Blooming occurs early June through early July; fruiting occurs throughout July. The optimal identification period for this species is early June through early July.
	<i>Platanthera hookeri</i>	Hooker orchis	SC	—	Found in a variety of dry to moist, mostly mixed coniferous-hardwood forests (i.e. southern and northern dry mesic forests). Blooming occurs late May through late July; fruiting occurs early July through late August. The optimal identification period for this species is early June through early September.

Alternative 3B-2 (Root River)
City of Waukesha Water Supply

Species Group	Scientific Name	Common Name	State Status ^a	Federal Status ^a	Habitat Description
Plants (cont.)	<i>Platanthera leucophaea</i>	Prairie white-fringed orchid	E	T	Found in moist, undisturbed, deep-soiled and/or calcareous prairies (i.e. mesic and wet mesic prairies) and rarely in tamarack fens with wet and moist soils. White flowers with large fringed petals at the bottom of the bloom. Blooming occurs early June through early August; fruiting occurs throughout August. The optimal identification period for this species is late June through late July.
	<i>Prenanthes aspera</i>	Rough rattlesnake-root	E	—	Found in dryish prairies (i.e. dry mesic prairies), usually on the lower slopes of hills. White flowers clustered at top of plant. Blooming occurs late August through early October; fruiting occurs throughout September. The optimal identification period for this species is late August through early October.
	<i>Ptelea trifoliata</i>	Wafer-ash	SC	—	Found on dry dolomite ledges in oak forests (i.e. southern dry and wet mesic forests). Blooming occurs late May through early June; fruiting occurs throughout July. The optimal identification period for this species is late May through late September.
	<i>Scutellaria ovata</i>	Heart-leaved skullcap	SC	—	Found in dry-mesic forests. Purple flowers in rows along the upper portions of the stem (above the leaves). Blooming occurs early June through late July; fruiting occurs late July through late August. The optimal identification period for this species is early June through late July.
	<i>Solidago caesia</i>	Bluestem goldenrod	E	—	Found in open forests, forest edges, clearings, and/or thickets. Occur on level ground, side slopes and protected ravine environments generally associated with Lake Michigan. Yellow clusters of flowers along the majority of the mid to upper portion of the stem. Blooming occurs from August to October.
	<i>Thalictrum revolutum</i>	Waxleaf meadowrue	SC	—	Found in moist, often calcareous meadows (i.e. southern sedge meadows) and mesic prairies. It is also naturalized on railroad embankments. Blooming occurs throughout June; fruiting occurs throughout July. The optimal identification period for this species is throughout June.
	<i>Triglochin maritime</i>	Common bog arrow-grass	SC	—	Found on fen mats, calcareous fens, bogs, open neutral to calcareous conifers swamps, northern wet forests, and Great Lakes swales with wet soils. Blooming occurs late June through early August; fruiting occurs late July through early September. The optimal identification period for this species is early July through late August.
	<i>Trillium recurvatum</i>	Reflexed trillium	SC	—	Found in rich hardwood forests (i.e. southern mesic and dry mesic forests), with rich, moist soils. Blooming occurs late April through early May; fruiting occurs throughout June. The optimal identification period for this species is late April through late May.
	<i>Viburnum prunifolium</i>	Smooth black-haw	SC	—	Found in rich hardwood forests (i.e. southern wet mesic and mesic forests), often with dolomite near the surface. Blooming occurs late May through late June; fruiting occurs early July through early September. The optimal identification period for this species is late May through early September.
Birds	<i>Spiza Americana</i>	Dickcissel	SC	—	Prefers open pasture and fields of clover and alfalfa. Grasslands, meadows, and savanna are also important nesting areas. This bird requires vegetation with medium to tall height-density and a significant component of forbs (i.e. herbaceous flowering plants that are not graminoids (grasses, sedges and rushes), some stiff-stemmed. Breeding occurs from late May to early August.
Reptiles & Amphibians	<i>Acris crepitans</i>	Northern cricket frog	E	—	Prefer ponds, lakes, and a variety of habitats along and adjacent to streams and rivers including, marshes, fens, sedge meadows, low prairies, and exposed mud flats. The species tends to breed in quiet water (no or low flow) and may also move from streams and rivers to adjacent wetlands and ponds. Cricket frogs are active from late-March through November. Breeding occurs from mid-May through mid-August, with some larvae not transforming until late September.
	<i>Emydoidea blandingii</i>	Blanding's turtle	T	—	Utilize a wide variety of aquatic habitats including deep and shallow marshes, shallow bays of lakes and impoundments where areas of dense emergent and submergent vegetation exists, sluggish streams, oxbows and other backwaters of rivers, drainage ditches (usually where wetlands have been drained), and sedge meadows and wet meadows adjacent to these habitats. This species is semi-terrestrial and individuals may spend a good deal of time on land. They often move between a variety of wetland types during the active season, which can extend from early March to mid-October. Blanding's generally breed in spring, late summer or fall. Nesting occurs from about mid-May through June depending on spring temperatures. They strongly prefer to nest in sandy soils and may travel well over a mile from preferred habitat to find suitable soils. Hatching occurs from early August through early September but hatchlings can successfully overwinter in the nest, emerging the following late April or May.
	<i>Lithobates catesbeianus</i>	American bullfrog	SC	—	Found throughout Wisconsin in any permanent body of water - lakes, ponds, rivers, and creeks. They have a very patchy distribution. In Wisconsin, bullfrogs typically favor oligotrophic (waters with low algal production; thus very clear) to mesotrophic (generally clear water with beds of submerged plants) waters; tend to breed where dense submergent vegetation filters out the majority of the suspended solids. Bullfrogs are active from April through mid-October. They breed from mid-May through late July or later.
	<i>Thamnophis butleri</i>	Butler's gartersnake	T	—	Prefer almost any open-canopy wetland type (not open water) and adjacent open to semi-open canopy upland, including prairies, old fields and weedy vacant lots. They also prefer low-canopy vegetation (<24"), although they will occupy habitats with taller vegetation, such as reed canary grass. Butler's gartersnakes can be active from mid-March through early November, usually emerging shortly after frost-out and remaining active until daytime temperatures fall consistently below 50 deg. F. Breeding usually occurs in April and early May, but can occur in the fall, in which case live young are born between mid-July and mid-August.
Fish	<i>Luxilus chrysocephalus</i>	Striped shiner	E	—	Prefers clear to slightly turbid waters of runs and shallow pools of the lower Milwaukee River, with dense aquatic vegetation over substrates of cobble, boulders, silt, sand, mud or bedrock. Sometimes present in large schools at the foot of riffles and shallow, hard-bottomed pools with some flow. Spawning occurs from late May through June.
	<i>Lythrurus umbratilis</i>	Redfin shiner	T	—	Prefers turbid waters of pools in low-gradient streams over substrates of boulders, cobble, sand, silt or detritus. Spawning occurs from early June through mid-August in sunfish nests.

Alternative 3B-2 (Root River)
City of Waukesha Water Supply

^a E, Endangered; T, Threatened; SC, Species of Concern (not legally protected).

City of Waukesha Water Supply

Species Group	Scientific Name	Common Name	State Status ^a	Federal Status ^a	Habitat Description
Habitat	—	Calcareous fen	N/A	—	Calcareous fens occur mostly in southern Wisconsin, on sites that are fed by carbonate-enriched groundwater. Most fens are small, covering no more than a few acres, and are often associated and can intergrade with more abundant and widespread wetland communities such as southern sedge meadow, wet prairie, shrub-carr, emergent marsh, and southern tamarack swamp. An accumulation of peat can raise the fen surface to a height of several meters above the adjoining lands. Common or representative plants include sedges, marsh fern, shrubby cinquefoil, shrubby St. John’s wort, Ohio goldenrod, grass-of-parnassus, twig-rush, brook lobelia, boneset, swamp thistle, and asters. Many fens have a significant number of prairie or sedge meadow components, and some contain plants often associated with bogs, such as tamarack, bog birch and pitcher plant. Fens occur in several landscape settings, including the bases of morainal slopes, on sloping deposits of glacial outwash, in the headwaters regions of spring runs and small streams, and on the shores of alkaline drainage lakes.
	—	Southern dry-mesic forest	N/A	—	Southern dry-mesic forests occur on loamy soils of glacial till plains and moraines, and on erosional topography with a loess cap, south of the tension zone. Red oak is a common dominant tree of this upland forest community type. White oak, basswood, sugar and red maples, white ash, shagbark hickory, and black cherry are also important. The herbaceous understory flora is diverse and includes many species listed under southern dry forest plus jack-in-the-pulpit, enchanter’s-nightshade, large-flowered bellwort, interrupted fern, lady fern, tick-trefoils, and hog peanut.
	—	Southern mesic forest	N/A	—	Oaks are the dominant species in this upland forest community of dry sites. White oak and black oak are dominant, often with admixtures of northern red and bur oaks and black cherry. In the well-developed shrub layer, brambles (<i>Rubus</i> spp.), gray dogwood, and American hazelnut are common. Frequent herbaceous species are wild geranium, false Solomon’s-seal, hog-peanut, and rough-leaved sunflower.
	—	Springs and spring runs (hard)	N/A	—	A water source from the ground.
Plants	<i>Asclepias purpurascens</i>	Purple milkweed	E	—	Found in open oak forest (i.e. southern dry mesic forests) margins and roadsides; it has wide soil moisture tolerances. Pink/purple flowers at flat top. Blooming occurs early June through late July; fruiting occurs early July through late August. The optimal identification period for this species is late June through late July.
	<i>Aster furcatus</i>	Forked aster	T	—	Found in dry to mesic hardwoods (i.e. southern wet and wet mesic forests), often on stream-sides or slopes with dolomite near the surface. White flowers, clustered at the very top of stem. Blooming occurs early August through early October; fruiting occurs late August through early October. The optimal identification period for this species is late August through late September.
	<i>Astragalus neglectus</i>	Cooper’s milkvetch	E	—	Found on riverbanks, ravines, and lakeshores, especially on dolomite near Lake Michigan, with calcareous soils. It can also be found in old fields and mesic forests. White flowers at top of stem, with alternate leaves. Blooming occurs throughout June; fruiting occurs throughout July. The optimal identification period for this species is early June through late July.
	<i>Cacalia muehlenbergii</i>	Great Indian plantain	SC	—	Found in mesic hardwood forests (i.e. southern wet and wet mesic forests) and adjacent mesic prairies, often with dolomite near the surface. Blooming occurs late June through late July; fruiting occurs late July through late August. The optimal identification period for this species is early June through late September.
	<i>Cakile lacustris</i>	American sea-rocket	SC	—	Found on Lake Michigan beaches or, less commonly, on dunes (sandy soils). Small white, 4-petal flowers at top of plant. Blooming occurs early July through early September; fruiting occurs late July through late September. The optimal identification period for this species is early July through late September.
	<i>Calamagrostis stricta</i>	Slim-stem small reedgrass	SC	—	Found on dry to moist dunes, barrens, and dolomite or sandstone ledges, mostly near the Great Lakes, as well as calcareous wetlands, southern sedge meadows, and occasionally pine barrens. Occurs in wet, sandy soils. Blooming occurs throughout June; fruiting occurs early July through late August. The optimal identification period for this species is early July through late August.
	<i>Carex tenuiflora</i>	Sparse-flowered sedge	SC	—	Found in open- to closed canopy cold, wet, coniferous forests (northern wet mesic and mesic forests), usually on neutral to calcareous substrates. Blooming occurs late May through early June; fruiting occurs late June through late July. The optimal identification period for this species is early June through late July.
	<i>Conioselinum chinense</i>	Hemlock parsley	E	—	Found in discharge areas in forested seeps, calcareous fens, and tamarack swamps (including northern wet forests) with wet soils. Blooming occurs late August through late September; fruiting occurs throughout September. The optimal identification period for this species is late August through late September.
	<i>Cypripedium arietinum</i>	Ram’s-head lady’s slipper	T	—	Found on basic substrates in various habitats (including northern dry mesic to mesic forests), but it is most characteristic of conifer swamps with moist, acidic soils. Blooming occurs late May through early June; fruiting occurs late June through late July. The optimal identification period for this species is late May through early June.
	<i>Cypripedium candidum</i>	Small white lady’s slipper	T	—	Found in calcareous fens, and wet and mesic prairies with wet or moist soils. Blooming occurs late May through early June; fruiting occurs throughout September. The optimal identification period for this species is late May through early June.
	<i>Cypripedium parviflorum</i>	Northern yellow lady’s slipper	SC	—	Found in fens, calcareous swales, and rich springy forest edges (i.e. southern or northern wet mesic forests) with moist to wet soils. Blooming occurs late May through late June; fruiting occurs late June through late July. The optimal identification period for this species is late May through early July.
	<i>Cypripedium reginae</i>	Showy lady’s slipper	SC	—	Found in neutral to alkaline forested wetlands (i.e. southern mesic and northern wet mesic forests); it is also found in rich upland forests in seeps and moist to dry clay bluffs with moist, neutral to calcareous soils. White and purple/pinkish flower. Blooming occurs late June through late July; fruiting occurs late July through late August. The optimal identification period for this species is late June through early August.
<i>Equisetum variegatum</i>	Variegated horsetail	SC	—	Found most characteristically on wet dolomite flats and gravelly swales near Lake Michigan but also in other wet, open, neutral to calcareous wetlands (i.e. lake dunes, beach, and northern sedge meadows). The optimal identification period for this species is late May through late September.	

PREFERRED HABITAT FOR STATE-LISTED SPECIES Alternative 3B-3 (Direct to Lake Michigan) City of Waukesha Water Supply					
Species Group	Scientific Name	Common Name	State Status ^a	Federal Status ^a	Habitat Description
Plants (cont.)	<i>Erigenia bulbosa</i>	Harbinger-of-spring	E	—	Found in rich hardwoods (i.e. southern mesic forests) with rich soils. White flower clustered at the top of the stems. Blooming occurs late April through early May; fruiting occurs throughout May. The optimal identification period for this species is late April through early May.
	<i>Euphorbia polygonifolia</i>	Seaside spurge	SC		Found on sandy beaches and dunes along Lake Michigan. Blooming occurs early July through late August; fruiting occurs early August through early October. The optimal identification period for this species is early July through late September.
	<i>Gentianopsis procera</i>	Lesser fringed gentian	SC	—	Found on wet dolomite pavement near Lake Michigan, as well as cold fens, seeps, and meadows (i.e. northern sedge meadows) with wet, calcareous soils. Deep blue flowers with fringed edges. Blooming occurs late August through early October; fruiting occurs early September through early October. The optimal identification period for this species is late August through early October.
	<i>Glycyrrhiza lepidota</i>	Wild licorice	SC	—	Found in moist prairies and other grasslands and streambanks. It has been found naturalized on cinders of railroads and other disturbed areas. Blooming occurs throughout July; fruiting occurs early August through late October. The optimal identification period for this species is early August through late October.
	<i>Liatris spicata</i>	Marsh blazing star	SC	—	Found in moist, sandy calcareous prairies (i.e. dry to wet mesic prairies) with moist to wet soils. Deep purple flowers with wispy petals. Blooming occurs late July through early August; fruiting occurs throughout August. The optimal identification period for this species is early August through early September.
	<i>Lithospermum latifolium</i>	American gromwell	SC	—	Found in upland hardwood forests (southern wet mesic forests), often with dolomite near the surface, and dry, calcareous soils. Small yellow flowers with 5 petals at top of plant. Blooming occurs throughout June; fruiting occurs early July through late August. The optimal identification period for this species is early June through late August.
	<i>Medeola virginiana</i>	Indian cucumber-root	SC	—	Found in rich hardwood or mixed conifer-hardwood forests (i.e. northern mesic or dry mesic forests). Leaves occur in a star pattern where yellowish whitish flower extends out of. Blooming occurs early May through late June; fruiting occurs late July through late August. The optimal identification period for this species is early May through late August.
	<i>Penstemon hirsutus</i>	Hairy beardtongue	SC	—	Found on dry gravelly and sandy prairies (i.e. dry mesic prairies), or in hillside oak openings or woodlands, or pine barrens. It is also naturalized on roadsides. Blooming occurs late May through late June; fruiting occurs late July through late August. The optimal identification period for this species is late May through late June.
	<i>Platanthera dilatata</i>	Leafy white orchis	SC	—	Found on neutral to calcareous bog and fen mats (or calcareous fens), or northern wet forests (sometimes with scattered tamarack and white cedar) with wet, neutral to calcareous soils. White flowers down the length of the stem. Blooming occurs early June through early July; fruiting occurs throughout July. The optimal identification period for this species is early June through early July.
	<i>Platanthera hookeri</i>	Hooker orchis	SC	—	Found in a variety of dry to moist, mostly mixed coniferous-hardwood forests (i.e. southern and northern dry mesic forests). Blooming occurs late May through late July; fruiting occurs early July through late August. The optimal identification period for this species is early June through early September.
	<i>Platanthera leucophaea</i>	Prairie white-fringed orchid	E	T	Found in moist, undisturbed, deep-soiled and/or calcareous prairies (i.e. mesic and wet mesic prairies) and rarely in tamarack fens with wet and moist soils. White flowers with large fringed petals at the bottom of the bloom. Blooming occurs early June through early August; fruiting occurs throughout August. The optimal identification period for this species is late June through late July.
	<i>Solidago caesia</i>	Bluestem goldenrod	E	—	Found in open forests, forest edges, clearings, and/or thickets. Occur on level ground, side slopes and protected ravine environments generally associated with Lake Michigan. Yellow clusters of flowers along the majority of the mid to upper portion of the stem. Blooming occurs from August to October.
	<i>Solidago ohioensis</i>	Ohio goldenrod	SC	—	Found most commonly on wet dolomite lake flats in Door County, and in fens, moist calcareous prairies, and sedge meadows in the southeast portion of the state with moist soils. Yellow, flat-topped flowers. Blooming occurs early August through late September; fruiting occurs throughout September. The optimal identification period for this species is late August through early September.
	<i>Thalictrum revolutum</i>	Waxleaf meadowrue	SC	—	Found in moist, often calcareous meadows (i.e. southern sedge meadows) and mesic prairies. It is also naturalized on railroad embankments. Blooming occurs throughout June; fruiting occurs throughout July. The optimal identification period for this species is throughout June.
	<i>Tofieldia glutinosa</i>	Sticky false-asphodel	T	—	Found in moist calcareous bogs, fens and wet locations. White flowers clustered at the top of the plant with reddish/purple anthers. Blooming occurs between June and August.
	<i>Triglochin maritime</i>	Common bog arrow-grass	SC	—	Found on fen mats, calcareous fens, bogs, open neutral to calcareous conifers swamps, northern wet forests, and Great Lakes swales with wet soils. Blooming occurs late June through early August; fruiting occurs late July through early September. The optimal identification period for this species is early July through late August.
	<i>Triglochin palustris</i>	Slender bog arrow-grass	SC	—	Found on muddy to marly fen and bog edges, as well as calcareous sedge meadows and northern wet forests. Blooming occurs throughout July; fruiting occurs throughout August. The optimal identification period for this species is early July through late August.
	<i>Trillium recurvatum</i>	Reflexed trillium	SC	—	Found in rich hardwood forests (i.e. southern mesic and dry mesic forests), with rich, moist soils. Blooming occurs late April through early May; fruiting occurs throughout June. The optimal identification period for this species is late April through late May.

PREFERRED HABITAT FOR STATE-LISTED SPECIES Alternative 3B-3 (Direct to Lake Michigan) City of Waukesha Water Supply					
Species Group	Scientific Name	Common Name	State Status ^a	Federal Status ^a	Habitat Description
Plants (cont.)	<i>Trisetum melicoides</i>	Purple false oats	E	—	Found in rich hardwood or mixed forests (i.e. northern mesic or boreal forests) near Lake Michigan, as well as shoreline dolomite and in swales, with gravelly and rocky soils. Blooming occurs from June. The optimal identification period for this species is mid-July to late August.
Birds	<i>Spiza Americana</i>	Dickissel	SC	—	Prefers open pasture and fields of clover and alfalfa. Grasslands, meadows, and savanna are also important nesting areas. This bird requires vegetation with medium to tall height-density and a significant component of forbs (i.e. herbaceous flowering plants that are not graminoids (grasses, sedges and rushes), some stiff-stemmed. Breeding occurs from late May to early August.
Reptiles & Amphibians	<i>Acris crepitans</i>	Northern cricket frog	E	—	Prefer ponds, lakes, and a variety of habitats along and adjacent to streams and rivers including, marshes, fens, sedge meadows, low prairies, and exposed mud flats. The species tends to breed in quiet water (no or low flow) and may also move from streams and rivers to adjacent wetlands and ponds. Cricket frogs are active from late-March through November. Breeding occurs from mid-May through mid-August, with some larvae not transforming until late September.
	<i>Thamnophis butleri</i>	Butler's gartersnake	T	—	Prefer almost any open-canopy wetland type (not open water) and adjacent open to semi-open canopy upland, including prairies, old fields and weedy vacant lots. They also prefer low-canopy vegetation (<24"), although they will occupy habitats with taller vegetation, such as reed canary grass. Butler's gartersnakes can be active from mid-March through early November, usually emerging shortly after frost-out and remaining active until daytime temperatures fall consistently below 50 deg. F. Breeding usually occurs in April and early May, but can occur in the fall, in which case live young are born between mid-July and mid-August.
	<i>Emydoidea blandingii</i>	Blanding's turtle	T	—	Utilize a wide variety of aquatic habitats including deep and shallow marshes, shallow bays of lakes and impoundments where areas of dense emergent and submergent vegetation exists, sluggish streams, oxbows and other backwaters of rivers, drainage ditches (usually where wetlands have been drained), and sedge meadows and wet meadows adjacent to these habitats. This species is semi-terrestrial and individuals may spend a good deal of time on land. They often move between a variety of wetland types during the active season, which can extend from early March to mid-October. Blanding's generally breed in spring, late summer or fall. Nesting occurs from about mid-May through June depending on spring temperatures. They strongly prefer to nest in sandy soils and may travel well over a mile from preferred habitat to find suitable soils. Hatching occurs from early August through early September but hatchlings can successfully overwinter in the nest, emerging the following late April or May.
	<i>Lithobates catesbeianus</i>	American bullfrog	SC	—	Found throughout Wisconsin in any permanent body of water - lakes, ponds, rivers, and creeks. They have a very patchy distribution. In Wisconsin, bullfrogs typically favor oligotrophic (waters with low algal production; thus very clear) to mesotrophic (generally clear water with beds of submerged plants) waters; tend to breed where dense submergent vegetation filters out the majority of the suspended solids. Bullfrogs are active from April through mid-October. They breed from mid-May through late July or later.
Fish	<i>Luxilus chrysocephalus</i>	Striped shiner	E	—	Prefers clear to slightly turbid waters of runs and shallow pools of the lower Milwaukee River, with dense aquatic vegetation over substrates of cobble, boulders, silt, sand, mud or bedrock. Sometimes present in large schools at the foot of riffles and shallow, hard-bottomed pools with some flow. Spawning occurs from late May through June.
	<i>Lythrurus umbratilis</i>	Redfin shiner	T	—	Prefers turbid waters of pools in low-gradient streams over substrates of boulders, cobble, sand, silt or detritus. Spawning occurs from early June through mid-August in sunfish nests.
	<i>Moxostoma valenciennesi</i>	Greater redborse	T	—	Prefers clear water of medium to large rivers (moderately rapid), reservoirs and large lakes at depths of less than 3 feet (1m) over sand, gravel or boulders. Spawning occurs in May or June.
	<i>Fundulus diaphanus</i>	Banded killfish	SC	—	Prefers clear water of bays and quiet backwaters of large lakes and medium to large streams with sparse to no vegetation over gravel, sand, silt, marl, clay detritus or cobble. Spawning occurs from June through mid-August.
	<i>Pompeius verna</i>	Little glassy wing	SC	—	Found in grassy openings in wooded areas near swamps, streams, bogs. Host plants appear to include grasses, especially purple top grass (<i>Tridens flavus</i>). Flight period is from late June-July.
Crustaceans	<i>Procambarus gracilis</i>	Prairie crayfish	SC	—	Typically restricted to prairie regions of southeastern Wisconsin and is the rarest crayfish in Wisconsin. This species frequents burrows in banks of ponds, roadside ditches, small sluggish creeks, marshes, swamps, and small artificial lakes, as well as wet pastures and flat fields in prairies. The burrows can be quite deep and branching, with a characteristic mud chimney. Breeding occurs and young hatch in early spring, as early as March, with juveniles occurring through spring and summer. Females move to open water for a relatively short period in the summer where the newly hatched young are released.

^a E, Endangered; T, Threatened; SC, Species of Concern (not legally protected).

Sources for all Preferred Habitat for State-Listed Species tables:

WDNR, 2010a. Wisconsin Department of Natural Resources Endangered Resources, Species and Natural Communities, Natural Heritage Inventory Working List Animals and Animal Species of Greatest Conservation Need. Available at: <http://dnr.wi.gov/org/land/er/biodiversity/index.asp?mode=TaxaList&Taxa=A>, accessed June 2010.

WDNR, 2010b. Wisconsin Department of Natural Resources Endangered Resources, Species and Natural Communities, Rare Vascular Plants. Available at: <http://dnr.wi.gov/org/land/er/biodiversity/index.asp?mode=detail&Grp=20>, accessed June 2010.

WDNR, 2010c. Wisconsin Department of Natural Resources Endangered Resources, Species and Natural Communities, Natural Communities of Wisconsin. Available at: <http://dnr.wi.gov/org/land/er/communities/>, accessed June & July 2010.

CITY OF WAUKESHA WATER SUPPLY – HABITAT ASSESSMENT SURVEY RESULTS
Alternative 1 (Deep and Shallow Wells)

Site No.	Habitat Type	Dominant Species			Invasive Species		Type of Maintenance	Access Type		Wildlife Species Observed	Wetlands/ Waterbodies	Stream Conditions			Photo Numbers	Potential Stated-Listed Species Habitat	Comments
		Overstory	Understory	Herbaceous	Species Observed	Percent Dominance		Direct	Indirect			Width	Depth	Quality			
ALT1-1	Forested riparian corridor with multiple pockets of different habitat (i.e. PEM and PSS wetlands)	White pine, black willow, linden, bur oak, American elm, green ash, red and white cedar, box elder, tamarack,	Honeysuckle, apple, hawthorn, red osier dogwood, buckthorn, sandbar willow, silky dogwood, highbush cranberry	Wild cucumber, wild mint, swamp milkweed, turk's cap lily, RCG, blue vervain, skunk cabbage, willow herb, common mullein, Carex sp., spotted joe-pye weed, horsetail, narrowleaf cattail, thistle, great angelica, riverbank grape, yellow water lily, St. John's wort, fringed loosestrife, boneset, wild parsnip, daisy fleabane, viburnum species, sweet pea, hedge nettle, bindweed, cinnamon fern, jewelweed, wild geranium, soft stem bulrush, dark green bulrush, lance-leaf and tall goldenrod; lily pads, duckweed and arrowhead within the stream.	RCG Buckthorn Cattail (native)	25% Not dominant Not dominant	None	Direct access from Oakdale Road		Swallows, snapping turtle, red-winged blackbird, bull frog, red-tailed hawk, dragonflies, cat bird	Pebble Brook and fringing PEM wetlands along the stream.	20 feet	2 feet	Potentially moderate to high; potentially good quality fringing wetlands and wooded riparian corridor, a lot of overhanging vegetation, good habitat for wildlife	Day 2 (7/7/2010) Photos 8, 9, 10, 11	Potentially, Habitat is potentially high quality, good vegetation diversity, connected to a large, unfragmented forested area to the northeast	Potentially good habitat quality.
ALT1-2	Scrub-shrub and forested; with PEM and PSS wetlands	Aspen, black willow, red-panicle and silky dogwood, American elm, cottonwood, silver maple, green ash	Downy juneberry, sandbar willow (dominant), red osier dogwood, common elder, smooth gooseberry, buckthorn	Redtop grass, great water dock, dark green bulrush, strawcolored flatsedge, crested sedge, Polygonum species, narrowleaf and broadleaf cattail, RCG, white clover, tall goldenrod, horsetail, crown vetch, wild cucumber, daisy fleabane, chicory, stinging nettle, honeysuckle, black raspberry, jewelweed, riverbank and cat grape, agrimony, common plantain, Dudley's rush, swamp milkweed, Virginia creeper, duckweed (in the standing water of the wetland areas)	Buckthorn RCG	20-30% 40-50%	Evidence of herbicide directly adjacent to farm road, but otherwise not maintained except for the road itself. Also looks to have been cleared in the past away from the ag fields; however, it is now growing back.	Direct access from farm road on Lather's property off of County Rd I.		Rabbits, dragonflies, turkey, deer, raccoon, red fox, and coyote tracks, red-winged blackbird, monarch butterflies, crayfish burrows	PEM and PSS wetlands with fringing forests (standing water was present). No waterbodies observed.	N/A	N/A	N/A	Day 2 (7/7/2010) Photos 1, 2, 3	Not likely; fragmented habitat in between active agricultural fields (soybean)	Adjacent to active ag fields.

CITY OF WAUKESHA WATER SUPPLY – HABITAT ASSESSMENT SURVEY RESULTS
Alternative 1 (Deep and Shallow Wells)

Site No.	Habitat Type	Dominant Species			Invasive Species		Type of Maintenance	Access Type		Wildlife Species Observed	Wetlands/ Waterbodies	Stream Conditions			Photo Numbers	Potential Stated-Listed Species Habitat	Comments
		Overstory	Understory	Herbaceous	Species Observed	Percent Dominance		Direct	Indirect			Width	Depth	Quality			
ALT1-3	Forested and swampy (potential PFO wetland)	Aspen, green ash, American elm, black willow, bur oak, box elder, pin oak	Gooseberry, buckthorn, prickly ash, sandbar willow, red osier and silky dogwood, honeysuckle	Tall and lanceleaf goldenrod, hedge nettle, RCG, wood nettle, strawcolored flatsedge, wild strawberry, Solomon's seal, sphagnum moss, agrimony species, common milkweed, multiflora rose, jack in the pulpit, Virginia creeper, daisy fleabane, cat and riverbank grape, horsetail, cow parsnip, wool grass, dark green bulrush, flatsedge species, heal-all, stinging nettle	RCG Buckthorn	Not dominant 25-30% (majority in forested area)	None; but the site is directly adjacent to and active agricultural field (corn)	Direct access from agricultural fields (farm road off of County Rd I) (Lather's property).		Crayfish burrows, monarch butterflies, deer and turkey tracks	Potential PFO wetland (swampy and low further back into the forested area. No waterbodies observed.	N/A	N/A	N/A	Day 2 (7/7/2010) Photos 4, 5, 7	Not likely; adjacent to active agricultural field (corn)	The overstory (and some understory) is very thick in the forested area, so the herbaceous layer is very limited. Herbaceous vegetation is mainly along the edges of the forested area (where it meets the ag field). Bare soil is present within the forested area.

CITY OF WAUKESHA WATER SUPPLY – HABITAT ASSESSMENT SURVEY RESULTS
Alternative 2 (Shallow Aquifer & Fox River Alluvium)

Site No.	Habitat Type	Dominant Species			Invasive Species		Type of Maintenance	Access Type		Wildlife Species Observed	Wetlands/ Waterbodies	Stream Conditions			Photo Numbers	Potential Stated-Listed Species Habitat	Comments
		Overstory	Understory	Herbaceous	Species Observed	Percent Dominance		Direct	Indirect			Width	Depth	Quality			
ALT2-1	Note: Same as ALT1-1																
ALT2-2	Note: Same as ALT1-2																
ALT2-3	Note: Same as ALT1-3																
ALT2-4A	PEM wetland with fringing PSS and several stands of trees	Cottonwood, box elder, aspen, black willow	Sandbar willow	RCG (no other herbaceous vegetation)	RCG	85-90% (basically a monotypic stand of RCG with willow understory (scrub-shrub))	None		Indirect access; observations taken and notes made from County Rd I.	Red-tailed hawk, red-winged blackbird (indirect access impeded further observations of wildlife within the site boundaries).	PEM wetlands (floodplain) along the Fox River, which is further west (restricted access impeded direct observation).	Likely the same as Site ALT2-4B	Likely the same as Site ALT2-4B	Likely the same as Site ALT2-4B	Day 4 (7/9/2010) Photo 4	Not likely; monotypic stand of RCG.	Active agricultural field (corn) is adjacent to the site on the west side of the Fox River).
ALT2-4B	Floodplain forest along the Fox River	Black walnut, box elder, silver maple, cottonwood, red oak, green ash, sugar maple, American and slippery elm, pin oak, bur oak, white pine, aspen, bitternut hickory	Buckthorn, common elder, prickly ash, juneberry, red osier dogwood, gooseberry, lilac shrub, may-apple	Virginia creeper, riverbank grape, black raspberry, RCG, wild mint, garlic mustard, multiflora rose, bindweed, wood nettle, stinging nettle, tall goldenrod, jack in the pulpit, duckweed (within river)	Buckthorn RCG Garlic mustard	40-45% (as understory in wooded area) 35-40% along the Fox River banks Not dominant	None; but the east side of the floodplain forest is directly adjacent to an active agricultural field (soybean).	Direct access along farm field and through woods to the east bank of the Fox River		Robin, monarch butterflies, dragonflies, crayfish burrows, nuthatch, deer bed	Fox River (high water level due to recent heavy rainfall)	50-60 feet	1-2 feet	Potentially moderate	Day 2 (7/7/2010) Photos 12, 13, 14 Day 4 (7/9/2010) Photos 1, 2, 3	Potentially; but only within close proximity to the Fox River.	Almost all of the herbaceous vegetation is along the edge of the forested area and the Fox River. The Forested area has a lack of herbaceous vegetation and a lack in diversity of understory. Buckthorn is the dominant understory species.
ALT2-4C	Floodplain forest along the Fox River; as well as scrub-shrub habitat between forested area and active ag field (soybean)	Green ash, silver maple, box elder, American elm, cottonwood, black willow (dominant)	Sandbar willow (dominant), buckthorn,	Virginia creeper, riverbank grape, garlic mustard, wood nettle, black raspberry, RCG, tall goldenrod	RCG Buckthorn Garlic mustard	40% along the forest scrub-shrub edge; 35-40% along the Fox River banks Not dominant Not dominant	None; appears to be prior converted due to the height of the vegetation growth and that it is directly adjacent to an active agricultural field (soybean).		Indirect access; observations taken and notes made from County Rd I.	Indirect/restricted access impeded observations of wildlife within the site boundaries.	Fox River (further west, restricted access impeded direct observation)	Likely the same as Site ALT2-4B	Likely the same as Site ALT2-4B	Likely the same as Site ALT2-4B	Day 2 (7/7/2010) Photos 15, 16	Not likely; area dominated by willow and appears to be very dense; directly adjacent to active ag field; previously disturbed or cleared. Potentially along the Fox River.	Scrub-shrub habitat dominated by black and sandbar willow is very dense.

CITY OF WAUKESHA WATER SUPPLY – HABITAT ASSESSMENT SURVEY RESULTS
Alternative 3A-1 (Milwaukee Supply)

Site No.	Habitat Type	Dominant Species			Invasive Species		Type of Maintenance	Access Type		Wildlife Species Observed	Wetlands/ Waterbodies	Stream Conditions			Photo Numbers	Potential State-Listed Species Habitat	Comments
		Overstory	Understory	Herbaceous	Species Observed	Percent Dominance		Direct	Indirect			Width	Depth	Quality			
ALT3A1-1	Scrub-shrub/forested upland (potentially low quality) Potential PEM wetland within site	American elm, cottonwood, white oak, shagbark hickory, green ash, blue spruce	Buckthorn, Washington hawthorn, staghorn sumac	Virginia creeper, riverbank and cat grape, garlic mustard, daisy fleabane, tall goldenrod (dominant), common mullein, yarrow, teasel, St. John's wort, bee balm/ bergamot, curled dock	Buckthorn Garlic mustard	60-65% Not dominant	None		Indirect access to site; observations taken from subdivision at the end of Cherokee Drive (north of site), and from the end of Marlin Road within business park. Only direct access to proposed ROW.	Indirect/restricted access impeded observations of wildlife within the site boundaries. None observed at two locations where notes were recorded.	Potential PEM wetland at site, but no direct access to confirm.	N/A	N/A	N/A	Day 1 (7/6/2010) Photos 50, 51 Taken only from location at the end of Marlin Drive, none taken at Cherokee Drive.	Potentially; direct access would be required to make determination.	Understory and herbaceous is limited in the wooded areas.
ALT3A1-2A	Scrub-shrub/forested upland	Green ash, box elder, cottonwood	Staghorn sumac, silky dogwood, honeysuckle, buckthorn, choke cherry, common elder, alder, gooseberry	Riverbank and cat grape, sweet pea, stopped knapweed, RCG, wood nettle, bouncing bet, Solomon's seal, multiflora rose, wild geranium, Indian hemp dogbane	Buckthorn RCG	60% 40%	The areas directly adjacent to the New Berlin Trail are mowed, and the power line corridor is maintained.	Direct access from the New Berlin Trail (We Energies ROW)		Potential beaver dam, dragonflies (white thorax with black wings), red-tailed hawk, frog, red-winged blackbird	Unnamed stream with fringing, potentially low quality wetlands along the banks	18 feet	1-1.5 feet	Potentially low to moderate; large dominance of invasives; cobbles, gravel, stone with silt over top on bottom of stream	Day 1 (7/6/2010) Photos 1 thru 6	Not likely; large, potentially moderate quality PEM/ PSS wetland to the south of site, but high amount of invasives and proximity to maintained trail and RR.	Coontail is the only submerged vegetation within the stream.
ALT3A1-2B	Scrub-shrub/forested	Northern red oak, black walnut, white oak, shagbark hickory, quaking aspen, American elm, cottonwood, green ash	Choke cherry, Washington hawthorne, staghorn sumac, prickly ash, honeysuckle, buckthorn	Tall goldenrod, bee balm/ bergamot, field horsetail, narrowleaf cattail, dark green bulrush, St. John's wort, common mullein, spotted knapweed, Queen Anne's lace, riverbank and cat grape, brome species, Solomon's seal, thimbleweed, shasta daisy, Indian hemp dogbane, white sweet clover, Dudley's rush	Buckthorn Cattail (native)	Not dominant Not dominant	The north side of the New Berlin Trail has been sprayed with herbicide; south side of trail is mowed and the RR easement is maintained. Also the power line corridor is maintained.	Direct access from the New Berlin Trail (We Energies ROW)		None observed during surveys	PEM wetland (or wet ditch, potentially very low quality) on the north side of the trail and parallel to it (south side of trail is drier, more upland species). No waterbodies observed	N/A	N/A	N/A	Day 1 (7/6/2010) Photos 7 thru 12	Not likely; potentially low quality habitat with evidence of herbicide; diversity is fair, but the area of undisturbed forest is very narrow and is adjacent to maintained trail and RR corridor.	

CITY OF WAUKESHA WATER SUPPLY – HABITAT ASSESSMENT SURVEY RESULTS
Alternative 3A-1 (Milwaukee Supply)

Site No.	Habitat Type	Dominant Species			Invasive Species		Type of Maintenance	Access Type		Wildlife Species Observed	Wetlands/ Waterbodies	Stream Conditions			Photo Numbers	Potential State-Listed Species Habitat	Comments
		Overstory	Understory	Herbaceous	Species Observed	Percent Dominance		Direct	Indirect			Width	Depth	Quality			
ALT3A1-2C	PEM wetland/ open water	American elm, black and weeping willow, box elder	Staghorn sumac, buckthorn, honeysuckle	Spotted knapweed, RCG, common reed, narrowleaf cattail, chicory, common burdock, white clover, riverbank and cat grape, hedge nettle, wild mint, common mullein, dark green bulrush, Dudley's rush, common milkweed, great water dock, bouncing bet, Virginia creeper, brome species, bindweed, thistle, garlic mustard, tall goldenrod, strawcolored flatsedge	RCG Common reed Cattail (native) Buckthorn Garlic mustard	90% (on north side of trail only; nondominant on south side of trail) 45% (just south of trail north of RR tracks) Not dominant Not dominant Not dominant	The areas directly adjacent to the New Berlin Trail are mowed. RR corridor just south trail within the site is maintained, along with the power line corridor to the north of the trail.	Direct access from the New Berlin Trail (We Energies ROW)		Grackle, Canadian geese, robin, red-winged blackbird, monarch butterflies, great blue heron, dragonflies, gold finch, swallow	All area is PEM wetland; to the north of the trail it slopes from an open upland field down to a ditch and wetland; the wetland is a monotypic stand of RCG with a channelized stream/ditch through it; the south side of the trail has a large open body of water with fringing and adjacent PEM (more vegetation diversity than north of the trail, but the presence of common reed, cattail and RCG as well).	20 feet (stream to the north of the trail)	2-3 feet	Potentially low; channelized and very silty	Day 1 (7/6/2010) Photos 13 thru 20	Potentially, to the south of the trail only due to the potentially moderate to high quality waterbody south of the RR tracks and the PEM wetlands surrounding it. Not to the north of the trail though, due to the potentially low quality of the stream and the monotypic stand of RCG	Numerous dead trees that could be potential nesting; swallows flew into a hole in a dead tree (nest)
ALT3A1-3	Scrub-shrub/forested with fringing PEM wetland along the edges of the stream	Black willow, green ash	Silky dogwood, honeysuckle, buckthorn, sandbar willow, common elder, white mulberry	RCG, swamp milkweed, narrowleaf cattail, tall goldenrod, spotted joe-pye weed, riverbank and cat grape, horsetail, Virginia creeper, jewelweed, thistle, great water dock	RCG Cattail Buckthorn Garlic mustard	Not dominant Not dominant Not dominant Not dominant	The areas directly adjacent to the New Berlin Trail are mowed. There is also evidence of herbicide along the maintained power line corridor.	Direct access from the New Berlin Trail (We Energies ROW)		Mourning dove, red-winged blackbird	UNT to Poplar Creek; with some limited fringing PEM along the stream edges; flows under trail via culvert	20 feet	1.5-2 feet	Potentially low; good diversity and vigor of vegetation, but banks are eroded and a lot of garbage is present; gravel, cobble bottom with silt overlaying	Day 1 (7/6/2010) Photos 34 thru 40	Not likely; good vegetation density and diversity, but a lot of garbage present and evidence of herbicide application. Also directly adjacent to a recreational park.	

CITY OF WAUKESHA WATER SUPPLY – HABITAT ASSESSMENT SURVEY RESULTS
Alternative 3A-1 (Milwaukee Supply)

Site No.	Habitat Type	Dominant Species			Invasive Species		Type of Maintenance	Access Type		Wildlife Species Observed	Wetlands/ Waterbodies	Stream Conditions			Photo Numbers	Potential State-Listed Species Habitat	Comments
		Overstory	Understory	Herbaceous	Species Observed	Percent Dominance		Direct	Indirect			Width	Depth	Quality			
ALT3A1-4A	PEM with forested fringe on the west side of the Root River Parkway (small upland area with thistle)	Weeping willow, green ash, black walnut, northern red oak, box elder, cottonwood	Washington hawthorn	RCG, hedge nettle, sweet pea, wild parsnip, thistle, Queen Anne's lace, tall goldenrod, riverbank and cat	RCG	95%	Only 3-4 feet directly adjacent to the parkway is mowed/ maintained.	Direct access from Root River Parkway		Dragonflies, red-winged blackbird, swallows (pair), deer tracks, wood pecker	PEM with forested fringe and a small intermittent stream (UNT to Root River) on the west side of the parkway.	4-8 feet	4-12 inches	Potentially low; silty/mucky bottom, good wooded riparian area, but eroding banks and garbage present; PEM adjacent is a monotypic stand of RCG	Day 1 (7/6/2010) Photos 63 thru 71	Not likely; monotypic stand of RCG and potentially low quality streams with garbage present; directly adjacent to well traversed Root River Parkway	A lot of flooding is evident on the east side of the parkway in the forested riparian corridor
	Forested riparian corridor (floodplain) on east side of the parkway along the Root River	American elm, black walnut, box elder, green ash, black willow, cottonwood, tamarack (planted, nonnative)	Lacking in understory vegetation	garpe, common milkweed, bindweed Garlic mustard, wood violets, dames's rocket, bindweed, bull and Canada thistle, tall goldenrod, Virginia creeper, RCG, riverbank grape, jewelweed	RCG Garlic mustard	Not dominant Not dominant						20 feet at parkway edge, but 8 feet as it flows east	4-5 inches	Potentially low to moderate as it moves east; silty/mucky bottom			
ALT3A1-4B	PEM with forested riparian corridor	Green ash, cottonwood, black willow	Sandbar willow	RCG, narrowleaf cattail, bull thistle, sweet pea, tall goldenrod, common milkweed, blunt spike rush, dark green bulrush, soft stem bulrush, great water dock, brown fox sedge, Dudley's rush, jewelweed, daisy fleabane, wild mint	RCG Cattail (native)	50% 50%	Only 3-4 feet directly adjacent to the Oak Leaf Trail is mowed/ maintained.	Direct access from Oak Leaf Trail off the Root River Parkway		Bullfrog, red-winged blackbird, gold finch	PEM wetland (pretty monotypic with narrowleaf cattail and RCG; diversity is only present in small pockets of rushes and sedges; not widespread diversity)	N/A	N/A	N/A	Day 1 (7/6/2010) Photos 75 thru 78	Not likely; monotypic stands of cattail and RCG, no vegetation diversity	

CITY OF WAUKESHA WATER SUPPLY – HABITAT ASSESSMENT SURVEY RESULTS
Alternative 3A-1 (Milwaukee Supply)

Site No.	Habitat Type	Dominant Species			Invasive Species		Type of Maintenance	Access Type		Wildlife Species Observed	Wetlands/ Waterbodies	Stream Conditions			Photo Numbers	Potential State-Listed Species Habitat	Comments
		Overstory	Understory	Herbaceous	Species Observed	Percent Dominance		Direct	Indirect			Width	Depth	Quality			
ALT3A1-4C	Open, upland meadow with some woody species (south side of trail) Scrub-shrub/forested (north side of trail)	Black walnut, box elder, cottonwood, green ash, flowering crabapple, white cedar, bur oak	Honeysuckle, silky and red osier dogwood, juniper, choke cherry, buckthorn, sandbar willow, Washington hawthorn, nanny berry	Crown vetch, cow vetch, wild parsnip, bull/field thistle, tall goldenrod (dominant), riverbank grape, sweet pea, Dudley's rush, bee balm/ bergamot, teasel, great angelica, garlic mustard, common milkweed, black raspberry, daisy fleabane, jewelweed, crested sedge, yarrow	Buckthorn Garlic mustard	45-50% (only on the north side of the trail) Not dominant	Only 3-4 feet directly adjacent to the Oak Leaf Trail is mowed.	Direct access from Oak Leaf Trail		Robin, red-winged blackbird, gold finch	Northwest of the site (directly adjacent) is a large PEM wetland of potentially moderate to high quality (vegetation included: soft stem bulrush, boneset, narrowleaf cattail, tall goldenrod, brown fox sedge, bottlebrush sedge, Dudley's rush, blue vervain, mountain mint, dark green bulrush, St. John's wort; wildlife observed in the PEM included dragonflies, moth (Photos 88 and 89)).	N/A	N/A	N/A	Day 1 (7/6/2010) Photos 78 thru 92	Potentially; the PEM wetland to the north portion of the site is potential Butler's garter snake habitat	

CITY OF WAUKESHA WATER SUPPLY – HABITAT ASSESSMENT SURVEY RESULTS
Alternative 3A-3 (Oak Creek Supply)

Site No.	Habitat Type	Dominant Species			Invasive Species		Type of Maintenance	Access Type		Wildlife Species Observed	Wetlands/ Waterbodies	Stream Conditions			Photo Numbers	Potential State-Listed Species Habitat	Comments
		Overstory	Understory	Herbaceous	Species Observed	Percent Dominance		Direct	Indirect			Width	Depth	Quality			
ALT3A3-1	Note: Same as ALT3A1-1																
ALT3A3-2A	Note: Same as ALT3A1-2A																
ALT3A3-2B	Note: Same as ALT3A1-2B																
ALT3A3-2C	Note: Same as ALT3A1-2C																
ALT3A3-3	Note: Same as ALT3A1-3																
ALT3A3-4A	Note: Same as ALT3A1-4A																
ALT3A3-4B	Note: Same as ALT3A1-4B																
ALT3A3-4C	Note: Same as ALT3A1-4C																
ALT3A3-4D	Forest riparian corridor	Green ash, box elder, American elm, black willow,	Smooth juneberry, buckthorn, honeysuckle, common elder, white mulberry, highbush cranberry	Bee balm, wild bergamot, great angelica, jewelweed, Virginia creeper, riverbank grape, tall goldenrod (dominant), cow parsnip, teasel, common milkweed, wild parsnip, wood nettle	Buckthorn	25-30%	Only 3-4 feet directly adjacent to the Oak Leaf Trail is mowed/ maintained.	Direct access from Oak Leaf Trail and HWY 100		Dragonfly (metallic green thorax and black wings)	Root River; no wetlands were observed	25-30 feet	1-2 feet	Potentially low to moderate; good quality forest riparian corridor, but located between residential development and HWY 100 (heavy traffic roadway)	Day 2 (7/7/2010) Photos 17, 18	Not likely; good riparian corridor along Root River, but forested area is fragmented between residential development, roadways (heavily trafficked), and commercial areas.	Observations/notes taken immediately following a heavy rainfall, accounting for the high water level, turbidity, and fast flow
ALT3A3-4E	Forested riparian corridor (west side of trail) Dry, upland meadow/field with fringing forest/ shrubs (east side of trail)	Apple, black locust, green ash, black willow, black walnut, cottonwood, box elder, eastern red cedar	Buckthorn, honeysuckle, highbush cranberry, downy juneberry	Great angelica, black raspberry, common milkweed, tall and lance-leaf goldenrod (dominant), teasel, asparagus, riverbank and cat grape, poison ivy, wild parsnip, bee balm/ bergamot, yarrow, daisy fleabane, hedge nettle	Buckthorn	35-40%	Only 3-4 feet directly adjacent to the Oak Leaf Trail is mowed/ maintained.	Direct access from Oak Leaf Trail and Coldspring Road		Robin, red-winged blackbird A low potential Butler's garter snake habitat.	Root River; no wetlands were observed	25-30 feet	1-2 feet	Potentially low to moderate; good quality forest riparian corridor, but located between residential/commercial development heavily trafficked roadways	Day 2 (7/7/2010) Photos 19 thru 22	Not likely; good riparian corridor along Root River, but forested area is fragmented between residential and commercial development, roadways (heavily trafficked)	Observations/notes taken immediately following a heavy rainfall, accounting for the high water level, turbidity, and fast flow West of the site is a large PEM wetland (monotypic stand of RCG)

CITY OF WAUKESHA WATER SUPPLY – HABITAT ASSESSMENT SURVEY RESULTS
Alternative 3A-3 (Oak Creek Supply)

Site No.	Habitat Type	Dominant Species			Invasive Species		Type of Maintenance	Access Type		Wildlife Species Observed	Wetlands/ Waterbodies	Stream Conditions			Photo Numbers	Potential State-Listed Species Habitat	Comments
		Overstory	Understory	Herbaceous	Species Observed	Percent Dominance		Direct	Indirect			Width	Depth	Quality			
ALT3A3-5	Forested riparian corridor (narrow) The remaining/ majority portion of the site is mowed/ maintained open, grassy field with single planted trees	Black walnut, silver maple, sugar maple, box elder, basswood, northern red oak, green ash, beech	Highbush cranberry, northern prickly-ash	Garlic mustard, tall goldenrod, cat grape	Garlic mustard	80%	Mowed, open grassy field along the parkway.	Direct access from Root River Parkway		None observed during the surveys	Root River; no wetlands were observed	25-30 feet	1-2 feet	Potentially low to moderate; good quality forest riparian corridor, but very narrow, and is fragmented by residential development and roadways	Day 2 (7/7/2010) Photos 23, 24, 25	Not likely; good riparian corridor along Root River, but forested area is narrow, is located between residential development and roadways, and majority of the area is mowed, open grass field.	Herbaceous vegetation and understory is very limited due to thick maple overstory Observations/notes taken immediately following a heavy rainfall, accounting for the high water level, turbidity, and fast flow
ALT3A3-6	Forested with maintained/mowed grassy areas	White oak, green ash, sugar maple (dominant), shagbark hickory, basswood, black walnut, American elm, black cherry	Choke cherry, honeysuckle, gooseberry, buckthorn, silky dogwood	Riverbank and cat grape, Virginia creeper, tall goldenrod, poison ivy, bloodroot, jack in the pulpit, garlic mustard, wild geranium, black raspberry, daisy fleabane	Buckthorn Garlic mustard	Not dominant Not dominant	Only the mowed grassy areas along the parkway are maintained.	Direct access from 92 nd Street		Toads, swallows	Root River is approximately 0.25 miles east of the site; no wetlands or waterbodies observed within the site.	N/A	N/A	N/A	Day 3 (7/8/2010) Photos 1, 2, 3	Not likely; site is fragmented by 92 nd Street and Whitnall Park Drive; no wetlands or waterbodies present; a majority of the site is mowed grassy areas	Not much herbaceous vegetation is present except along the edges of the wooded areas, due to the thick overstory of maples.
ALT3A3-7	Forested area east of 92 nd Street (parking area and boy scout house located within site)	Northern red oak, shagbark hickory, green ash, white oak, pignut, black cherry, bur oak, sugar maple, black walnut, American elm, red elm	Buckthorn, gooseberry, prickly ash, highbush cranberry	Black raspberry, stinging nettle, garlic mustard, bloodroot, Virginia creeper, tall goldenrod, jack in the pulpit, burdock	Buckthorn Garlic mustard	30-35% (of understory) Not dominant	The parking area and boy scout house east of 92 nd Street, along with the golf course located west of 92 nd Street.	Direct access from 92 nd Street		None observed at the time of the surveys	Root River is approximately 0.40 miles east of the site; no wetlands or waterbodies were observed within the site.	N/A	N/A	N/A	Day 3 (7/8/2010) Photos 4, 5	Potentially; large, unbroken forested area between 92 nd Street and Root River (with some large potential PEM wetland areas east of the site).	Golf course and parking area is on the west side of 92 nd Street

CITY OF WAUKESHA WATER SUPPLY – HABITAT ASSESSMENT SURVEY RESULTS
Alternative 3A-3 (Oak Creek Supply)

Site No.	Habitat Type	Dominant Species			Invasive Species		Type of Maintenance	Access Type		Wildlife Species Observed	Wetlands/ Waterbodies	Stream Conditions			Photo Numbers	Potential State-Listed Species Habitat	Comments
		Overstory	Understory	Herbaceous	Species Observed	Percent Dominance		Direct	Indirect			Width	Depth	Quality			
ALT3A3-8	Forested riparian corridor along Root River; along with some fringing PEM wetland areas	Green ash, cottonwood, red elm (dead), box elder, Russian olive	Nannyberry, buckthorn, cypress spurge	Gray-headed coneflower, giant ragweed, tall and lance-leaved goldenrod, bull thistle, RCG, cow parsnip, chicory, Indian hemp dogbane, Queen Anne's lace, hedge nettle, swamp milkweed, sunflower species, yellow sweet clover, narrowleaf cattail, white clover, great angelica, curled dock, soft stem bulrush	RCG Buckthorn	Not dominant Not dominant	Only 2-3 feet on either side of the Oak Leaf Trail is mowed/ maintained.	Direct access from Oak Leaf Trail off of Rawson Avenue and 68 th Street		Red-winged blackbird, swallow (nest under the Rawson Ave bridge over the Root River)	Root River and narrow fringing wetlands	40 feet	3-4 feet	Potentially low to moderate (a large waterway, but is directly adjacent to a heavily trafficked roadway)	Day 3 (7/8/2010) Photos 6 thru 9	Not likely; forested riparian corridor is very narrow, river flows beneath heavily trafficked roadway (Rawson Avenue), active agricultural fields directly adjacent to the NW and SE. State listed species habitat has more potential to occur north of the site within a large, unfragmented PEM, PSS, and forested riparian area along the Root River.	Observation made and notes taken following heavy rainfall; Root River had a high water level and was moving quickly.
ALT3A3-9	PEM wetland with limited scrub-shrub vegetation (north of Puetz Road) Narrow forested riparian corridor along Root River (south of Puetz Road)	Silver maple Silver maple, box elder	Sandbar willow Sandbar willow	RCG, giant ragweed, chicory Bindweed, giant ragweed, RCG, chicory, thistle, stinging nettle, great angelica	RCG RCG	90-95% Not dominant	Maintained power line corridor (no trees/shrubs, cleared occasionally, only herbaceous vegetation).	Direct access from Puetz Road		Great blue heron, red-winged blackbird, dragonflies (neon green thorax and black wings)	PEM wetland on north side of Puetz road; Oak Creek traverses through the site	15-20 feet	1-1.5 feet	Potentially low; directly adjacent to active agricultural fields (soybean), dominant presence of an invasive species (RCG); appears to be somewhat channelized	Day 3 (7/8/2010) Photos 10 thru 14	Not likely; directly adjacent to large roadway and active ag fields; north side of Puetz Road is monotypic stand of RCG; low vegetation diversity	

CITY OF WAUKESHA WATER SUPPLY – HABITAT ASSESSMENT SURVEY RESULTS
Alternative 3A-3 (Oak Creek Supply)

Site No.	Habitat Type	Dominant Species			Invasive Species		Type of Maintenance	Access Type		Wildlife Species Observed	Wetlands/ Waterbodies	Stream Conditions			Photo Numbers	Potential State-Listed Species Habitat	Comments
		Overstory	Understory	Herbaceous	Species Observed	Percent Dominance		Direct	Indirect			Width	Depth	Quality			
ALT3A3-10	Forested area to the north of the power line corridor PSS wetland to the south of the power line corridor	Silver maple, box elder, basswood, black walnut	Common elder, buckthorn, sandbar willow, red osier dogwood, honeysuckle Sandbar willow (dominant), red osier dogwood (dominant)	Bladder campion, stinging nettle, bouncing bet, tall goldenrod, giant ragweed, wild cucumber, garlic mustard, burdock, wild mint, Virginia creeper, black raspberry, chicory, jewelweed, annual rye, thistle, riverbank grape, wild onion	RCG Buckthorn Garlic mustard	35-40% (only within the power line corridor; not dominant to the north and south) Not dominant Not dominant	Maintained power line corridor (no trees/shrubs, cleared occasionally, only herbaceous vegetation).	Direct access from Pennsylvania Avenue		Robin	PSS wetland area south of power line corridor; no waterbodies within the site, only a channelized ag drainage ditch on the west side of Pennsylvania Ave	N/A	N/A	N/A	Day 3 (7/8/2010) Photos 15, 16	Potentially due to large PEM and PSS wetland east of the site	
ALT3A3-11	Forested with some scrub-shrub vegetation along the edges	Green ash, basswood, box elder, black cherry, quaking aspen, sugar maple, silver maple	Staghorn sumac, red osier dogwood, honeysuckle	Riverbank grape	None observed	--	Maintained power line corridor (no trees/shrubs, cleared occasionally, only herbaceous vegetation).		Indirect/restricted access; observations and notes were taken from American Avenue, approximately 0.05 miles from the site	Indirect/restricted access impeded observations of wildlife within the site boundaries. None observed at the location where notes were recorded.	Indirect/restricted access prohibited the observation of wetland/waterbodies within the site. According to aerial photos, no waterbodies or wetlands appear to be within the site.	N/A	N/A	N/A	Day 3 (7/8/2010) Photo 17	Not likely; site is smaller and directly adjacent to residential subdivisions.	Potential for limited understory and herbaceous vegetation due to large and thick overstory.
ALT3A3-12	According to aerial photos, appears to be a large PEM wetland with pockets of PSS wetland and small stands of trees	--	--	--	--	--	According to aerial photos, the site does not appear to be maintained.		Indirect/restricted access.	Indirect/restricted access impeded observations of wildlife within the site boundaries.	Indirect/restricted access prohibited the observation of wetland/waterbodies within the site. According to aerial photos, no waterbodies appear to be within the site. Potential PEM/PSS wetlands.	N/A	N/A	N/A	Day 3 (7/8/2010) Photos 18, 19 Taken at power line substation off of Ryan Road, approximately 0.15 miles south of the site.	Potentially, due to large PEM and PSS wetland shown on aerial photos	

CITY OF WAUKESHA WATER SUPPLY – HABITAT ASSESSMENT SURVEY RESULTS
Alternative 3A-4 (Racine Supply)

Site No.	Habitat Type	Dominant Species			Invasive Species		Type of Maintenance	Access Type		Wildlife Species Observed	Wetlands/ Waterbodies	Stream Conditions			Photo Numbers	Potential State- Listed Species Habitat	Comments
		Overstory	Understory	Herbaceous	Species Observed	Percent Dominance		Direct	Indirect			Width	Depth	Quality			
ALT3A4-1	Note: Same as ALT3A1-1																
ALT3A4-2A	Note: Same as ALT3A1-2A																
ALT3A4-3	Large PEM wetland with fringing forested areas to the east and west	Black willow, black walnut, box elder, cottonwood, green ash	Buckthorn, honeysuckle	RCG, which transitions to narrowleaf cattail closer to the power line substation	RCG Cattail (native) Buckthorn	95-100% 95-100% Not dominant	Maintained power line corridor (no trees/shrubs, cleared occasionally, only herbaceous vegetation).	Indirect/restricted access; observations and notes taken from the gate off of Lincoln Avenue leading up a gravel access road to the power line substation	Indirect/restricted access; observations and notes taken from the gate off of Lincoln Avenue leading up a gravel access road to the power line substation	No wildlife observed during the surveys	Large PEM wetland (monotypic stands of RCG and cattail); no waterbodies were observed.	N/A	N/A	N/A	Day 3 (7/8/2010) Photo 40	Not likely; PEM wetland is monotypic and lacks diversity; potentially low quality since it's within the maintained power line corridor; evidence of herbicide application within power line corridor 40-50 feet north of Cleveland Avenue	
ALT3A4-4	PEM wetland with scrub-shrub vegetation along an ag drainage ditch	Black willow, box elder	Honeysuckle, choke cherry, red osier dogwood	RCG, riverbank grape, thistle, great angelica	RCG	95%	Maintained power line corridor (no trees/shrubs, cleared occasionally, only herbaceous vegetation).		Indirect/restricted access; observations and notes taken from Lincoln Avenue	Red-winged blackbird	Large PEM wetland (monotypic stand of RCG); ag drainage ditch flows through wetland (potentially extremely low quality); no other waterbodies within the site.	N/A	N/A	N/A	Day 3 (7/8/2010) Photos 38, 39	Not likely; PEM wetland is potentially low quality due to monotypic nature and lack of diversity; evidence of herbicide application	Active agricultural field directly adjacent to the west and east
ALT3A4-5	Large PEM wetland with some scrub-shrub and tree stands	Green ash, black willow, American elm, silver maple, bur oak, red cedar	Buckthorn, honeysuckle, red osier dogwood	Blue vervain, bee balm/ bergamot, narrowleaf cattail, RCG, thistle, spotted joe-pye weed, common milkweed, swamp milkweed, cow parsnip	RCG Cattail (native) Buckthorn	75-80% 20-25% Not dominant	Maintained power line corridor (no trees/shrubs, cleared occasionally, only herbaceous vegetation).		Indirect/restricted access; observations and notes taken from Cleveland Avenue	Monarch butterfly, red-winged blackbird	Large PEM wetland (monotypic stand of cattail and RCG); no defined stream, but appears to be an old channelized drainage-way that goes thru the wetland	N/A	N/A	N/A	Day 3 (7/8/2010) Photos 36, 37	Not likely; wetland is large and vegetation is vigorous, but monotypic in nature and lacks diversity	
ALT3A4-6	Large PEM wetland with limited scrub-shrub and trees scattered throughout	Green ash, black willow, American elm, silver maple, bur oak, red cedar	Buckthorn, honeysuckle, red osier dogwood	Blue vervain, bee balm/ bergamot, narrowleaf cattail, RCG, thistle, spotted joe-pye weed, common milkweed, swamp milkweed, cow parsnip	RCG Cattail (native) Buckthorn	75-80% 20-25% Not dominant	Maintained power line corridor (no trees/shrubs, cleared occasionally, only herbaceous vegetation).		Indirect/restricted access; observations and notes taken from Cleveland Avenue	Monarch butterfly, red-winged blackbird, deer (mother and fawn)	Large PEM wetland (monotypic stand of cattail and RCG); no defined stream, but appears to be an old channelized drainage-way that goes thru the wetland	N/A	N/A	N/A	Day 3 (7/8/2010) Photos 34, 35	Not likely; wetland is large and vegetation is vigorous, but monotypic in nature and lacks diversity	Active agricultural fields to the east and west

CITY OF WAUKESHA WATER SUPPLY – HABITAT ASSESSMENT SURVEY RESULTS
Alternative 3A-4 (Racine Supply)

Site No.	Habitat Type	Dominant Species			Invasive Species		Type of Maintenance	Access Type		Wildlife Species Observed	Wetlands/ Waterbodies	Stream Conditions			Photo Numbers	Potential State-Listed Species Habitat	Comments
		Overstory	Understory	Herbaceous	Species Observed	Percent Dominance		Direct	Indirect			Width	Depth	Quality			
ALT3A4-7	Upland, deciduous forest; and potential PEM/PSS wetland in eastern portion of the site	Northern red oak, Shagbark hickory, green ash, box elder, American elm, white oak, black cherry, ironwood, quaking aspen	Buckthorn, honeysuckle	--	Buckthorn	Not dominant	According to aerial photos, the site does not appear to be maintained.		Indirect/restricted access; observations and notes taken from Hidden Court	Indirect/ restricted access impeded observations of wildlife within the site boundaries.	Indirect/restricted access prohibited the observation of wetland/ waterbodies within the site. According to aerial photos, no waterbodies appear to be within the site. Potential PEM/PSS wetlands.	N/A	N/A	N/A	Day 3 (7/8/2010) Photo 33 Taken from Hidden Court.	Potentially, due to potential PEM/PSS wetlands shown on aerial photos	Were unable to observe potential wetland area due to restricted/ indirect access; appeared to be limited herbaceous vegetation
ALT3A4-8	Upland, deciduous forest	Northern red oak, Shagbark hickory, green ash, box elder, American elm, white oak, black cherry, ironwood, quaking aspen	Highbush cranberry, honeysuckle, buckthorn	Queen Anne's lace, black raspberry	Buckthorn	Not dominant	Maintained power line corridor (no trees/shrubs, cleared occasionally, only herbaceous vegetation).		Indirect/restricted access; observations and notes taken from cul-de-sac off Crestview Drive (new residential development)	Indirect/ restricted access impeded observations of wildlife within the site boundaries.	Indirect/restricted access prohibited the observation of wetland/ waterbodies within the site. According to aerial photos, no wetlands or waterbodies appear to be within the site.	N/A	N/A	N/A	Day 3 (7/8/2010) Photos 32, 31	Not likely; forested area I fragmented by surrounding agricultural fields and power line corridor; new residential development directly adjacent to site.	
ALT3A4-9	Upland, deciduous forest	Box elder, ironwood (dominant), sugar maple, American elm, black cherry, shagbark hickory, chestnut, northern red oak, white oak	Washington hawthorn, rock and tartarian honeysuckle, buckthorn, red osier dogwood, choke cherry, may apple, gooseberry	Burdock, riverbank grape, garlic mustard, thistle, bittersweet nightshade, Virginia creeper, dame's rocket, poison ivy	Buckthorn Garlic mustard	Not dominant Not dominant	Maintained power line corridor (no trees/shrubs, cleared occasionally, only herbaceous vegetation). Also homes and residential yards are located within the site.		Indirect/restricted access; observations and notes taken from Beeheim Road	None observed during surveys	UNT to Mill Creek (narrow and intermittent)	1 foot	4-8 inches	Potentially low; concrete channel through residential properties; however, potentially not channelized through the forested area, meaning the quality could potentially be moderate within the site	Day 3 (7/8/2010) Photos 28, 29, 30	Not likely; undisturbed portion of forested area is small and fragmented by the residential development that surrounds it.	
ALT3A4-10	From aerial photos is appears to be a mixture of PEM/PSS wetlands and some fringing forested areas	--	--	--	--	--	According to aerial photos, the site does not appear to be maintained; except for maintained power line corridor (no trees/shrubs, cleared occasionally, only herbaceous vegetation)		Indirect/restricted access; observations and notes taken from Lawnsdale Road	Indirect/ restricted access impeded observations of wildlife within the site boundaries.	Indirect/restricted access prohibited the observation of wetland/ waterbodies within the site. According to aerial photos, potential PEM/PSS wetlands and one intermittent stream appear to be within the site.	N/A	N/A	N/A	Day 3 (7/8/2010) Photo 27 Taken from Lawnsdale Road.	Potentially, due to potential PEM/PSS wetlands and stream shown on aerial photos	

CITY OF WAUKESHA WATER SUPPLY – HABITAT ASSESSMENT SURVEY RESULTS
Alternative 3A-4 (Racine Supply)

Site No.	Habitat Type	Dominant Species			Invasive Species		Type of Maintenance	Access Type		Wildlife Species Observed	Wetlands/ Waterbodies	Stream Conditions			Photo Numbers	Potential State-Listed Species Habitat	Comments
		Overstory	Understory	Herbaceous	Species Observed	Percent Dominance		Direct	Indirect			Width	Depth	Quality			
ALT3A4-11	Dry upland forest with upland meadow/field within the power line corridor	Green ash, American elm, black walnut, box elder, bur oak, northern red oak, black locust, cottonwood	Sandbar willow, staghorn sumac	Common mullein, Canada and sow thistle, white and yellow sweet clover, white and red clover, Queen Anne's lace, chicory, curled dock, common reed, common milkweed, RCG	RCG Common reed	Not dominant Not dominant	Maintained power line corridor (no trees/shrubs, cleared occasionally, only herbaceous vegetation).	Direct access from gravel access road to gravel pits (off of Crowbar Drive)		Monarch butterfly, eastern kingbird; potential for grassland birds to occur.	No wetlands or waterbodies observed during the surveys (confirmed by aerial photos)	N/A	N/A	N/A	Day 3 (7/8/2010) Photo 26	Not likely; looks to be previously disturbed, directly adjacent to gravel pits and industrial activity, no wetlands/ waterbodies within the site	Appears to have been previously graded and disturbed, potentially during the installation of the power lines.
ALT3A4-12	According to aerial photos, appears to be forested (potential to be lowland forest or PFO)	--	--	--	--	--	According to aerial photos, does not appear to be maintained; except for maintained power line corridor (no trees/shrubs, cleared occasionally, only herbaceous vegetation) and active agricultural fields.		Indirect/restricted access; observations and notes taken from Parker Road	Indirect/ restricted access impeded observations of wildlife within the site boundaries.	Indirect/restricted access prohibited the observation of wetland/ waterbodies within the site. According to aerial photos, potential PFO wetlands could occur within the site.	N/A	N/A	N/A	Day 3 (7/8/2010) Photo 25 Taken from Parker Road across active agricultural field (corn) towards the forested site (in background).	Potentially, if PFO wetland occurs within the site; the site also abuts Muskego Lake	
ALT3A4-13	PEM/PSS wetlands/ lowlands with patches of forested areas (upland and lowland areas) NOTE: Expected to be very low, wet area; flooded during surveys	Green ash, box elder	Willow species, dogwood species	RCG, cattail, soft stem bulrush	RCG	Unknown at site	According to aerial photos, does not appear to be maintained; except for maintained power line corridor (no trees/shrubs, cleared occasionally, only herbaceous vegetation) and active agricultural fields.		Indirect/restricted access; observations and notes taken from Muskego Dam Drive	Indirect/ restricted access impeded observations of wildlife within the site boundaries. Dragonfly (blue thorax and black wings with 2 white bands) was observed from Muskego Dam Drive.	Indirect/restricted access prohibited the observation of wetland/ waterbodies within the site. According to aerial photos, potential PEM, PSS, and/or PFO wetlands could occur within the site. Also a channelized stream (drainage ditch) runs north from Muskego Dam Drive to the site.	6-8 feet	2-3 feet	Potentially low; is channelized and very mucky; a fair amount of overhanging vegetation, but a majority of herbaceous veg is an invasive species (RCG).	Day 3 (7/8/2010) Photos 23, 24 Taken from Muskego Dam Drive north along power line corridor.	Potentially, if good quality wetlands occur within the site; the site also abuts Muskego Lake	Site would have a direct hydrologic connection to Muskego Lake; observation and notes are based solely off aerial photos and what could be seen north of Muskego Dam Drive along power line corridor.

CITY OF WAUKESHA WATER SUPPLY – HABITAT ASSESSMENT SURVEY RESULTS
Alternative 3A-4 (Racine Supply)

Site No.	Habitat Type	Dominant Species			Invasive Species		Type of Maintenance	Access Type		Wildlife Species Observed	Wetlands/ Waterbodies	Stream Conditions			Photo Numbers	Potential State-Listed Species Habitat	Comments
		Overstory	Understory	Herbaceous	Species Observed	Percent Dominance		Direct	Indirect			Width	Depth	Quality			
ALT3A4-14	Deciduous hardwood forest with riparian corridor along the streams	Black walnut, green ash, box elder, bur oak	--	Black raspberry	--	--	According to aerial photos, does not appear to be maintained; except for maintained power line corridor (no trees/shrubs, cleared occasionally, only herbaceous vegetation) and adjacent active agricultural fields.		Indirect/restricted access; observations and notes taken from 76 th Street	Indirect/ restricted access impeded observations of wildlife within the site boundaries.	UNT to Root River Canal	Unknown due to restricted access.	Unknown due to restricted access.	Unknown due to restricted access.	Day 3 (7/8/2010) Photo 22 Taken from 76 th Street east along power line corridor.	Potentially; forested area is large and two waterbodies run through it.	Power line corridor is approximately 200 feet wide; expect to find dry, mesic vegetation, meaning the veg typically found in disturbed areas
ALT3A4-15	Deciduous hardwood forest with riparian corridor along the streams	Black walnut, green ash, box elder, bur oak	--	Black raspberry	--	--	According to aerial photos, does not appear to be maintained; except for maintained power line corridor (no trees/shrubs, cleared occasionally, only herbaceous vegetation) and adjacent active agricultural fields.		Indirect/restricted access; observations and notes taken from 76 th Street	Indirect/ restricted access impeded observations of wildlife within the site boundaries.	Root River Canal (tributary to Root River)	Unknown due to restricted access.	Unknown due to restricted access.	Unknown due to restricted access.	Day 3 (7/8/2010) Photo 22 Taken from 76 th Street east along power line corridor.	Potentially; forested area is large and two waterbodies run through it.	Power line corridor is approximately 200 feet wide; expect to find dry, mesic vegetation, meaning the veg typically found in disturbed areas
ALT3A4-16	Forested riparian corridor	Box elder, green ash, black willow, basswood, sugar maple, American elm, cottonwood	Juneberry, sandbar willow	RCG, giant ragweed, tall goldenrod, narrowleaf cattail, jewelweed, burdock, riverbank grape, Virginia creeper, multiflora rose, dark green bulrush, arrowhead, garlic mustard, chicory	RCG Cattail (native) Garlic mustard	70% (only along stream banks; dissipates within forested area) Not dominant Not dominant	Maintained power line corridor (no trees/shrubs, cleared occasionally, only herbaceous vegetation).	Direct access from Seven Mile Road		None observed during surveys	UNT to Root River (observations made following a heavy rainfall; stream has a high water level) Fringing PEM wetlands along the stream.	4 feet	6-8 inches	Potentially low to moderate; active agricultural field is directly adjacent, but good quality riparian corridor	Day 3 (7/8/2010) Photos 20, 21	Potentially; forested area is fairly large and unfragmented with an intermittent/ perennial stream and a good quality riparian corridor	The forest along the stream is a potential floodplain forest.

CITY OF WAUKESHA WATER SUPPLY – HABITAT ASSESSMENT SURVEY RESULTS
Alternative 3B-1 (Underwood Creek)

Site No.	Habitat Type	Dominant Species			Invasive Species		Type of Maintenance	Access Type		Wildlife Species Observed	Wetlands/ Waterbodies	Stream Conditions			Photo Numbers	Potential State-Listed Species Habitat	Comments
		Overstory	Understory	Herbaceous	Species Observed	Percent Dominance		Direct	Indirect			Width	Depth	Quality			
ALT3B1-1A	Note: Same as ALT3A1-2A																
ALT3B1-1B	Note: Same as ALT3A1-2B																
ALT3B1-1C	Note: Same as ALT3A1-2C																
ALT3B1-2	Note: Same as ALT3A1-3																
ALT3B1-3	Forested riparian corridor Upland meadow/field	Jack pine, black willow, green ash, cottonwood, apple,	Honeysuckle, buckthorn, red osier dogwood	Henbit, hedge nettle, chicory, Queen Anne's lace, riverbank grape, bee balm/ bergamot, wild parsnip (dominant), curled dock, bindweed, tall goldenrod, brome species, RCG, yarrow, daisy fleabane, white and yellow sweet clover, white clover, butter-and-eggs, sweet timothy, musk thistle	Buckthorn RCG	30-40% Not dominant	Only 3-4 feet directly west of Underwood Creek Parkway is mowed/ maintained.	Direct access from Underwood Creek Parkway		Robin	Underwood Creek; no wetlands were observed.	15-20 feet	6 inches	Potentially low; good forest riparian corridor, but stream is channelized	Day 1 (7/6/2010) Photos 57, 58, 60, 61	Not likely; directly south of a large interstate and west of a heavily trafficked commercial area	
ALT3B1-4	Forested riparian corridor (forested floodplain)	Green ash, American elm, box elder, black willow, cottonwood	Buckthorn, gooseberry	Burdock, riverbank grape, tall goldenrod, bittersweet nightshade, jewelweed, black raspberry	Buckthorn	65%	Only the paved Oak Leaf Trail.	Direct access from the Greenway Trail System, Krueger Park		Robin	Underwood Creek; potential PFO wetlands due to forested floodplain area	15-20 feet	6 inches	Potentially low; good forest riparian corridor, but stream is channelized	Day 1 (7/6/2010) Photos 52 thru 55	Not likely; area is fragmented between two large, high traffic roadways, a recreational park and residential area	The site is within the City of Brookfield's designated Floodplain Forest Restoration area

CITY OF WAUKESHA WATER SUPPLY – HABITAT ASSESSMENT SURVEY RESULTS
Alternative 3B-2 (Root River)

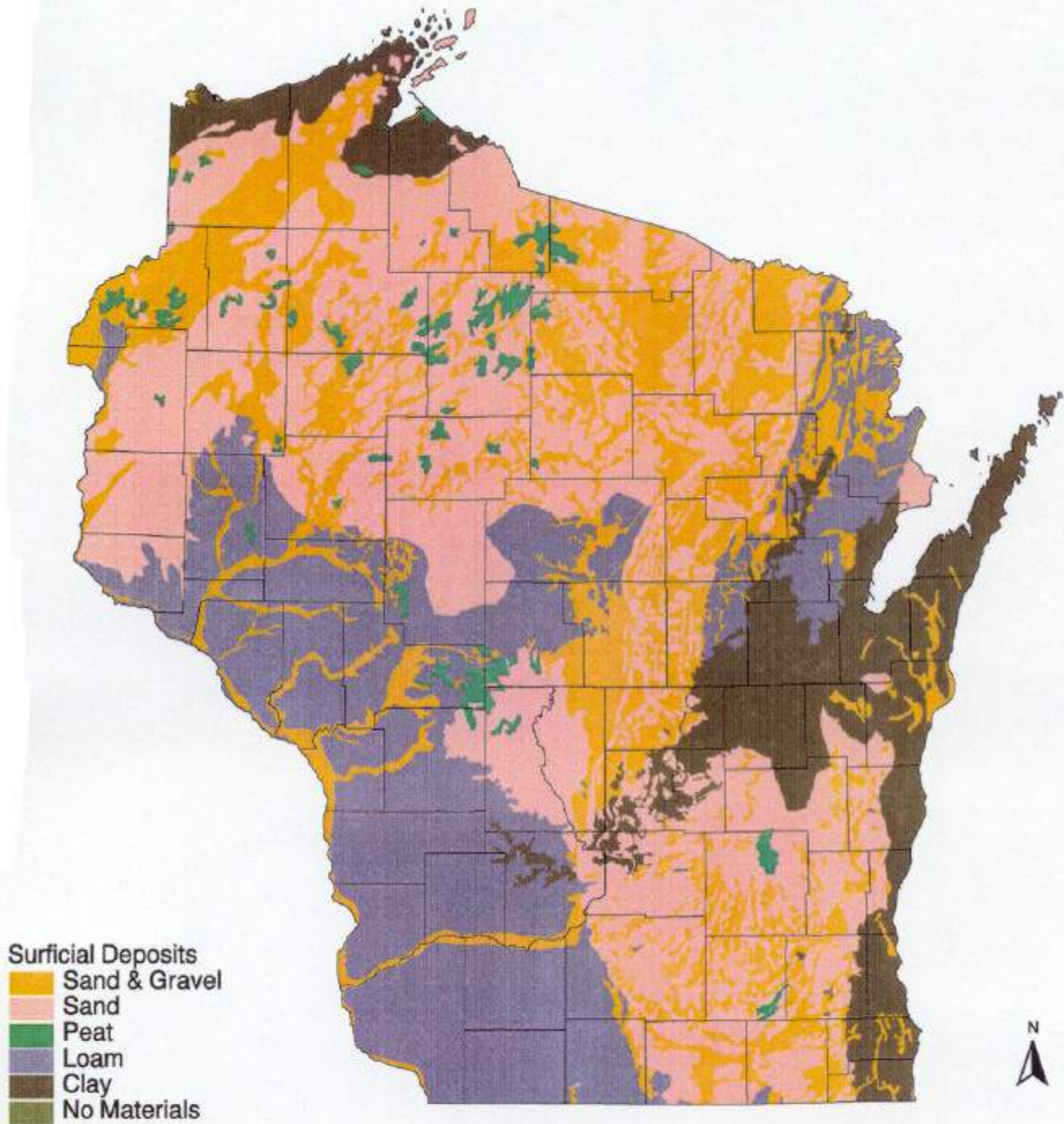
Site No.	Habitat Type	Dominant Species			Invasive Species		Type of Maintenance	Access Type		Wildlife Species Observed	Wetlands/ Waterbodies	Stream Conditions			Photo Numbers	Potential State-Listed Species Habitat	Comments
		Overstory	Understory	Herbaceous	Species Observed	Percent Dominance		Direct	Indirect			Width	Depth	Quality			
ALT3B2-1A	Note: Same as ALT3A1-2A																
ALT3B2-1B	Note: Same as ALT3A1-2B																
ALT3B2-1C	Note: Same as ALT3A1-2C																
ALT3B2-2	Note: Same as ALT3A1-3																
ALT3B2-3A	Note: Same as ALT3A1-4A																
ALT3B2-3B	Note: Same as ALT3A1-4B																
ALT3B2-3C	Note: Same as ALT3A1-4C																
ALT3B2-3D	Note: Same as ALT3A3-4D																
ALT3B2-3E	Note: Same as ALT3A3-4E																
ALT3B2-4	Note: Same as ALT3A3-5																

CITY OF WAUKESHA WATER SUPPLY – HABITAT ASSESSMENT SURVEY RESULTS
Alternative 3B-3 (Direct to Lake Michigan)

Site No.	Habitat Type	Dominant Species			Invasive Species		Type of Maintenance	Access Type		Wildlife Species Observed	Wetlands/ Waterbodie	Stream Conditions			Photo Numbers	Potential State-Listed Species Habitat	Comments
		Overstory	Understory	Herbaceous	Species Observed	Percent Dominance		Direct	Indirect			Width	Depth	Quality			
ALT3B3-1A	Note: Same as ALT3A1-2A																
ALT3B3-1B	Note: Same as ALT3A1-2B																
ALT3B3-1C	Note: Same as ALT3A1-2C																
ALT3B3-2	Note: Same as ALT3A1-3																
ALT3B3-3	Potential ephemeral PEM wetland with some tree stands (north of Bottsford Avenue and south of Oak Leaf Trail) PEM wetland north of Oak Leaf Trail	Black Willow, box elder, northern red oak, black walnut, black locust, green ash, American elm, hybrid poplar, silver and sugar maple, white birch, Washington hawthorn	Sandbar willow (dominant), smooth blackhaw, choke cherry, highbush cranberry, white mulberry, honeysuckle, red osier dogwood	Bindweed, tall goldenrod (dominant), black raspberry, riverbank and cat grape, tiger lily, bee balm/ bergamot, Dudley's rush, wild strawberry, daisy fleabane, crested sedge, Virginia creeper, burdock, common milkweed, yarrow, purple loosestrife, Shasta daisy, wool grass, wild mint, brown fox sedge, birds' oot trefoil, horsetail, black-eyed susan, white clover, teasel, field mustard, bittersweet nightshade, motherwort, creeping bellflower, narrowleaf cattail, joe-pye weed, garlic mustard	RCG Cattail (native) Garlic mustard	45% (only north of trail) 35% (only north of trail) Not dominant	Only 3-4 feet on either side of the Oak Leaf Trail is mowed/ maintained grassy field. Also, the area south of the trail appears to have been historically, heavily disturbed.	Direct from Oak Leaf Trail and HWY 32		Robin, swallow, woodpecker, monarch butterfly, red-winged blackbird, dragonfly, deer	PEM wetlands with fringing PSS (possible); Lake Michigan to the east; no other waterbodies observed.	N/A	N/A	N/A	Day 4 (7/9/2010) Photos 5 thru 9	Not likely; very small, fragmented habitats, adjacent to heavily trafficked roadway, residential development to north, south and west.	

Appendix 6-8
Wisconsin Geology Maps

SURFICIAL DEPOSITS



Cartography by Bill Shockley

20 0 20 40 60 Miles

1:2750000

Wisconsin Transverse Mercator Projection
NAD 1983, 1991 adjustment

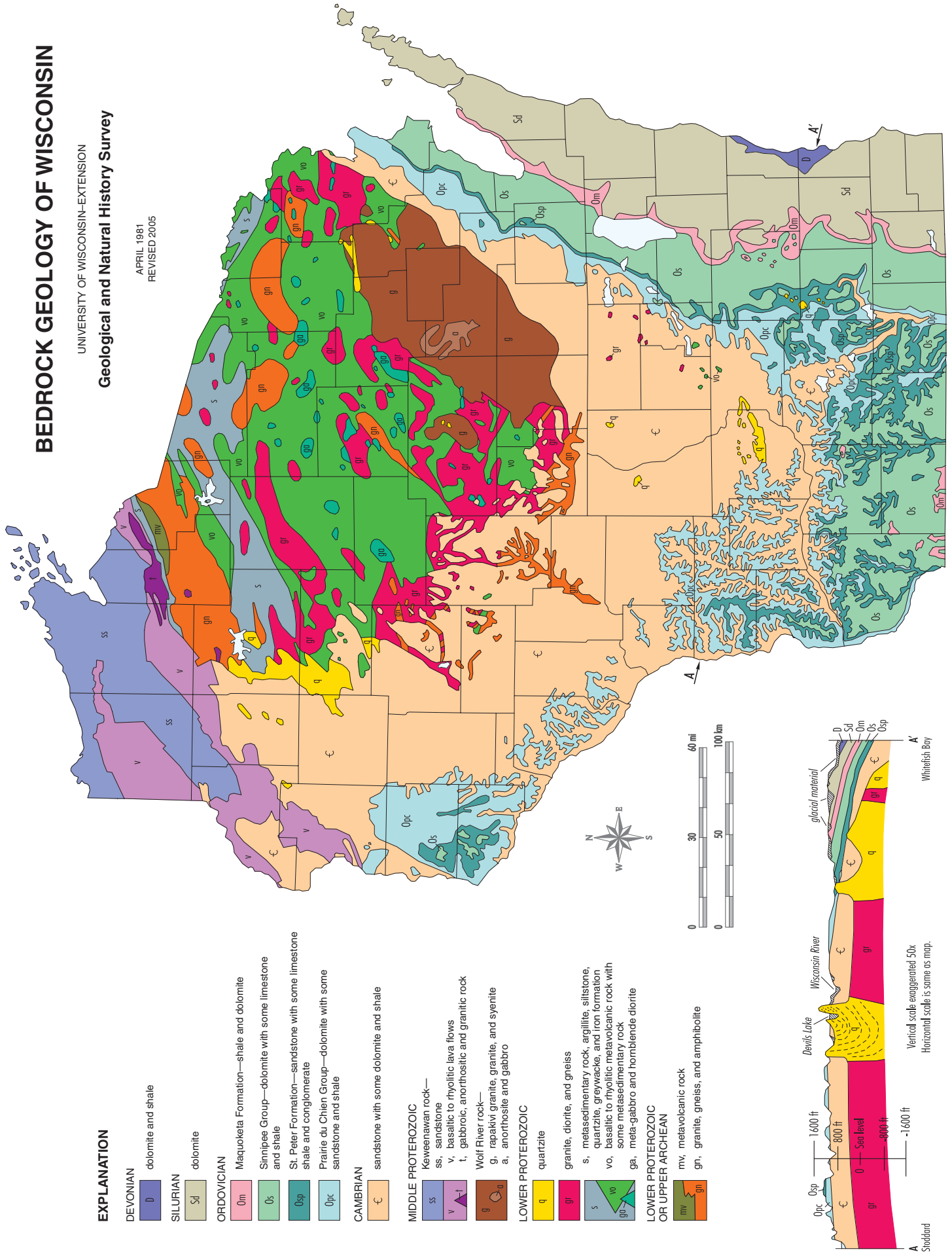
Suprficial Deposits are defined as the unconsolidated materials above the bedrock. Because the soil layer includes only the material in the first 5' below the surface, the superficial deposit layer is intended to account for the unconsolidated material between the soil and the top of the bedrock.

The data shown on this map are available on a cost of resources basis from WDNR, GeoServices Section. See the "GIS Datasharing" section, visit <http://www.dnr.state.wi.us/org/at/et/geo>.

BEDROCK GEOLOGY OF WISCONSIN

UNIVERSITY OF WISCONSIN—EXTENSION
Geological and Natural History Survey

APRIL 1981
REVISED 2005



GEOLOGIC HISTORY OF WISCONSIN'S BEDROCK

INTRODUCTION

The bedrock geologic record in Wisconsin is divided into two major divisions of time: the Precambrian, older than 600 million years, and the Paleozoic, younger than 600 million years. The Precambrian rocks are at the bottom and consist predominantly of crystalline rocks. They are overlain by Paleozoic rocks which consist of relatively flat-lying, in some cases fossil-bearing, sedimentary rocks.

Precambrian rocks form the bedrock beneath the glacial deposits in northern Wisconsin and occur beneath the Paleozoic rocks in the south (see the cross section on the reverse side). Paleozoic rocks may once have covered northern Wisconsin, but if they did, they have been removed by erosion. Glacial deposits, including clay and sand and gravel, cover bedrock in the northern and eastern three-fifths of the state.

In areas covered by glacial deposits, surface outcrops are so sparse that details of the bedrock geology are obscured. In such areas the only clues to the underlying rocks are obtained from rock cuttings and cores obtained from drill holes and from geophysical surveys which disclose magnetic and gravity variations.

Precambrian Eon

The Precambrian is divided into two eras, the older Archean and the younger Proterozoic. Each is subdivided into three periods—Early, Middle, and Late.

Archean

Rocks older than 2,500 million years are termed Archean. The oldest Archean rocks are gneisses (gn), or banded rocks. These are more than 2,800 million years old and are in Wood County. Similar old ages have been determined for rocks south of Hurley, where recognizable volcanic rocks (mv) have been intruded by 2,700 million year old granite (gn). All of these rocks have been extensively deformed, and in many areas they are so highly altered that their original nature and origin are extremely difficult to interpret. Because of this difficulty, the older gneisses and some younger (Proterozoic) gneissic and crystalline rocks are combined on this geologic map.

Proterozoic

There are four principal groups of rocks in the Proterozoic. The oldest are around 1,800 to 1,900 million years old. These Early Proterozoic rocks consist of sedimentary (s) rocks including slates, greywacke and iron formation, and volcanic (vo) rocks. The sedimentary rocks dominate in the north, with volcanic rocks becoming more abundant in central Wisconsin. These layered rocks were intruded by gabbros (ga), diorities, and granites (gr) about the same time that they were being folded and deformed.

Quartz-rich Early Proterozoic sedimentary rocks (q) occur as erosional remnants, or outliers, on the older Proterozoic rocks; they were deformed about 1,700 million years ago. The Barron Quartzite in the Blue Hills of Rusk and Barron Counties, the Baraboo Quartzite in Sauk and Columbia Counties, and Rib Mountain Quartzite in Marathon County are some of the major remaining areas of once widespread blankets of sandstone.

The oldest Middle Proterozoic rocks include the granites, syenites, and anorthosites (g, a) of the Wolf River complex. This extensive body of related granitic rocks was intruded into Lower Proterozoic volcanic and sedimentary rocks around 1,500 million years ago.

The youngest Proterozoic rocks in Wisconsin are about 1,100 million years old and are called Keweenaw rocks. At the time of their formation a major rift or fracture zone split the continent from Lake Superior south through Minnesota and into southern Kansas. Keweenaw rocks can be divided into two groups: an older sequence of igneous rocks including lavas (v) and gabbros (t); and a younger sequence of sandstone (ss). These rocks occur in northwestern Wisconsin. In central Wisconsin diabase dikes were also emplaced at this time.

At the close of the Precambrian, most of Wisconsin had been eroded to a rather flat plain upon which stood hills of more resistant rocks such as the quartzites in the Baraboo bluffs.

Phanerozoic Eon

The Phanerozoic is divided into three eras. They are from the oldest to the youngest: the Paleozoic (old life), Mesozoic (middle life), and Cenozoic (most recent life). The Paleozoic is represented

by a thick sequence of sandstones, shales, and dolomites (dolomite is similar to limestone); the Mesozoic, possibly by gravels; and the Cenozoic, only by glacier-related deposits.

In the Paleozoic Era the sea advanced over and retreated from the land several times. The Paleozoic Era began with the Cambrian Period (€) during which Wisconsin was submerged at least twice beneath the sea. Sediments eroded by waves along the shoreline and by rivers draining the land were deposited in the sea to form sandstone and shale. These same processes continued into the Ordovician Period (Op, Osp, Os, Om) during which Wisconsin was submerged at least three more times. Animals and plants living in the sea deposited layers and reefs of calcium carbonate which are now dolomite. Deposits that built up in the sea when the land was submerged were partially or completely eroded during the times when the land was elevated above sea level. At the close of the Ordovician Period, and in the succeeding Silurian (Sd) and Devonian (D), Wisconsin is believed to have remained submerged. There are no rocks of the Paleozoic Era younger than Devonian in Wisconsin. Whether material was deposited and subsequently removed by erosion, or was never deposited, is open to speculation.

Absence of younger Paleozoic rocks makes interpretation of post-Devonian history in Wisconsin a matter of conjecture. If dinosaurs roamed Wisconsin, as they might well have in the Mesozoic Era some 200 million years ago, no trace of their presence remains. Available evidence from neighboring areas indicates that toward the close of the Paleozoic Era the area was gently uplifted and it has remained so to the present. The uplifted land surface has been carved by millions of years of rain, wind, running water, and glacial action. With the possible exception of some pebbles about 100 million years old, no Mesozoic age bedrock has been identified in Wisconsin.

In the last million years during a time called the Pleistocene, glaciers invaded Wisconsin from the north and modified the land surface by carving and gouging out soft bedrock, and depositing hills and ridges of sand and gravel as well as flat lake beds of sand, silt, and clay. In this manner, the glaciers smoothed the hill tops, filled the valleys, and left a deposit of debris over all except the southwestern part of the state. The numerous lakes and wetlands which dot northern Wisconsin occupy low spots in this Pleistocene land surface. Glacial deposits are not shown on the map of bedrock geology. A separate glacial deposits map is available.

Cross Section

To assist in understanding the bedrock geology of Wisconsin, a cross section has been prepared (see reverse side). A cross section represents a vertical slice of the Earth's crust showing the subsurface rock layers in much the same way as a vertical slice of cake shows the layers of cake and frosting. The Wisconsin cross section shows the subsurface geology along a line from Stoddard in Vernon County, through Devils Lake near Baraboo in Sauk County, to Whitefish Bay in Milwaukee County. The horizontal scale is the same as that of the geologic map, but the vertical scale is exaggerated so that vertical thicknesses are expanded 50 times compared to horizontal distances. The Paleozoic rocks are shown as layers, the younger units lying above the older units. They are also shown dipping to the west in the western part of the state and dipping east in the eastern part of the state, thus forming an arch. The center and oldest parts of this arch are found in the Baraboo bluffs, where the Baraboo Quartzite is exposed at the surface. As shown in the cross section by fine lines in the quartzite, the Baraboo area was folded into a U-shaped structure, or syncline, before the Paleozoic rocks were deposited. Quartzite and granite underlie the Paleozoic rocks along this section.

The gray unit shown at the top of the rock sequence in the eastern part of the cross section represents glacial materials which do not occur to the west.



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James M. Robertson, Director and State Geologist

Section 7

Evaluation of Project Significance

Evaluation of Project Significance

7.1 Long-Term versus Short-Term Effects

Long-term and short-term effects have been considered in the evaluation criteria used in Table 5-61 of this document to determine significant impacts. The Lake Michigan water supply proposed project from the City of Oak Creek with Root River return flow has a minor adverse impact.

7.2 Effects on Geographically Scarce Resources

Relative effects on geographically scarce resources for the proposed project are summarized in Table 5-61 in Section 5 of this document. There are also additional details in corresponding sub-sections in Section 5.

7.3 Reversibility of Effects

The impacts identified for the Lake Michigan water supply and return flow are minor adverse impacts. The minor adverse impacts for Lake Michigan water supply are for aquatic habitat change in the Fox River, which is approximately 2 inches of water depth change or less (see Section 5.1.2.2); flooding changes to the Root River which has less than 1 percent change in the 100-year return period flow (see Section 5.1.2.2), and temporary wetland construction impacts the majority of which will be eliminated after construction of the pipeline as wetlands affected by the pipeline construction are restored (see Section 5.1.3).

7.4 Cumulative Effects

The Compact and state statutes require that the proposed project have no significant adverse impacts to the Great Lakes basin. Specifically, they require that:

A diversion must be implemented so as to ensure that it will result in no significant adverse individual impacts or cumulative impacts to the quantity or quality of the waters and water dependent natural resources of the basin, including cumulative impacts that might result due to any precedent-setting aspects of the proposal, based upon a determination that the proposal will not have any significant adverse impacts on the sustainable management of the waters of the Great Lakes basin. Reference: Compact Article 4, Section 4.9.4.d.; Wis. Stat. §§ 281.346(4)(f)5.

The Compact and state statutes also define cumulative impacts as:

the impacts on the Great Lakes basin ecosystem that result from incremental effects of all aspects of a withdrawal, diversion, or consumptive use in addition to other past, present, and reasonably foreseeable future withdrawals, diversions, and consumptive uses regardless of who undertakes the other withdrawals, diversions, and consumptive uses, including individually

minor but collectively significant withdrawals, diversions, and consumptive uses taking place over a period of time. Wis. Stat. § 281.346(1)(g); See also Compact, Article 1.

The proposed project will have no significant adverse individual or cumulative impacts on the quantity or quality of the waters and water dependent natural resources of the Basin. To the contrary, the proposed project is anticipated to have a net positive impact on the waters and water dependent natural resources to the groundwater and inland waterways.

As a result of switching to a Lake Michigan source of water, the City of Waukesha would discontinue its use of groundwater from the deep and shallow aquifers. Pumping the deep aquifer pulls down water from the overlaying shallow aquifer to the deep aquifer. If pumping of the deep aquifer is replaced with a Lake Michigan supply, Waukesha will no longer pull water from the shallow aquifer to the deep aquifer. Discontinuing the use of groundwater would stop the cumulative adverse impacts to the groundwater and connected surface water resources (e.g. streams and wetlands) identified in the Water Supply Service Area Plan (Volume 2 of the Application) and in Section 5.1.2.2 of this document. This will improve critical baseflows to surface water resources, including wetlands, streams and lakes.

Switching to a Lake Michigan water supply and discontinuing the withdrawal of groundwater from the deep aquifer would also benefit the waters of the Lake Michigan basin. Historically, water from the deep aquifer flowed towards Lake Michigan. As pumping increased, the flow of groundwater was actually reversed and water that otherwise would have fed Lake Michigan was drawn to the groundwater wells. Now, waters of the Great Lakes Basin are flowing into the deep aquifer rather than recharging Lake Michigan. See ER Section 5.1.4 and the Water Supply Service Area Plan (Volume 2 of the Application). Switching from the groundwater supply to a Lake Michigan surface water supply would contribute to aquifer recovery and would eliminate the diversion of water from the Lake Michigan groundwater watershed to the Mississippi River watershed.

Flow within Lake Michigan will not be affected by a Lake Michigan water supply or return flow, because the City of Waukesha's return flow management plan goal will provide continuous return of the water at the WWTP (see and the Return Flow Plan in Volume 4 of the Application). In general, the return flow management plan provides return flow up to the maximum day water demand if sufficient water is available at the WWTP. The portion of water at the WWTP in excess of this amount will continue to be discharged into the Fox River and meet permit limits. The Return Flow Plan analysis shows that no less than 100 percent of the water volume will be returned to the Great Lakes basin. This will return the water so that there will be no volume decrease to the Great Lakes basin and therefore no significant cumulative impact to the water dependent industries (e.g. shipping and hydropower generation) in the Great Lakes basin.

The withdrawal of water from Lake Michigan will also not endanger the integrity of the Lake Michigan ecosystem. This is because the return flow water quality will meet all WDNR requirements and the City will meet the Compact return flow requirements. The return flow will also improve or maintain the physical and biological resources, and improve or have no adverse impact to the chemical resources of the tributary stream and Lake Michigan (see Section 5.1.2 Inland Waterways in this document).

7.5 Risk (Including Unknowns and Problems Due to Installation and Operation)

Risk to public health is minimized with the Lake Michigan water supply alternative compared to the Deep and Shallow Aquifer as well as the Shallow Aquifer and Fox River Alluvium alternatives. This comparison of public health risk is documented in The Water Supply Service Area Plan (Volume 2 of the Application).

7.6 Precedence

The City of Waukesha's proposed project for Lake Michigan water is supported by detailed alternatives evaluations and modeling from numerous experts, including the WDNR, USGS, WGNHS, academia and SEWRPC. The City has demonstrated that its use of Lake Michigan water will not result in significant adverse impacts to the Great Lakes basin. The application demonstrates that the Great Lakes basin will be benefited if the City completes the proposed project.

Because the return flow management plan meets all the requirements without exception and exceeds some requirements, it would create a high standard if it were to be used as a precedent in the future. By proposing to exceed the Compact and Wisconsin requirements, the City of Waukesha has set a precedent beyond that which is required.

See the Application Summary for additional information about precedence.

7.7 Public Controversy

The proposed project is the first straddling county diversion application under the Compact and Wisconsin Act 227. Consequently, the project is expected to be closely followed by interested stakeholders throughout the Great Lakes basin. The Compact was developed to allow straddling counties to obtain Great Lakes water, and it was approved by eight states and the U.S. Congress with a parallel approval process in Canada. Consequently, public interest is expected to be high, but many stakeholders across the Great Lakes basin have already developed the process whereby such an application can be proposed and approved.

In Wisconsin, the City of Waukesha has been evaluating water supply alternatives for radium compliance for over 20 years. In recent years, the City of Waukesha has publicly communicated efforts to evaluate Lake Michigan as a water supply source and has communicated with potential Lake Michigan water suppliers and communities that may be affected with a return flow. The City has continued their public education program that has allowed the public to obtain detailed information about the future water supply alternatives, to ask questions, and to provide comments. The City of Waukesha's future water supply will be the single largest capital project ever completed by the City and will subsequently have high public interest. The Compact and state statute provides the process for a straddling county diversion evaluation and there are established means for working with neighboring municipalities, obtaining public input, and resolving disputes.

The preparation of this document is in response to the public interest over this project to provide a method to evaluate impacts to environmental resources comprehensively. This process provides a means for the public to have input, review, and comment on the proposed project.

Section 8

References

SECTION 8

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