Section 6

Alternatives to the Proposed Project: Affected Environment and Environmental Effects

SECTION 6

Alternatives to the Proposed Project: Affected Environment and Environmental Effects

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 three Lake Michigan water suppliers with return flow to Underwood Creek. Ultimately, only one water supplier will be determined through contract negotiations. The other two will become alternatives to the proposed project.

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)
Lake Michigan (City of Racine)
Return Flow Alternatives (for Lake Michigan Water Supplies)
Underwood Creek to Lake Michigan
Root River to Lake Michigan
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
Lake Michigan (City of Milwaukee)	Direct to Lake Michigan
Lake Michigan (City of Oak Creek)	Underwood Creek to Lake Michigan
Lake Michigan (City of Oak Creek)	Root River to Lake Michigan
Lake Michigan (City of Oak Creek)	Direct to Lake Michigan
Lake Michigan (City of Racine)	Underwood Creek to Lake Michigan
Lake Michigan (City of Racine)	Root River to Lake Michigan
Lake Michigan (City of Racine)	Direct to Lake Michigan

6.1 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 five 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 Attachment 6-2.

A map showing pipeline alignments and other infrastructure associated with the alternatives is found in Attachment 3-1 in Section 3 for maps associated with the proposed project and Attachment 6-1 at the end of this Section for maps associated with alternatives to the proposed project.

6.1.1 Water Source

6.1.1.1 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).[1] 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.

Figure 6-1 and Attachment 6-1 shows the wells, pipelines, and treatment facilities for this alternative.

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[1] CH2M HILL and Ruekert & Mielke. 2002. *Future Water Supply Report for the Waukesha Water Utility.*

6.1.1.2 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.

Figure 6-2 and Attachment 6-1 shows the wells, pipelines, and treatment facilities for this alternative.

6.1.1.3 Lake Mchigan Water Supply (City of Mlwaukee)

This alternative is a potential component 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 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 3-1 and Attachment 3-1 in Section 3 shows the pipeline alignment for this alternative.

6.1.1.4 Lake Mchigan Water Supply (City of Oak Creek)

This alternative is a potential component 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 the water treatment plant. A new pipeline and booster pump station would be constructed to connect to this supply.

Figure 3-2 and Attachment 3-1 in Section 3 shows the pipeline alignment for this alternative.

6.1.1.5 Lake Mchigan Water Supply (City of Racine)

This alternative is a potential component 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 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 3-3 and Attachment 3-1 in Section 3 shows the pipeline alignment for this alternative.

6.1.2 Supply Pipeline

6.1.2.1 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 Attachment 6-1 show the wells, pipelines, and treatment facilities for this alternative.

6.1.2.2 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 Attachment 6-1 show the wells, pipelines, and treatment facilities for this alternative.

FIGURE 6-1
Facilities for Deep and Shallow Aquifers Water Supply

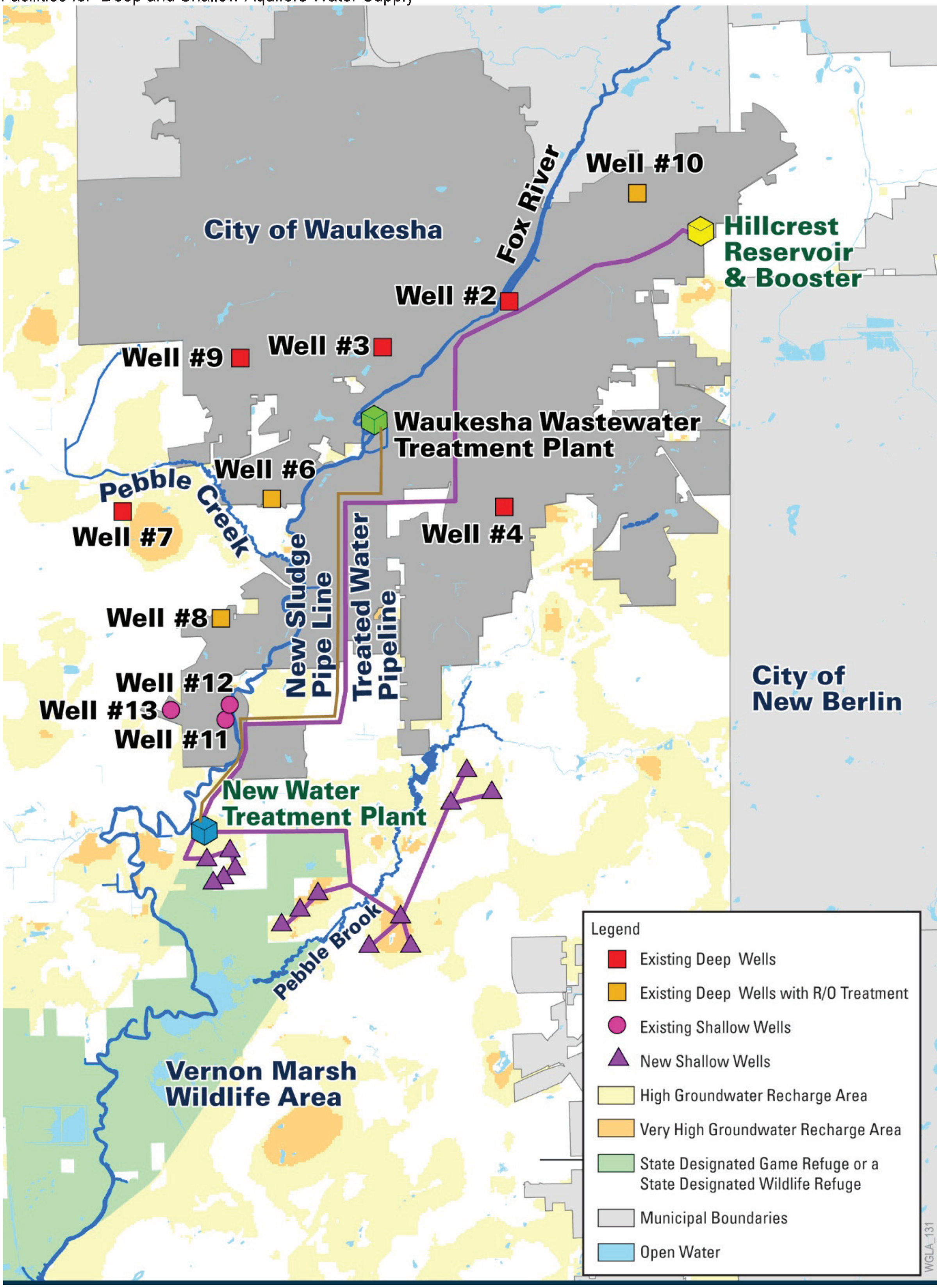
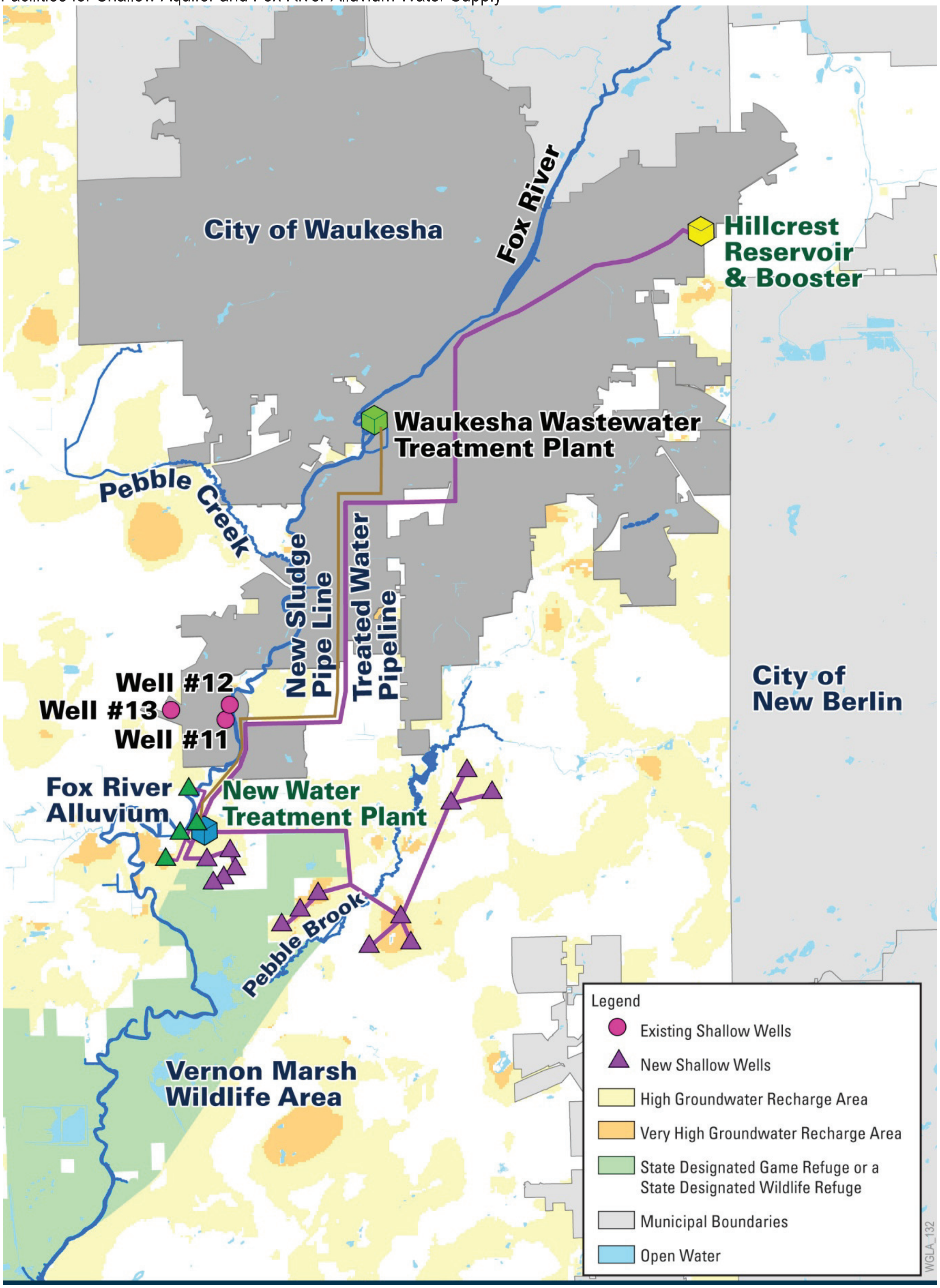


FIGURE 6-2
Facilities for Shallow Aquifer and Fox River Alluvium Water Supply



6.1.2.3 Lake Michigan Water Supply (City of Milwaukee)

This alternative is a potential component of the proposed project. The supply pipeline is described in Section 3.

6.1.2.4 Lake Michigan Water Supply (City of Oak Creek)

This alternative is a potential component of the proposed project. The supply pipeline is described in Section 3.

6.1.2.5 Lake Michigan Water Supply (City of Racine)

This alternative is a potential component of the proposed project. The supply pipeline is described in Section 3. Table 6-3 lists the water supply pipeline lengths and diameters.

TABLE 6-3
Water Supply Pipeline Alternatives Summary

Supply Alternatives	Diameter (In.)	Length (miles)	Counties
Deep and Shallow Aquifers	8 to 36	13.9	Waukesha
Shallow Aquifer and Fox River Alluvium	8 to 36	14.7	Waukesha
Lake Michigan (City of Milwaukee)	36	15	Milwaukee and Waukesha
Lake Michigan (City of Oak Creek)	36	27	Milwaukee and Waukesha
Lake Michigan (City of Racine)	36	38	Racine and Waukesha

6.1.3 Water Supply Treatment

6.1.3.1 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 36 inch diameter pipeline would convey treated water to the City of Waukesha and connect with the water distribution system and Hillcrest reservoir.

6.1.3.2 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 36 inch diameter pipeline would convey treated water to the Hillcrest reservoir and to the distribution system.

6.1.3.3 Lake Michigan Water Supply (City of Milwaukee)

This alternative would utilize treatment from the City of Milwaukee's two existing drinking water treatment plants.

6.1.3.4 Lake Michigan Water Supply (City of Oak Creek)

This alternative would utilize treatment from the City of Oak Creek's existing drinking water treatment plant.

6.1.3.5 Lake Michigan Water Supply (City of Racine)

This alternative would utilize treatment from the City of Racine's existing drinking water treatment plant.

6.1.4 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.

6.2 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 any Lake Michigan supplier could be paired with any of the return flow alternatives listed below.

6.2.1 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), NH_3-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[2] that identified improvements and WWTP expansion projects for the next 20 years. Included in that plan were provisions for UV disinfection and reaeration improvements. An amendment to that facility plan (Appendix E in the Application) was developed that identified improvements required for a return flow 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.

[2] Strand Associates. 2011. *City of Waukesha Wastewater Treatment Facility Plan*.

6.2.2 Return Flow Pipeline

Table 6-4 lists the water supply pipeline lengths and diameters.

TABLE 6-4
Return Flow Pipeline Alternative Summary

Return Flow Alternative	Diameter (In.)	Length (miles)	Counties
Underwood Creek to Lake Michigan	36	11.5	Milwaukee and Waukesha
Root River to Lake Michigan	36	15.5	Milwaukee and Waukesha
Direct to Lake Michigan	36	23.5	Milwaukee and Waukesha

6.2.2.1 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.

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 to balance the volume of water withdrawn. Discharge to the Fox River would continue for volumes greater than that withdrawn from the Lake Michigan basin 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 Section 5 of the Application. For example, the Fox River outfall would be utilized when flooding conditions are observed in Underwood Creek and Root River return flow alternatives. Section 5 of the Application and Appendixes E, H, and J in the Application summarize the return flow management plan and the decision flow charts for when wastewater will flow to each respective water course. For any of the return flow scenarios, no new pipelines are needed for a discharge to the Fox River.

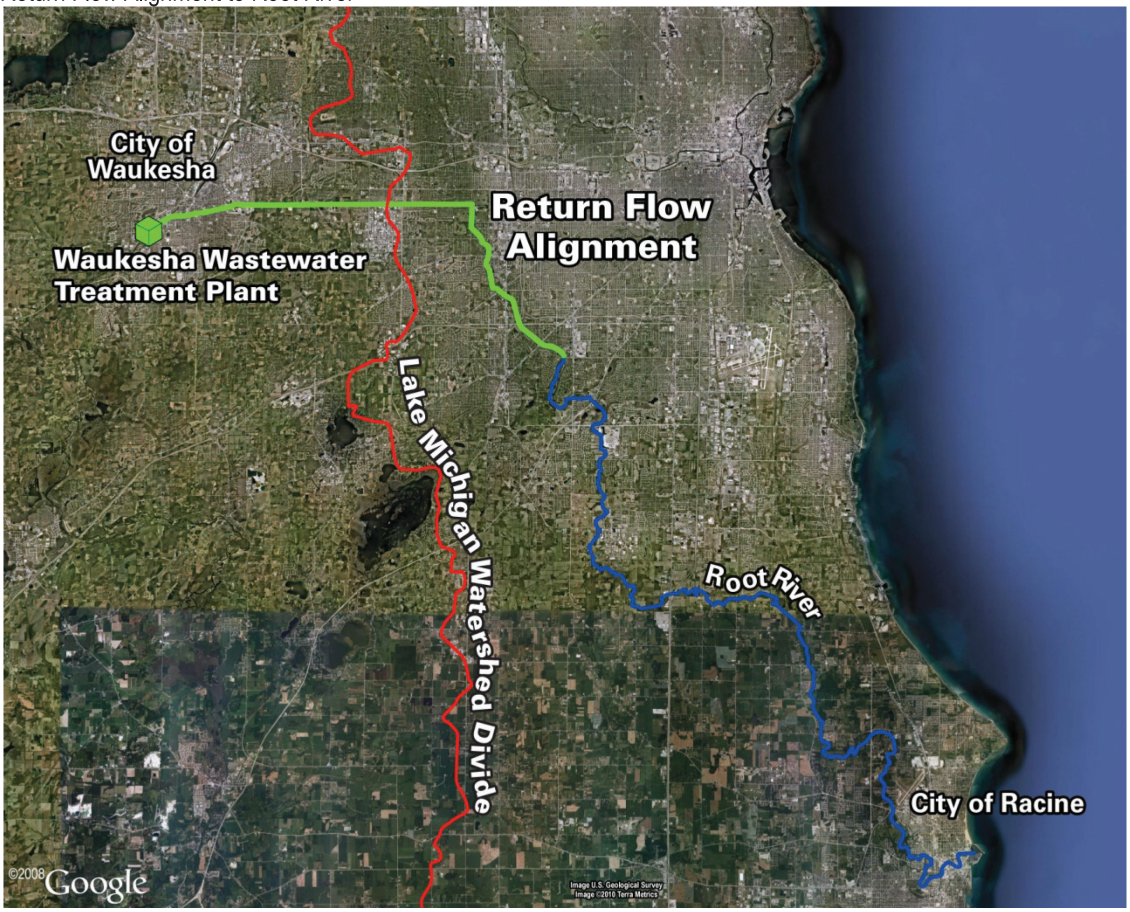
6.2.2.2 Underwood Creek to Lake Mchigan Return Flow

This alternative is a potential component of the proposed project. The return flow pipeline is described in Section 3. See Figure 3-10 and Attachment 3-1 for this proposed pipeline alignment.

6.2.2.3 Root River to Lake Mchigan Return Flow

The conceptual pipeline alignment (Figure 6-3 and Attachment 6-1) 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 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 36-inch diameter pipe.

FIGURE 6-3
Return Flow Alignment to Root River



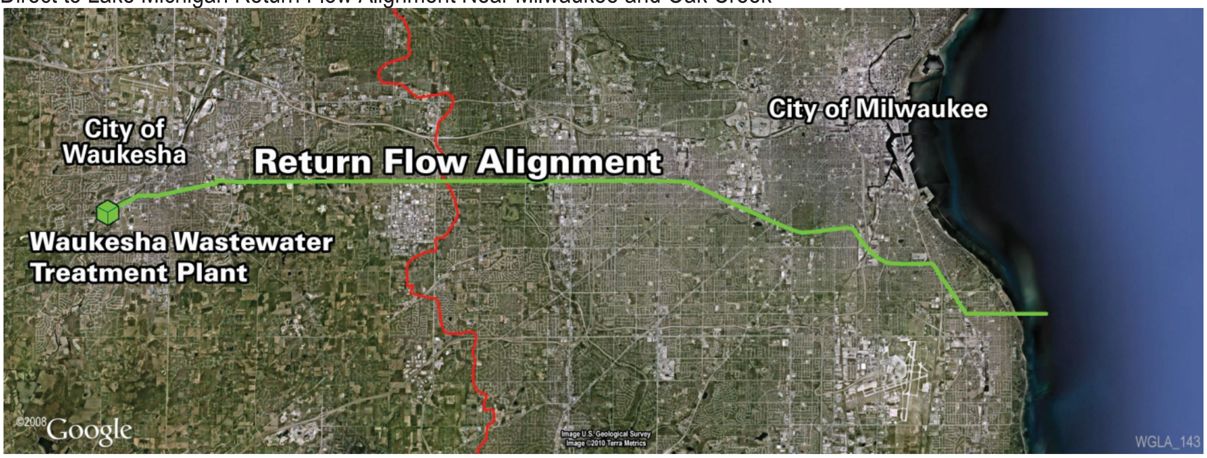
6.2.2.4 Direct to Lake Mchigan Return Flow

A screening-level alignment for return flow directly to Lake Michigan was developed to evaluate the environmental effects and costs (Figure 6-4 and Attachment 6-1). The conceptual pipeline alignment is the same as that for Underwood Creek and Root River 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 36-inch diameter pipe.

6.2.3 Effluent Discharge

The Wisconsin Pollutant Discharge Elimination System (WPDES) permit for the City of Waukesha WWTP is effective until December 31, 2012. The WPDES permit is included as an attachment to Appendix E in 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), NH_3-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 6-4
Direct to Lake Michigan Return Flow Alignment Near Milwaukee and Oak Creek



The City is anticipating lower effluent limits for TP. The WDNR has not provided the City with revised limits, however the City has completed their WWTP facility planning assuming a new effluent limit could equal 0.075 mg/L (compared to the current limit of 1.0 mg/L and recent average annual historic 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 limit[3] set for a discharge to Lake Michigan. Based on the historic performance of the WWTP, the City is anticipating an effluent TP limit of less than 0.5 mg/L in the next permit renewal. The City will not have to make any modifications to their treatment operations to meet this limit because as summarized in Appendixes E and F of the Application, the historic annual average effluent TP concentration has been 0.16 mg/L[4].

The WDNR has adapted 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 will meet WDNR thermal discharge requirements following the rules and applicable guidance regardless of a discharge to the Fox River, Lake Michigan tributary, or direct to Lake Michigan.

PHYSICAL AND BIOLOGICAL ENVIRONMENT

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

- Aquatic resource impacts

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[3] 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. 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.*

[4] Based on WWTP effluent data between October 1, 2002 and August 31, 2009.

- 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 Attachment 6-2.

The No Action alternative only effects groundwater and socioeconomic resources. Consequently, the No Action alternative is only discussed for these resources.

6.3 Aquatic Resources

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

6.3.1 Lake Mchigan

Lake Michigan will be affected only by the proposed project. The groundwater supply alternatives do not significantly affect Lake Michigan or tributaries to Lake Michigan.

6.3.1.1 Physical Description

6.3.1.1.1 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.[5] 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.[6]

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

5 http://www.dnr.state.wi.us/org/water/greatlakes/discover/lakemichigan.htm. Accessed March 4, 2010.

6 *The Great Lakes: An Environmental Atlas and Resource Book.* United States Environmental Protection Agency/Environment Canada ISBN 0-662-23441-3. http://www.epa.gov/greatlakes/atlas/ Accessed January 16, 2012.

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.[7]

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.[8] 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).

6.3.1.1.2 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. Flooding in the Lake will not be altered because, as discussed in Section 5 of the Application, a Lake Michigan water supply with return flow will provide a water balance. A water balance will prevent excess volume from being transferred into Lake Michigan, eliminating flooding impacts in the lake. With all the water supply and return flow alternatives, no change to the size, volume, or floodplain of Lake Michigan occurs with the proposed project or alternatives to the proposed project.

6.3.1.2 Water Quality

6.3.1.2.1 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 indicted (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.

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[7] http://www.dnr.state.wi.us/ORG/water/greatlakes/cladophora/. Accessed March 3, 2010.

[8] http://www.epa.gov/glnpo/aoc/milwaukee.html. Accessed March 3, 2010.

- 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.

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

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

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).

6.3.1.2.2 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, Attachment 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.

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). A significant source of chloride in the Waukesha WWTP is residential water softening. Residential water softening would continue with the groundwater alternatives. The allowance for an interim chloride limit would also consequently be needed. The Waukesha WWTP also currently has an allowance for mercury in the form of an interim limit governed under NR 106.145(4) which requires a mercury minimization plan that Waukesha is implementing. The water supply source is not expected to have an effect on mercury at the WWTP. Other water quality parameters may be addressed by similar regulatory approaches for allowances under current or future regulations for all discharge location alternatives.

The WDNR has adapted 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 will meet WDNR thermal discharge requirements following the rules and applicable guidance regardless of a discharge location.

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 because all alternatives have temporary construction impacts and operational impact will be a long-term permanent impact.

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, 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, and Direct to Lake Michigan Return Flow

All water returned to the Lake Michigan watershed will meet WDNR water quality permit requirements. All return flow alternatives are assumed to share in common expected effluent limits for the purpose of this analysis. A summary of proposed discharge limits from the WDNR and a comparison to historical Waukesha WWTP performance are detailed in Return Flow Alternatives Summary (Appendix F of the Application). It is important to note that the Waukesha WWTP historical effluent (October 1, 2002, to August 31, 2009) already consistently produces an effluent quality better than the proposed permit limits. A comparison of historical WWTP discharge quality to other Lake Michigan tributary dischargers is shown in Table 6-24 in the Inland Waterways section.

The groundwater alternatives would continue to require water softening, but 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 same approach to permit allowances for existing chloride discharge to the Fox River would be expected to be required for return flow.

Return flow will switch discharge up to a maximum amount from the Fox River to the Lake Michigan watershed. The return flow management plan is discussed in Section 5 of the Application. In general, the return flow management plan provides return flow up to a value of 115 percent of the average day water demand if sufficient water is available at the WWTP. 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 6.3.2.3.2.

Flow from all return flow alternatives ultimately ends up in Lake Michigan. The findings for all return flow alternatives with respect to Lake Michigan water quality inputs are, therefore, the same and listed here before discussing individual alternatives. 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 Appendix I of the Application and then compared to the SEWRPC annual average load findings. The analysis indicates the following:

- Fecal coliform contribution in the return flow under very conservative, worst-case conditions is only 0.20 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 0.21 percent of all total suspended solids loading from the greater Milwaukee watersheds.
- Phosphorus contribution in the return flow is only 1.23 percent of all phosphorus loading under worst-case conditions and only 0.62 percent of all phosphorus loading given the City of Waukesha's WWTP historic performance. These contributions could be even less, because the WDNR has adopted phosphorus regulations that could require more stringent phosphorus discharge limitations. For example, the WWTP historic annual phosphorus discharge is 0.16 mg/L while Underwood Creek and the Fox River

both 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.

6.3.1.2.3 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.

For water quality in Lake Michigan only, a discussion of relative impact for the various alternatives is included below. Section 6.3.2.3 contains a comparison for water quality for inland waterways.

TABLE 6-6
Environmental Impact Category Description: Water Quality

No adverse impact	Temporary impacts from construction; during operation water quality numeric standards compliance improves or stays approximately the same based upon expected water quality from historical wastewater treatment plant performance. Contributes a de minimis change (< 1%) in total water quality parameter average annual loading to Lake Michigan near Milwaukee based upon expected water quality from historical wastewater treatment plant performance. Operational changes in stormwater runoff quality occur due to new above ground structures.
Minor adverse impact	Water quality numeric standards compliance improves or stays approximately the same based upon expected water quality from historical wastewater treatment plant performance and recognizing allowances commonly provided in other municipal discharge permits. Contributes a minor change (> 1% but < 10%) in total water quality parameter average annual loading to Lake Michigan near Milwaukee based upon expected water quality from historical wastewater treatment plant performance.
Moderate adverse impact	Lowering of in-stream water quality, but no numeric water quality standard exceedences for water quality parameters that were not exceeded without return flow based upon historical wastewater treatment plant performance and recognizing allowances commonly provided in other municipal discharge permits. Numeric water quality standard exceedences for water quality parameters that were already exceeded without return flow based upon historical wastewater treatment plan performance. Contributes a moderate change (>10% but < 25%) in total water quality parameter average annual loading to Lake Michigan near Milwaukee based upon expected water quality from historical wastewater treatment plant performance.
Significant adverse impact	New exceedence of numeric water quality standards occurs for water quality parameters that were not exceeded without return flow based upon historical wastewater treatment plant performance and recognizing allowances commonly provided in other municipal discharge permits. Contributes a substantial change (> 25%) in total water quality parameter average annual loading to Lake Michigan near Milwaukee based upon expected water quality from historical wastewater treatment plant performance.

Table 6-7 compares the water quality impact on Lake Michigan.

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)	No adverse impact
Lake Michigan (City of Racine)	No adverse impact
Return Flow Alternatives for Lake Michigan Water Supplies	
Underwood Creek to Lake Michigan	Minor adverse impact
Root River to Lake Michigan	Minor adverse impact
Direct to Lake Michigan	Minor adverse impact

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, 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 both groundwater supply alternatives. 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.

Underwood Creek to Lake Michigan Return Flow

Water quality loading to Lake Michigan from the watersheds around greater Milwaukee was reviewed and found to be only 0.2 percent of all fecal coliform loading and only 0.21 percent of all total suspended solids loading under conservative, worst-case conditions. Phosphorus loading was found to be only 0.62 percent of all phosphorous loading under past historical performance and only 1.23 percent of all phosphorus loading under worst-case conditions. These phosphorus contributions could be even less in the future, because the WDNR has new phosphorus regulations that could require more stringent phosphorus discharge limitations. Consequently, the water quality impacts to Lake Michigan would be expected to have minor adverse impacts.

Root River to Lake Michigan Return Flow

Water quality impacts to Lake Michigan would be the same minor adverse impacts described for return flow to Underwood Creek.

Direct to Lake Michigan Return Flow

Water quality impacts to Lake Michigan would be the same minor adverse impacts described for return flow to Underwood Creek.

6.3.1.3 Geomorphology and Sediments

6.3.1.3.1 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.[9] Near Milwaukee, the near-shore geomorphology is varied. Example lakebed substrates include: rock, cobble and sand, sand, and clay outcrops.[10]

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).

6.3.1.3.2 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 alternative, because the City of Waukesha's return flow management plan goal is to return 100 percent of the withdrawn water (see Section 5 of the Application). In general, the return flow management plan provides return flow up to 115 percent of the average day water demand if sufficient water is available at the WWTP. 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 6.3.2.4. The geomorphology and sediment of Lake Michigan will not be affected by the return flow

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[9] *The Great Lakes: An Environmental Atlas and Resource Book.* United States Environmental Protection Agency/Environment Canada ISBN 0-662-23441-3. http://www.epa.gov/greatlakes/atlas/ Accessed January 17, 2012.

[10] *Final Environmental Impact Statement Elm Road Generating Station,* Wisconsin Public Service Commission, July 2003.

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 6.4.1.2 and is expected to have a minor adverse impact to the lake's geomorphology.

6.3.1.3.3 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 6.3.2.4. Table 6-9 summarizes the Lake Michigan geomorphology and sediment impact.

TABLE 6-8
Environmental Impact Category Description: Geomorphology and Sediments

No adverse impact	With return flow, channel is stable for flows up to the 2-year return where the channel is currently stable. No substrate change to Lake Michigan from construction.
Minor adverse impact	With return flow, channel has some instability for flows up to the 2-year return where the channel is currently stable. Substrate change to Lake Michigan of fewer than 10 acres.
Moderate adverse impact	With return flow, channel has frequent instability for flows up to the 2-year return where the channel is currently stable. Substrate change to Lake Michigan of greater than 10 but less than 20 acres.
Significant adverse impact	With return flow, channel is unstable at most flows where the channel is currently stable. Substrate change to Lake Michigan of 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 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.

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)	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	No adverse impact
Direct to Lake Michigan	Minor adverse impact

Lake Michigan Water Supply (Cities of Milwaukee, Oak Creek, 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

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 6.4.1.2) could be affected. Return flow direct to Lake Michigan consequently would produce a minor adverse impact on geomorphology and sediment in the lake.

6.3.1.4 Flora and Fauna

6.3.1.4.1 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.[11]

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.[12] 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.[13]

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 6.3.3 on 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.

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[11] http://dnr.wi.gov/org/land/er/communities/index.asp?mode=detail&Code=C9&Section=overview. Accessed December 7, 2011.

[12] *Final Environmental Impact Statement: U.S. Coast Guard Rulemaking for Dry Cargo Residue Discharges in the Great Lakes*, U.S. Coast Guard and USEPA, August 2008.

[13] http://www.dnr.state.wi.us/ORG/water/greatlakes/cladophora/. Accessed March 3, 2010.

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

The following fish species occur in near-shore waters of Lake Michigan (WPSC 2003).

Common Name	Scientific Name	Common Name	Scientific Name
Alewife	*Alosa pseudoharengus*	Round whitefish	*Prosopium cylindraceum*
Bowfin	*Amia calva*	Bloater	*Coregonus hoyi*
Brook trout	*Salvelinus fontinalis*	Rainbow smelt	*Osmerus mordax*

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

6.3.1.4.2 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. Discussion of how the project alternatives will protect against the spread of invasive species is included in Section 6.3.2.5.2.

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.

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.[14] Water quality of the proposed return flow has been analyzed (see Section 5 and also Appendix I of the Application, Water Quality Model of Proposed Discharge to Underwood Creek (CH2M HILL 2010). Given the conclusions of the water quality

[14] WDNR letter from Duane Schuettpelz. October 16, 2008.

modeling, and 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. 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 6.3.3), because most of the sensitive natural communities and endangered resources identified for the project alternatives are associated with wetlands.

Environmental Effects Comparison: Lake Mchigan Flora and Fauna

Level of relative impact in aquatic habitat was developed to compare one alternative to another. Impacts were compared based upon Table 6-10. 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 6.3.2.2.4 and summarized in Table 6-11.

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

TABLE 6-10
Environmental Impact Category Description: Aquatic Habitat

No adverse impact	Temporary impacts from construction; neutral or improved habitat creation and frequency of availability from operation.
Minor adverse impact	Reduced baseflow in warm water streams of up to 25%, causing habitat loss. Substrate change to Lake Michigan of fewer than 10 acres.
Moderate adverse impact	Reduced baseflow in warm water streams of greater than 25% but less than 50%, causing habitat loss. Reduced baseflow to cold water streams, but less than 25%. Substrate change to Lake Michigan of greater than 10 but less than 20 acres.
Significant adverse impact	Reduced baseflow in cold water streams of 25% or more or reduced baseflow in warm water streams of 50% or more, causing habitat loss. Substrate change to Lake Michigan of greater than 20 acres.

TABLE 6-11
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)	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	No adverse impact
Direct to Lake Michigan	Minor adverse impact

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.

Lake Mchigan Water Supply (Cities of MIlwaukee, Oak Creek, and Racine)

Lake Michigan water supply from Milwaukee, Oak Creek, or Racine 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, because of the return flow management plan, as discussed in Section 5 of the Application, "Return Flow Management Plan," no change in Lake Michigan volume will result in no habitat changes.

Underwood Creek or Root River to Lake Mchigan Return Flow

A geomorphology analysis of Underwood Creek (Appendix G 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, page 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 Mchigan 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 for would have a minor adverse impact on Lake Michigan aquatic habitat.

6.3.2 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.

6.3.2.1 Location, Existing Designations/Classifications

6.3.2.1.1 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 6-12 through 6-14 list surface waters that are crossed with a water supply or return flow pipeline and receive only temporary construction impacts.

TABLE 6-12
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	—	0.019	WWSF
	4310	Honey Creek	Perennial	26	0.04	—
	21136	Deer Creek	—	77.4	0.02	—
	22799	North Branch Root River	—	23.2	0.04	—
	22800	North Branch Root River	—	23.2	0.04	—
Lake Michigan (City of Oak Creek)	1845	Poplar Creek	Perennial	16.8	0.0	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
	4671	East Branch Root River	—	81.6	0.06	—
	4887	North Branch Root River	—	93.3	0.04	—
	5210	Oak Creek	Perennial	77.9	0.10	—
	6272	North Branch Root River	—	89.9	0.06	—
	6929	North Branch Oak Creek	—	75.0	0.05	—
	21136	Deer Creek	—	77.4	0.02	—

TABLE 6-12
Water Body Crossings

Alternative	Water Body/ Stream No.	Water Body Name	Water Body Type	Approximate Crossing Width (ft)	Crossing Area (acres)	Fisheries Classification[a]
	22799	North Branch Root River	—	220.3	0.08	—
Lake Michigan (City of Racine)	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	—	164.9	0.03	—
	668	Hoods Creek	—	81.5	0.04	—
	1827	Goose Lake Branch Canal	—	4411.8[b]	2.23	—
	2282	Root River Canal	—	75.3	0.07	—
	20172	Mill Creek	—	98.0	0.01	—
Return						
Underwood Creek to Lake Michigan	1738	Unnamed	Intermittent/ephemeral	—	0.002	—
	1845	Poplar Creek	Perennial	—	0.032	Unknown
	3052	Unnamed	Intermittent/ephemeral	—	0.012	—
	3054	Unnamed	Intermittent/ephemeral	—	0.082	—
	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
	21136	Deer Creek	—	77.4	0.02	

TABLE 6-12
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	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	—	93.3	0.04	—
	5985	North Branch Root River	—	42.8	0.03	—
	21136	Deer Creek	—	77.4	0.02	—
	22799	North Branch Root River	—	496.2	0.16	—
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	—
	21136	Deer Creek	—	77.4	0.02	—

[a] WDNR (2010f).

[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 6-13
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	Lake Michigan–Racine Supply	Underwood Creek to Lake Michigan Return Flow	Root River to Lake Michigan Return Flow	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
Honey Creek	—	—	—	—	—	—	—	—
North Branch Root River	—	—	—	—	—	—	—	—
East Branch Root River	—	—	—	—	—	—	—	—
Husher Creek	—	—	—	—	—	—	—	—
Hoods Creek	—	—	—	—	—	—	—	—
Oak Creek	—	—	—	—	—	—	—	—
North Branch Oak Creek	—	—	—	—	—	—	—	—
Goose Lake Branch Canal	—	—	—	—	—	—	—	—
Root River Canal	—	—	—	—	—	—	—	—
Mill Creek	—	—	—	—	—	—	—	—
Unnamed	0.04	0.04	0.01	0.01	0.72	0.11	0.10	0.10
Grand Total	**0.36**	**0.71**	**0.06**	**0.06**	**2.35**	**0.16**	**0.15**	**6.39**

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.

TABLE 6-14
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)	11
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	11
Direct to Lake Michigan	9

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.

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 6-12 through 6-14.

6.3.2.1.2 Environmental Effects

As described below in Section 6.3.2.2, 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.

6.3.2.2 Size, Flows, and Floodplain

6.3.2.2.1 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.[15] 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 documented in the groundwater modeling attachment to the Water Supply Service Area Plan, Appendix B of the Application.

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 documented in the groundwater modeling attachment to the Water Supply Service Area Plan, Appendix B of the Application.

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 documented in the groundwater modeling attachment to the Water Supply Service Area Plan, Appendix B of the Application.

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

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[15] http://waterdata.usgs.gov/wi/nwis/rt, gage number 05543830 accessed April, 2010.

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,[16] and $99 million in the County Grounds flood control project, completed in 2010.[17] 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.[18]

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.[19]

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.[20]

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 04087214 in the City of Greenfield near the return flow location, the average annual stream flow is 17.5 cfs (11.3 mgd) over the period of record 2004 to 2009.

6.3.2.2.2 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 6-12 through 6-14 list the extents of the perennial and intermittent surface water crossings for each alternative. Refer to the maps found in

[16] MMSD. http://v3.mmsd.com/hartparkproject.aspx. Accessed January 13, 2010.

[17] MMSD. http://v3.mmsd.com/milwaukeecogrounds.aspx. Accessed January 13, 2010.

[18] HNTB. 2006. *Environmental Assessment Milwaukee County Grounds Floodwater Management Facility and Underwood Creek Rehabilitation Projects.*

[19] http://waterdata.usgs.gov/wi/nwis/rt, gage number 04087088 accessed April, 2010.

[20] http://waterdata.usgs.gov/wi/nwis/rt, gage number 04087120 accessed April, 2010.

Attachment 3-1 of Section 3 and to Attachment 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 Attachment 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. 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.

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 the 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.

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.[21] A subsequent study estimated significant baseflow reductions near Waukesha when only 3.9 mgd of shallow groundwater was pumped and artificial recharge was used.[22]

Detailed groundwater modeling of this alternative (in the groundwater modeling attachment to the Water Supply Service Area Plan, Appendix B of the Application) found that average groundwater baseflows to the river could decrease significantly. 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. In the base scenario, groundwater flow *to the river* is estimated to be about 1.7 mgd in the study area. Groundwater pumping under this alternative would withdraw 0.7 mgd of groundwater *away from* the Fox River, resulting in a 2.4 mgd flow reduction in groundwater baseflow to the river.

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 Attachment 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), because 2.4 mgd of baseflow would be removed from the Fox River (i.e., 2.4 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 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 (in the groundwater modeling attachment to the Water Supply Service Area Plan) of this alternative found average groundwater baseflows to the river could be reduced significantly. 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. In the base scenario, groundwater flow *to the river* is estimated to be about 1.7 mgd in the study area. Under this alternative, groundwater

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[21] SEWRPC. 2008. Planning Report on Regional Water Supply Plan for Southeastern Wisconsin, Preliminary Draft.

[22] Cherkauer. 2009.

pumping would withdraw 4.2 mgd of groundwater *away from* the Fox River, resulting in a 5.9 mgd flow reduction in groundwater baseflow to the river.

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 Attachment 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 5.9 mgd of baseflow would be removed from the Fox River (i.e., 5.9 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 Mchigan Water Supply (Cities of MIwaukee, Oak Creek, 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 Section 5 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 shift of most 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. As discussed in Section 5 of the Application, “Return Flow Management Plan,” flow to the Fox River will occur when the WWTP flow exceeds the maximum return flow rate or during extreme flooding conditions in a Lake Michigan tributary (for a tributary return flow location). 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 in Section 5 of the Application. As a result, WWTP flow will still occur at times to the Fox River with any Lake Michigan water supply alternative.

A study by the USGS and University of Milwaukee reports that wastewater flows from Sussex, Brookfield, and Waukesha contribute 40 percent of the total Fox River flow during annual low flows.[23] 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 annual low flow periods, when the WWTP return flow likely would be entirely to the Lake Michigan basin, Fox River flow would be reduced by roughly 25 percent. Lower flows change the amount of aquatic habitat available, however as described in Appendix H to the Application, water depth change is expected to be less than 2 inches. Consequently, significant habitat change is not expected. The reduction in flow, and thus in aquatic habitat, would have a minor adverse impact on the river during annual low flow conditions compared to existing 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 Mchigan 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. As discussed in the return flow management plan in Section 5 of the Application, return flow to the Lake Michigan basin would be temporarily paused during flooding events downstream of the return flow discharge location, and flow from the WWTP would be conveyed to the Fox River. This would maintain the same flow in the Fox River during flooding events as the groundwater supply alternatives and as currently occurs. 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.

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[23] Doug Cherkauer, D. Feinstein, T. Grundl, W. Kean. "Is riverbank filtration a viable means of extending groundwater supplies?" Presentation to the Compact Implementation Coalition and Sweet Water NGO Team, February 18, 2010, Great Lakes Water Institute, Milwaukee, Wisconsin.

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 (in the groundwater modeling attachment to the Water Supply Service Area Plan, Appendix B of the Application) of this alternative found average groundwater baseflows to these cold water streams could be reduced significantly. For example, groundwater baseflow to Pebble Brook would be reduced by 61 percent, to Pebble Creek by 9 percent, and to Mill Book by 29 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 because of the 61 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 (in the groundwater modeling attachment to the Water Supply Service Area Plan, Appendix B of the Application) 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. For example, groundwater baseflow to Pebble Brook would be reduced by 58 percent, to Pebble Creek by 23 percent, and to Mill Book by 30 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 Mchigan 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 Mchigan Water Supply (Cities of Mlwaukee, Oak Creek, 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 Mchigan 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.

Appendixes G and H of the Application contain 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 Appendix J 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.

Root River to Lake Mchigan Return Flow

There would be no flow change in Underwood Creek and the Menomonee River under this alternative.

Direct to Lake Mchigan 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 Mchigan Water Supply (Cities of MIwaukee, Oak Creek, 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 affect flooding in inland waterways because the water intake in all cases would be in Lake Michigan.

Underwood Creek to Lake Mchigan Return Flow

Return flow to any watercourse would not affect flooding or floodplain delineations. Return flow is less than 2 percent of the creek flow during a 2-year frequency storm and would be an even a smaller percentage of flow during a flood. But if an extreme flood condition threatens personal property or public investments, return flow would be paused temporarily, as discussed in the return flow management plan in Section 5 of the Application. The return flow management plan has proposed to temporarily pause return flow when flow in Underwood Creek is above a 2-year recurrence interval flow (1,000 cfs). As described in Section 5 of the Application, the Compact requirements for return flow will still be met. The 2-year flood flow is much less than the 100-year flood flow. Even though return flow is a very small percentage of the flow in the creek during a flood, by temporarily pausing the return flow during flood events greater than a 2-year recurrence interval, the return flow will not cause flood damage downstream of the return flow discharge.

When return flow is paused, flow from the City of Waukesha WWTP would be conveyed through the existing outfall to the Fox River, and would not adversely affect flood levels in either Underwood Creek or the Fox River. An example of the operation of the return flow management plan in the historically wet year 2008 is detailed in Appendix J of the Application. The analysis demonstrated the return flow did not affect the flood flows in Underwood Creek, and the City was still able to meet its goal of 100 percent return flow that year. Therefore, there would be no increase in the flood elevation with return flow in either Underwood Creek or the Fox River. With the planned return flow operational methodology to trigger a temporary pause in return flow, there is no increased flooding potential.

The Wastewater Treatment Plant Facility Plan Amendment (Appendix E 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 Mchigan Return Flow
There would be no flow change in Underwood Creek and the Menomonee River with this alternative.

Direct to Lake Mchigan 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 Mchigan Water Supply (Cities of Mlwaukee, 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 Mchigan Return Flow
There would be no flow change in the Root River under this alternative.

Root River to Lake Mchigan Return Flow
The average annual stream flow is 17.5 cfs (11.3 mgd) over the period of record. Appendix F of the Application contains additional information on the flow and geomorphic conditions. Return flow is about 5 percent of the 2-year river flow in the reach at the discharge location, and about 2.2 percent at the next reach about 1.3 miles downstream of the return flow outfall location (MMSD 2007, TM 3 hydraulic model). Return flow would be an even smaller percentage of flow during a flood.

Consequently, return flow to the Root River is expected to have an insignificant impact on flooding, just as with Underwood Creek. Similar to Underwood Creek, 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. These flow changes are similar those in Underwood Creek. A detailed evaluation concluded that the return flow would not affect the geomorphic stability of the rehabilitated parts of the creek.

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.[24] For these reasons, return flow will not adversely affect the flow 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 Mchigan Return Flow

There would be no flow change in the Root River under this alternative.

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 Mchigan Water Supply (Cities of Mlwaukee, 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 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 Mchigan Return Flow

There would be no flow change in the Root River under this alternative.

Root River to Lake Mchigan Return Flow

As discussed in Section 5 of the Application, return flow to Underwood Creek (Menomonee River) or Root River would be paused during flooding events that threaten personal or public property.

The outfall structure would be designed to blend in with the streambanks along the Root River and to not affect regional flood elevations adversely.

Direct to Lake Mchigan Return Flow

There would be no flow change in the Root River under this alternative.

6.3.2.2.3 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 6-15. The impact of the various alternatives on aquatic habitats and

24 MMSD. *Root River Sediment Transport Planning Study*. May 4, 2007. Hydraulics Technical Memorandum 6. Page 1.

flooding is discussed below. The inland waterway aquatic habitat and flooding impacts are summarized in Table 6-16. The comparison for aquatic habitat impacts for Lake Michigan is included in Section 6.3.1.4.

TABLE 6-15
Environmental Impact Category Description: Inland Waterways – Aquatic Habitat and Flooding

Category	Aquatic Habitat	Flooding
No adverse impact	Temporary impacts from construction; neutral or improved habitat creation and frequency of availability from operation.	No increase in flooding depth for the 100-year return period storm.
Minor adverse impact	Reduced baseflow in warm water streams of up to 25%, causing habitat loss. Substrate change to Lake Michigan of fewer than 10 acres.	Causes an increase in flooding depth of greater than 0.01 but less than 0.1 foot at buildings for the 100-year return period storm.
Moderate adverse impact	Reduced baseflow in warm water streams of greater than 25% but less than 50%, causing habitat loss. Reduced baseflow to cold water streams, but less than 25%. Substrate change to Lake Michigan of greater than 10 but less than 20 acres.	Causes an increase in flooding depth of greater than 0.1 but less than 1.0 foot at buildings for the 100-year return period storm.
Significant adverse impact	Reduced baseflow in cold water streams of 25% or more or reduced baseflow in warm water streams of 50% or more, causing habitat loss. Substrate change to Lake Michigan of greater than 20 acres.	Causes an increase in flooding depth of greater than 1.0 foot at buildings for the 100-year return period storm.

TABLE 6-16
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)	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	No adverse impact
Root River to Lake Michigan	No adverse impact	No adverse impact
Direct to Lake Michigan	No adverse impact	No adverse impact

6.3.2.2.4 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 2.4 mgd less flow. 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 Pebble Brook experiencing a baseflow reduction of 61 percent on average, 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 5.9 mgd less flow. 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 Pebble Brook experiencing a baseflow reduction of 58 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 Mchigan Water Supply (Cities of MIlwaukee, Oak Creek, and Racine)

The Lake Michigan water supply alternatives would change base flows in the Fox River by approximately 25 percent. Consequently, the impact to the Fox River would be a minor adverse impact.

Underwood Creek to Lake Mchigan 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 Mchigan Return Flow

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 Mchigan 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 6.3.1.

6.3.2.2.5 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 Mchigan Water Supply (Cities of MIlwaukee, Oak Creek, 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, Root River, or Direct to Lake Mchigan Return Flow

The return flow to any location would not affect flooding. Return flow would be paused during flooding downstream of the return flow discharge location, and flow from the WWTP would be conveyed to the Fox River. This would maintain the same flow in the Fox River during flooding as the groundwater supply alternatives. No return flow alternative would cause adverse impact to flooding.

6.3.2.3 Water Quality

6.3.2.3.1 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 6-17 for WDNR Station numbers 683206 and 683096.

TABLE 6-17
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.[25] 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)).

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).

25 http://dnr.wi.gov/org/water/wm/wqs/303d/303d.html. Accessed January 19, 2010.

Mll 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.[26] The proposed 2012 303(d) list includes the South Branch of Underwood Creek, which is upstream of the proposed return flow location, for phosphorous.[27] 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.[28] The City of Waukesha is an active stakeholder in the TMDL development.

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.[29] 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.[30]

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.[31]

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26 http://dnr.wi.gov/org/water/wm/wqs/303d/303d.html accessed January 19, 2010.

27 http://dnr.wi.gov/water/impairedSearch.aspx accessed December 28, 2011.

28 http://v3.mmsd.com/Report.aspx accessed December 28, 2011.

29 WDNR NR 102.04(4).

30 WDNR NR 102.06.

31 SEWRPC. 2008. *A Regional Water Supply Plan for Southeastern Wisconsin.* Planning Report No. 52.

The USGS conducted water quality sampling at USGS gage 04087088 on Underwood Creek at Wauwatosa with data obtained from February 2004 through August 2005.[32] Table 6-18 lists concentration ranges for dissolved oxygen, phosphorus, and fecal coliform.

TABLE 6-18
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. The average of annual sample results at locations downstream of the expected return flow location is summarized in Table 6-19.

TABLE 6-19
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)

The USGS water quality sampling occurred at USGS gage 04087120 on the Menomonee River at Wauwatosa with data obtained primarily from 1991to 1993 and again from 2004 to 2009.[33] Table 6-20 lists concentration ranges for dissolved oxygen, phosphorus, and fecal coliform.

TABLE 6-20
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

32 http://waterdata.usgs.gov/wi/nwis/rt, gage number 04087088 accessed February 2010.

33 http://waterdata.usgs.gov/wi/nwis/rt, gage number 04087120 accessed February 2010.

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 6-21 for three points closest to the proposed return flow location (SEWRPC, 2007, Appendix N).

TABLE 6-21
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 location is on the 303(d) list for low dissolved oxygen with reported causes from sediment and phosphorus.[34] 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.[35] The proposed 2012 303(d) list includes portions of the Root River in Milwaukee and Racine Counties for phosphorous.[36]

Water quality information is gathered by a number of organizations in the Root River watershed. The USGS has 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.[37]

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.[38]

The USGS water quality sampling occurred at USGS gage 04087214 on the Root River at Grange Avenue in Greenfield, with data obtained from 2004 through 2009.[39] Dissolved oxygen, phosphorus, and fecal coliform concentration ranges are included in Table 6-22.

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34 http://dnr.wi.gov/org/water/wm/wqs/303d/303d.html accessed January 19, 2010.

35 http://dnr.wi.gov/org/water/wm/wqs/303d/303d.html accessed January 19, 2010.

36 http://dnr.wi.gov/water/impairedSearch.aspx accessed December 28, 2011.

37 WDNR NR 102.04(4).

38 SEWRPC. 2008.

39 http://waterdata.usgs.gov/wi/nwis/rt, gage number 04087120 accessed February, 2010.

TABLE 6-22
Average Water Quality Data Downstream of Root River Return Flow Location

Parameter	Samples	Minimum	Maximum	Mean
Dissolved oxygen	21	2.5 mg/L	20.3 mg/L	8.5 mg/L
Phosphorus of unfiltered water	12	0.03 mg/L	0.16 mg/L	0.11 mg/L
Fecal coliform	13	110 per 100 mL	7,500 per 100 mL	1,395 per 100 mL

6.3.2.3.2 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 Attachment 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.

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). A significant source of chloride in the Waukesha WWTP is residential water softening. Residential water softening would continue with the groundwater alternatives. The allowance for an interim chloride limit would also consequently be needed. The Waukesha WWTP also currently has an allowance for mercury in the form of an interim limit governed under NR 106.145(4) which requires a mercury minimization plan that Waukesha is implementing. The water supply source is not expected to have an effect on mercury at the WWTP. Other water quality parameters may be addressed by similar regulatory approaches for allowances under current or future regulations for all discharge location alternatives.

The WDNR has adapted 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 will meet WDNR thermal discharge requirements following the rules and applicable guidance regardless of a discharge location.

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 6-45) that will produce stormwater pollution runoff from previously undeveloped land. The increased runoff could affect stormwater water quality and the Fox River. 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 Appendix I of the Application. Historical performance is included in the discussion of Underwood Creek water quality in Table 6-24.

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 same approach to permit allowances for discharge to the Fox River as currently occurs would be 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 6-45), 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 same approach to permit allowances for discharge to the Fox River as currently occurs would be expected with this water supply alternative.

Lake Mchigan 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, and Direct-to-Lake-Mchigan Return Flow

Return flow will switch discharge up to a maximum amount from the Fox River to the Lake Michigan watershed. The return flow management plan is discussed in detail in Section 5 of the Application. In general, the return flow management plan provides return flow up to a value of 115 percent of the average day water demand if sufficient water is available at the WWTP. 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.

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 6.3.2.2.2). For example, groundwater baseflow to Pebble Brook would be reduced by 61 percent, to Pebble Creek by 9 percent, and to Mill Book by 29 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.

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 6.3.2.2.2). For example, groundwater baseflow to Pebble Brook would be reduced by 58 percent, Pebble Creek would be reduced by 23 percent, and Mill Book would be reduced by 30 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 Mchigan 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, and Direct-to-Lake-Mchigan 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

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. All return flow alternatives are assumed to share in common expected effluent limits for the purpose of this analysis. A summary of proposed discharge limits from the WDNR and a comparison to historical Waukesha WWTP performance are detailed in the Return Flow Alternatives Summary (Appendix F of the Application). It is important to note that the Waukesha WWTP historical effluent (October 1, 2002, to August 31, 2009) already consistently produces an effluent quality better than the proposed permit limits. A comparison of the proposed WWTP limits[40] and historical performance is shown in Table 6-23. The table also includes a comparison to two other discharge permits to Lake Michigan tributaries as a comparison.

TABLE 6-23
Comparison of WDNR-Proposed WPDES Limits to
Historical WWTP Performance and Other Lake Michigan Tributary Dischargers

	City of Waukesha Potential Return Flow			
Water Quality Parameter	WDNR-Proposed Limit for Lake Michigan Tributary Return	Waukesha Historic Average[a]	Lake Michigan Tributary WWTP Discharger #1[b]	Lake Michigan Tributary WWTP Discharger #2[c]
Biological oxygen demand	≤ 5.0 to ≤ 10.0 mg/L	1.8 mg/L	≤ 10.0 to ≤ 15 mg/L	≤ 30.0 mg/L monthly avg.
Total suspended solids	≤ 5.0 to ≤ 10.0 mg/L	1.2 mg/L	≤15.0 mg/L	≤ 30.0 mg/L monthly avg.
Dissolved oxygen	≥ 7.0 mg/L	9.2 mg/L	≥ 6.0 mg/L	≥ 6.0 mg/L
Phosphorus	≤ 1.0 mg/L	0.16 mg/L	≤ 1.0 mg/L	≤ 1.0 mg/L
Ammonia (NH_3-N)	Likely lower than current range of 2.0 to 6.0 mg/L	< 1.0 mg/L	3.3 to 6.4 mg/L monthly avg.	6.3 to 12.0 mg/L monthly avg.

[a] October 1, 2002, to August 31, 2009.
[b] WPDES Permit No. WI-0020222-08-0
[c] WPDES Permit No. WI-0020184-08-0

While the groundwater alternatives would continue the need for water softening, 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.

40 WDNR letter from Duane Schuettpelz. October 16, 2008.

The same approach to permit allowances for existing discharge to the Fox River would be expected to be required for return flow.

Return flow will switch discharge up to a maximum amount from the Fox River to the Lake Michigan watershed. Water at the WWTP in excess of this amount will continue to be discharged into the Fox River and meet permit limits.

Flow from all return flow alternatives ultimately ends up in Lake Michigan. Water quality impacts to Lake Michigan have been previously covered under Section 6.3.1.2.

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). Appendix I 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 three of four water quality parameters (fecal coliform, dissolved oxygen, and total suspended solids). For the fourth water quality parameter (phosphorus), concentrations increased and were more frequently higher than the planning level goal used in the SEWRPC modeling (0.1 mg/L), which is now the Menomonee River phosphorus water quality standard. However, the modeling results indicate that with return flow, nuisance algae growth will decrease in Underwood Creek and Menomonee River. 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.

The 303(d) listing 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 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 303(d) listings on the last 2.67 miles of the Menomonee River will not be exacerbated with return flow. The proposed fecal coliform listing 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 listing for PCBs from contaminated sediment will not become worse because the return flow does not include this chemical. The listing for *E. coli* bacteria for recreational restrictions will not become worse because disinfection at the WWTP works so well that only between 2 and 49 cells/100 mL of fecal coliform occur during the recreational season, and a similar high quality would be expected for other bacteria such as *E. coli*.

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 Appendix I 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 Return Flow Alternatives (Appendix F of the Application) with additional detailed modeling found in Appendix I to the Application.

Root River and Direct-to-Lake-Mchigan Return Flow

These return flow alternatives do not have any discharge to Underwood Creek. Consequently, any impacts to Underwood Creek are insignificant.

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 Mchigan Water Supply (Cities of Mlwaukee, 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 the Root River.

Underwood Creek and Direct-to-Lake-Mchigan 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 Mchigan Return Flow

All water returned to the Lake Michigan watershed will meet WDNR water quality permit requirements. All return flow alternatives are assumed to share in common expected effluent limits for the purpose of this analysis. A summary of proposed discharge limits from the WDNR and a comparison to historical Waukesha WWTP performance are detailed in Return Flow Alternatives Summary (Appendix F of the Application). It is important to note that the Waukesha WWTP historical effluent (October 1, 2002, to August 31, 2009) already consistently produces an effluent quality better than the proposed permit limits.

While the groundwater alternatives would continue the need for water softening, 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 same approach to permit allowances for existing discharge to the Fox River would be expected to be required for return flow.

Return flow will switch discharge up to a maximum amount from the Fox River to the Lake Michigan watershed. The return flow management plan is discussed in detail in Section 5 of the Application. In general, the return flow management plan provides return flow up to a value of 115 percent of the average day water demand if sufficient water is available at the WWTP. Water at the WWTP in excess of this amount will continue to be discharged into the Fox River and meet permit limits.

Flow from all return flow alternatives ultimately ends up in Lake Michigan. Water quality impacts to Lake Michigan have been previously covered under Section 6.3.1.2.

The Root River to Lake Michigan return flow 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 95 and 100 percent of the time for the 11-year period of record analyzed (SEWRPC, 2007, Appendix N). No or little change in dissolved oxygen standard compliance would be expected with return flow to the Root River because historical WWTP performance has produced a BOD concentration less than 2 mg/L on average as described in Appendix I of the Application. The Root River is listed as impaired for phosphorus. However, the phosphorus limit is not expected to be lower than the 0.075 mg/L water quality standard in the Root River. The 0.075 mg/L value 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.

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. Water quality analysis for this water body is summarized in Section 5 of the Application.

6.3.2.3.3 Environmental Effects Comparison: Inland Waterways Water Quality

Adverse impacts from changes in inland waterways water quality were compared based upon Table 6-24.

For water quality impacts in inland waterways, a discussion of relative impact for the various alternatives is included in Table 6-25. The comparison for water quality impacts for Lake Michigan is included in Section 6.3.1.2.3.

TABLE 6-24
Environmental Impact Category Description: Water Quality

No adverse impact	Temporary impacts from construction; during operation water quality numeric standards compliance improves or stays approximately the same based upon expected water quality from historical wastewater treatment plant performance. Contributes a de minimis change (<1%) in total water quality parameter average annual loading to Lake Michigan near Milwaukee based upon expected water quality from historical wastewater treatment plant performance. Operational changes in stormwater runoff quality occur due to new above ground structures.
Minor adverse impact	Water quality numeric standards compliance improves or stays approximately the same based upon expected water quality from historical wastewater treatment plant performance and recognizing allowances commonly provided in other municipal discharge permits. Contributes a minor change (>1%, but less than 10%) in total water quality parameter average annual loading to Lake Michigan near Milwaukee based upon expected water quality from historical wastewater treatment plant performance.
Moderate adverse impact	Lowering of in-stream water quality, but no numeric water quality standard exceedences for water quality parameters that were not exceeded without return flow based upon historical wastewater treatment plant performance and recognizing allowances commonly provided in other municipal discharge permits. Numeric water quality standard exceedences for water quality parameters that were already exceeded without return flow based upon historical wastewater treatment plan performance. Contributes a moderate change (>10%, but less than 25%) in total water quality parameter average annual loading to Lake Michigan near Milwaukee based upon expected water quality from historical wastewater treatment plant performance.
Significant adverse impact	New exceedence of numeric water quality standards occurs for water quality parameters that were not exceeded without return flow based upon historical wastewater treatment plant performance and recognizing allowances commonly provided in other municipal discharge permits. Contributes a substantial change (>25%) in total water quality parameter average annual loading to Lake Michigan near Milwaukee based upon expected water quality from historical wastewater treatment plant performance

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 allowances for chloride and mercury. These allowances are 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 6-25
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	Minor adverse impact
Lake Michigan (City of Milwaukee)	No adverse impact
Lake Michigan (City of Oak Creek)	No adverse impact
Lake Michigan (City of Racine)	No adverse impact
Return Flow Alternatives for Lake Michigan Water Supplies	
Underwood Creek to Lake Michigan	Minor adverse impact
Root River to Lake Michigan	Minor 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 Pebble Brook experiencing a baseflow reduction of 61 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 are expected to be minor adverse impacts.

Shallow Aquifer and Fox River Alluvium Water Supply

This alternative would maintain WWTP discharge to the Fox River as currently occurs. Impacts are expected to be the same to the Fox River as with the Deep and Shallow Aquifer alternative. Consequently, the water quality impacts to the Fox River would be expected to be minor 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 59 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 would be expected to be minor adverse impacts.

Lake Mchigan Water Supply (Cities of MIlwaukee, Oak Creek, 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 both groundwater supply alternatives. 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 Mchigan Return Flow

Return flow to Underwood Creek would take flow currently discharged to the Fox River and send it to Underwood Creek 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 WNDR for return flow discharge have been reviewed, and the WWTP would currently meet these requirements based upon historical performance. The water quality modeling found that average water quality improved or continued to meet water quality standards or background reference concentrations for three of four water quality parameters (fecal coliform, dissolved oxygen, and total suspended solids). For the fourth water quality parameter (phosphorus), concentrations increased and were more frequently higher than the planning level goal used in the SEWRPC modeling (0.1 mg/L), which is now the Menomonee River phosphorus water quality standard. However, the modeling results indicate that with return flow, nuisance algae growth will decrease in Underwood Creek and Menomonee River.

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.

The allowances in the current WDNR discharge permit are expected to continue under this water supply source. Consequently, the water quality impacts to Underwood Creek would be expected to have minor adverse impacts.

Water quality loading to Lake Michigan from the watersheds around greater Milwaukee was reviewed and return flow was found to be only 0.2 percent of all fecal coliform loading and only 0.21 percent of all total suspended solids loading under conservative, worst-case conditions. Phosphorus loading was found to be only 0.62 percent of all phosphorous loading under past historical performance and only 1.23 percent of all phosphorus loading under worst-case conditions. These phosphorus contributions could be even less in the future because the WDNR's new phosphorus regulations could require more stringent phosphorus discharge limitations. Consequently, the water quality impacts to Lake Michigan would be expected to have minor adverse impacts.

Root River to Lake Mchigan 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 WNDR for return flow discharge have been reviewed, and the WWTP would currently meet these requirements based upon historical performance. The allowances in the current WDNR discharge permit are expected to continue under this water supply source. Consequently, the water quality impacts to the Root River would be expected to have minor adverse impacts.

Water quality impacts to Lake Michigan would be the same as those described for return flow to Underwood Creek: minor adverse impacts.

Direct to Lake Mchigan 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 6.3.1.2.

6.3.2.4 Geomorphology and Sediments

6.3.2.4.1 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.[41] Farther

41 Fox River, Upper Fox River - Illinois Watershed (FX07). http://dnr.wi.gov/water/waterDetail.aspx?key=296926. Site Accessed January 24, 2012.

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 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 historic 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.[42]

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.[43] 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

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[42] Waukesha County Department of Parks and Land Use and Southeastern Wisconsin Regional Planning Commission. 2008. Pebble Creek Watershed Protection Plan. Waukesha County, Wisconsin. Part One. Community Assistance Planning Report Number 284. Page 82.

[43] Waukesha County Department of Parks and Land Use and Southeastern Wisconsin Regional Planning Commission. 2008. Pebble Creek Watershed Protection Plan. Waukesha County, Wisconsin. Part One. Community Assistance Planning Report Number 284. Page 78.

assigned a warm water sport fish use objective.[44] Most of the streams within Pebble Creek watershed have riparian buffers that exceed 75 feet.[45] 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 MIl 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.[46] 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.[47] 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

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[44] Waukesha County Department of Parks and Land Use and Southeastern Wisconsin Regional Planning Commission. 2008. Pebble Creek Watershed Protection Plan. Waukesha County, Wisconsin. Part One. Community Assistance Planning Report Number 284. Page 50.

[45] Waukesha County Department of Parks and Land Use and Southeastern Wisconsin Regional Planning Commission. 2008. Pebble Creek Watershed Protection Plan. Waukesha County, Wisconsin. Part One. Community Assistance Planning Report Number 284. Page 130.

[46] Milwaukee Metropolitan Sewerage District (MMSD). 2008. “Watercourse: Underwood Creek Rehabilitation and Flood Management—Phase 1.” Designed by Short Elliott Hendrickson, Inc.

[47] Short Elliot Hendrickson, Inc. (SEH). 2009. “Underwood Creek Effluent Return Evaluation”. Technical memorandum dated July 23, 2009, page 2.

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.[48] 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.

6.3.2.4.2 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.

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[48] MMSD. May 4, 2007. *Root River Sediment Transport Planning Study.*

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. The expected changes are detailed in Section 6.3.2.2.2. A change of 2.4 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 2.4 mgd is only about 3 percent of the 71 mgd annual average flow in the river, and even less than 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. The expected changes are detailed in Section 6.3.2.2.2. A change of 5.9 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 5.9 mgd is about 8 percent of the 71 mgd annual average flow in the river, even less than 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 Mchigan Water Supply (Cities of Mlwaukee, Oak Creek, 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 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 returning flow to Underwood Creek or Root River or direct to Lake Michigan. A Lake Michigan supply would require a shift of most of the WWTP discharge from the Fox River to the Lake Michigan basin, but the return flow will not eliminate discharge to the Fox River.

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 in Section 5 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 Milwaukee reports that wastewater flows from Sussex, Brookfield, and Waukesha contribute 40 percent of the total Fox River flow during annual low flows.[49] 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 annual low flow periods when return flow (WWTP flow) would likely be entirely to the Lake Michigan basin, a 25 percent reduction in the Fox River 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 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. When the Fox River has these higher flows, the Waukesha WWTP effluent likely would exceed the maximum return flow rate, as discussed in Section 5 of the Application, and WWTP would temporarily pause return flow to the Lake Michigan basin and instead discharge to the Fox River. During these times, the impact to the Fox River would be even less, because the WWTP would continue to supplement the Fox River flows.

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 Mll 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 (see the groundwater modeling attachment to the Water Supply Service Area Plan, Appendix B of the Application) found that average groundwater baseflows to the cold water streams could decrease significantly. For example, groundwater baseflow to Pebble Brook would be reduced by 61 percent, to Pebble Creek by 9 percent, and to Mill Book by 29

[49] Doug Cherkauer, D. Feinstein, T. Grundl, W. Kean. "Is riverbank filtration a viable means of extending groundwater supplies?" Presentation to the Compact Implementation Coalition and Sweet Water NGO Team, February 18, 2010, Great Lakes Water Institute, Milwaukee, Wisconsin.

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 (see the groundwater modeling attachment to the Water Supply Service Area Plan, Appendix B of the Application) found that average groundwater baseflows to the cold water streams could decrease significantly, and greater than the Deep and Shallow Aquifer alternative. For example, groundwater baseflow to Pebble Brook would be reduced by 58 percent, to Pebble Creek by 23 percent, and to Mill Book by 30 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 Mchigan 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 Mchigan Water Supply (Cities of MIlwaukee, Oak Creek, and Racine)

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

Underwood Creek to Lake Mchigan 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 Alternatives Summary (Appendix F of the Application), Appendix G (Underwood Creek Effluent Return evaluation), and Appendix H (Return Flow Effects on Habitat in Underwood Creek and Menomonee River. The purpose of Appendix G 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 recently rehabilitated 2,400-foot reach of the creek 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 Appendix H 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 (Appendix G), 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 Mchigan 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 Mchigan Water Supply (Cities of MIwaukee, Oak Creek, 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 Mchigan 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 to Lake Mchigan Return Flow

The geomorphology in the Root River would be affected only by a Lake Michigan water supply with return flow to the Root River. As noted, the average annual stream flow in the Fox River is 17.5 cfs (11.3 mgd) over the period of record. The Return Flow Alternatives Summary (Appendix F of the Application) contains a detailed discussion of the geomorphic conditions.

Return flow to the Root River is expected to have an insignificant impact on geomorphology, similar to that for Underwood Creek. Similar to Underwood Creek, 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. For example, a return flow is about 5 percent of the 2-year river flow near the discharge location, and about 2.2 percent at the next reach about 1.3 miles downstream of the return flow outfall location.[50] These are similar to the

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[50] MMSD. *Root River Sediment Transport Planning Study.* May 4, 2007. Hydraulics Technical Memorandum 3. HEC-RAS model from enclosed CD.

Underwood Creek flow, for which a detailed evaluation concluded that the return flow would not affect the geomorphic stability of the rehabilitated parts of the creek.

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.[51] 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.

6.3.2.4.3 Environmental Effects Comparison: Inland Waterway Geomorphology and Sediments

Adverse impacts from changes in inland waterway geomorphology and sediments are compared based upon Table 6-26.

Table 6-27 summarizes the impacts of the various alternatives on geomorphology and sediments impacts in inland waterways. Section 6.3.1.3 contains a comparison of geomorphology impacts for Lake Michigan.

TABLE 6-26
Environmental Impact Category Description: Inland Waterways Geomorphology and Sediments

No adverse impact	With return flow, channel is stable for flows up to the 2-year return where the channel is currently stable. No substrate change to Lake Michigan from construction.
Minor adverse impact	With return flow, channel has some instability for flows up to the 2-year return where the channel is currently stable. Substrate change to Lake Michigan of fewer than 10 acres.
Moderate adverse impact	With return flow, channel has frequent instability for flows up to the 2-year return where the channel is currently stable. Substrate change to Lake Michigan of greater than 10 but less than 20 acres.
Significant adverse impact	With return flow, channel is unstable at most flows where the channel is currently stable. Substrate change to Lake Michigan of greater than 20 acres.

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 alternative indicates that the Fox River would receive 2.4 mgd less flow. The small cold water streams Pebble Brook, Pebble Creek, and Mill Brook would also experience baseflow reduction from groundwater pumping, with Pebble Brook experiencing a baseflow reduction of 61 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 5.9 mgd less flow. The small cold water

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51 MMSD. *Root River Sediment Transport Planning Study*. May 4, 2007. Hydraulics Technical Memorandum 6. Page 1.

streams Pebble Brook, Pebble Creek, and Mill Brook would also experience baseflow reduction from groundwater pumping, with Pebble Brook experiencing a baseflow reduction of 58 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 Mchigan Water Supply (Cities of Mlwaukee, Oak Creek, 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.

TABLE 6-27
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)	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	No adverse impact
Direct to Lake Michigan	No adverse impact

Underwood Creek to Lake Mchigan 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 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 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 Mchigan 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 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.

Direct to Lake Mchigan 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.

6.3.2.5 Flora and Fauna

6.3.2.5.1 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.[52]

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.[53] These impairments

52 http://dnr.wi.gov/master_planning/land_legacy/documents/seglacial.pdf. Accessed December 19, 2011.

53 http://dnr.wi.gov/org/water/wm/wqs/303d/303d.html. Accessed January 19, 2010.

result in a loss of habitat within the waterway and water temperature fluctuations.[54]

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 6.3.3 on 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 (2011). 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 6-28). Figure 6-5 shows the sampling locations relative to the WWTP. Fishery surveys were conducted in 1999, 2000, 2003, 2004, and 2006 (Table 6-29).

The surveys identified 36 species of fish (Table 6-29). 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 6-28
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, 2002).

54 *The State of the Southeast Fox River Basin*, a report by the WDNR in cooperation within the Southeast Fox River Basin Land and Water Partners Team, February 2002, PUBL WT-701-2002.

FIGURE 6-5
Approximate Fish Sampling Locations Relative to the Waukesha WWTP

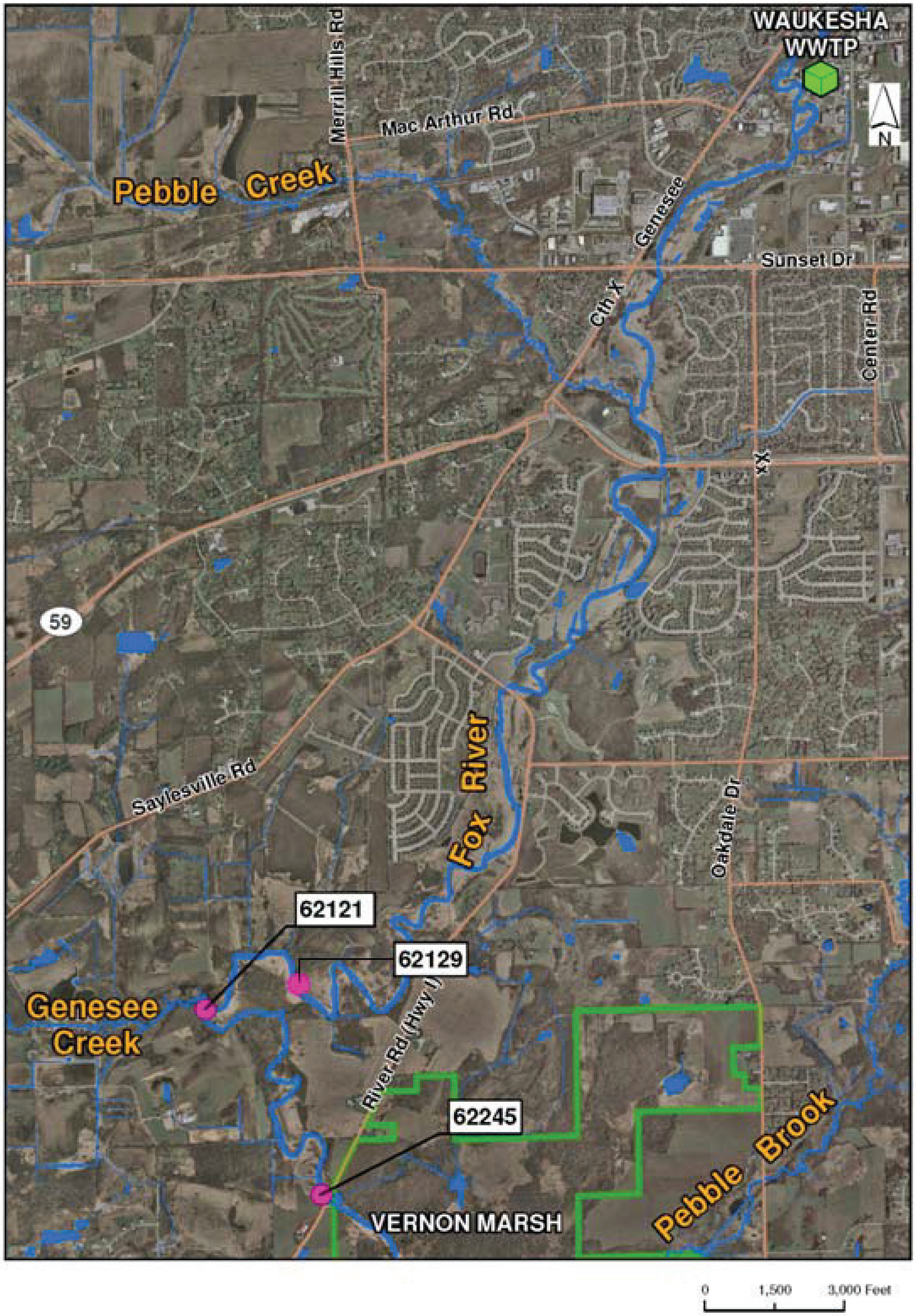

TABLE 6-29
Fisheries Data from WDNR Surveys in the Fox River Downstream of the Waukesha WWTP

	WDNR Site Numbers			
Species	**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

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 Department of Parks 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).

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, 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, 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 (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 Alternatives Summary (Appendix F 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 Appendix H of the Application. Table 6-30 lists the dominant fish species.

TABLE 6-30
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

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. 200–214). 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.

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 Alternatives Summary (Appendix F of the Application) and here.

Fishery data for in the Root River watershed show that 10 new species have been identified, but 10 of 64 recorded species have not been observed since 1986 (SEWRPC, 2007, pp. 200–14). The most recent fishery surveys, conducted in 2004 and 2007 by the USGS, identified 17 species in the Root River near the proposed return flow location. 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 that of the Menomonee River watershed. Macroinvertebrate data collected within the Root River watershed suggest that the river is dominated by species tolerant of a low-quality habitat. Most species within the fish and macroinvertebrate communities generally indicate fair habitat quality.

With the potential presence of one state-listed endangered and three state-listed threatened fish species, there appear 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.

6.3.2.5.2 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 less than 2 inches 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 6.3.3.

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 6.3.3) 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 6.3.2.2. 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 Mchigan Supply (Cities of MIlwaukee, Oak Creek, 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, and Direct to Lake Mchigan 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 6.3.2.2). 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 Appendix H 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 always less than 2 inches 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 6-31) and threatened and endangered species (Tables 6-32 and 6-33) generally would still be met. Table 6-32 includes cold water and threatened and endangered species found during surveys used for this analysis. Table 6-33 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.

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 base flow 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.

TABLE 6-31
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 redhorse	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 6-31
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 6-32
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	Quit 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 6-33
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 redhorse (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/

Impacts to flora and fauna are closely associated with baseflow changes. Consequently, the information below is consistent with that found in Section 6.3.2.2 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 (see the groundwater modeling attachment to the Water Supply Service Area Plan, Appendix B of the Application) found that average groundwater baseflows to these cold water streams could decrease significantly. For example, groundwater baseflow to Pebble Brook would be reduced by 61 percent, to Pebble Creek by 9 percent, and to Mill Book by 29 percent. The baseflow reductions could have a significant adverse impact to the flow in the channels (especially Pebble 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 (see the groundwater modeling attachment to the Water Supply Service Area Plan, Appendix B of the Application) found that average groundwater baseflows to these cold water streams could decrease significantly, more than under the Deep and Shallow Aquifer alternative. For example, groundwater baseflow to Pebble Brook would be reduced by 58 percent, to Pebble Creek by 23 percent, and to Mill Book by 30 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 Pebble 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 Mchigan 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 Mchigan 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 Mchigan Return Flow

An analysis of potential Underwood Creek habitat changes from an increase in flow from return flow was documented in Appendix H. The analysis found that the estimated increase in water surface elevation with a return flow of 20 cubic feet per second (ft^3/sec) (12.9 mgd) was 0.78 foot at 2 cross section survey sites (Appendix H). The estimated average velocity at base flow for these locations was 0.85 ft/sec. With a return flow range of 11.6 to 20 ft^3/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 Appendix J 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 6-34 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 (Wisconsin Department of Natural Resources, 2009) and the WDNR Animals, Plants, and Natural Communities Database identified several threatened, endangered, or species of special concern in Underwood Creek area (Table 6-35). Because of the physical habitat limitation within Underwood Creek noted in Section 6.3.2.2, it is unlikely any of these species would be present.

Return flow will increase the base flow, 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 Appendix H 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 base flows 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.
- Under base flow 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 macroinvertebate 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.

TABLE 6-34
Habitat Characteristic for Dominant Fish Species in Underwood Creek and Menomonee River Near Underwood Creek

Dominant Fish Species	Preferred Current Velocity[a]	Stream Gradient	General Habitat Characteristics	Dominant Substrate Preference	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 6-34
Habitat Characteristic for Dominant Fish Species in Underwood Creek and Menomonee River Near Underwood Creek

Dominant Fish Species	Preferred Current Velocity[a]	Stream Gradient	General Habitat Characteristics	Dominant Substrate Preference	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.

TABLE 6-35
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/.

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, all of which are within the ordinary high water mark, no significant adverse impacts to emergent marsh, riparian species, or floodplain forests or the species that depend upon these habitats is expected.

Root River and Direct-to-Lake Mchigan 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 Mchigan Water Supply (Cities of Mlwaukee, 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 Mchigan 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 to Lake Mchigan Return Flow

A return flow to Root River is expected to improve aquatic habitat, similar to an Underwood Creek discharge location as discussed above. The greatest benefits will occur during low flow conditions in the river, when the return flow contributes the greatest portion of flow. The same as an Underwood Creek return flow, a return flow to the Root River will have a beneficial effect on the aquatic habitat, especially during low flow conditions in the river.

Direct to Lake Mchigan 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.

6.3.2.5.3 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 base flow changes. Base flow changes have been previously documented in the Section 6.3.2.2 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 6.3.3 on Wetlands, since most of the potential impacts involve federal- or state-listed species associated with wetlands.

6.3.3 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.

6.3.3.1 Location, Type, Size

6.3.3.1.1 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 6-36 lists the wetlands crossed by the supply and return flow alternatives. Refer to the maps found in Attachment 3-1 of Section 3 and to Attachment 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 6-37 lists wetlands that would be affected by the pipeline or aboveground structure construction.

Wetlands affected by groundwater pumping were determined from groundwater modeling results. Groundwater modeling is documented in the groundwater modeling attachment to the Water Supply Service Area Plan, Appendix B of the Application. The wetlands affected by 5 foot or greater or 1 foot or greater groundwater drawdown are shown in Attachment 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.

6.3.3.1.2 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.

TABLE 6-36
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

TABLE 6-36
Wetland Crossings

Alternative	Wetland No.	Wetland Type	Crossing Width (ft)	Crossing Area (acres)
	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
	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

TABLE 6-36
Wetland Crossings

Alternative	Wetland No.	Wetland Type	Crossing Width (ft)	Crossing Area (acres)
	12650	Forested	—	0.15
	12660	Forested	—	0.01
Lake Michigan (City of Oak Creek)	4965	Scrub/shrub	—	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
	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

TABLE 6-36
Wetland Crossings

Alternative	Wetland No.	Wetland Type	Crossing Width (ft)	Crossing Area (acres)
	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
	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 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

TABLE 6-36
Wetland Crossings

Alternative	Wetland No.	Wetland Type	Crossing Width (ft)	Crossing Area (acres)
	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
	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

TABLE 6-36
Wetland Crossings

Alternative	Wetland No.	Wetland Type	Crossing Width (ft)	Crossing Area (acres)
	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
	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

TABLE 6-36
Wetland Crossings

Alternative	Wetland No.	Wetland Type	Crossing Width (ft)	Crossing Area (acres)
	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
	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	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

TABLE 6-36
Wetland Crossings

Alternative	Wetland No.	Wetland Type	Crossing Width (ft)	Crossing Area (acres)
	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
	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
Direct to Lake Michigan	7962	Emergent/wet meadow	—	1.38
	7970	Emergent/wet meadow	—	0.00
	8015	Emergent/wet meadow	—	0.17

TABLE 6-36
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

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.

Wetland crossing acreages associated with each of the alternatives are discussed below and summarized in Table 6-37. 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 6.4.1.2, "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 Attachment 6-4, Vernon Marsh Wildlife Area Wetland Habitat Impact Analysis. Table 37 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 Attachment 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.

(Acres)

	Wetlands									
	Emergent/Wet Meadow		Scrub/Shrub		Forested		Open Water		Other[3]	
	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)
[4]	4	2	5	1	2	1	0	0	<1	0
water	710	710	1,294	1,294	932	932	89	89	62	62
water	241	241	419	419	307	307	11	11	14	14
	714	712	1,299	1,295	934	933	89	89	63	62
lluvium										
[4]	4	2	7	2	11	3	0	0	<1	0
water	1,079	1,079	1,558	1,558	1,279	1,279	103	103	87	87
water	475	475	871	871	548	548	37	37	33	33
vium	1,083	1,081	1,565	1,560	1,290	1,282	103	103	88	87
es										
[7]	1	0	2	<1	4	1	<1	0	0	0
[7]	3	0	4	1	6	1	<1	0	0	0
	16	0	22	4	7	1	2	0	6	0
n[7]	2	0	2	0	5	1	<1	0	0	0
	2	0	3	<0.1	7	1	<1	0	0	0
	2	0	2	0	1	<1	<1	0	<1	0

ily impacted by the construction of the supply and return flow alternatives. Total values are slightly different due to rounding.

permanently for groundwater drawdowns and the operation of the alternatives, which includes new access roads, new aboveground structures, and pipeline maintenance corridors. Total values are slig

and flats/unvegetated wet soil areas.

access roads (15 feet wide), well houses, and WTP.

r Groundwater Drawdown is contained within the Areas of the 1-Foot or Greater Groundwater Drawdown.

Structures and Areas of 1-Foot or Greater Groundwater Drawdown.

s follow previously disturbed areas and maintained utility corridors. Forested wetlands are generally not present in maintained utility corridors. Potential permanent wetland impacts are consequently co
mental Report are consequently estimated to be less than 5 acres, minor adverse impact.

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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 6-37, 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 6-37. 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.

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 6-37, 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 6-37. 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 Mchigan 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 6-37, 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 Mchigan Water Supply (City of Oak Creek)

Twelve PEM, 21 PSS, 20 PFO, and 3 open-water wetlands along this alternative could be affected by pipeline construction. As shown in Table 6-37, 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 Mchigan Water Supply (City of Racine)

Twenty-nine PEM, 29 PSS, 16 PFO, 4 filled/drained, 8 flat/unvegetated soil, and 6 open-water wetlands along this alternative could be affected by pipeline construction. As shown in Table 6-37, 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 Mchigan Return Flow

Five PEM, 10 PSS, and 6 PFO wetlands along this alternative could be affected by pipeline construction. As shown in Table 6-37, 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 Mchigan Return Flow

Eight PEM, 13 PSS, 15 PFO, and 1 open-water wetland along this alternative could be affected by pipeline construction. As shown in Table 6-37, 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.

Direct to Lake Mchigan Return Flow

Seven PEM, 11 PSS, 6 PFO, 1 open-water, and 1 filled/drained wetland along this alternative could be affected by pipeline construction. As shown in Table 6-37, 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 Mnimization

Based on the results of the groundwater modeling study completed, 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 in the groundwater modeling attachment to the Water Supply Service Area Plan (Appendix B of the Application), 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 Attachment 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 Attachment 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 affects 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.

6.3.3.1.3 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 6-38. Table 6-39 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 6-38
Environmental Impact Category Description: Wetlands

No adverse impact	No temporary or operational impacts to existing wetlands greater than 0.1 acre.
Minor adverse impact	Temporary construction impacts to wetlands. Operational impacts of greater than 0.1 acre but less than 5 acres of existing wetlands.
Moderate adverse impact	Operational impacts of greater than 5 but less than 10 acres of existing wetlands.
Significant adverse impact	Operational impacts of more than 10 acres of existing wetlands.

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.

TABLE 6-39
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)	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	Minor adverse impact
Direct to Lake Michigan	Minor adverse impact

Lake Mchigan Water Supply (Cities of MIwaukee and Oak Creek)

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 Mchigan 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 Mchigan

For any return flow alternative, there would be approximately 1 acre of permanent wetland impacts in the form of wetland type changes. This would be a minor adverse impact.

6.3.3.2 Flora and Fauna

6.3.3.2.1 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 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.[55]

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.[56]

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), no vegetation communities of special concern or critical habitat occur within the construction workspaces associated with the supply and return flow alternatives.

WDNR (2010c) identified vegetation communities of special concern (referred to as "natural communities") that may occur within the supply and return flow alternative 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, 2010a):

Southern dry mesic forest
Southern mesic forest
Southern dry forest
Mesic prairie
Wet prairie
Calcareous fen
Shrub-carr
Southern tamarack swamp
Northern wet forest
Floodplain forest

55 http://dnr.wi.gov/landscapes/pdfs/Wet.pdf. Accessed December 19, 2011.

56 http://dnr.wi.gov/org/land/er/communities/index.asp?mode=group&Type=Wetland. Accessed December 19, 2011.

Emergent marsh	Springs and spring runs
Southern sedge meadow	Warm-water stream
Oxbow lake	Bird rookery

A habitat assessment was completed in July 2010 (CH2M HILL 2010c, Attachment 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. 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, orhigh potential suitability was used. There has been no confirmed presence of a bird rookery for any of the alternatives. Attachment 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. Attachment 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 Attachment 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. Attachment 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. Attachment 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. Attachment 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. Attachment 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. Attachment 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. Attachment 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. Attachment 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. Attachment 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. Attachment 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. Attachment 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. Attachment 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. Attachment 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. Attachment 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. Attachment 6-5, Exhibit 5 contains the relative comparison of potential southern tamarack swamp 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 Menomonee River.

At the Root River 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.

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 floodplain forest, emergent marsh, and warm-water streams 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 Attachment 6-5 with a relative comparison summary in Table 6-40.

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), no federally listed threatened or endangered species occur near the supply and return flow alternatives being evaluated. 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) identified several State listed species as potentially occurring near the proposed supply and return flow alternatives.

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 6.3.2.2.2, 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 6.3.2.5.2 discusses fish species in the Fox River.

Once a final water supplier has been negotiated and a return flow location has been approved, 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 Attachment 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, 2010d).

6.3.3.2.2 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. Attachment 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 GIS data received from the WDNR, supplemented by the findings from the 2010 field observations, 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 Attachment 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 Attachment 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 6-40 summarizes the relative impact ratings ranked "high," whereby impacts would occur for each water supply and return flow alternative.

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 6-41), the most significant impacts would be from groundwater supply alternatives.

TABLE 6-40
Summary of Natural Community High Suitability Ratings

Alternative	High Suitability Ratings (Out of 16 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)	1
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	0
Direct to Lake Michigan	0

The comparison of impacts to natural communities was not carried forward because the analysis was similar 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 6.3.3). Impacts also occur to cold water streams from groundwater drawdown and this is documented under (see Section 6.3.2.2).

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.

TABLE 6-41
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)	1	2
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	1	2
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.

Impacts to Endangered and Threatened Species

Based on the consultation response from USFWS (2010), no impacts to federally listed species or critical habitat are expected. 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 6.4.1.2, Table 6-46, 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 habitat assessment report is included as Attachment 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.

Attachment 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, and agriculture. The dominant land uses affected by the groundwater alternatives, including the groundwater drawdown area, are agricultural, residential, and wetlands.

Table 6-41 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.

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 Attachment 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. Attachment 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 6-42 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 6-42
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%	61
Shallow Aquifer and Fox River Alluvium[b]	9%	8%	19%	61%	61
Lake Michigan (City of Milwaukee)	10%	14%	14%	57%	36
Lake Michigan (City of Oak Creek)	11%	14%	14%	57%	52
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	12%	15%	13%	54%	35
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, Attachment 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

Attachment 6-5, Exhibit 9 and Table 6-42 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 Attachment 6-5, Exhibit 6 and summarized in Table 6-37) 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 a final water supplier has been negotiated and a return flow location approved, 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 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 Section 6.4.1.2.5, Table 6-50). 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, discussed in the groundwater modeling attachment to the Water Supply Service Area Plan (Appendix B of the Application), shows groundwater level drawdown associated with this alternative. Drawdown relative to the VWA is shown in the maps in Section 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 6.3.3.

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 Section 6.4.1.2.5, Table 6-50). 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, discussed in the groundwater modeling attachment to the Water Supply Service Area Plan (Appendix B of the Application), shows groundwater level drawdown associated with this alternative. Drawdown relative to the VWA is shown in the maps in Attachment 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 6.3.3.

Lake Michigan Water Supply (Cities of Milwaukee, Oak Creek, 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.

6.3.3.2.3 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[57]

Affected Environment

The proposed project and alternatives to the proposed project have impacts upon wetlands. The wetland impacts, summarized in Section 6.3.3, vary from 2 acres for the Lake Michigan–Milwaukee Supply alternative with return flow to Underwood Creek, to over 4,000 acres for the Shallow Aquifer and Fox River Alluvium alternative, which has impacts from groundwater drawdown.

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57 (Wetland Functional Values, WDNR, http://dnr.wi.gov/wetlands/function.html, Accessed January 20, 2012)

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 6-37. The groundwater alternatives also have operational impacts to wetlands caused by groundwater drawdown, as described in Table 6-37.

6.3.4 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).

6.3.4.1 Aquifers and Water Use

6.3.4.1.1 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, Appendix B 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 give 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.[58] 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 13 percent of their annual water supply from this aquifer. The Water Supply Service Area Plan (Appendix B 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 to 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,[59] the deep aquifer has been drawn down 500 to 600 feet, with continued drawdown in recent years of 5 to 9 feet per year.[60]

Near Waukesha, recharge of this aquifer occurs further west where the Maquoketa shale does not exist. Figures 6-6 through 6-8 illustrate the constraints limiting recharge of the deep aquifer near the City of Waukesha.

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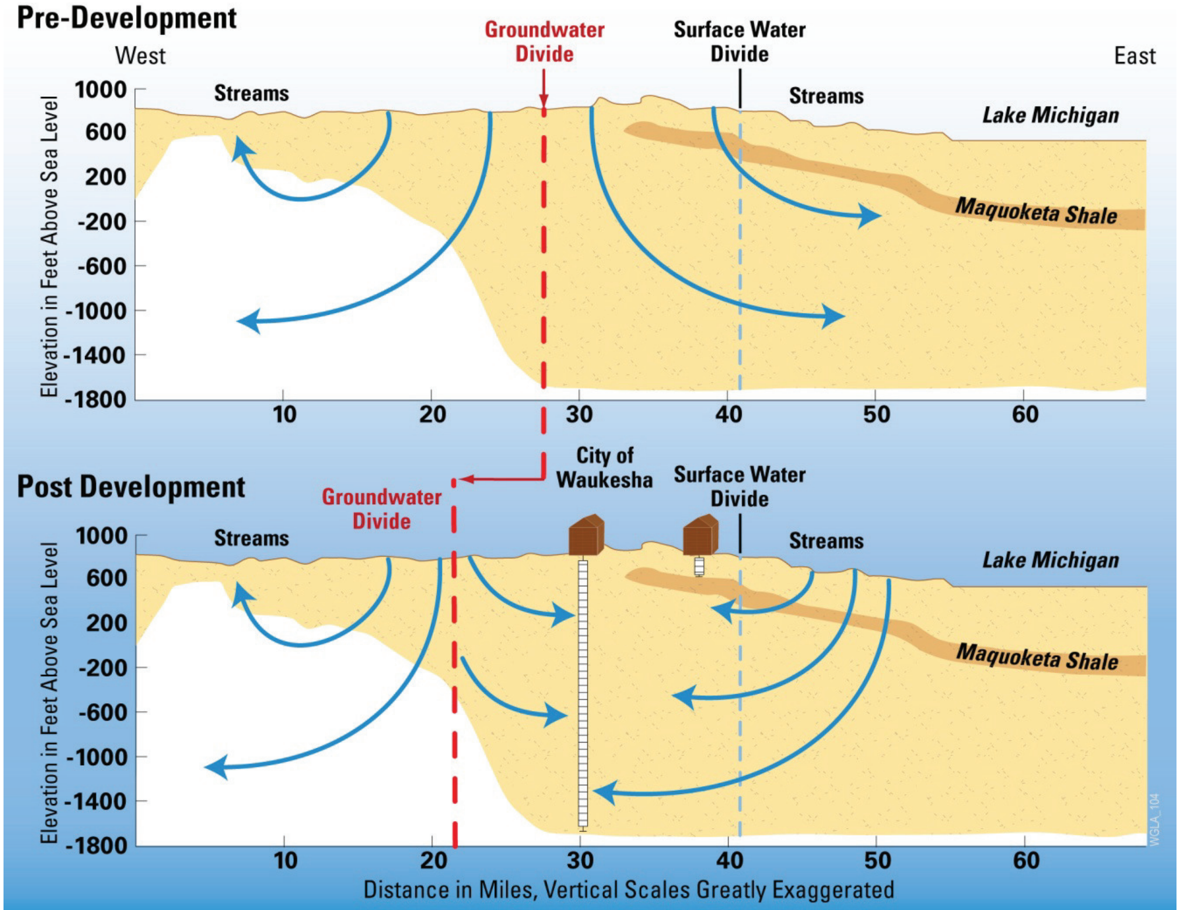
[58] SEWRPC. January 2010. Southeastern Wisconsin Regional Planning Commission Report No. 188.

[59] SEWRPC. 2008. Draft Planning Report on Regional Water Supply Plan for Southeastern Wisconsin. pp. 102–103.

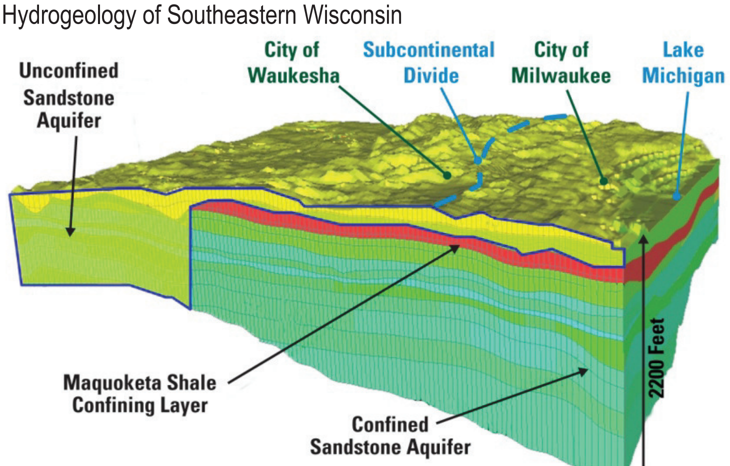
[60] Waukesha Water Utility operating data.

FIGURE 6-6
Flow of Groundwater in the St. Peter Sandstone Deep Aquifer



Adapted from: Effect of Pumping On Ground-water Divides In The Deep Sandstone In Southeastern Wisconsin, U.S. Geological Survey, J.T.Krohelski and D.T. Feinstein

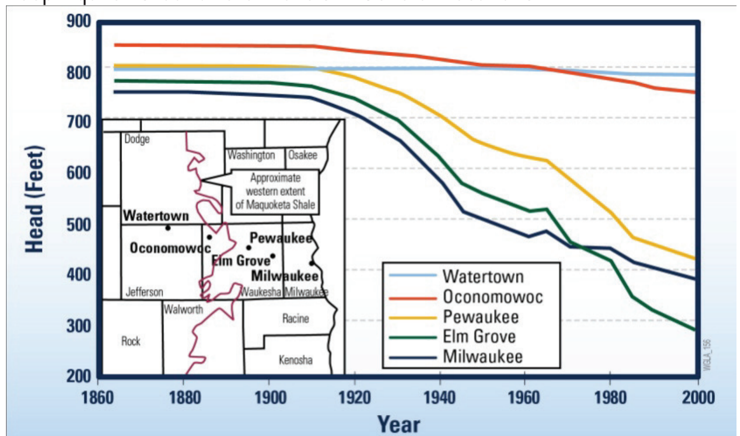
FIGURE 6-7
Hydrogeology of Southeastern Wisconsin



Source: Adapted from Ken Bradbury, Wisconsin Geological and Natural History Survey

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 6-8
Deep Aquifer Groundwater Levels in Several Locations



Water levels in the deep sandstone aquifer at selected locations. Curves represent simulated hydraulic heads (in feet above sea level) near the top of the deep aquifer (St. Peter Formation).
Source: SEWRPC Regional Water Supply Study

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 6.3.3.2.1.

6.3.4.1.2 Environmental Effects

Potential impacts to the aquifers present near the supply and return flow alternatives 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 36-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 WPTs 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 13 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.

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 (described in the groundwater modeling attachment to the Water Supply Service Area Plan, Appendix B of the Application), was developed to simulate groundwater flow and capacity of the shallow aquifer. 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 6.3.2.2.

Groundwater flow to the Fox River would be intercepted and flow from the Fox River reduced, for a total change of 2.4 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 61 percent, to Pebble Creek by 9 percent, and to Mill Book by 29 percent. The largest reduction of groundwater flow to a trout stream is 2.1 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 Attachment 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, Appendix B 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 (described in the groundwater modeling attachment to the Water Supply Service Area Plan, Appendix B of the Application), was developed to simulate the groundwater flow and capacity of the shallow aquifer. 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 6.3.2.2.

Groundwater flows to the Fox River would be intercepted, and flow from the Fox River would be reduced for a total change of 5.9 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 58 percent, to Pebble Creek by 23 percent, and to Mill Book by 30 percent. The largest reduction of groundwater flow to a trout stream would be 2.0 mgd from Pebble Brook. Groundwater flow reduction to Mill Brook would be roughly the same, but flow reduction to Pebble Creek increases under this alternative. The spatial extent over which groundwater drawdown of 5 feet or greater and of 1 foot or greater is shown in Attachment 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 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.

Lake Mchigan Water Supply (City of Oak Creek)

The Lake Michigan–Oak Creek Supply alternative will have the same effects on groundwater resources as the Milwaukee Supply alternative.

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

Root River to Lake Mchigan Return Flow

The Root River to Lake Michigan return flow alternative would have the same effects on regional groundwater resources as the Underwood Creek return flow alternative.

Direct to Lake Mchigan 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 affects 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 draw down 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, Appendix B of the Application, long-term water withdrawal from the deep and shallow aquifers would continue to draw down 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, Appendix B 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 Mchigan 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 Mchigan Water Supply (City of Oak Creek)

The Lake Michigan–Oak Creek Supply alternative would have the same effects on groundwater resources as the Milwaukee Supply alternative.

Lake Mchigan 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 Mchigan 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 Mchigan Return Flow

The Root River to Lake Michigan return flow alternative would have the same effects on regional groundwater resources as the Underwood Creek return flow alternative.

Direct to Lake Mchigan 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 affects 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 Attachment 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 Attachment 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 Mchigan Water Supply (City of MIwaukee)

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 Mchigan Water Supply (City of Oak Creek)

The Lake Michigan–Oak Creek Supply alternative would have the same effects on springs as the Milwaukee Supply alternative.

Lake Mchigan 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 Mchigan Return Flow

The Underwood Creek to Lake Michigan return flow alternative impacts to springs are expected to be insignificant.

Root River to Lake Mchigan Return Flow

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.

Direct to Lake Mchigan Return Flow

The Direct to Lake Michigan return flow alternative impacts to springs are expected to be insignificant

6.3.4.1.3 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 6-43. Table 6-44 summarizes the impacts to groundwater.

TABLE 6-43
Environmental Impact Category Description: Groundwater Resources

No adverse impact	Causes rebound of the deep aquifer in City of Waukesha and no drawdown of the shallow aquifer or temporary impacts from construction. Does not reduce stream at any time.
Minor adverse impact	Stabilizes draw down of the deep aquifer in City of Waukesha and shallow aquifer draw down of 5 feet or less affects fewer than 5 acres of wetlands. Reduced baseflow in warm water streams of up to 25% causing habitat loss.
Moderate adverse impact	Drawdown of the deep aquifer continues, and shallow aquifer drawdown of 5 feet or more affects greater than 5 but less than 10 acres of wetlands. Reduced baseflow in warm water streams of greater than 25% but less than 50%, causing habitat loss. Reduced baseflow to cold water streams, but less than 25%.
Significant adverse impact	Drawdown of the deep aquifer continues or shallow aquifer drawdown of 5 feet or more affects greater than 10 acres of wetlands. Reduced baseflow in cold water streams of 25% or more or reduced baseflow in warm water streams of 50% or more.

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 various streams. Groundwater modeling of the alternative indicates that the Fox River would experience 2.4 mgd less flow. The reduction of baseflow to the Fox River from groundwater pumping would be a minor adverse impact.

TABLE 6-44
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)	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	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 61 percent reduction in Pebble 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 5.9 mgd less flow. 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 Pebble Brook experiencing a baseflow reduction of 58 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, and Racine)

The Lake Michigan water supply alternatives would eliminate the need for pumping the deep aquifer, which would cause a partial rebound in the deep aquifer in the City of Waukesha. Due to 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 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 Return Flow

Because of the small change in the Lake Michigan tributary water depth with return flow, this alternative is not anticipate 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.

6.3.4.2 Groundwater Quality

6.3.4.2.1 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, Appendix B 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 (piC/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[61]. 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 because 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

61 http://dnr.wi.gov/org/water/dwg/radium.htm accessed Feb 4, 2012.

(RR) Program and has a Web-based mapping system—RR Sites Map[62]—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, 2010b) 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—three closed groundwater and soil 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
- 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 5,070 environmental repair (ERP) and leaky underground storage tank (LUST) sites, Racine County has approximately 792 ERP and LUST sites, and Waukesha County has approximately 1,616 ERP and LUST sites (WDNR, 2010c).

6.3.4.2.2 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

[62] http://www.dnr.state.wi.us/org/aw/rr/gis/.

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 would 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.

6.3.4.2.3 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 6-43. Consequently, no additional comparison of groundwater quality for water supply and return flow alternatives is provided.

6.4 Terrestrial Resources

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

6.4.1 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 Attachment 3-1 of Section 3 and Attachment 6-1 at the end of this Section.

6.4.1.1 Surficial and Bedrock Geology

6.4.1.1.1 Affected Environment

The maps in Attachment 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, 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 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, 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).

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, 2010a).

Racine County is dominated by clay deposits, with narrow strips of sand/gravel deposits streaking the county (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).

6.4.1.1.2 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.

6.4.1.2 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.

6.4.1.21 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 6-45 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 6.3.3 on natural communities and wetland impacts.

6.4.1.22 Environmental Effects

Table 6-46 (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 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 6-46 uses SEWRPC landuse data. The SEWRPC wetland landuse data is different from the WWI wetland data. Consequently, wetland acreage is different between Table 6-37 and Table 6-46. WWI wetland data was used for wetland analysis while SEWRPC wetland data was used for landuse analysis.

TABLE 6-45
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)	230.2[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	141.4	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.

TABLE 6-46
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	**122.2**
Lake Michigan (City of Oak Creek)[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 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[b]	1.61	2.31	92.18	0.92	9.14	0.00	19.68	1.18	0.17	14.23	**141.42**
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.

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 6-47 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 6-47 consider agriculture in the estimate for utility corridor use.

TABLE 6-47
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)	26	70
Lake Michigan (City of Racine)	59	69
Underwood Creek to Lake Michigan	50	74
Root River to Lake Michigan	36	66
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.

Once an alternative has been selected 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.

6.4.1.2.3 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 6-48 summarizes proposed new access roads for each alternative.

TABLE 6-48
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)	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	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.

6.4.1.2.4 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 6-49 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 6-49
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 proposed[b]	—
Lake Michigan (City of Oak Creek)	1 proposed[b]	—
Lake Michigan (City of Racine)	1 proposed[b]	—
Return Flow Alternatives for Lake Michigan Water Supplies		
Underwood Creek to Lake Michigan	Pump station[c]	—
Root River to Lake Michigan	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 of impact and will be sited to minimize impacts.
[c] Will be constructed within the Waukesha WWTP site, in a previously disturbed area.

6.4.1.2.5 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 if possible. 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 0.10 mile of the respective alternative alignments. Table 6-50 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

TABLE 6-50
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
	Root River Parkway	21.28
Lake Michigan (City of Oak Creek)	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 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

TABLE 6-50
Public or Conservation Lands within or Adjacent to the Alternatives

Alternative Name	Name of Resource	Acres within Proposed 75-ft Construction Workspace
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	Bethesda Springs Park	0.30
	Carroll College athletic fields	0.28
	Fox River Sanctuary	2.48
	Greenfield Park	0.17
	New Berlin Hills Golf Course	1.00
	Root River Parkway	43.99
Direct to Lake Michigan	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).

- 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

A review of Google Earth (2009) 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 6.3.3.2.2 and Attachment 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.

6.4.1.2.6 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 6-51. Table 6-52 summarizes the impacts to land use.

TABLE 6-51
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.

TABLE 6-52
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)	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	No adverse impact
Direct to Lake Michigan	No adverse impact

6.4.1.3 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.

6.4.1.3.1 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 6-53 through Table 6-60 contain specific information on soil characteristics and limitations for the supply and return flow alternatives.

6.4.1.3.2 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 6.4.1.2 on Land Use and Table 6-46. 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

6-53), but actual land in active agriculture use is much less (Table 6-46). 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 6-54), but actual land in active agriculture use is much less (Table 6-46). Land uses other than agricultural exist on most of the remaining soil that is prime farmland.

TABLE 6-53
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

TABLE 6-53
Prime Farmlands Crossed by the Deep and Shallow Aquifers Supply Alternative

Prime Farmland Soil Series	Soil Series Description	Acres Crossed
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 6-54
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

TABLE 6-54
Prime Farmlands Crossed by the Shallow Aquifer and Fox River Alluvium Alternative

Prime Farmland Soil Series	Soil Series Description	Acres Crossed
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 Mchigan Water Supply (City of MIwaukee)

This alternative would affect prime farmland (Table 6-55), but the actual land use of such land is other than agricultural.

TABLE 6-55
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

TABLE 6-55
Prime Farmlands Crossed by the Lake Michigan (City of Milwaukee) Alternative

Prime Farmland Soil Series	Soil Series Description	Acres Crossed
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 Mchigan Water Supply (City of Oak Creek)

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 6-56), 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 6-56
Prime Farmlands Crossed by the Lake Michigan (City of Oak Creek) 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
BlA	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

TABLE 6-56
Prime Farmlands Crossed by the Lake Michigan (City of Oak Creek) Alternative

Prime Farmland Soil Series	Soil Series Description	Acres Crossed
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 Mchigan 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 6-57), but actual active agricultural is much less. Land uses other than agricultural exist on most of the remaining soil classified as prime farmland.

TABLE 6-57
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
BlA	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

TABLE 6-57
Prime Farmlands Crossed by the Lake Michigan (City of Racine) Alternative

Prime Farmland Soil Series	Soil Series Description	Acres Crossed
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
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

TABLE 6-57
Prime Farmlands Crossed by the Lake Michigan (City of Racine) Alternative

Prime Farmland Soil Series	Soil Series Description	Acres Crossed
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**

Underwood Creek to Lake Mchigan Return Flow

This alternative would affect soil classified as prime farmland (Table 6-58), but actual active agriculture is much less. Land uses other than agricultural exist on all the remaining soil classified as prime farmland.

TABLE 6-58
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

TABLE 6-58
Prime Farmlands Crossed by the Underwood Creek to Lake Michigan Return Flow Alternative

Prime Farmland Soil Series	Soil Series Description	Acres Crossed
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**

Root River to Lake Mchigan Return Flow

This alternative would affect soil classified as prime farmland (Table 6-59), but none is used actively for agriculture. Land uses other than agricultural occur on all the remaining soil classified as prime farmland.

TABLE 6-59
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

TABLE 6-59
Prime Farmlands Crossed by the Root River to Lake Michigan Return Flow Alternative

Prime Farmland Soil Series	Soil Series Description	Acres Crossed
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**

Direct to Lake Mchigan Return Flow

This alternative would affect soil classified as prime farmland (Table 6-60), but none is used actively for agriculture. Land uses other than agricultural occur on all the remaining soil classified as prime farmland.

TABLE 6-60
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

TABLE 6-60
Prime Farmlands Crossed by the Direct to Lake Michigan Return Flow Alternative

Prime Farmland Soil Series	Soil Series Description	Acres Crossed
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**

6.4.1.3.3 Environmental Effects Comparison: Soils

Adverse impacts from changes to soils are summarized below for each alternative. 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 6-61. The impacts to soils are summarized in Table 6-62.

TABLE 6-61
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.

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.

TABLE 6-62
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)	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	No adverse impact
Direct to Lake Michigan	No adverse impact

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.

Lake Mchigan Water Supply (Cities of MIlwaukee, Oak Creek, 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, or Direct to Lake Mchigan Return Flow

There would be no significant aboveground structures with these alternatives and thus insignificant impacts to prime farmland. Consequently, there would be no adverse impacts.

6.4.2 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.

6.4.2.1 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 Attachment 3-1 of Section 3 and to Attachment 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 Attachment 3-1 of Section 3 and to Attachment 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 6.3.2.2.4.

- *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.[63]

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 6.3.3, Wetlands, since most of the impacts would be to wetlands.

The maps found in Attachment 3-1 of Section 3 and to Attachment 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 6-46 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.

6.4.2.1.1 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).

6.4.2.1.2 Hot Continental Division

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63 http://dnr.wi.gov/landscapes/index.asp?mode=detail&Landscape=12. Accessed December 19, 2011

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).

6.4.2.1.3 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).

6.4.2.1.4 Vegetation Communities of Special Concern

According to correspondence from the USFWS (2010), no vegetation communities of special concern or critical habitat occur within the construction workspaces associated with the supply and return flow alternatives.

WDNR (2010c) 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 6.3.3.2.1.

6.4.2.2 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 6-50). 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.

6.5 Air Quality

6.5.1 Affected Environment

The project area is located in an attainment area for carbon monoxide, lead, and sulfur dioxide. The project area is in a non-attainment area for particulate matter (PM/$PM_{2.5}$) and moderate non-attainment category for 8-hour ozone.[64]

6.5.2 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 6-63 compares the energy use and the greenhouse gas emissions of each alternative.

64 http://www.epa.gov/oaqps001/greenbk/ancl3.html accessed January 24, 2012.

TABLE 6-63
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	22,700	21,100
Shallow Aquifer and Fox River Alluvium	21,100	19,600
Lake Michigan (City of Milwaukee)	14,600	13,500
Lake Michigan (City of Oak Creek)	18,700	17,300
Lake Michigan (City of Racine)	17,400	16,100
Return Flow Alternatives for Lake Michigan Water Supplies		
Underwood Creek to Lake Michigan	2,200	2,100
Root River to Lake Michigan	1,900	1,800
Direct to Lake Michigan	2,100	2,000

The Lake Michigan water sources with return flow would 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.

6.6 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.[65] 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

[65] SEWRPC. 2010. *A Regional Water Supply Plan for Southeastern Wisconsin.* Planning Report No. 52

TABLE 6-64
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

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.

6.6.1 Population

6.6.1.1 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 6-64). 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, Appendix B of the Application).

6.6.1.1.1 Age

Based on the results of the 2010 census, the median age in Waukesha County is 42 (USCB, 2010a). Table 6-65 summarizes age statistics for the state, Waukesha County, and the City of Waukesha.

TABLE 6-65
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

6.6.1.1.2 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.

6.6.1.1.3 Heath 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.

6.6.1.1.4 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[66] 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. 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.

6.6.1.2 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.

6.6.2 Economy

6.6.2.1 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 6-66). 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 6-67 provides an overview of state, regional, and local leading industries (historic and present).

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[66] SEWRPC Technical Report No. 10 *The Economy of Southeastern Wisconsin* (July 2004) and SEWRPC Technical Report No. 11 *The Population of Southeastern Wisconsin* (July 2004).

TABLE 6-66
Waukesha and Regional Economy

	1960		1970		1980		1990		2000	
County	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 UW Milwaukee 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 (UW Madison 2010).[67]

6.6.2.1.1 Employment and Industry

As shown in Table 6-67, 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).

6.6.2.1.2 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).

[67] University of Wisconsin Milwaukee, Center for Economic Development. 2010. Chapter 3, page 15.

TABLE 6-67
Leading Industries in 2000 and 2010

	Industries											
	Manufacturing		Educational Services		Retail Trade		Recreation & Entertainment		Professional, Scientific, & Management		In Labor Force (population 16 years and older)	
Geography	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)

6.6.2.1.3 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 historic 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 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 6-67 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.

6.6.2.1.4 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 6-68), 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).

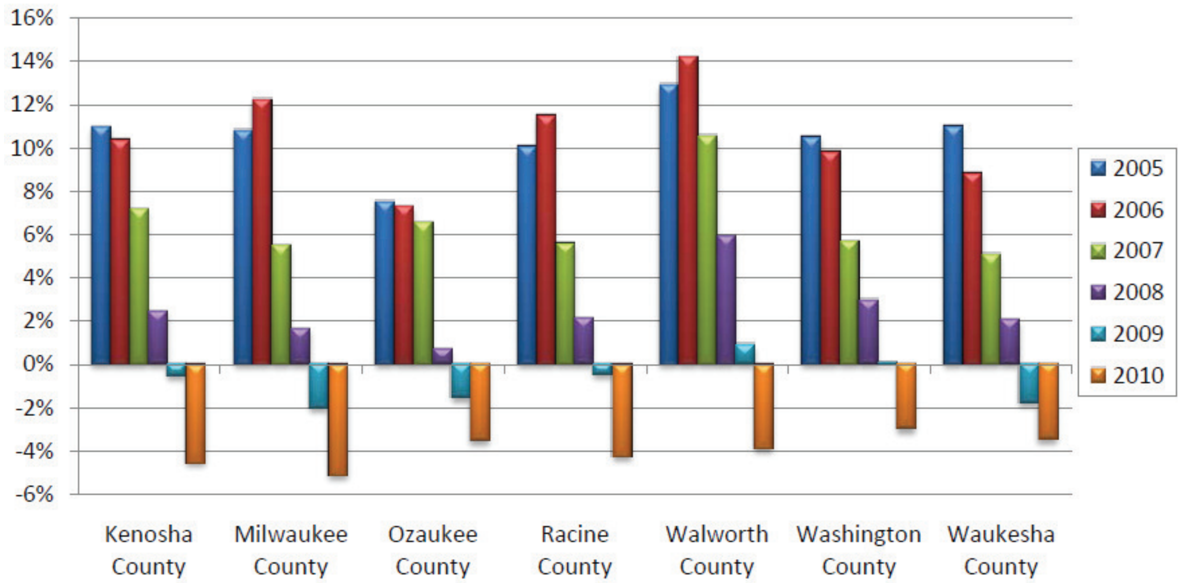
In recent years, property values in southeast Wisconsin have declined by at least 3 percent in each of the 7 counties (Public Policy Forum, 2011). Milwaukee County has seen the greatest decline. Figure 6-9 provides a visual representation of property value trends in southeast Wisconsin from 2005 to 2010.

TABLE 6-68
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 6-9
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 6-69 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" (PPF, 2011).

6.6.2.2 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, Appendix B 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.

TABLE 6-69
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

The CED study found that the source of water is not a differentiating factor on development within a municipal service area.[68] 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.

6.6.3 Land Use, Zoning, and Transportation

6.6.3.1 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 6-47).

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 6.4.1.3, 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.

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.

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68 University of Wisconsin Milwaukee, Center for Economic Development. 2010. Chapter 3, page 19.

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.

6.6.3.2 Land Use, Zoning, and Transportation Effects

6.6.3.2.1 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 6.4.1.2 of this environmental report provides a more detailed examination of existing land use. Table 6-45 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.

6.6.3.2.2 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.

6.6.3.2.3 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.

6.6.4 Energy Use

6.6.4.1 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.

6.6.4.2 Energy Use Effects

As described in Table 6-63, energy use and greenhouse gas emissions would be lower for of 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 similar energy requirements.

6.6.5 Recreation and Aesthetics

6.6.5.1 Affected Recreation and Aesthetics

6.6.5.1.1 Recreation

According to a review of Google Earth (2009) 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 6-51 for a list of public (nonfederal) parks, golf courses, and wildlife areas associated with the supply and return flow alternatives.

6.6.5.1.2 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.

6.6.5.2 Recreation and Aesthetics Effects

6.6.5.2.1 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 6.3.3 Wetlands.

6.6.5.2.2 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.

6.6.6 Archeological and Historical Resources

6.6.6.1 Affected Resources

6.6.6.1.1 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: 11 sites and 11 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: 9 sites and 2 surveys
- Direct to Lake Michigan: 17 sites and 7 survey

Attachment 5-3 contains additional information regarding potential sites.

6.6.6.1.2 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, 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 0.1 mile of the Lake Michigan–Milwaukee, Lake Michigan–Oak Creek, 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 (Google Earth, 2010; NHRP, 2010b). 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 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 (Google Earth, 2010; NHRP, 2010b).

6.6.6.2 Environmental Effects

6.6.6.2.1 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.

6.6.6.2.2 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.

6.6.7 Public Water Supply and Uses

6.6.7.1 Affected Public Water Supply and Uses

6.6.7.1.1 Groundwater

The City of Waukesha currently obtains more than 87 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.[69] These levels continue to drop 5 to 9 feet per year.[70] Reduced groundwater levels in southeastern Wisconsin have in turn affected regional surface waters, which now receive about 18 percent[71] less in groundwater contribution as water migrates toward the deep aquifer. 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 less than 13 percent of its water supply from the shallow aquifer. Increased pumping of the shallow aquifer will stress surface water resources by reducing base flows to local streams and wetlands.[72] Additional information on drawdown

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[69] *Draft Planning Report on Regional Water Supply Plan for Southeastern Wisconsin*, Southeastern Regional Planning Commission, 2008, pp.102–103.

[70] Waukesha Water Utility 2009 operating data.

[71] U.S. Geological Survey and Wisconsin Geological and Natural History Survey.

[72] *Draft Planning Report on Regional Water Supply Plan for Southeastern Wisconsin*, SEWPRC, 2008, pp. 8–14.

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 6.3.4.

6.6.7.1.2 Surface Water

The City is seeking a water supply of 10.9 million gallons per day (mgd) to meet future average day water demand 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.

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.[73]

6.6.7.1.3 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, foundaries, dairies.
- **Commercial.** Commercial water use is presented by customers such as retail, restaurants, office buildings, medical facilities, 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).

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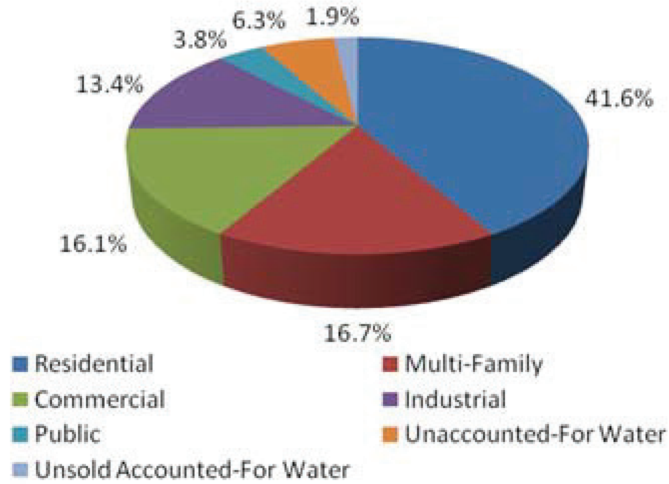
[73] http://www.dnr.state.wi.us/org/water/greatlakes/discover/lakemichigan.htm. Accessed March 4, 2010.

Water use by sector for 2010 is shown in Figure 6-10. 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.

FIGURE 6-10
Water Use by Customer Class: Waukesha Water Utility



Trends in water use annually over the 1999 to 2010 period are shown in Figure 6-11. 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 6-12 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 (CH2M HILL 2012).

FIGURE 6-11

Annual Water Use Trend by Customer Class: Waukesha Water Utility

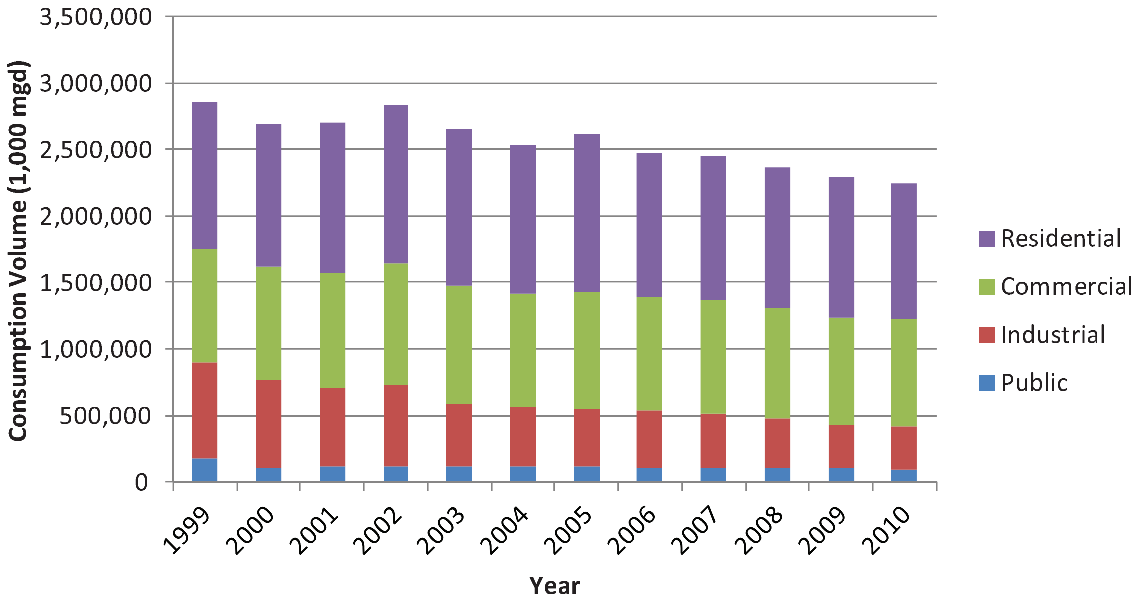
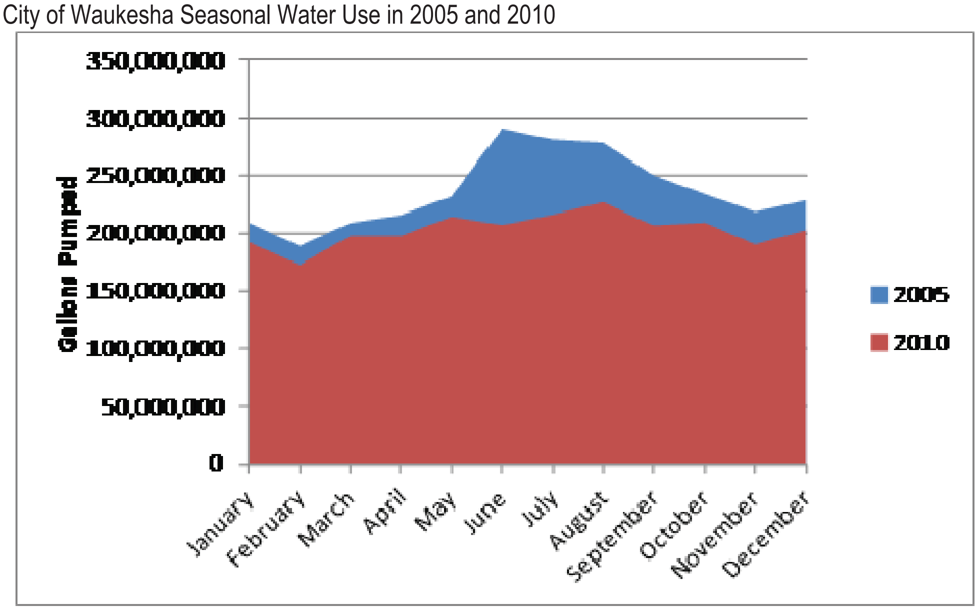


FIGURE 6-12

City of Waukesha Seasonal Water Use in 2005 and 2010



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

6.6.7.2 Public Water Supply and Use Effects

6.6.7.2.1 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 6.3.4. Groundwater drawdown affects wetland resources, as described in Section 6.3.3.1.2. 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.

6.6.7.2.2 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 (described in the groundwater modeling attachment to the Water Supply Service Area Plan, Appendix B of the Application) found average groundwater baseflows to the cold water streams (Pebble Brook, Pebble Creek, Mill Brook) could reduce significantly. These, as well as less significant baseflow reductions in the Fox River, are described in Inland Waterways, Section 6.3.2.2. 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.

Because of the volume of water present, withdrawal from Lake Michigan with return flow would result in no changes in lake volume. 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 would have no adverse impact on existing water supplies.

6.6.7.2.3 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.

6.6.8 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.

6.6.9 Safety

6.6.9.1 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.

6.6.9.2 Operation

6.6.9.2.1 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.

6.6.9.2.2 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.

6.6.10 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 6-70 and 6-71 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 6-70
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 6-71
Anticipated Socioeconomic Impacts

<table>
<tr><th rowspan="2">Alternatives</th><th colspan="4">Key Socioeconomic Considerations</th></tr>
<tr><th>Population & Housing</th><th>Local Economy & Employment</th><th>Environmental Justice</th><th>Safety</th></tr>
<tr><td colspan="5">Water Supply Alternatives</td></tr>
<tr><td>Deep and Shallow Aquifers</td><td colspan="4">No adverse impact</td></tr>
<tr><td>Shallow Aquifer and Fox River Alluvium</td><td colspan="4">No adverse impact</td></tr>
<tr><td>Lake Michigan (City of Milwaukee)</td><td colspan="4">No adverse impact</td></tr>
<tr><td>Lake Michigan (City of Oak Creek)</td><td colspan="4">No adverse impact</td></tr>
<tr><td>Lake Michigan (City of Racine)</td><td colspan="4">No adverse impact</td></tr>
<tr><td colspan="5">Return Flow Alternatives for Lake Michigan Water Supplies</td></tr>
<tr><td>Underwood Creek to Lake Michigan</td><td colspan="4">No adverse impact</td></tr>
<tr><td>Root River to Lake Michigan</td><td colspan="4">No adverse impact</td></tr>
<tr><td>Direct to Lake Michigan</td><td colspan="4">No adverse impact</td></tr>
</table>

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 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.

6.6.11 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.

6.7 Alternatives Impact Comparison Summary

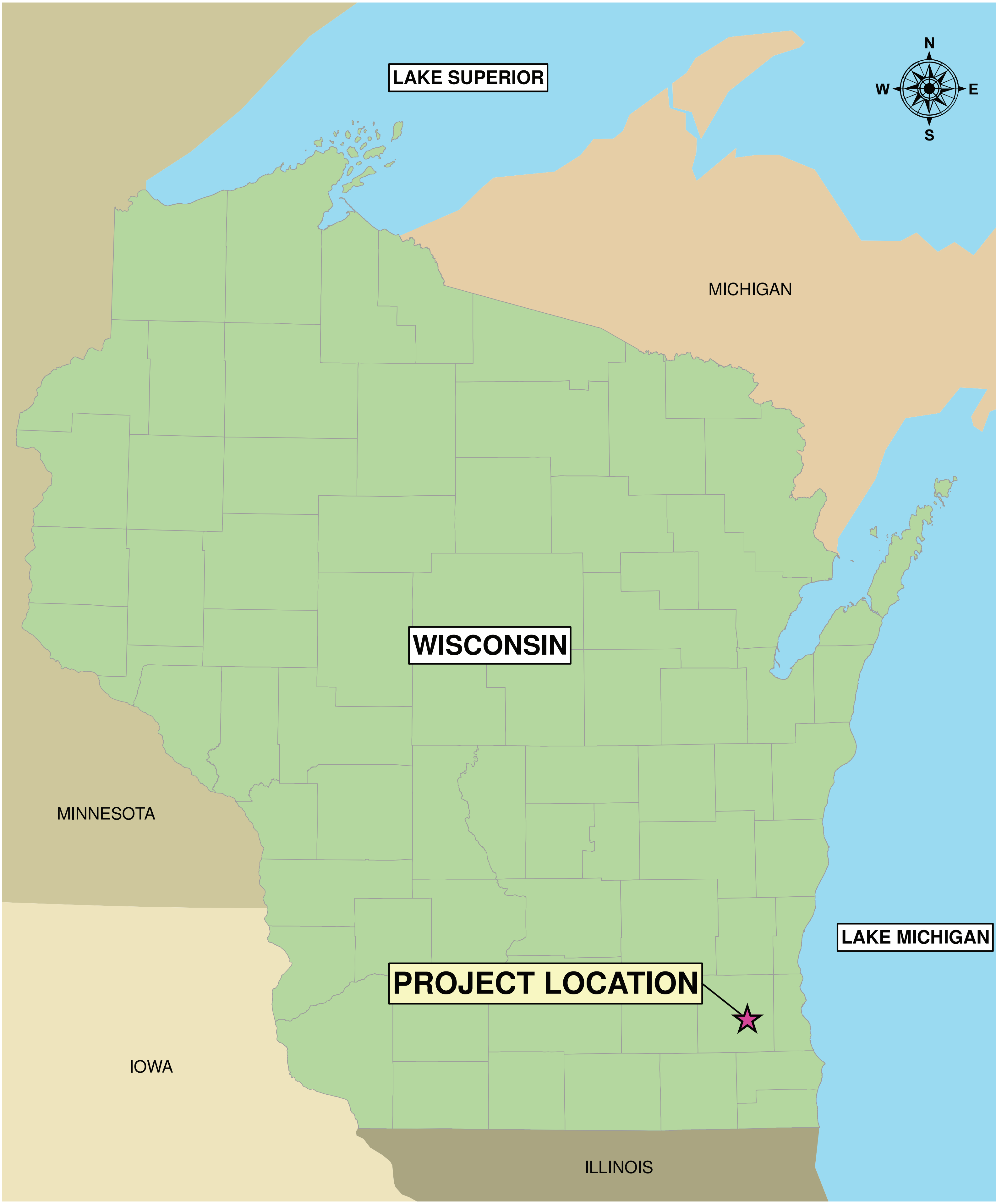
The side by side environmental impact comparison tables were compiled to have one overall comparison of the environmental impacts for all the water supply and return flow alternatives. Where resource impact tables occurred more than once (for example, water quality summary tables occur for both Lake 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 6-72. A side by side comparison of system alternatives (water supply with return flow) is included in Attachment 6-2.

TABLE 6-72
Water Supply and Return Flow Alternative Environmental Impact Comparison Summary

Water Supply Alternative	Groundwater Resources	Geomorphology and Sediments	Flooding	Aquatic Habitat	Water Quality	Wetlands	Vegetation and Wildlife Resources	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	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	Minor adverse impact	Significant 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	No adverse impact
Lake Michigan (City of Oak Creek)	No adverse impact	No adverse impact	No adverse impact	Minor adverse impact	No adverse impact	Minor adverse impact	No 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	No adverse impact
Return Flow Alternatives for Lake Michigan Water Supplies									
Underwood Creek to Lake Michigan	No adverse impact	No adverse impact	No adverse impact	No adverse impact	Minor adverse impact	Minor adverse impact	No adverse impact	No adverse impact	No adverse impact
Root River to Lake Michigan	No adverse impact	No adverse impact	No adverse impact	No adverse impact	Minor adverse impact	Minor adverse impact	No adverse impact	No adverse impact	No adverse impact
Direct to Lake Michigan	No adverse impact	Minor adverse impact	No adverse impact	Minor adverse impact	Minor adverse impact	Minor adverse impact	No adverse impact	No adverse impact	No adverse impact

Attachment 6-1

Alternatives to the Proposed Project Alignment Maps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MINNESOTA
LAKE MICHIGAN
PROJECT LOCATION
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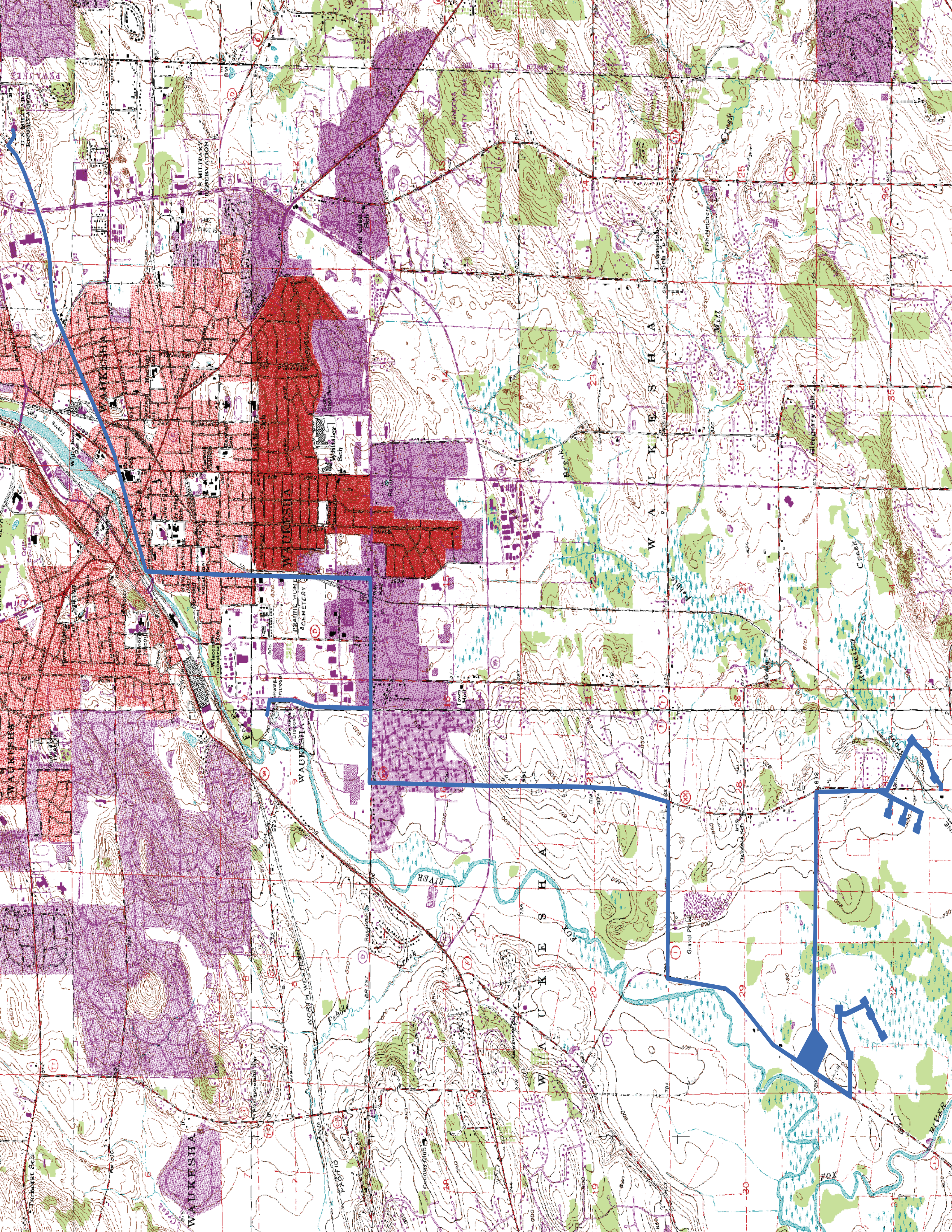
ILLINOIS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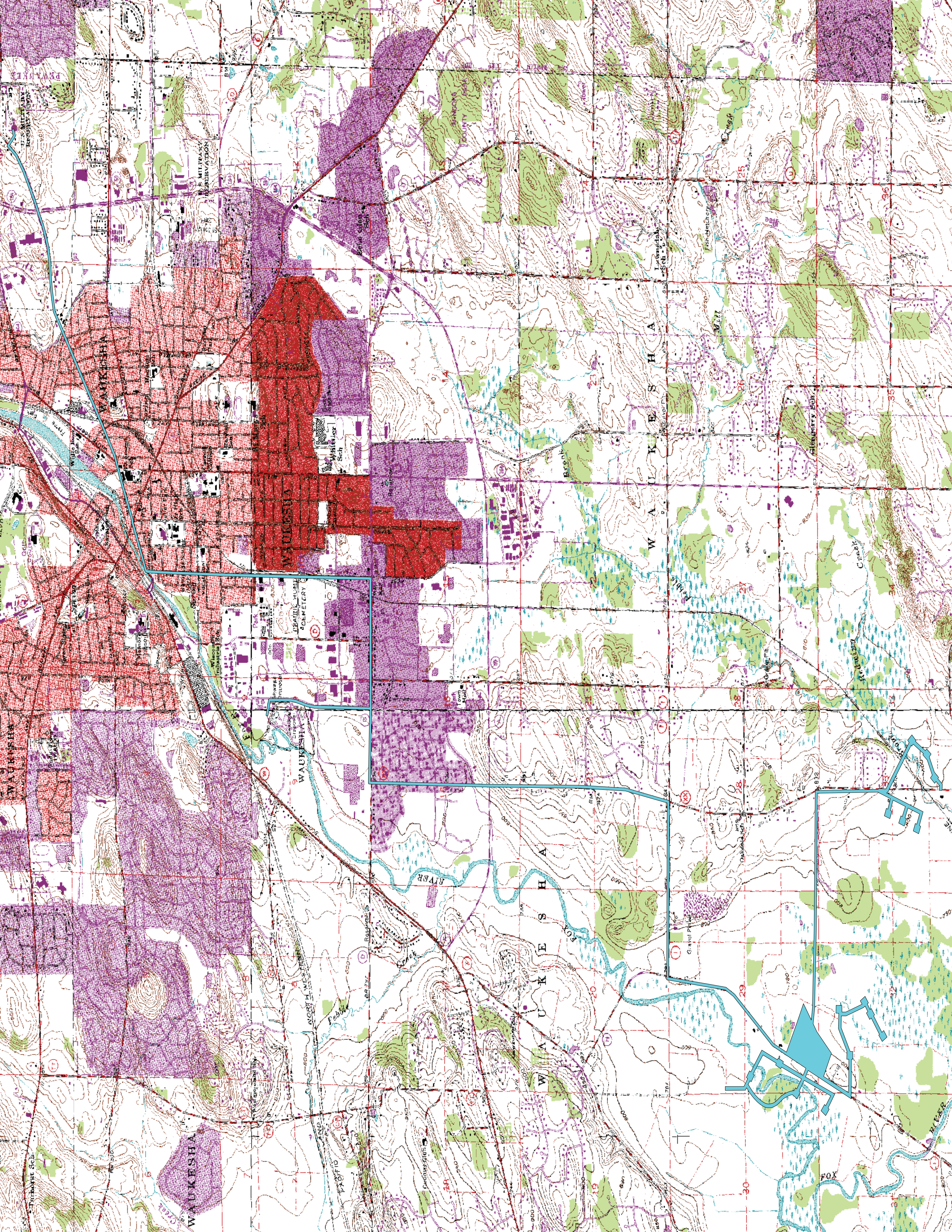
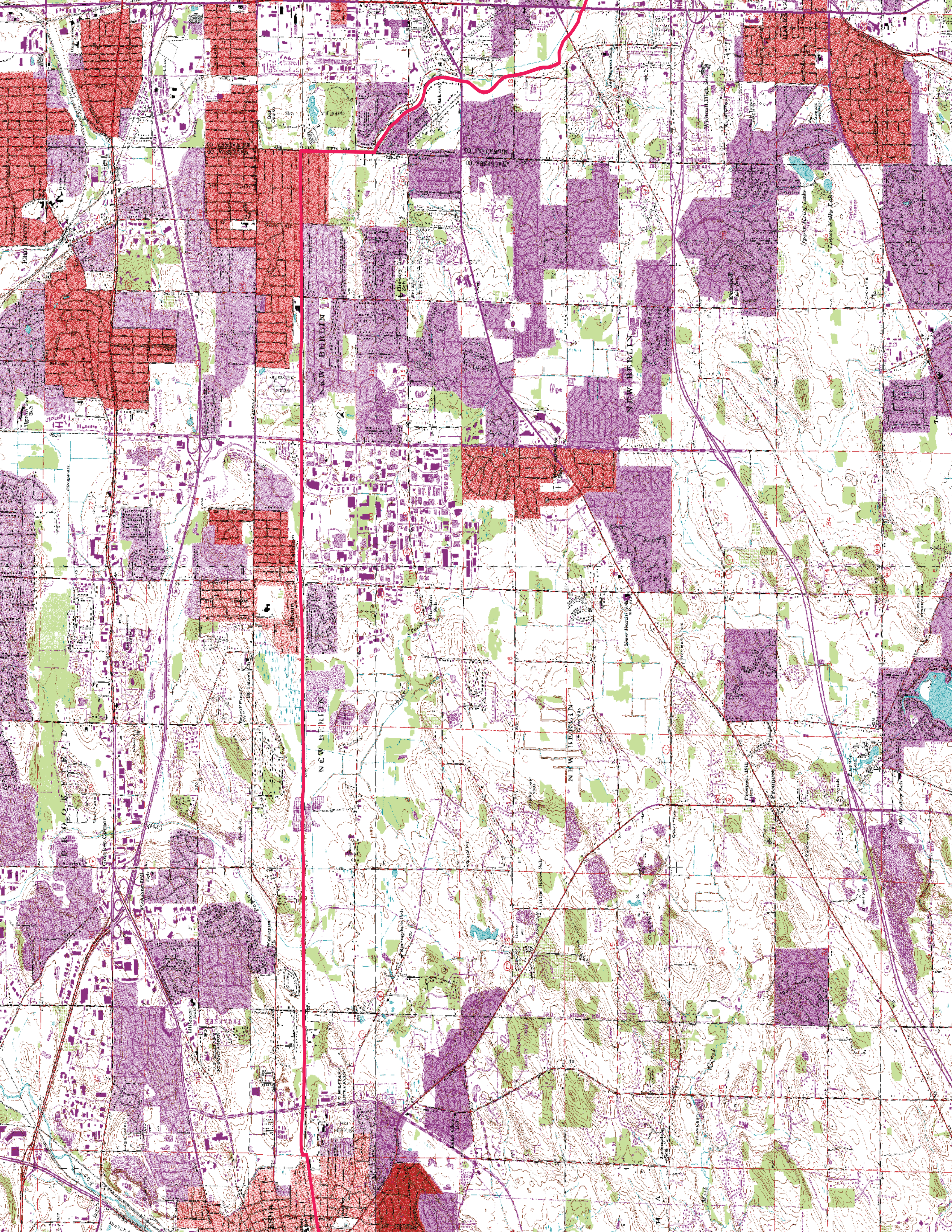
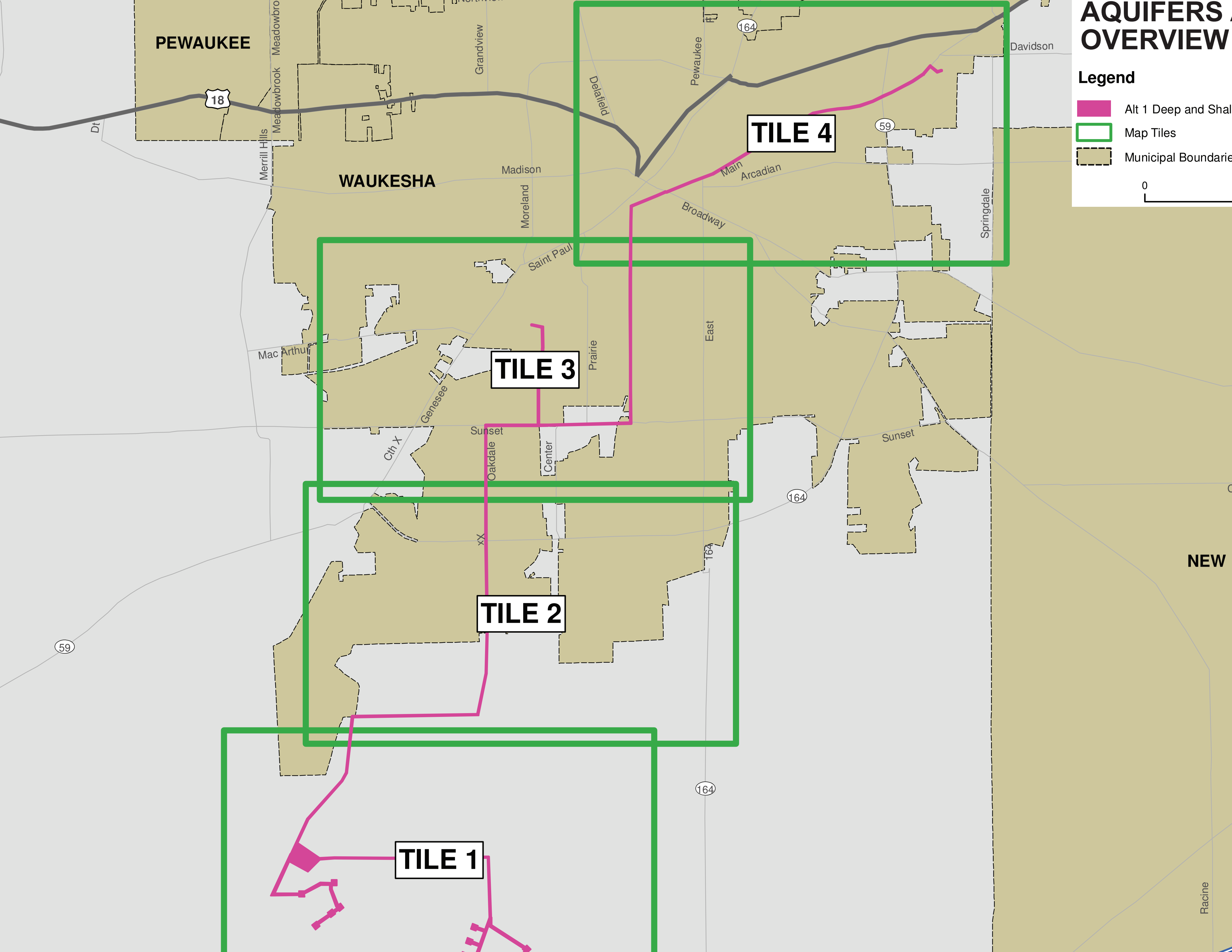
RIVER



WAUKESHA
FOX RIVER


NEW BERLIN


AQUIFERS
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Broadway
Delafield
Pewaukee
Saint Paul
Prairie
East
Madison
Moreland
Grandview
Meadowbrook
Merrill Hills
Mac Arthur
Genesee
Cth X
Sunset
Oakdale
Center
XX
Racine
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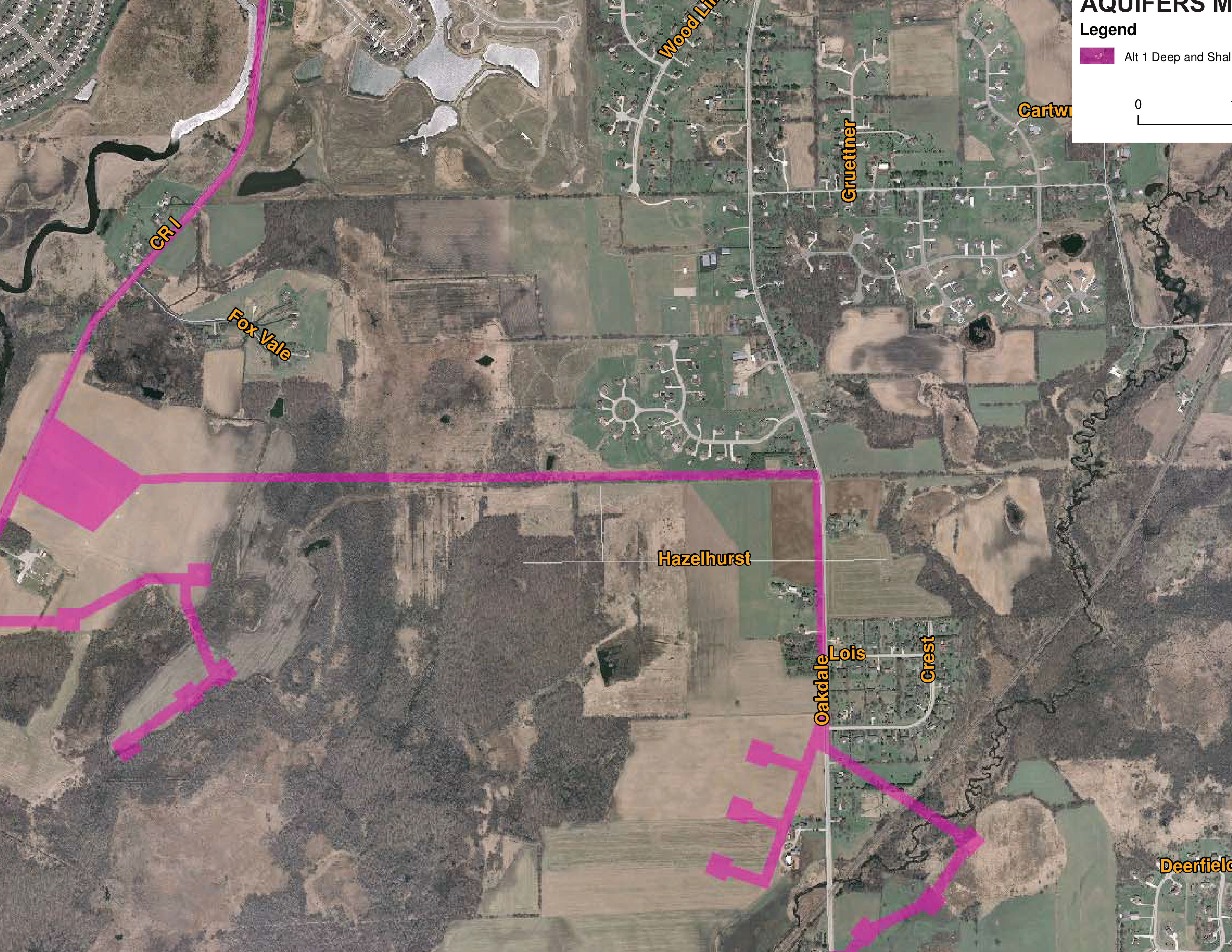

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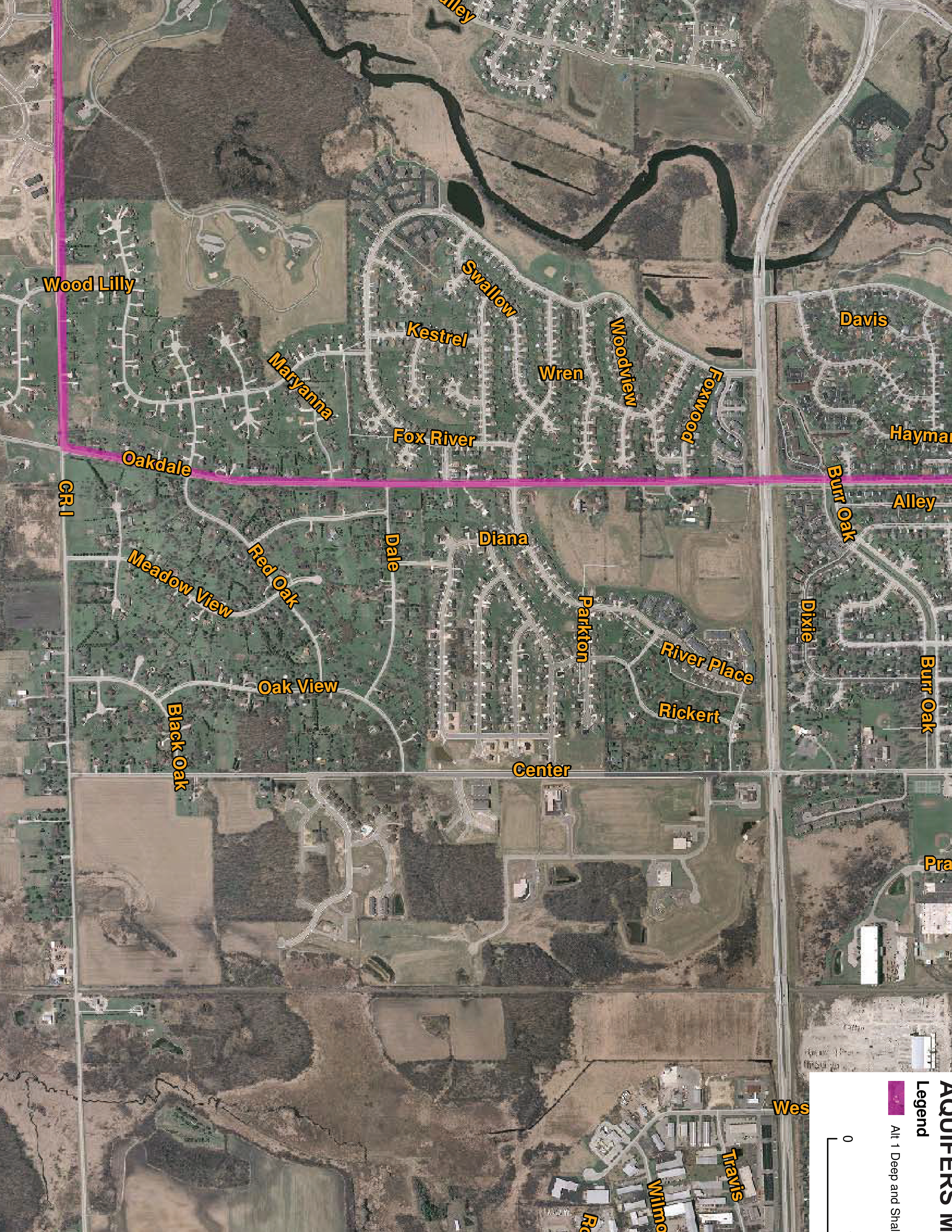
Hazelhurst
Oakdale
Lois
Crest
Deerfield



Wood Lilly
Swallow
Kestrel
Davis
Maryanna
Wren
Woodview
Foxwood
Fox River
Hayman
Oakdale
Burr Oak
Alley
CR I
Diana
Dale
Red Oak
Meadow View
Parkton
Dixie
River Place
Burr Oak
Oak View
Rickert
Black Oak
Center
Travis
AQUIFERS M
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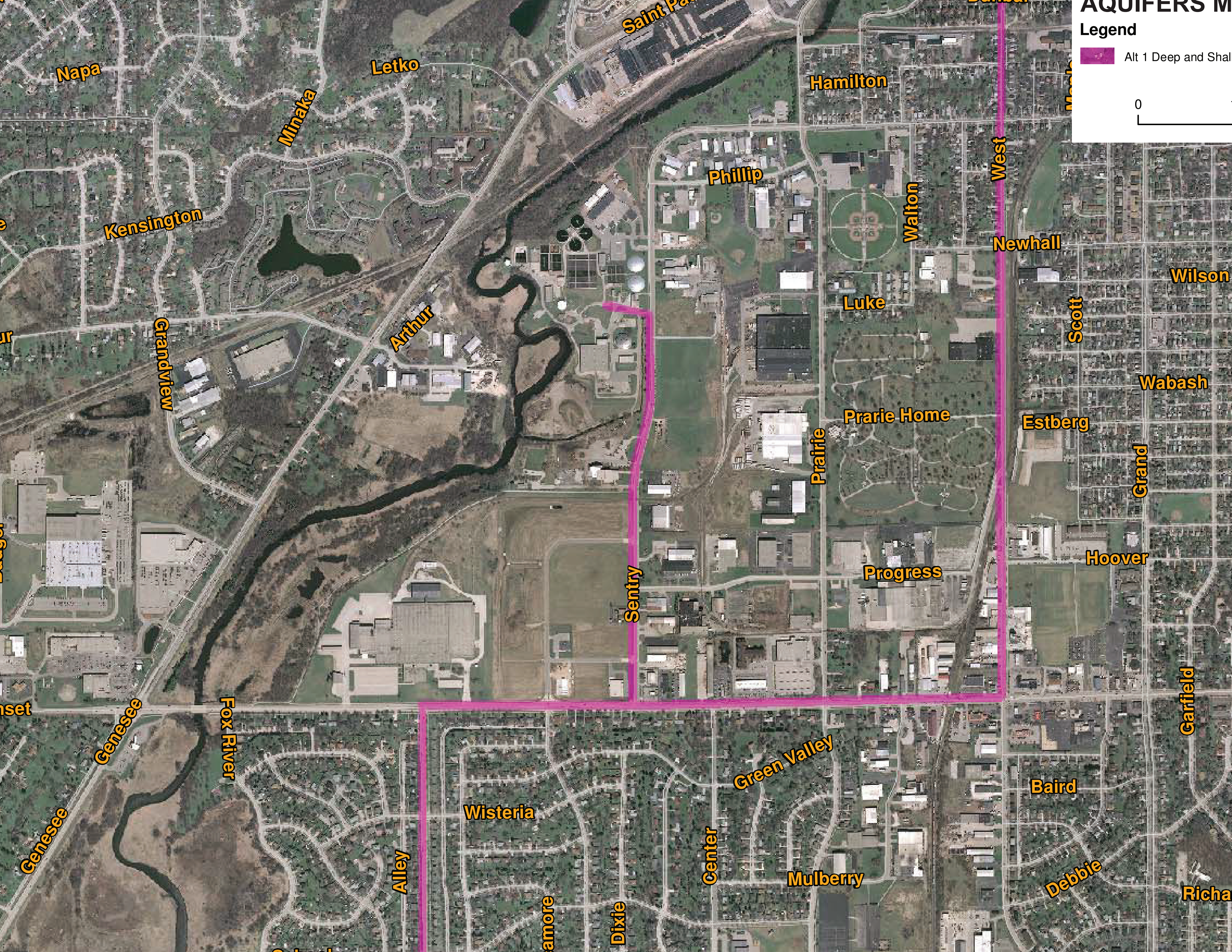

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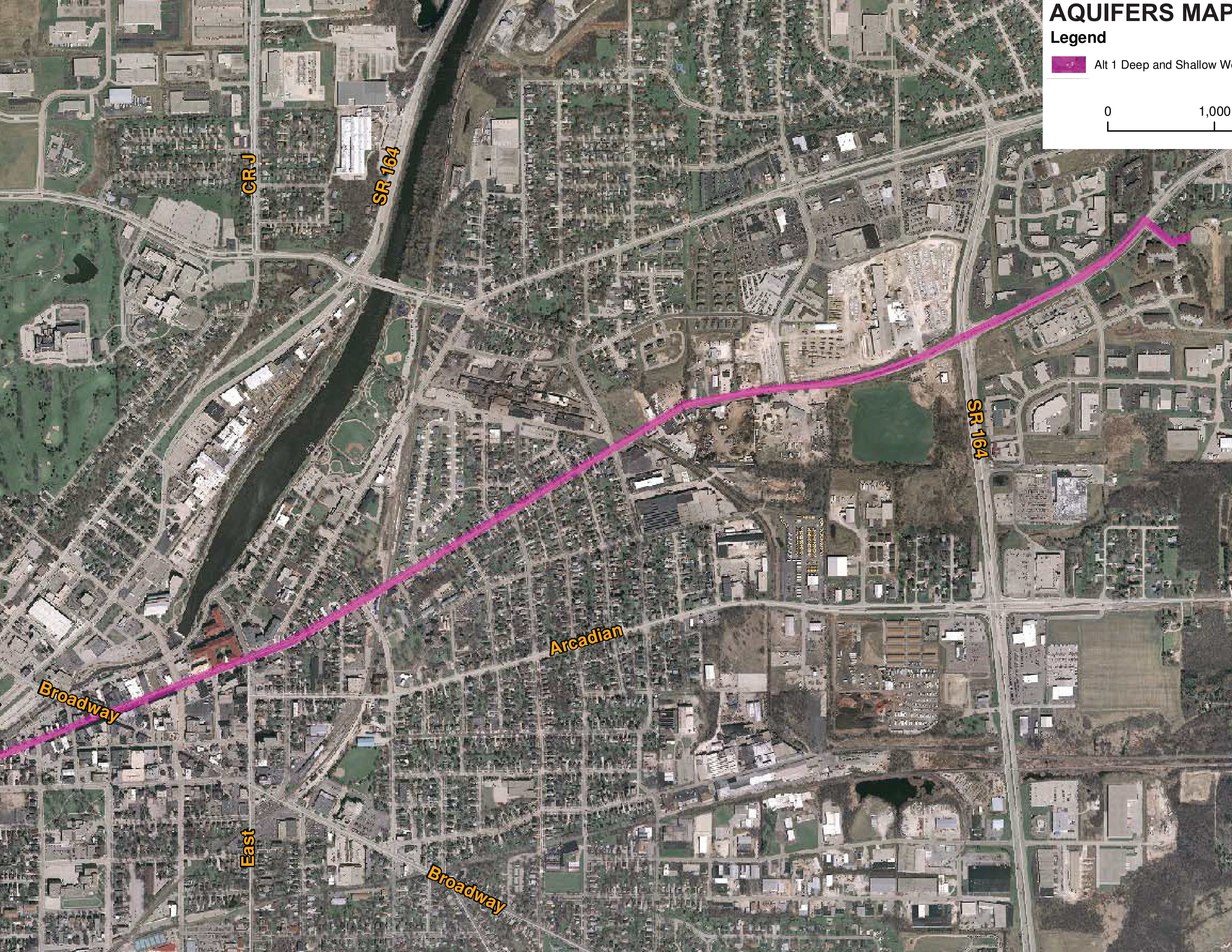
Scott
Wabash
Prarie Home
Estberg
Prairie
Grand
Hoover
Progress
Sentry
Garfield
Genesee
Fox River
Green Valley
Baird
Wisteria
Center
Mulberry
Alley
Dixie
Debbie
Richa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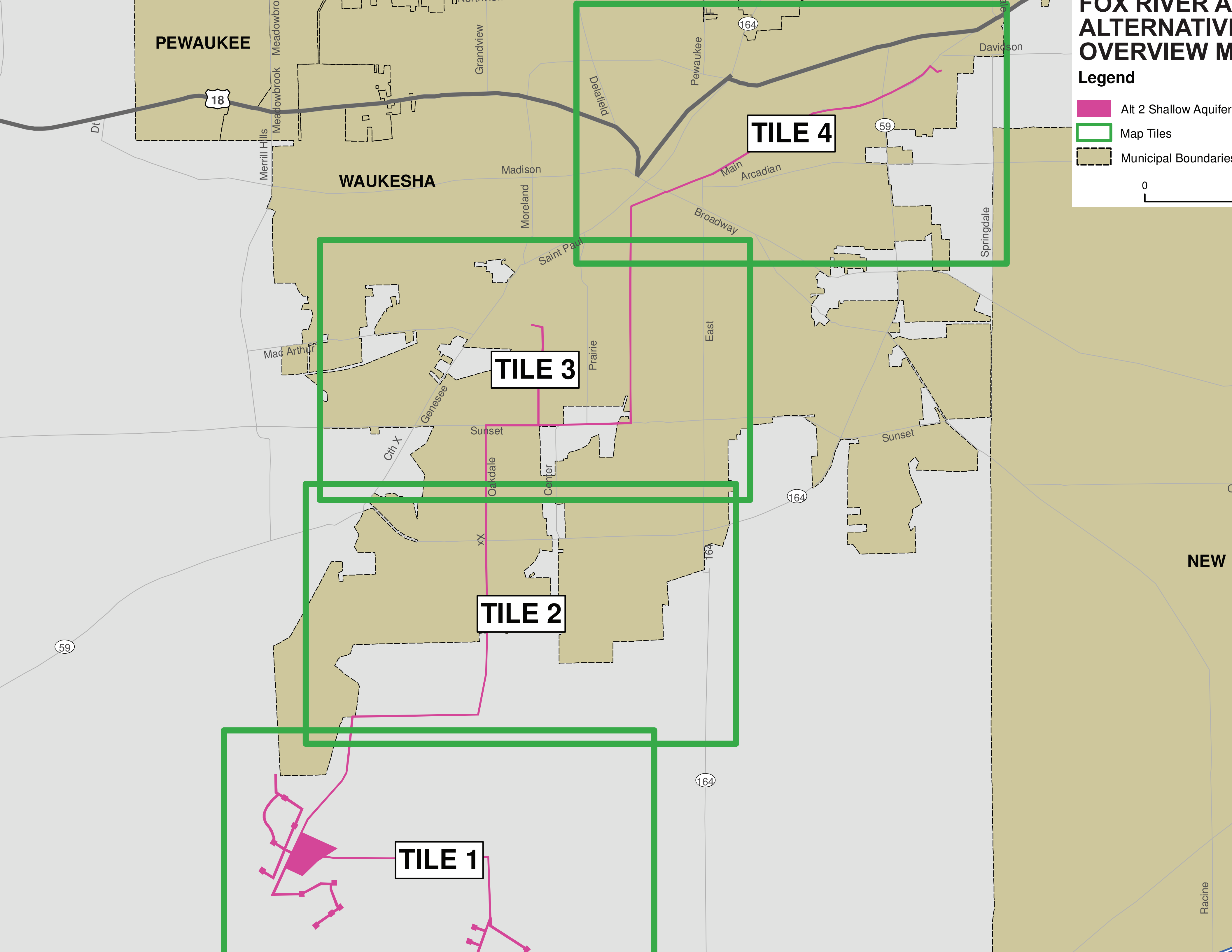
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Merrill Hills
Grandview
Madison
Moreland
Delafield
Pewaukee
Davidson
Main
Arcadian
Broadway
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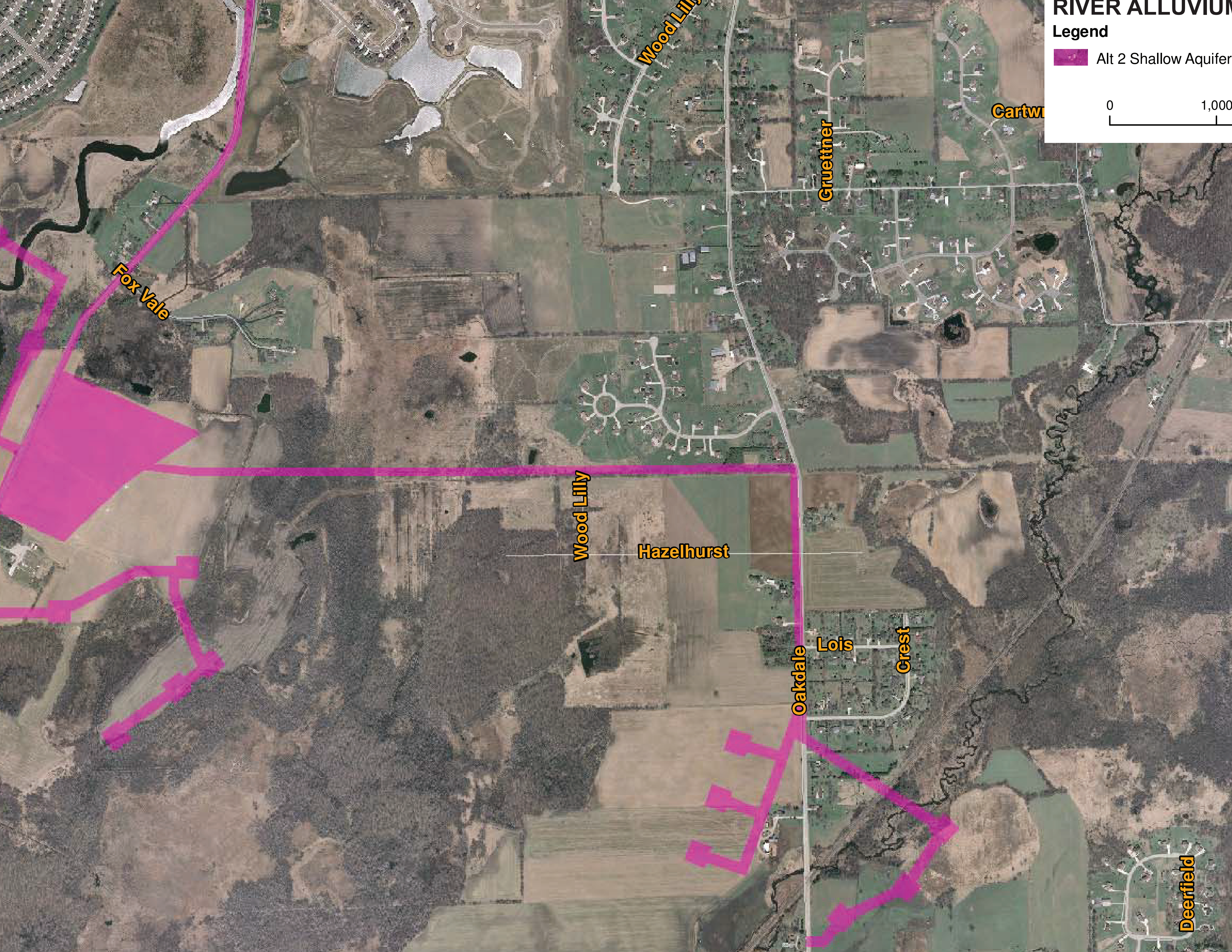
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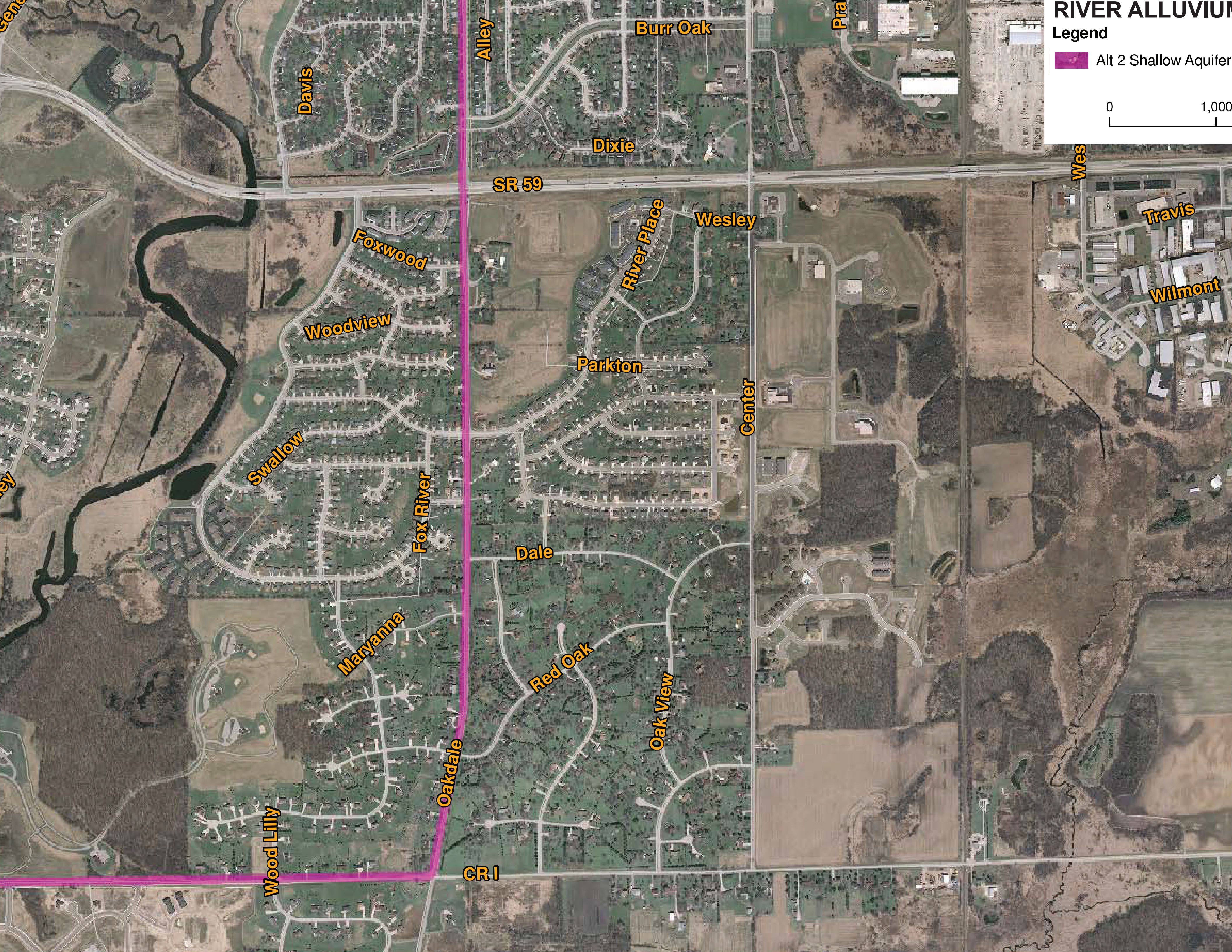
Fox Vale
Wood Lilly
Hazelhurst
Lois
Crest
Oakdale
Deerfield


RIVER ALLUVIUM
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Burr Oak
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Wesley
Foxwood
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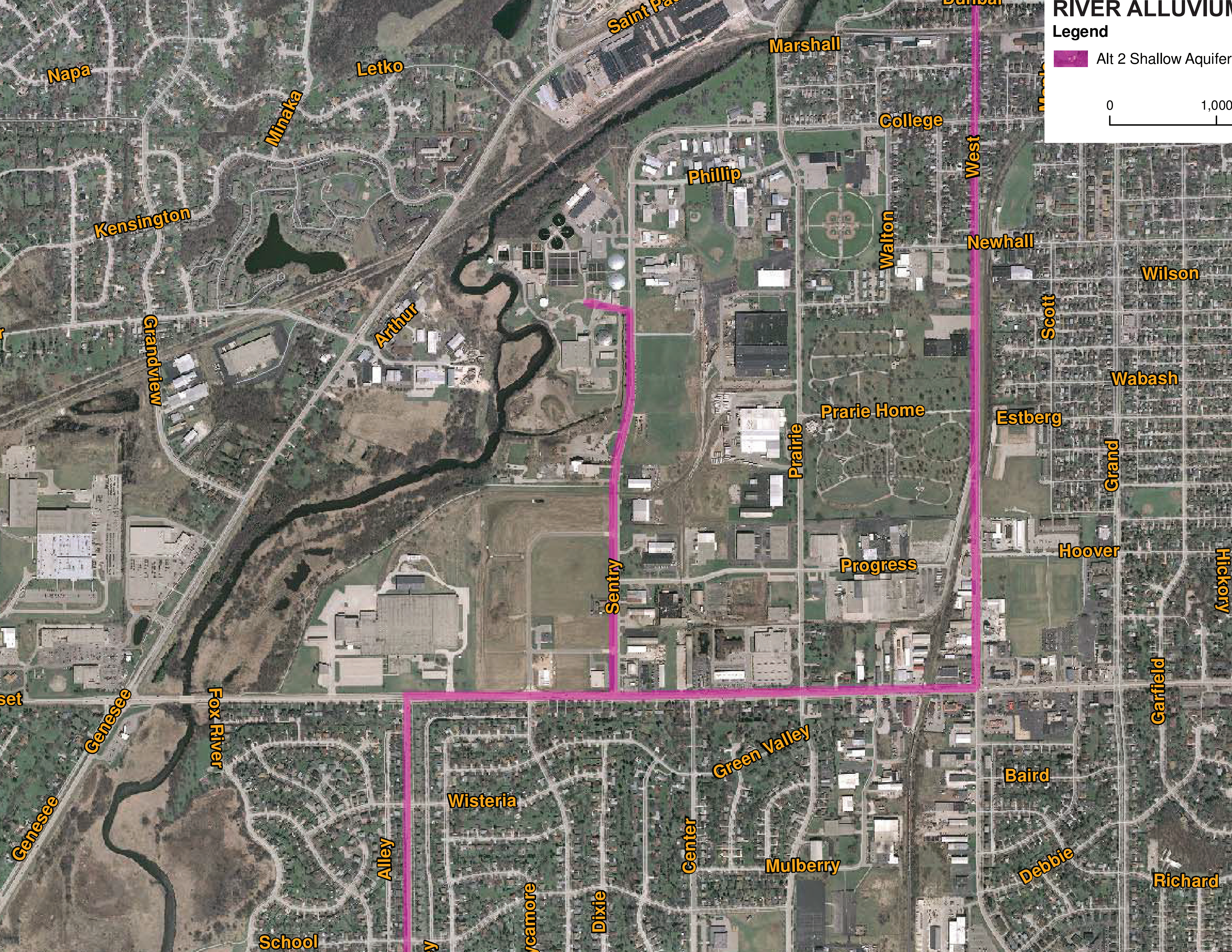
Wilmont
Woodview
Parkton
Center
Swallow
Fox River
Dale
Maryanna
Red Oak
Oak View
Oakdale
Wood Lilly
CR I



RIVER ALLUVIUM
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Hickory
Garfield
Baird
Debbie
Richard
Mulberry
Green Valley
Center
Dixie
Wisteria
Alley
School
Fox River
Genesee
Genesee
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Progress
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Arthur
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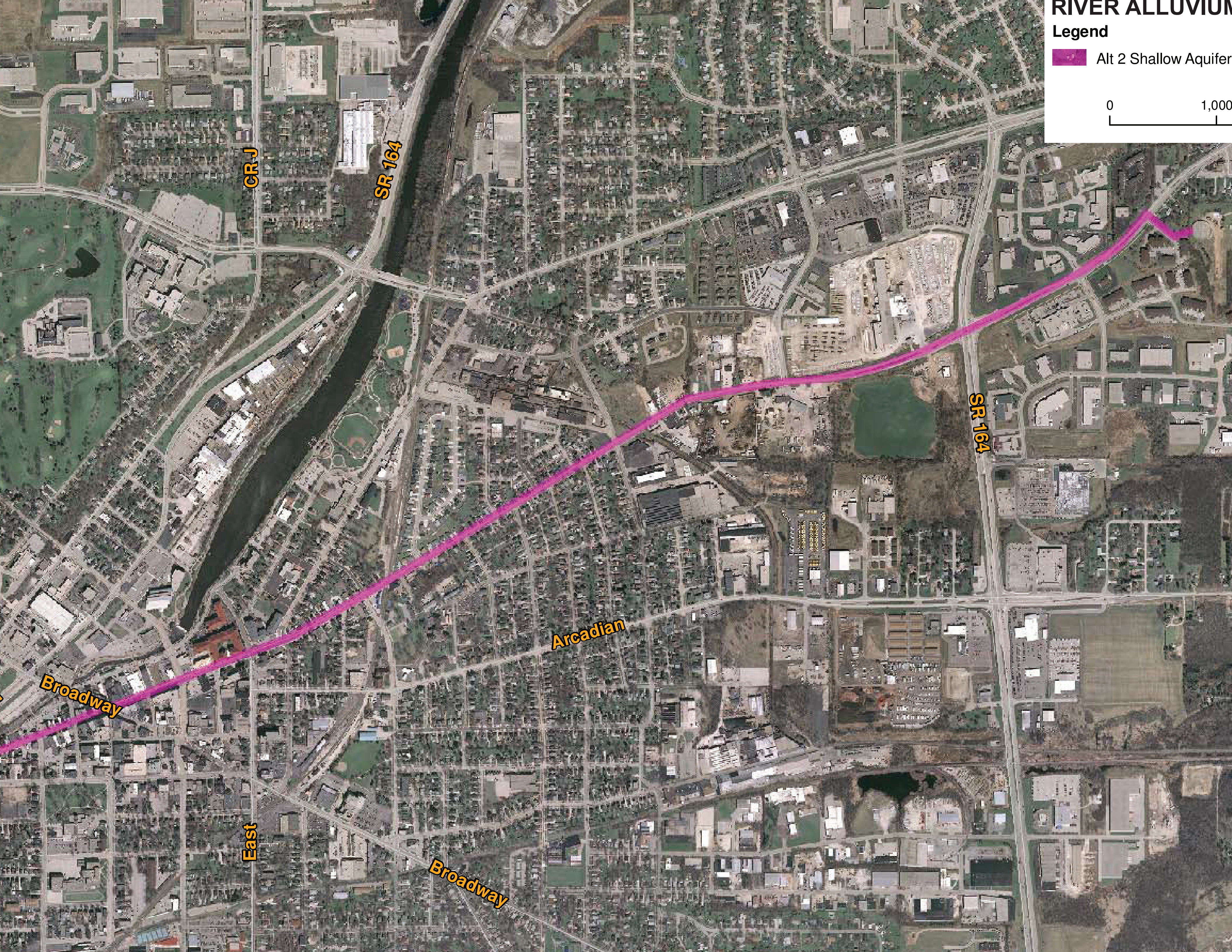
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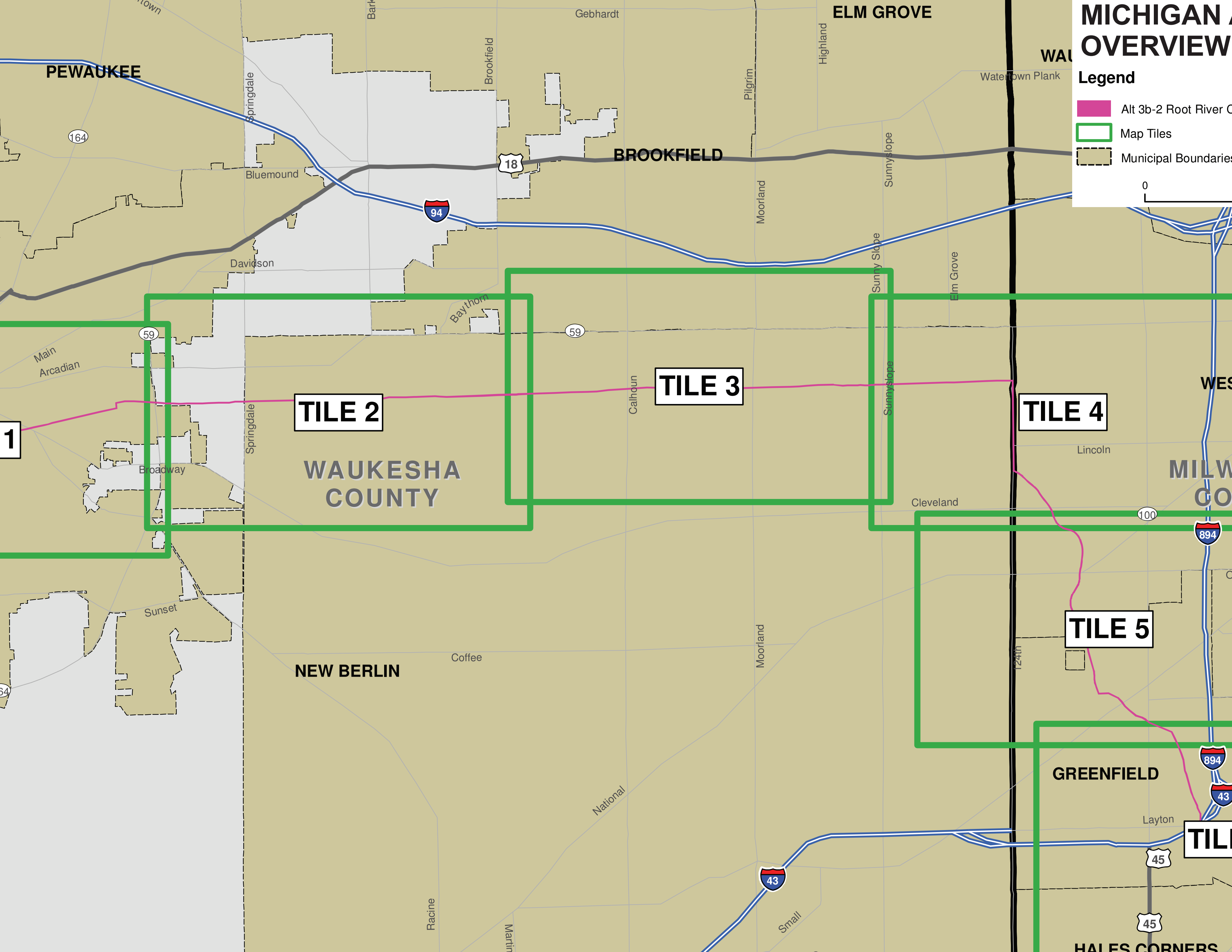
MICHIGAN
OVERVIEW
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PEWAUKEE
ELM GROVE
BROOKFIELD
WAUKESHA COUNTY
NEW BERLIN
GREENFIELD
Springdale
Bluemound
Davidson
Brookfield
Gebhardt
Pilgrim
Highland
Moorland
Sunnyslope
Sunny Slope
Elm Grove
Watertown Plank
Calhoun
Baythorn
Main
Arcadian
Broadway
Sunset
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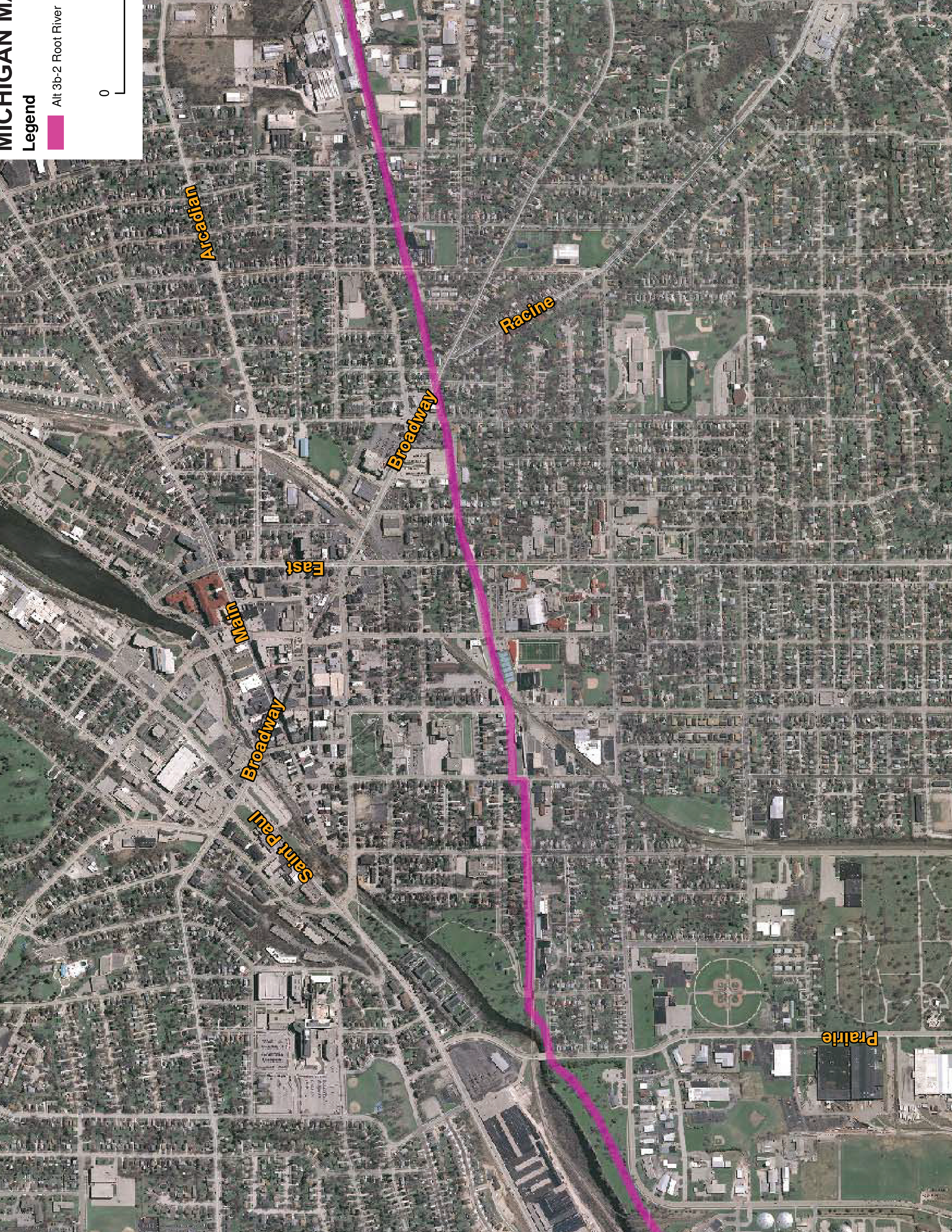

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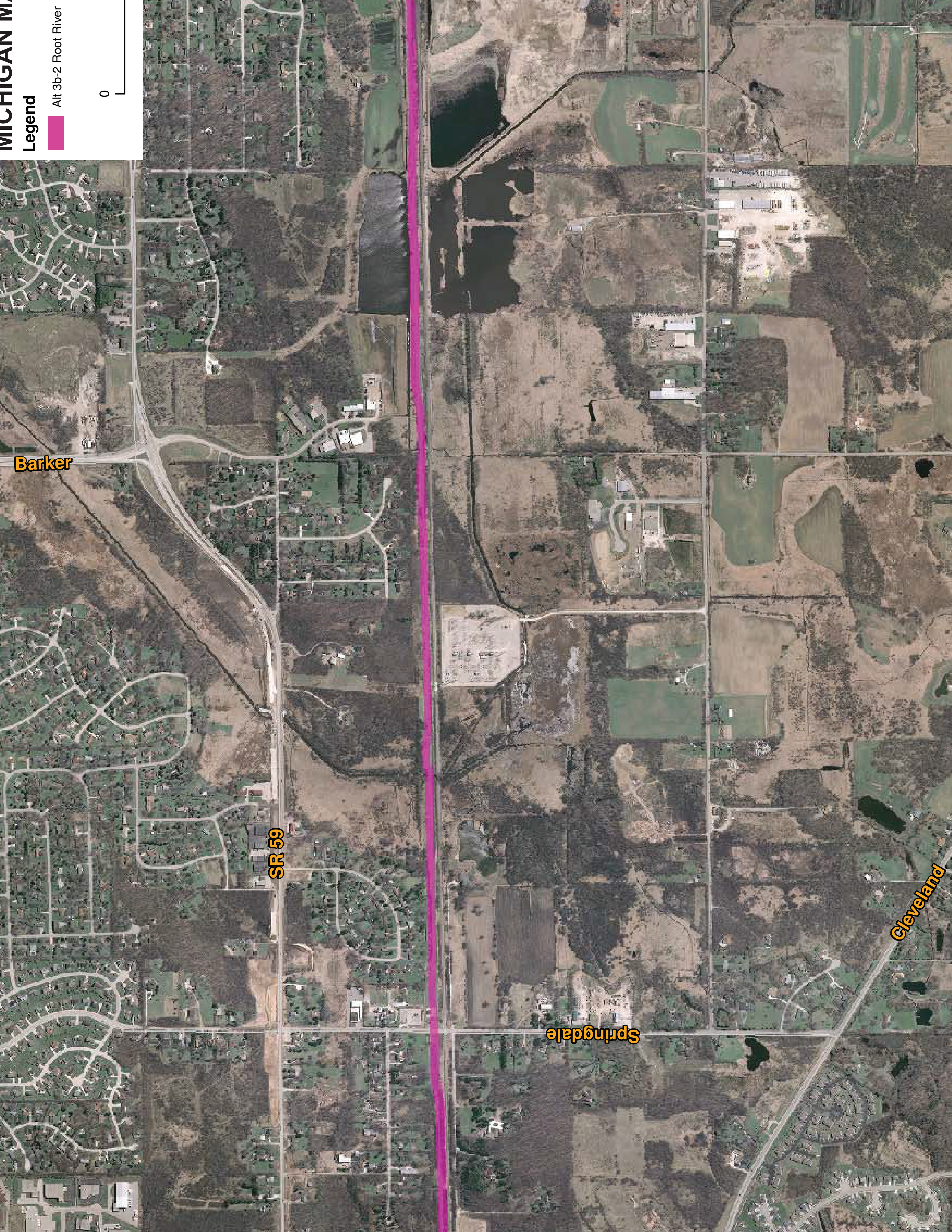

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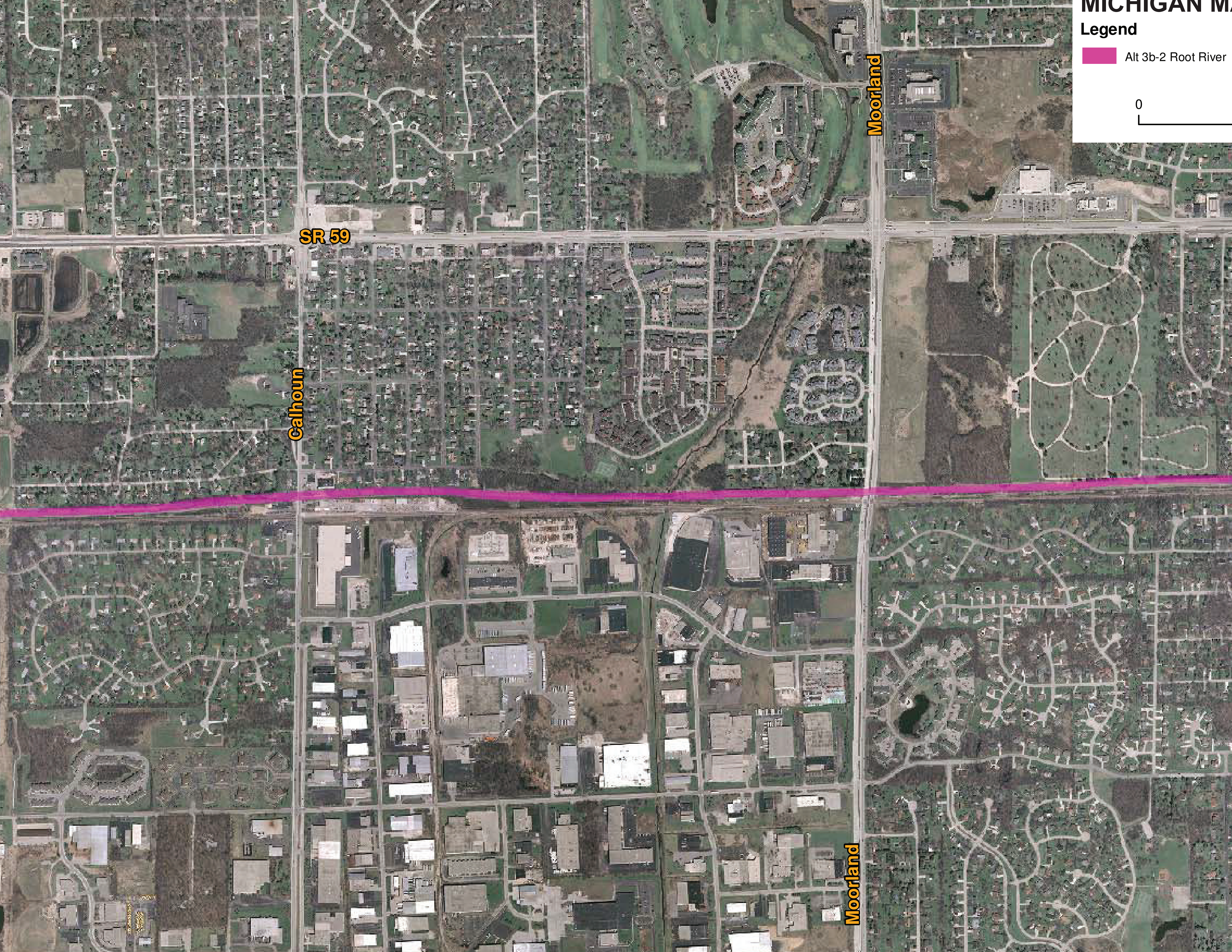

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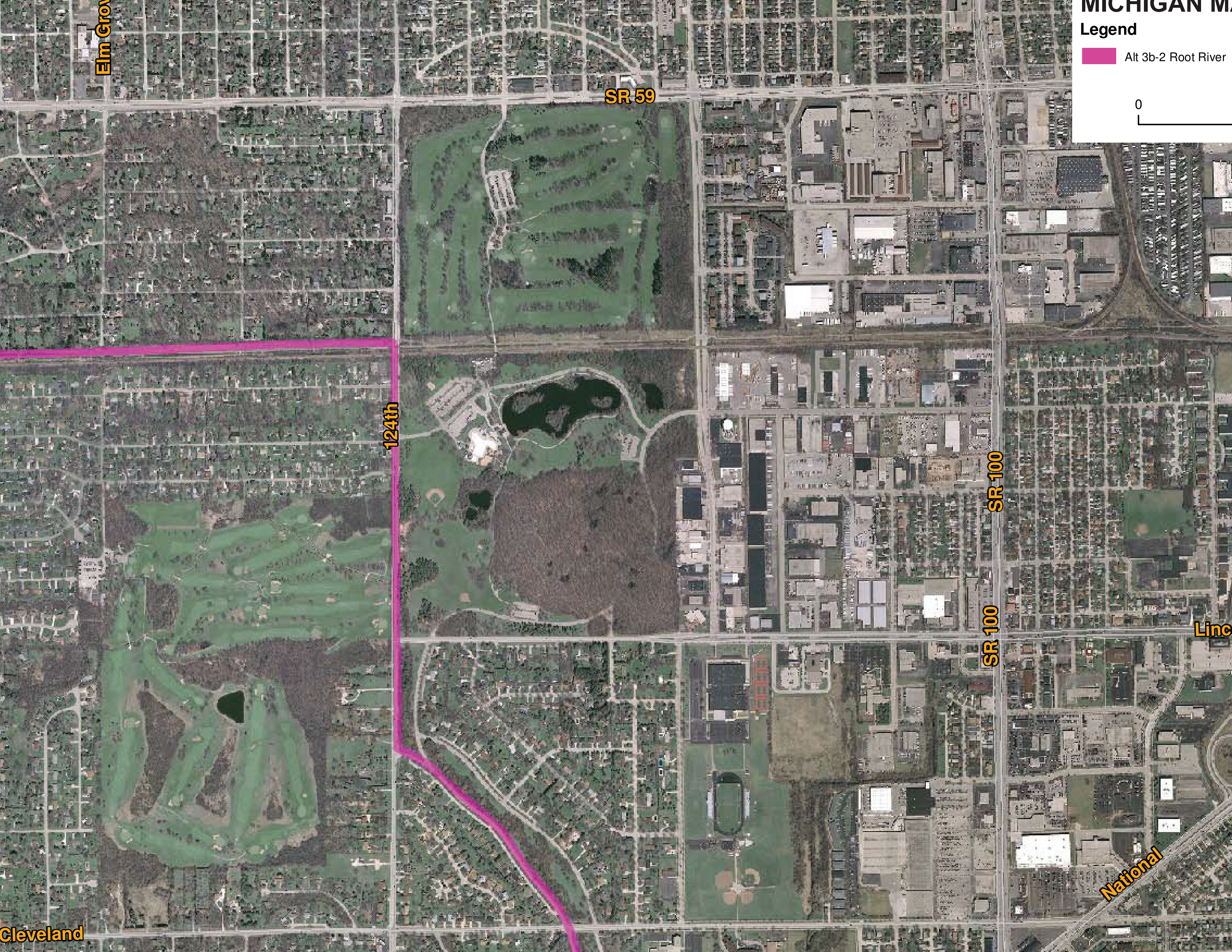
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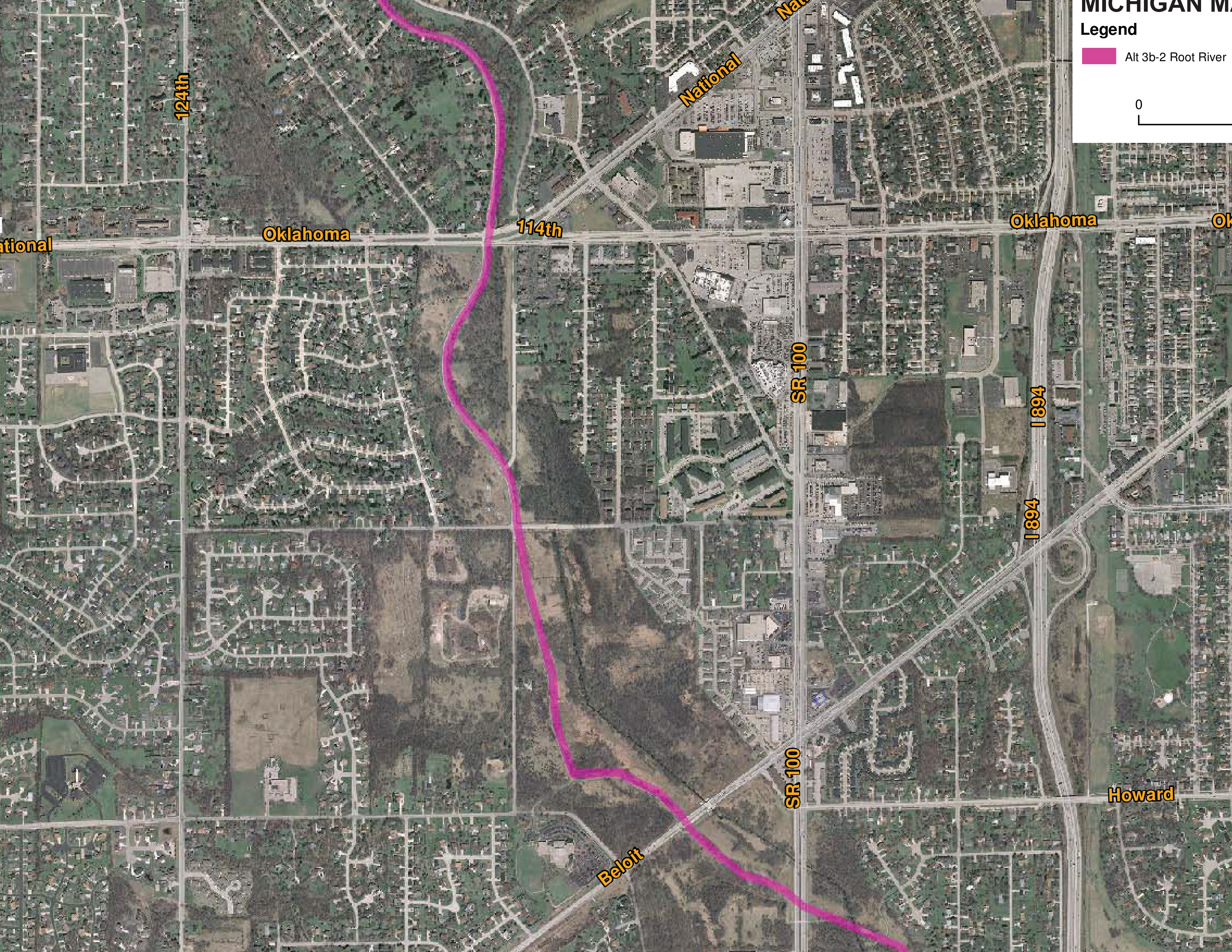
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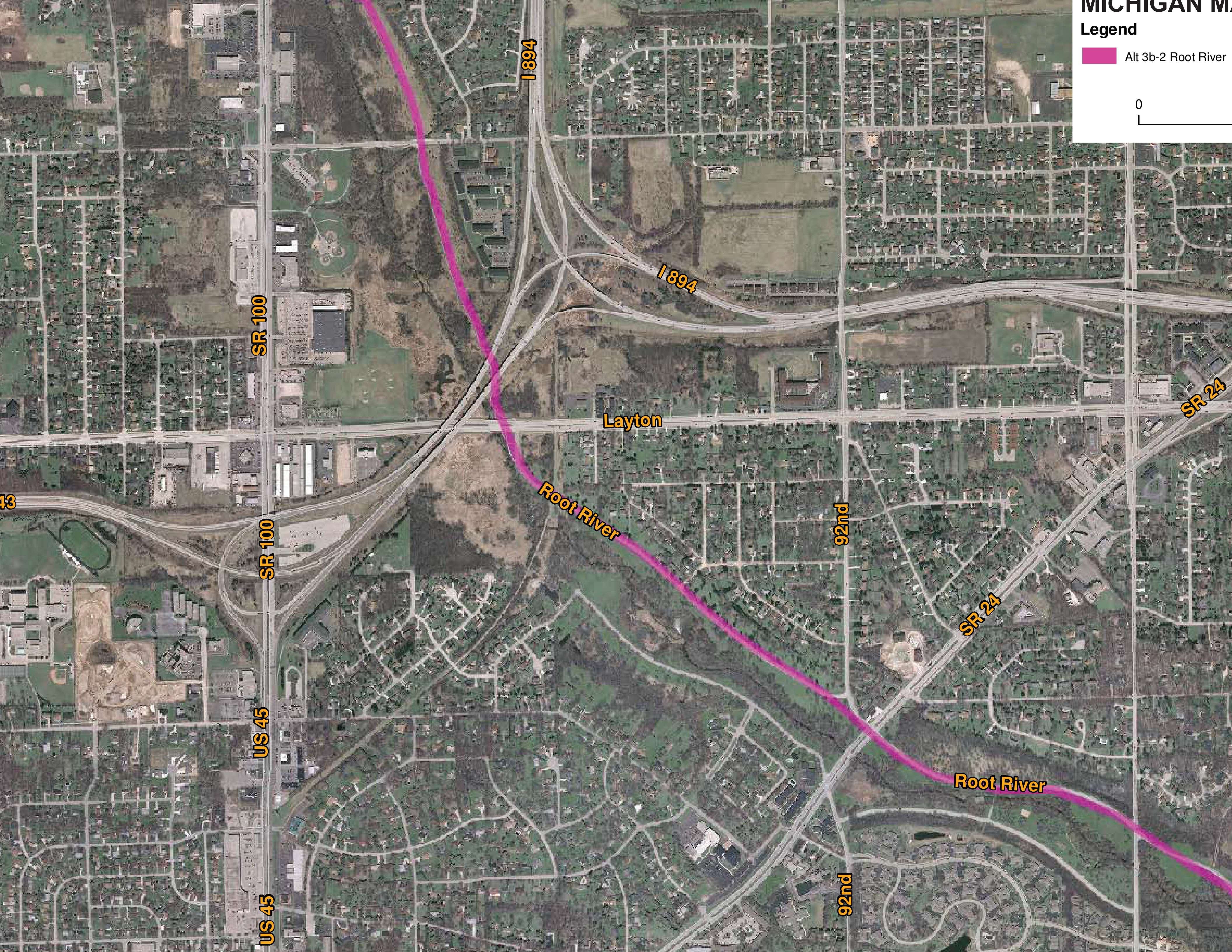
MICHIGAN MA
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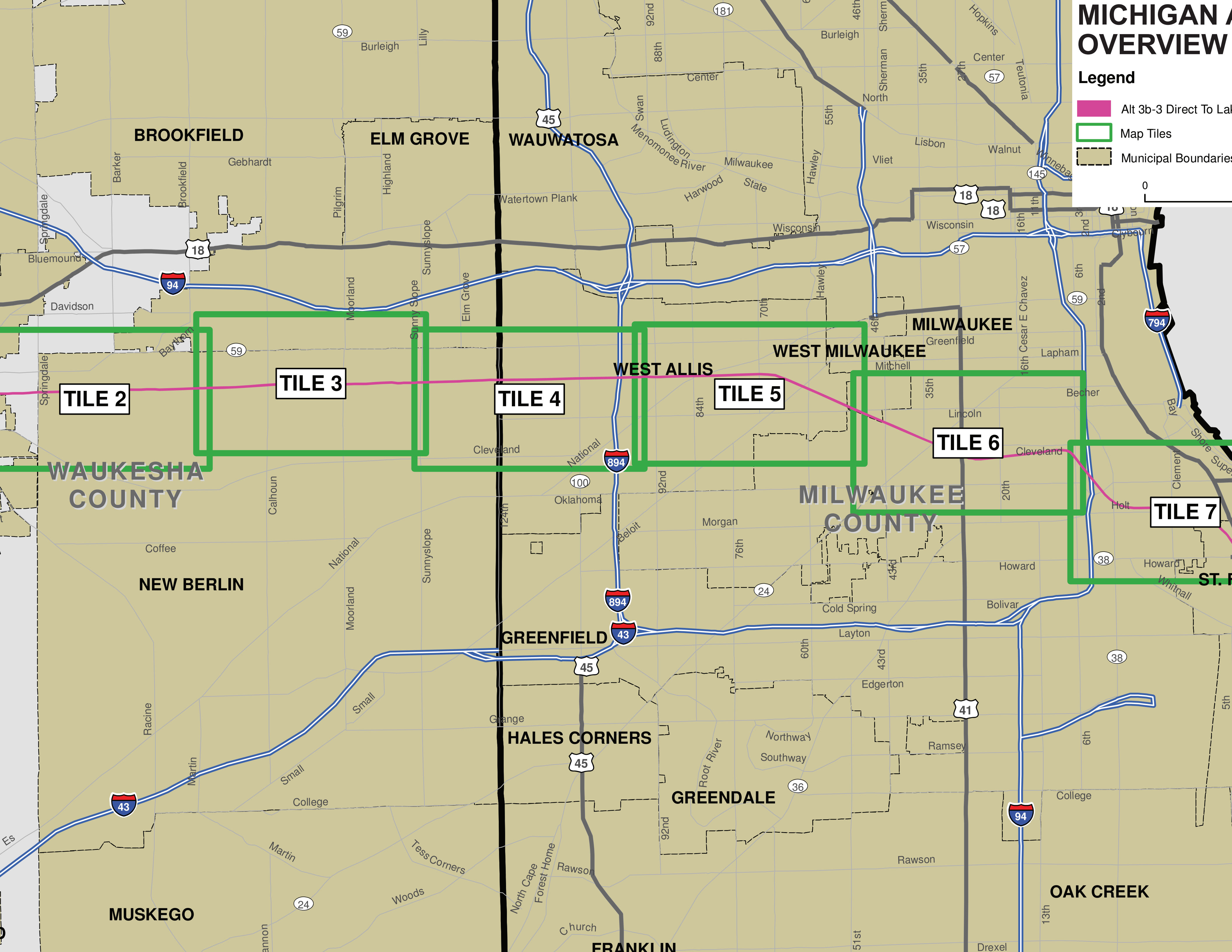

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MILWAUKEE
WEST MILWAUKEE
WEST ALLIS
MILWAUKEE COUNTY
WAUKESHA COUNTY
NEW BERLIN
GREENFIELD
HALES CORNERS
GREENDALE
OAK CREEK
MUSKEGO
FRANKLIN
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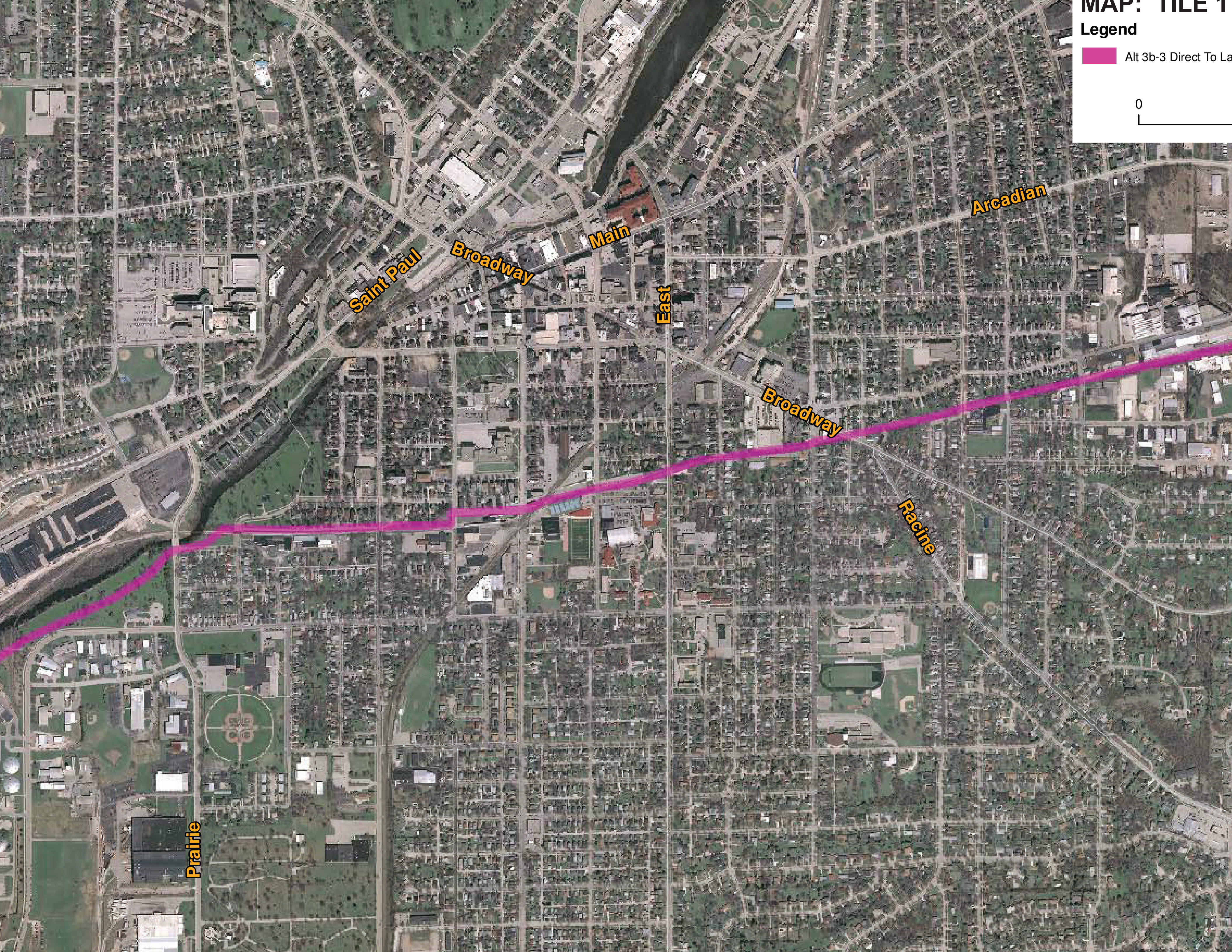
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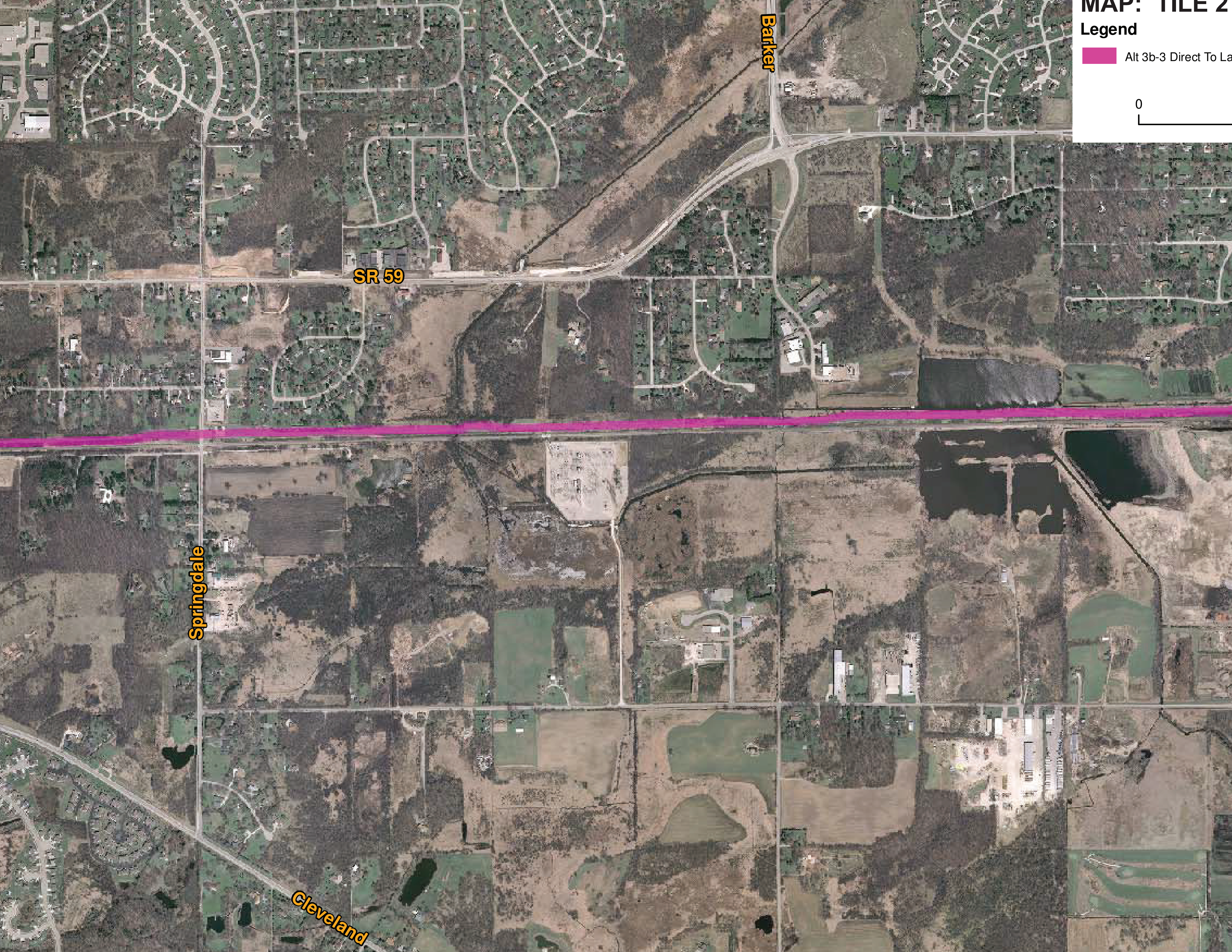
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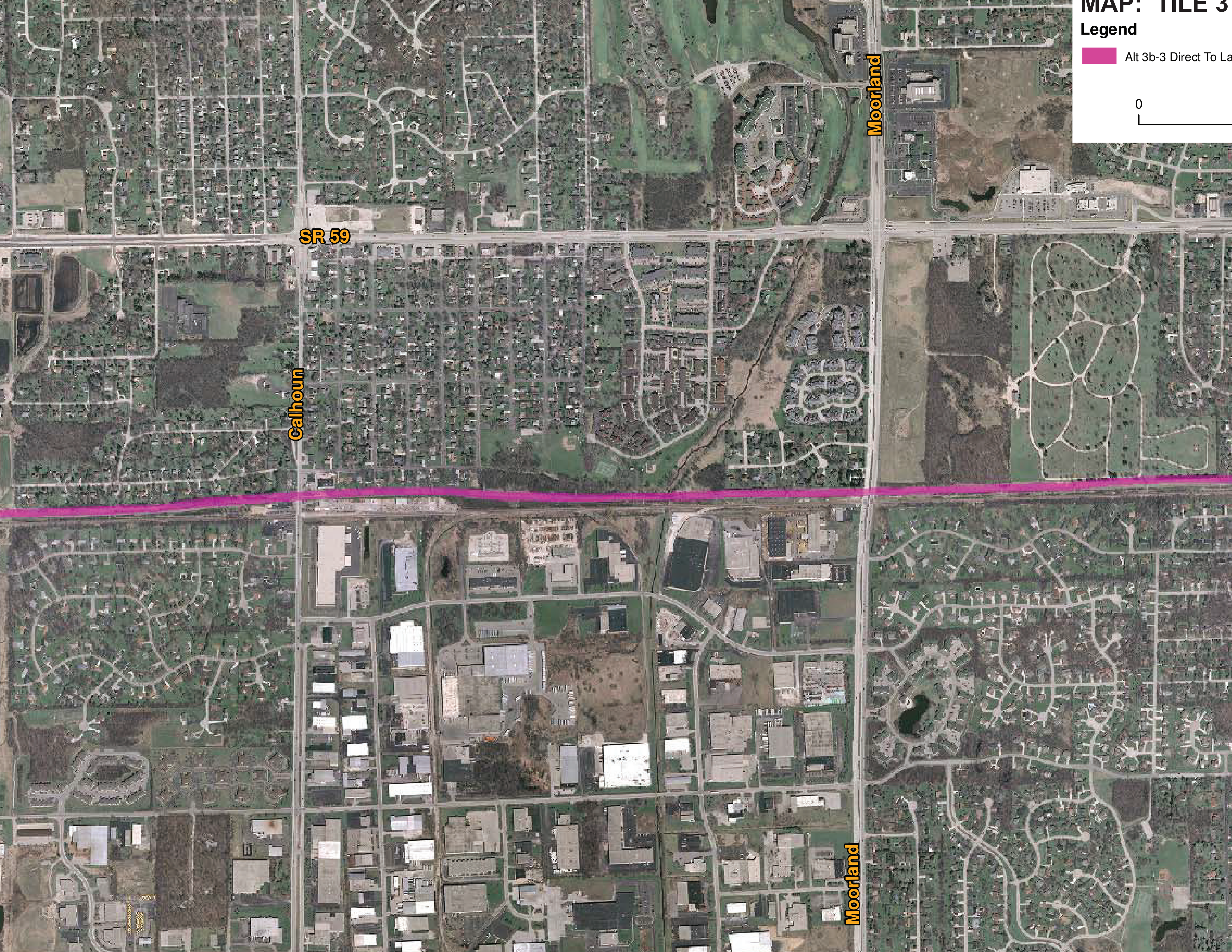

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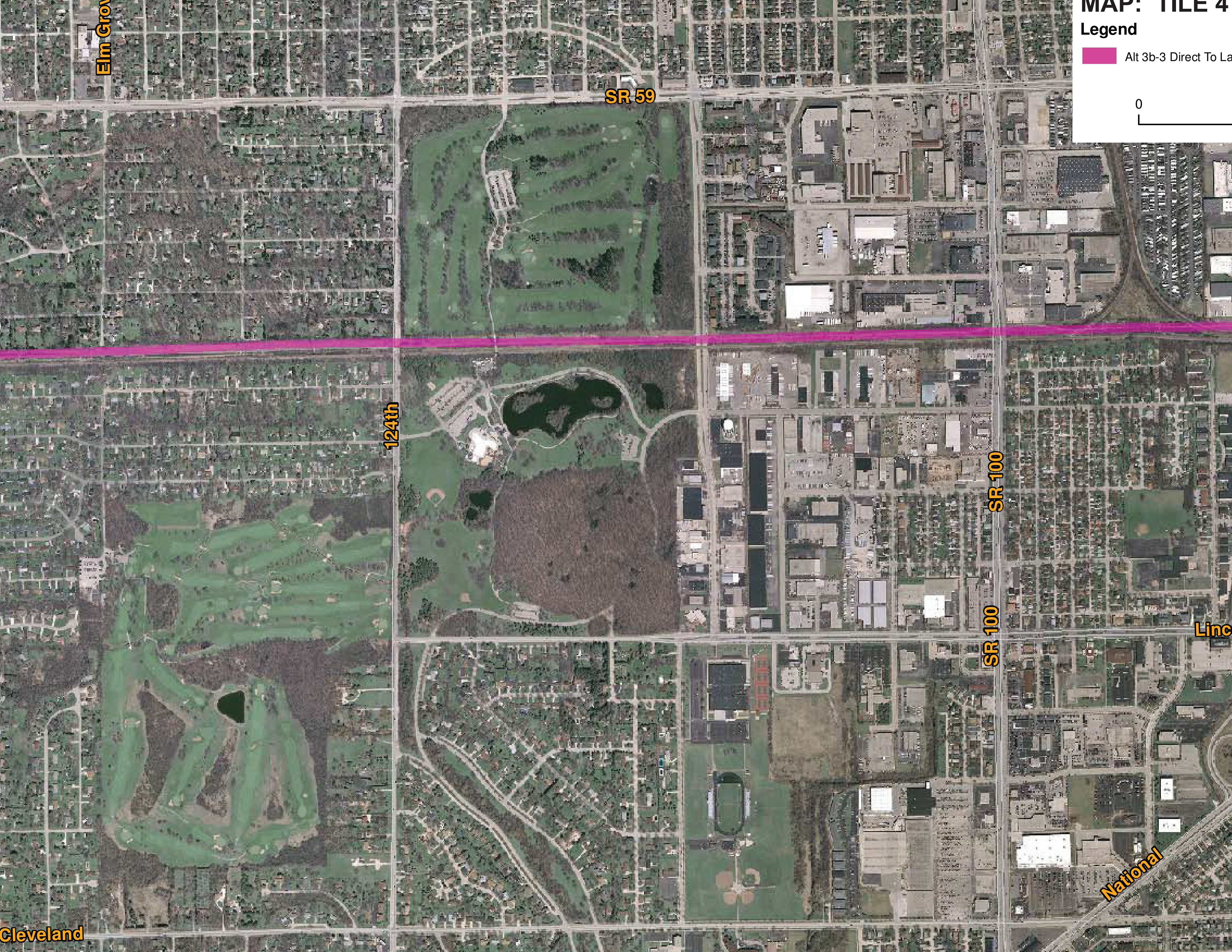
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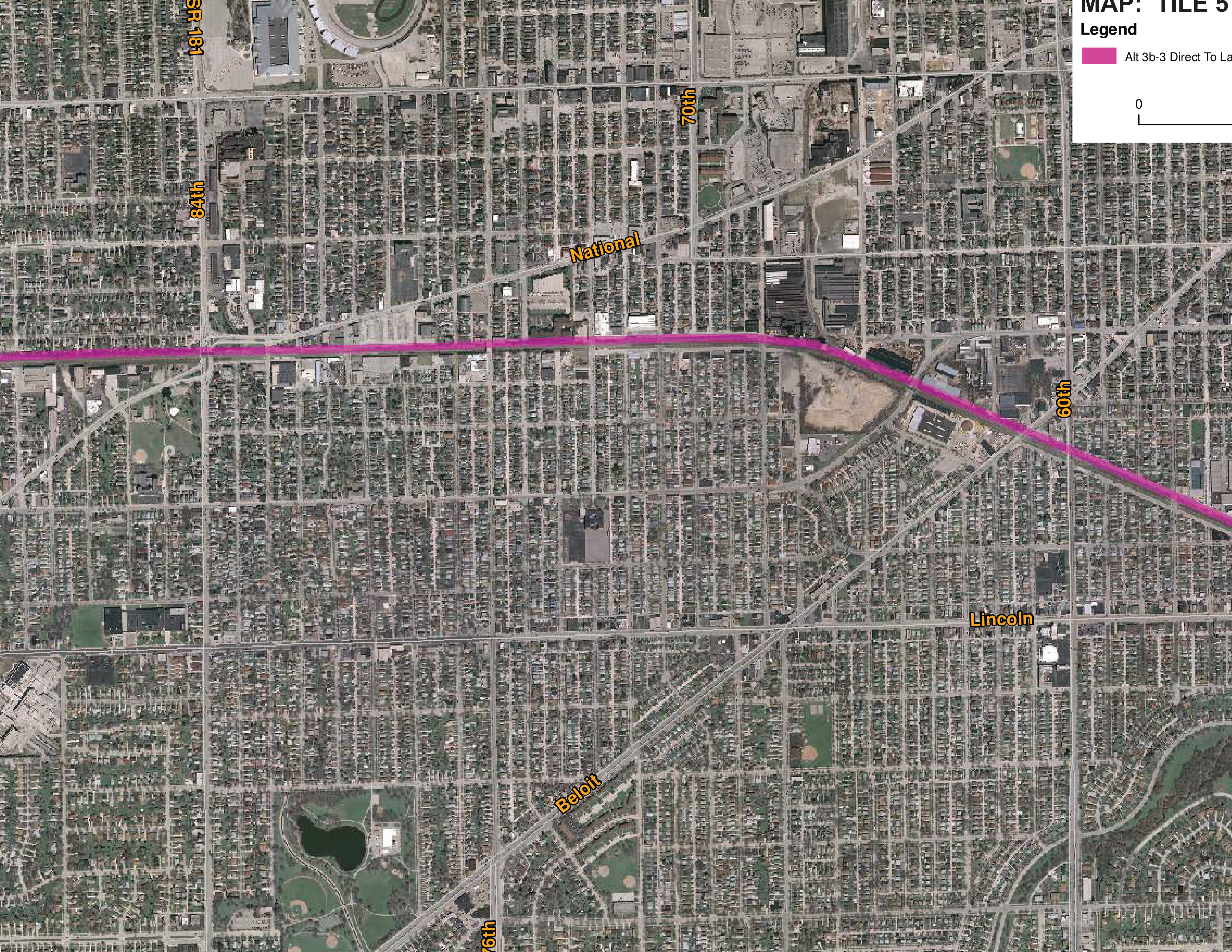
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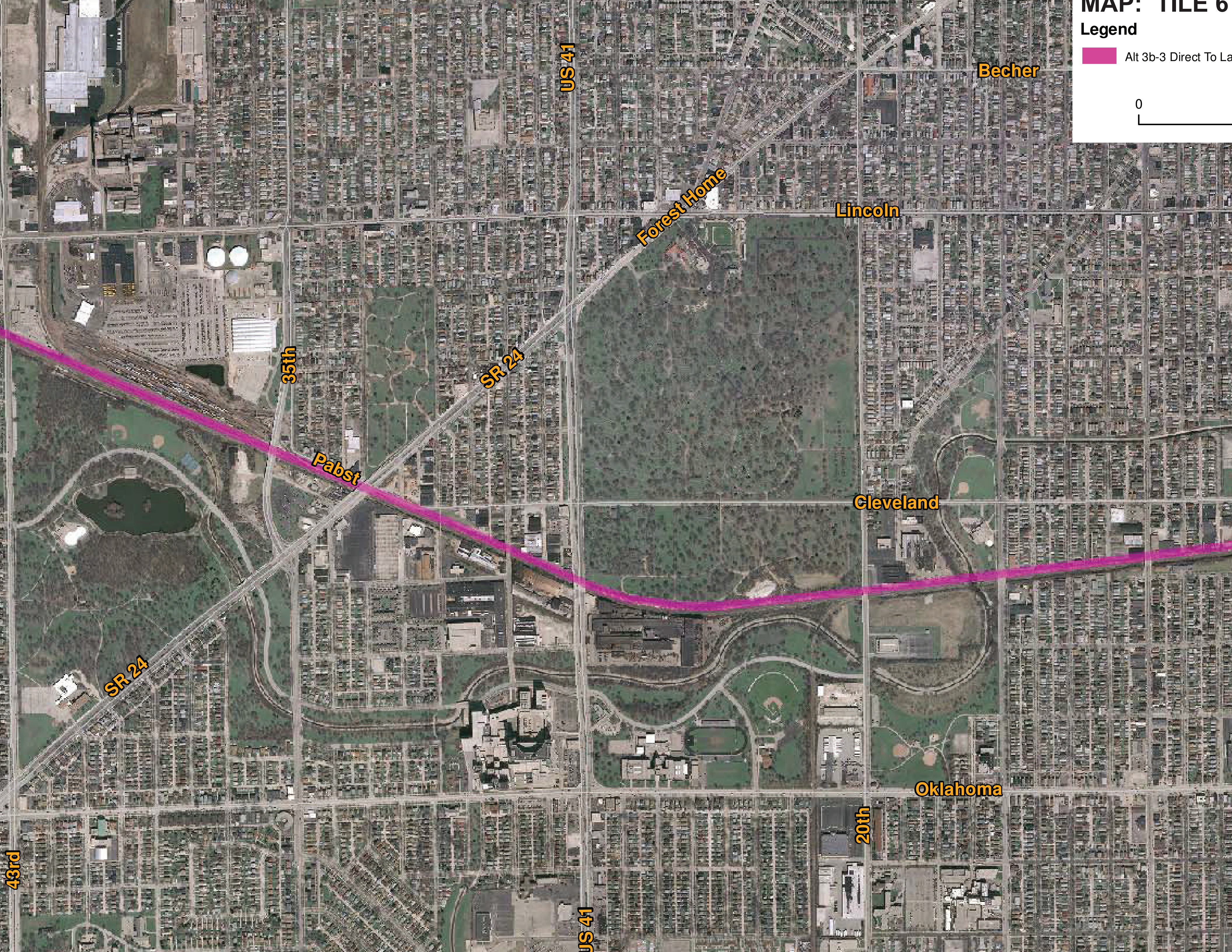
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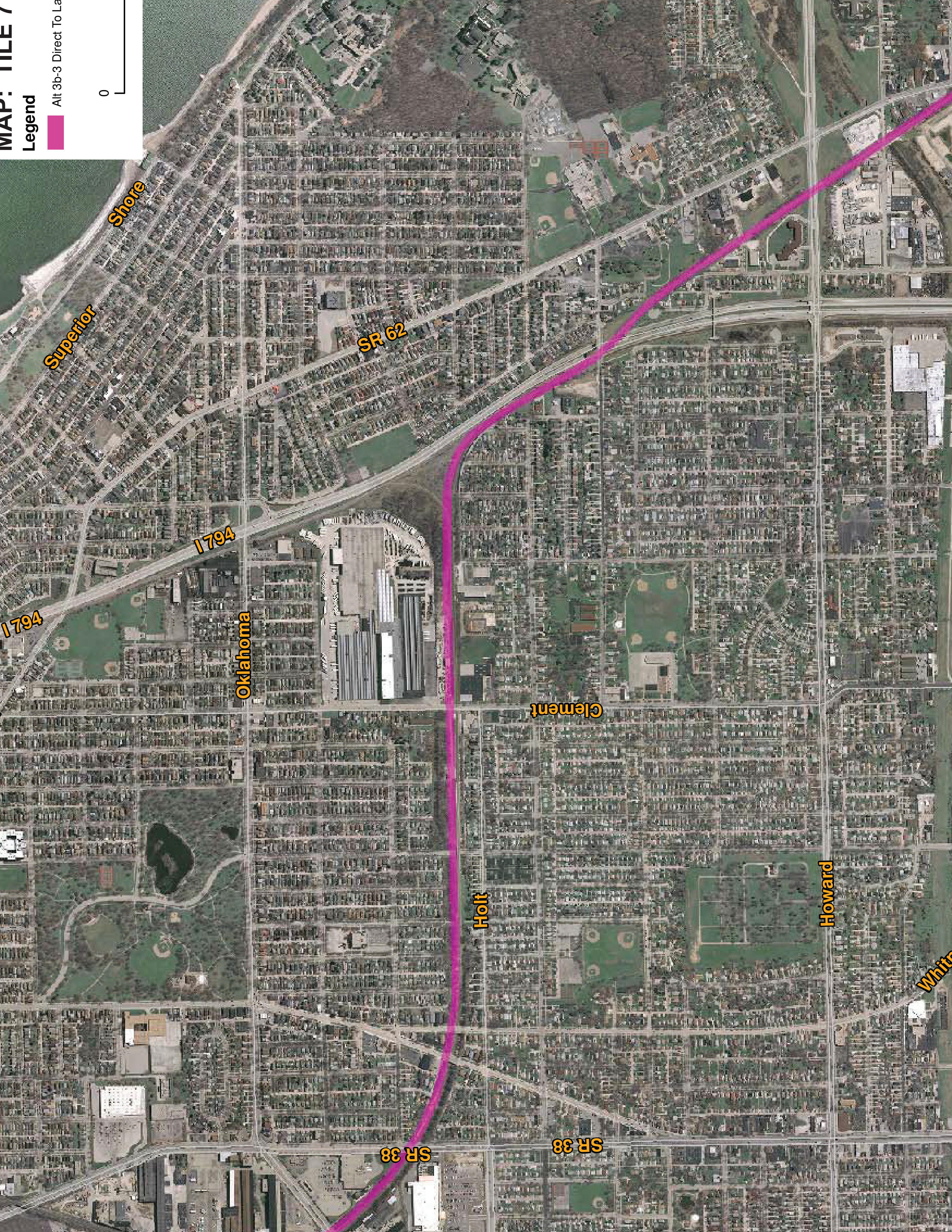
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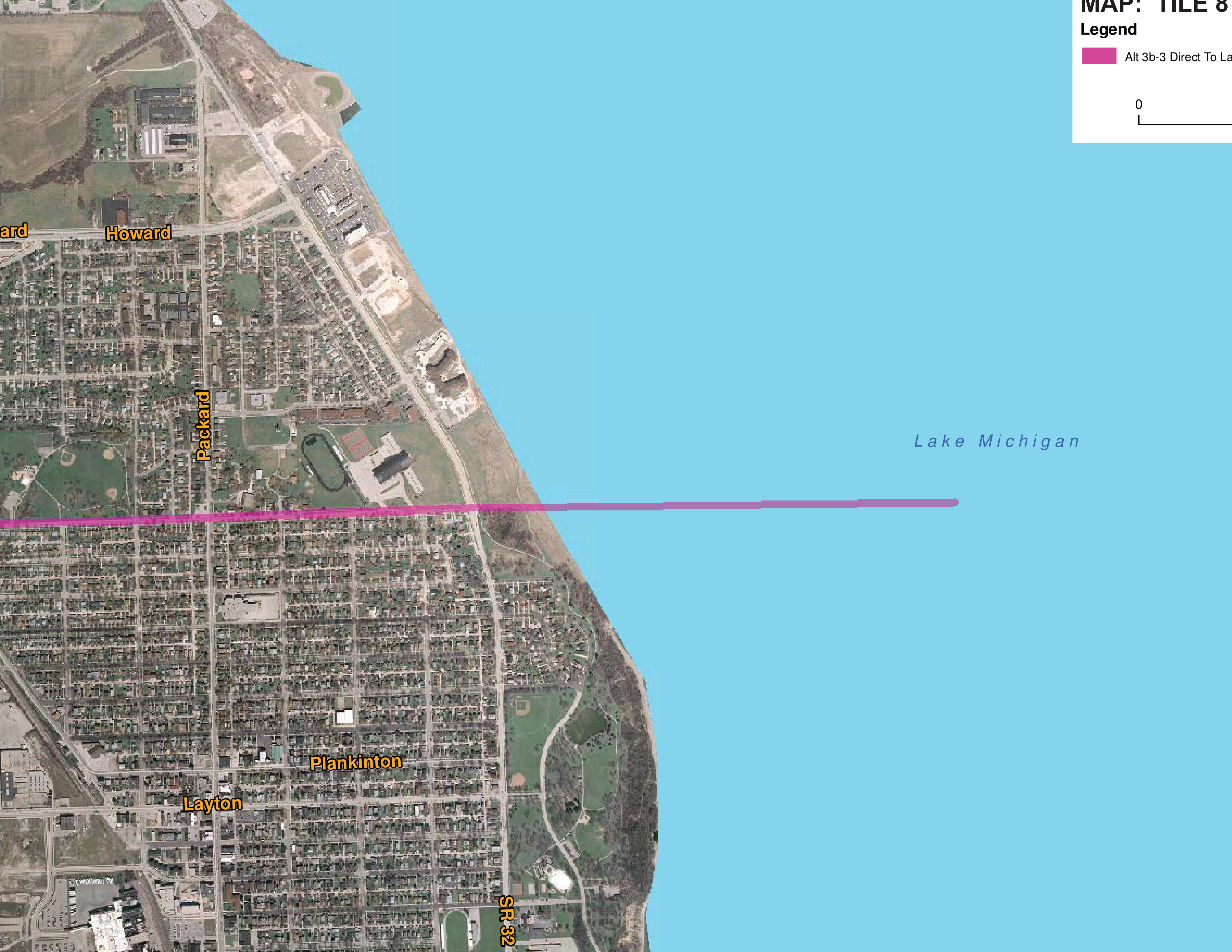

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Attachment 6-2

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 Section 6 is listed as "Table 6-7A" 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. 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

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	Minor adverse impact
Lake Michigan (City of Milwaukee)	Root River to Lake Michigan	Minor adverse impact
Lake Michigan (City of Milwaukee)	Direct to Lake Michigan	Minor adverse impact
Lake Michigan (City of Oak Creek)	Underwood Creek to Lake Michigan	Minor adverse impact
Lake Michigan (City of Oak Creek)	Root River to Lake Michigan	Minor adverse impact
Lake Michigan (City of Oak Creek)	Direct to Lake Michigan	Minor adverse impact
Lake Michigan (City of Racine)	Underwood Creek to Lake Michigan	Minor adverse impact
Lake Michigan (City of Racine)	Root River to Lake Michigan	Minor adverse impact
Lake Michigan (City of Racine)	Direct to Lake Michigan	Minor 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	No adverse impact
Lake Michigan (City of Milwaukee)	Direct to Lake Michigan	Minor adverse impact
Lake Michigan (City of Oak Creek)	Underwood Creek to Lake Michigan	No adverse impact
Lake Michigan (City of Oak Creek)	Root River to Lake Michigan	No adverse impact
Lake Michigan (City of Oak Creek)	Direct to Lake Michigan	Minor 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	No adverse impact
Lake Michigan (City of Racine)	Direct to Lake Michigan	Minor adverse impact

For Table 6-11A, the more conservative of the water supply alternative and water return alternative designations was used to define the system alternative impact.

TABLE 6-11A
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	No adverse impact
Lake Michigan (City of Milwaukee)	Direct to Lake Michigan	Minor adverse impact
Lake Michigan (City of Oak Creek)	Underwood Creek to Lake Michigan	No adverse impact
Lake Michigan (City of Oak Creek)	Root River to Lake Michigan	No adverse impact
Lake Michigan (City of Oak Creek)	Direct to Lake Michigan	Minor 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	No adverse impact
Lake Michigan (City of Racine)	Direct to Lake Michigan	Minor adverse impact

For Table 6-14A, 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 6-14A
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	19
Lake Michigan (City of Milwaukee)	Direct to Lake Michigan	17
Lake Michigan (City of Oak Creek)	Underwood Creek to Lake Michigan	20
Lake Michigan (City of Oak Creek)	Root River to Lake Michigan	22
Lake Michigan (City of Oak Creek)	Direct to Lake Michigan	20
Lake Michigan (City of Racine)	Underwood Creek to Lake Michigan	25
Lake Michigan (City of Racine)	Root River to Lake Michigan	27
Lake Michigan (City of Racine)	Direct to Lake Michigan	25

For Table 6-16A, the more conservative of the water supply alternative and water return alternative designations was used to define the system alternative impact.

TABLE 6-16A
System Alternatives Environmental Impact Comparison Summary: Inland Waterway Flooding and Aquatic Habitat

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	No adverse impact
Lake Michigan (City of Milwaukee)	Root River to Lake Michigan	Minor adverse impact	No adverse impact
Lake Michigan (City of Milwaukee)	Direct to Lake Michigan	Minor adverse impact	No adverse impact
Lake Michigan (City of Oak Creek)	Underwood Creek to Lake Michigan	Minor adverse impact	No adverse impact
Lake Michigan (City of Oak Creek)	Root River to Lake Michigan	Minor adverse impact	No adverse impact
Lake Michigan (City of Oak Creek)	Direct to Lake Michigan	Minor adverse impact	No adverse impact
Lake Michigan (City of Racine)	Underwood Creek to Lake Michigan	Minor adverse impact	No adverse impact
Lake Michigan (City of Racine)	Root River to Lake Michigan	Minor adverse impact	
Lake Michigan (City of Racine)	Direct to Lake Michigan	Minor adverse impact	

For Table 6-25A, the more conservative of the water supply alternative and water return alternative designations was used to define the system alternative impact.

TABLE 6-25A
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	Minor 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	Minor adverse impact
Lake Michigan (City of Milwaukee)	Direct to Lake Michigan	No adverse impact
Lake Michigan (City of Oak Creek)	Underwood Creek to Lake Michigan	Minor adverse impact
Lake Michigan (City of Oak Creek)	Root River to Lake Michigan	Minor adverse impact
Lake Michigan (City of Oak Creek)	Direct to Lake Michigan	No adverse impact
Lake Michigan (City of Racine)	Underwood Creek to Lake Michigan	Minor adverse impact
Lake Michigan (City of Racine)	Root River to Lake Michigan	Minor adverse impact
Lake Michigan (City of Racine)	Direct to Lake Michigan	No adverse impact

For Table 6-27A, the more conservative of the water supply alternative and water return alternative designations was used to define the system alternative impact.

TABLE 6-27A
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	No adverse impact
Lake Michigan (City of Milwaukee)	Direct to Lake Michigan	No adverse impact
Lake Michigan (City of Oak Creek)	Underwood Creek to Lake Michigan	No adverse impact
Lake Michigan (City of Oak Creek)	Root River to Lake Michigan	No adverse impact
Lake Michigan (City of Oak Creek)	Direct to Lake Michigan	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	No adverse impact
Lake Michigan (City of Racine)	Direct to Lake Michigan	No adverse impact

For Table 6-37A, 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 6-37A
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	19	2
Lake Michigan (City of Milwaukee)	Direct to Lake Michigan	12	1
Lake Michigan (City of Oak Creek)	Underwood Creek to Lake Michigan	23	2
Lake Michigan (City of Oak Creek)	Root River to Lake Michigan	26	3
Lake Michigan (City of Oak Creek)	Direct to Lake Michigan	19	2
Lake Michigan (City of Racine)	Underwood Creek to Lake Michigan	61	7
Lake Michigan (City of Racine)	Root River to Lake Michigan	64	7
Lake Michigan (City of Racine)	Direct to Lake Michigan	57	6

For Table 6-39A, the more conservative of the water supply alternative and water return alternative designations was used to define the system alternative impact.

TABLE 6-39A
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	Minor adverse impact
Lake Michigan (City of Milwaukee)	Direct to Lake Michigan	Minor adverse impact
Lake Michigan (City of Oak Creek)	Underwood Creek to Lake Michigan	Minor adverse impact
Lake Michigan (City of Oak Creek)	Root River to Lake Michigan	Minor adverse impact
Lake Michigan (City of Oak Creek)	Direct to Lake Michigan	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	Moderate adverse impact
Lake Michigan (City of Racine)	Direct to Lake Michigan	Moderate adverse impact

For Table 6-40A, 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 6-40A
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	0
Lake Michigan (City of Milwaukee)	Direct to Lake Michigan	0
Lake Michigan (City of Oak Creek)	Underwood Creek to Lake Michigan	1
Lake Michigan (City of Oak Creek)	Root River to Lake Michigan	1
Lake Michigan (City of Oak Creek)	Direct to Lake Michigan	1
Lake Michigan (City of Racine)	Underwood Creek to Lake Michigan	3
Lake Michigan (City of Racine)	Root River to Lake Michigan	3
Lake Michigan (City of Racine)	Direct to Lake Michigan	3

For Table 6-44A, the more conservative of the water supply alternative and water return alternative designations was used to define the system alternative impact.

TABLE 6-44A
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	No adverse impact
Lake Michigan (City of Milwaukee)	Direct to Lake Michigan	No adverse impact
Lake Michigan (City of Oak Creek)	Underwood Creek to Lake Michigan	No adverse impact
Lake Michigan (City of Oak Creek)	Root River to Lake Michigan	No adverse impact
Lake Michigan (City of Oak Creek)	Direct to Lake Michigan	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	No adverse impact
Lake Michigan (City of Racine)	Direct to Lake Michigan	No adverse impact

For Table 6-50A, 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 6-50A
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	10	72.34
Lake Michigan (City of Milwaukee)	Direct to Lake Michigan	13	30.17
Lake Michigan (City of Oak Creek)	Underwood Creek to Lake Michigan	15	66.67
Lake Michigan (City of Oak Creek)	Root River to Lake Michigan	15	106.94
Lake Michigan (City of Oak Creek)	Direct to Lake Michigan	18	64.77
Lake Michigan (City of Racine)	Underwood Creek to Lake Michigan	11	28.34
Lake Michigan (City of Racine)	Root River to Lake Michigan	11	68.61
Lake Michigan (City of Racine)	Direct to Lake Michigan	14	26.44

For Table 6-52A and Table 6-62A, the more conservative of the water supply alternative and water return alternative designations was used to define the system alternative impact.

TABLE 6-52A
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	No adverse impact
Lake Michigan (City of Milwaukee)	Direct to Lake Michigan	No adverse impact
Lake Michigan (City of Oak Creek)	Underwood Creek to Lake Michigan	No adverse impact
Lake Michigan (City of Oak Creek)	Root River to Lake Michigan	No adverse impact
Lake Michigan (City of Oak Creek)	Direct to Lake Michigan	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	No adverse impact
Lake Michigan (City of Racine)	Direct to Lake Michigan	No adverse impact

TABLE 6-62A
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	No adverse impact
Lake Michigan (City of Milwaukee)	Direct to Lake Michigan	No adverse impact
Lake Michigan (City of Oak Creek)	Underwood Creek to Lake Michigan	No adverse impact
Lake Michigan (City of Oak Creek)	Root River to Lake Michigan	No adverse impact
Lake Michigan (City of Oak Creek)	Direct to Lake Michigan	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	No adverse impact
Lake Michigan (City of Racine)	Direct to Lake Michigan	No adverse impact

For Table 6-63A, the water supply alternative and water return alternative values were added together to define the system alternative 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 CO_2)
Deep and Shallow Aquifers	Discharge to Fox River	22,700	21,100
Shallow Aquifer and Fox River Alluvium	Discharge to Fox River	21,100	19,600
Lake Michigan (City of Milwaukee)	Underwood Creek to Lake Michigan	16,800	15,600
Lake Michigan (City of Milwaukee)	Root River to Lake Michigan	16,500	15,300
Lake Michigan (City of Milwaukee)	Direct to Lake Michigan	16,700	15,500
Lake Michigan (City of Oak Creek)	Underwood Creek to Lake Michigan	20,900	19,400
Lake Michigan (City of Oak Creek)	Root River to Lake Michigan	20,600	19,100
Lake Michigan (City of Oak Creek)	Direct to Lake Michigan	20,800	19,300
Lake Michigan (City of Racine)	Underwood Creek to Lake Michigan	19,600	18,200
Lake Michigan (City of Racine)	Root River to Lake Michigan	19,300	17,900
Lake Michigan (City of Racine)	Direct to Lake Michigan	19,500	18,100

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.

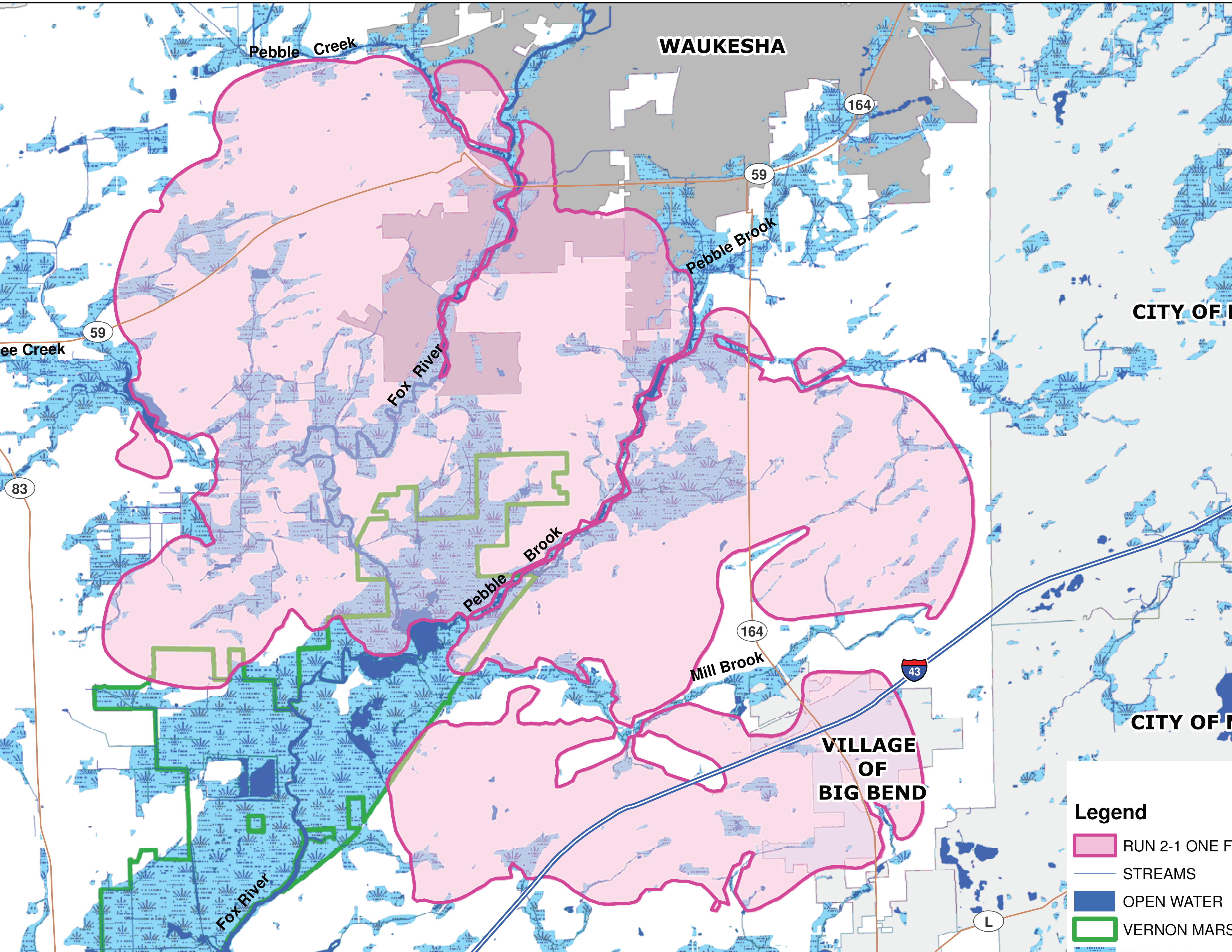
TABLE 6-72A
Water Supply and Return Flow Alternative Environmental Impact Comparison Summary

Water Supply Alternative	Water Return Alternative	Groundwater Resources	Geomorphology and Sediments	Flooding	Aquatic Habitat	Water Quality	Wetlands	Vegetation and Wildlife Resources	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	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	Minor adverse impact	Significant 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	No adverse impact	Minor adverse impact	Minor adverse impact	Minor adverse impact	No adverse impact	No adverse impact	No adverse impact
Lake Michigan (City of Milwaukee)	Root River to Lake Michigan	No adverse impact	No adverse impact	No adverse impact	Minor adverse impact	Minor adverse impact	Minor adverse impact	No 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	Minor adverse impact	Minor adverse impact	No adverse impact	No adverse impact	No adverse impact
Lake Michigan (City of Oak Creek)	Underwood Creek to Lake Michigan	No adverse impact	No adverse impact	No adverse impact	Minor adverse impact	Minor adverse impact	Minor adverse impact	No adverse impact	No adverse impact	No adverse impact
Lake Michigan (City of Oak Creek)	Root River to Lake Michigan	No adverse impact	No adverse impact	No adverse impact	Minor adverse impact	Minor adverse impact	Minor adverse impact	No adverse impact	No adverse impact	No adverse impact
Lake Michigan (City of Oak Creek)	Direct to Lake Michigan	No adverse impact	Minor adverse impact	No adverse impact	Minor adverse impact	Minor adverse impact	Minor adverse impact	No adverse impact	No adverse impact	No adverse impact
Lake Michigan (City of Racine)	Underwood Creek to Lake Michigan	No adverse impact	No adverse impact	No adverse impact	Minor adverse impact	Minor adverse impact	Moderate adverse impact	No adverse impact	No adverse impact	No adverse impact

TABLE 6-72A
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	Vegetation and Wildlife Resources	Soils	Land Use
Lake Michigan (City of Racine)	Root River to Lake Michigan	No adverse impact	No adverse impact	No adverse impact	Minor adverse impact	Minor adverse impact	Moderate adverse impact	No 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	Minor adverse impact	Moderate adverse impact	No adverse impact	No adverse impact	No adverse impact

Attachment 6-3
Groundwater Drawdown Maps



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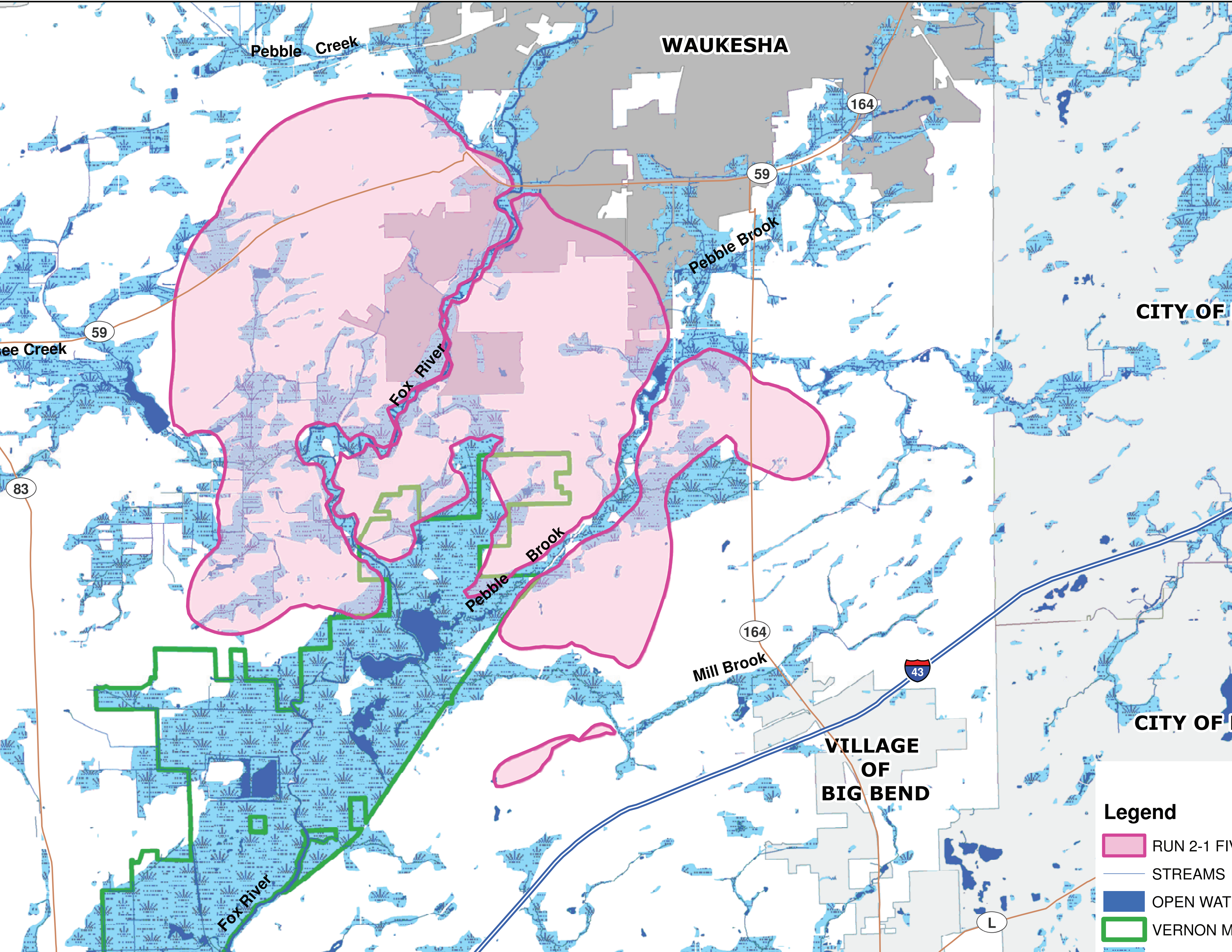
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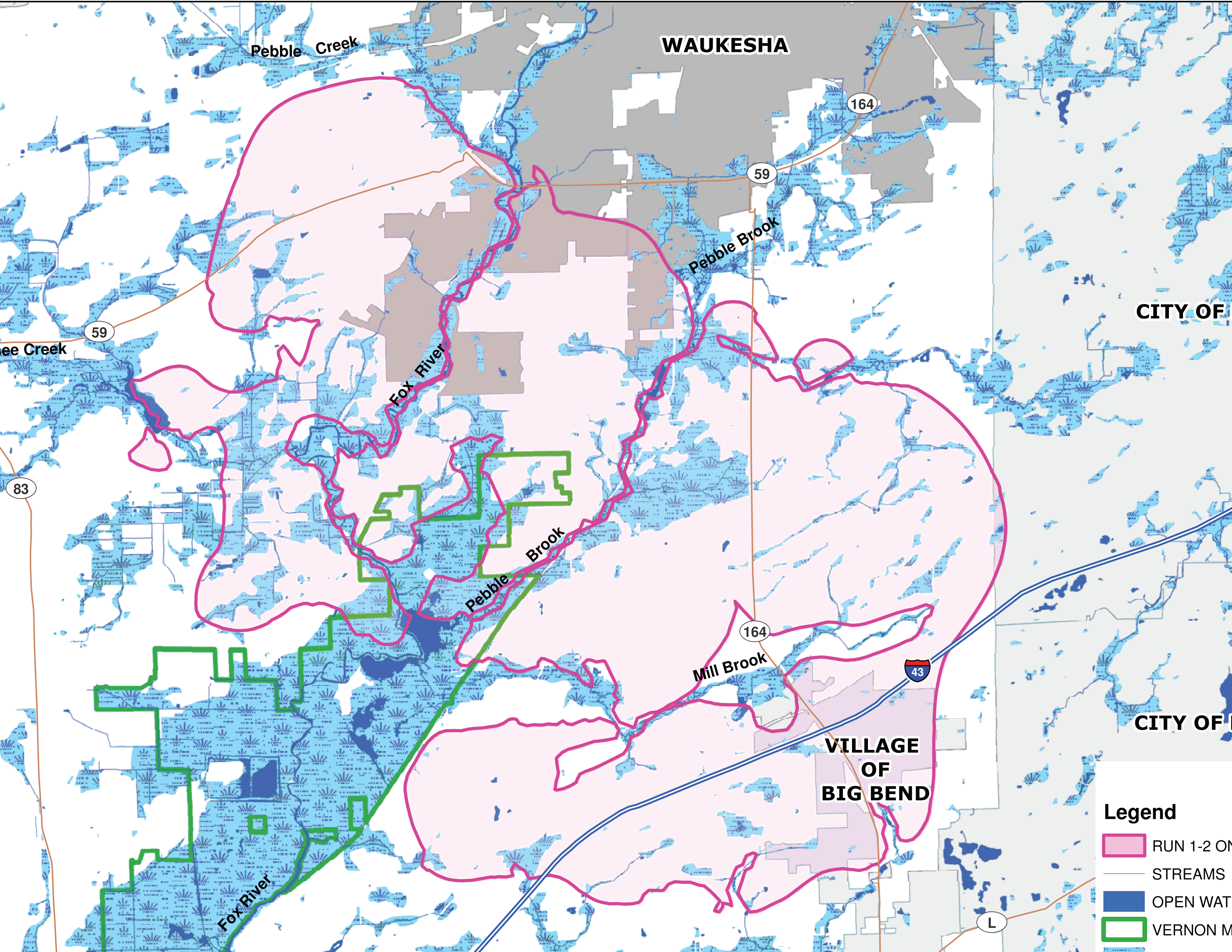

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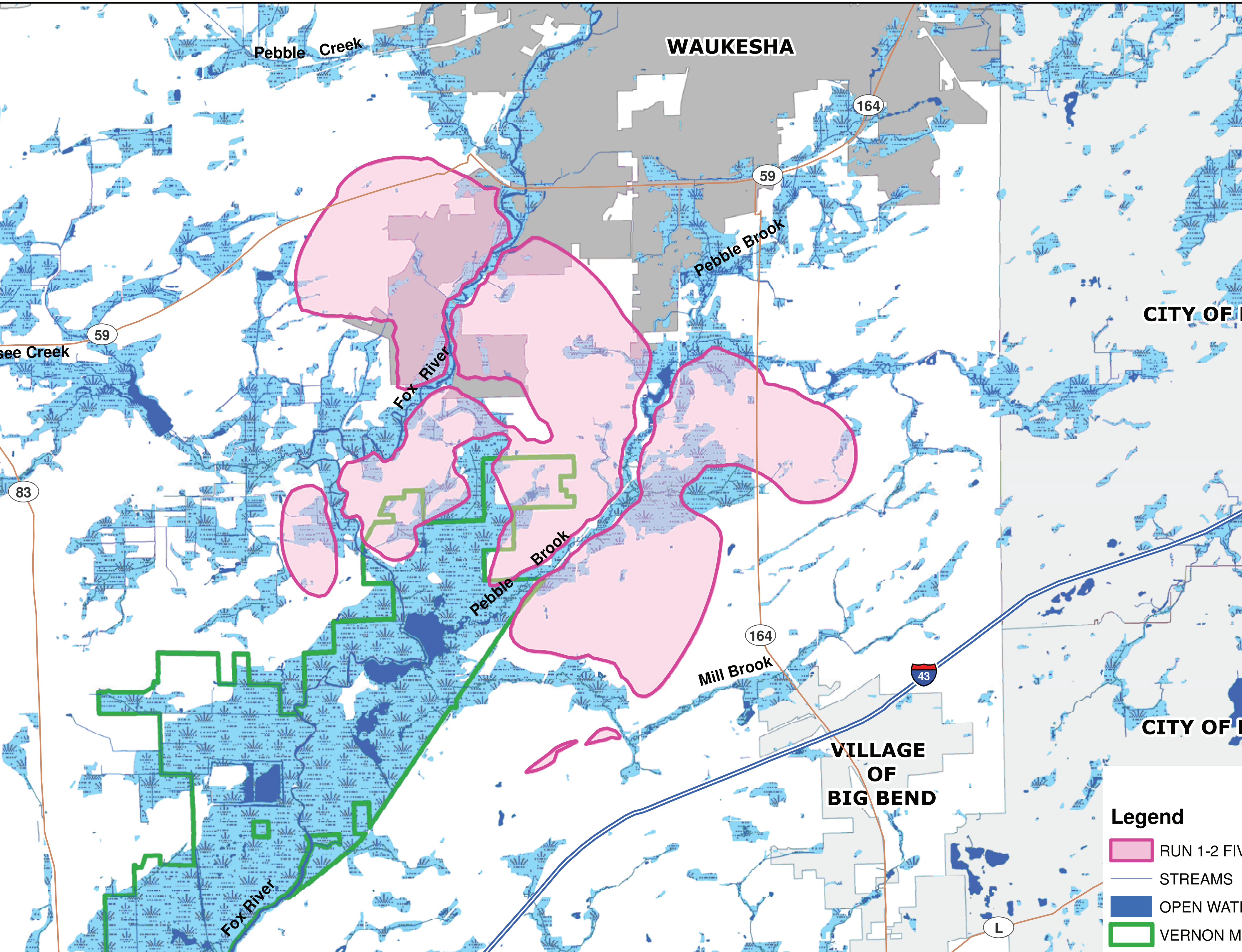
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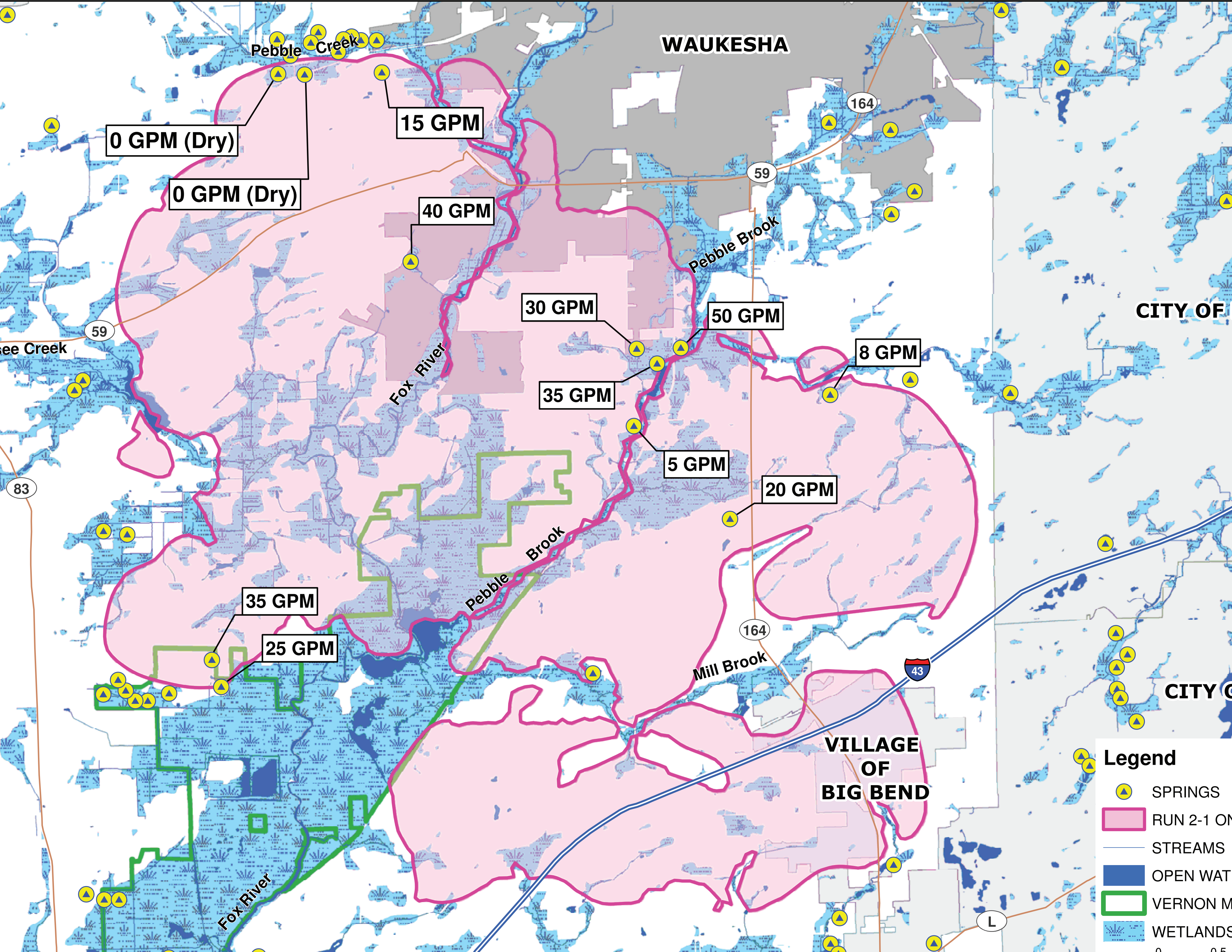
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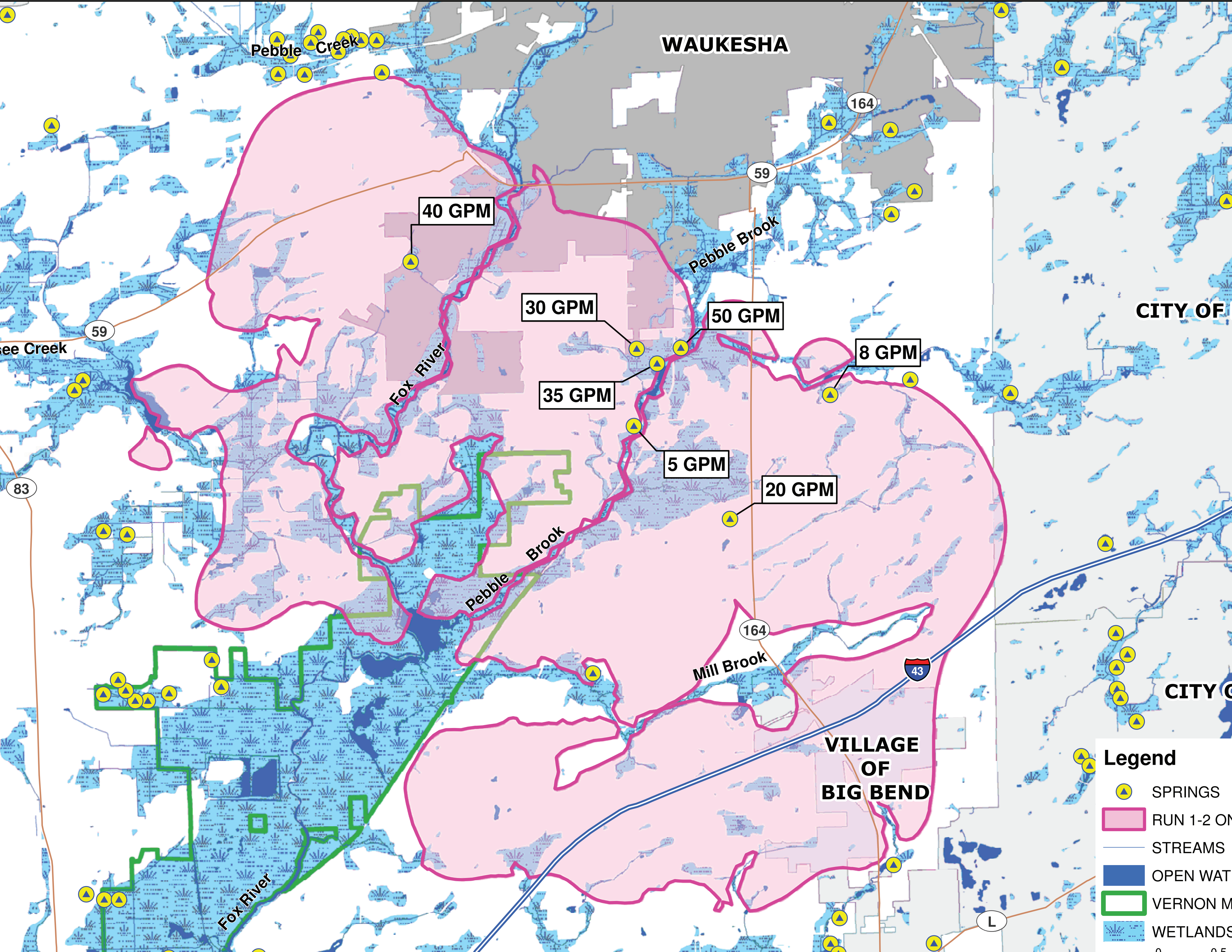
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Attachment 6-4
Vernon Marsh Wetland Habitat Impact Analysis Technical Memorandum

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 model[1] 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 Mtigation 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 affects 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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Attachment 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

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.

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.

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Wisconsin Geological and Natural History Survey (WGNHS). 2010. Spring Inventory provided March 9, 2010.

ely due to the sensitive nature of the potential habitat locations for threatened and endangered species.

	Bird Rookery		Wet Prairie		Springs and Spring Runs		Streams		Oxbow Lake		
ne	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]	Relativ Suitabili
s[1]	Moderate Suitability	Temporary and permanent	N/A	N/A	Low Suitability	Temporary	N/A	N/A	N/A	N/A	Low Suital
water Drawdown	High Suitability	Permanent	N/A	N/A	Moderate Suitability	Permanent	N/A	N/A	N/A	N/A	High Suita
water Drawdown[2]	High Suitability	Permanent	N/A	N/A	Moderate Suitability	Permanent	N/A	N/A	N/A	N/A	High Suita
lluvium											
s[1]	High Suitability	Temporary and permanent	N/A	N/A	Low Suitability	Temporary	N/A	N/A	N/A	N/A	Low Suital
water Drawdown	High Suitability	Permanent	N/A	N/A	Moderate Suitability	Permanent	N/A	N/A	N/A	N/A	High Suita
water Drawdown[2]	High Suitability	Permanent	N/A	N/A	Moderate Suitability	Permanent	N/A	N/A	N/A	N/A	High Suita
es											
	Low Suitability	Temporary and permanent	N/A	N/A	Absent	None	N/A	N/A	N/A	N/A	N/A
	N/A	N/A	Low Suitability	Temporary	Absent	None	N/A	N/A	N/A	N/A	High Suita
	High Suitability	Temporary and permanent	N/A	N/A	Absent	None	Low Suitability	Temporary	Absent	None	High Suita
n	N/A	N/A	N/A	N/A	Absent	None	N/A	N/A	N/A	N/A	Low Suital
	N/A	N/A	N/A	N/A	Absent	None	N/A	N/A	N/A	N/A	Moderate
	N/A	N/A	N/A	N/A	Absent	None	N/A	N/A	N/A	N/A	N/A

access roads (15 feet wide), well houses, and WTP.

r Groundwater Drawdown is contained within the Areas of the 1-Foot or Greater Groundwater Drawdown.

munity was not listed by the WDNR NHI results for the alternative, and was not observed during the 2010 Habitat Surveys.

<u>low Aquifer and Fox River Alluvium</u>

cts 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.

<u>res:</u> "Temporary" impacts are those only associated with construction. While "Temporary and Permanent" impacts include temporary impacts from construction, in addition to the permanent impacts fro
ipeline 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

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only a small subset of the "Temporary and Permanent" total. To be conservative, it is assumed that the temporary impacts occur.

upland prairie habitats as a result of the groundwater drawdowns.

	Emergent Marsh		Shrub-Carr		Floodplain F
ame	Relative Occurrence	Type Of Impact[4]	Relative Occurrence	Type Of Impact[4]	Relative Occurrence
s[1]	4 acres	Temporary and Permanent	5 acres	Temporary and permanent	2 acres
water Drawdown	710 acres	Permanent	1,294 acres	Permanent	438 acres
water Drawdown[2]	241 acres	Permanent	419 acres	Permanent	138 acres
	714 acres		1,299 acres		440 acres
lluvium					
s[1]	4 acres	Temporary and Permanent	7 acres	Temporary and permanent	8 acres
water Drawdown	1,079 acres	Permanent	1,558 acres	Permanent	676 acres
water Drawdown[2]	475 acres	Permanent	871 acres	Permanent	290 acres
vium Total[3]	1,083 acres		1,565 acres		684 acres
es					
	1 acre	Temporary	2 acres	Temporary and permanent	3 acres
	3 acres	Temporary	4 acres	Temporary and permanent	4 acres
	16 acres	Temporary	22 acres	Temporary and permanent	4 acres
n	2 acres	Temporary	2 acres	Temporary and permanent	0.5 acres
	2 acres	Temporary	3 acres	Temporary and permanent	7 acres
	2 acres	Temporary	2 acres	Temporary and permanent	Absent

access roads (15 feet wide), well houses, and WTP.

r Groundwater Drawdown is contained within the Areas of the 1-Foot or Greater Groundwater Drawdown.

Structures and Areas of 1-Foot or Greater Groundwater Drawdown.

<u>low Aquifer and Fox River Alluvium</u>

cts 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.

<u>es:</u> "Temporary" impacts are those only associated with construction. While "Temporary and Permanent" impacts include temporary impacts from construction, in addition to the permanent impacts fro
peline 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

<u>ernatives</u>

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are only a small subset of the "Temporary and Permanent" total. To be conservative, it is assumed that the temporary impacts occur.

y associated with construction. While "Temporary and Permanent" impacts include temporary impacts from construction, in addition to the permanent impacts from the pipeline maintenance corridors. T
are only a small subset of the "Temporary and Permanent" total. To be conservative, it is assumed that the temporary impacts occur.

, FEMA Firmette Mapping Database, & 2010 Habitat Surveys.

	Southern sedge meadow		Calcareous fen		
	Relative Suitabilty[3]	Type Of Impact[3,4]	Relative Suitabilty[3]	Type Of Impact[3,4]	Comments
1	Low Suitability	Temporary and permanent	Low Suitability	Temporary and permanent	
	High Suitability	Permanent	N/A[5]	N/A[5]	
	High Suitability	Permanent	N/A[5]	N/A[5]	
lluvium					
1	Low Suitability	Temporary and permanent	Low Suitability	Temporary and permanent	
	High Suitability	Permanent	N/A[5]	N/A[5]	
	High Suitability	Permanent	N/A[5]	N/A[5]	
es					
	Low Suitability	Temporary	N/A	N/A	Southern Sedge Meadow: Although southern sedge meadow was not listed as occurring along this alternative by t wetlands that contain sedge species, joe-pye weed, swamp milkweed, and reed canary grass are located along bo along this alternative during the July 2010 surveys.
	Low Suitability	Temporary	Low Suitability	Temporary	
	Moderate Suitability	Temporary	Moderate Suitability	Temporary	Southern Sedge Meadow: Although southern sedge meadow was not listed as occurring along this alternative by t wetlands that contain sedge species, joe-pye weed, swamp milkweed, and reed canary grass are located along bo 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, the were not able to observe.
					-
n	Low Suitability	Temporary	N/A	N/A	
	Low Suitability	Temporary	N/A	N/A	Southern Sedge Meadow: Although southern sedge meadow was not listed as occurring along this alternative by t wetlands that contain sedge species, joe-pye weed, swamp milkweed, and reed canary grass are located along bo along this alternative during the July 2010 surveys.

Southern sedge meadow		Calcareous fen		
Relative Suitabilty[3]	Type Of Impact[3,4]	Relative Suitabilty[3]	Type Of Impact[3,4]	Comments
Low Suitability	Temporary	Low Suitability	Temporary	Southern Sedge Meadow: Although southern sedge meadow was not listed as occurring along this alternative by th wetlands that contain sedge species, joe-pye weed, swamp milkweed, and reed canary grass are located along bo along this alternative during the July 2010 surveys.

ccess roads (15 feet wide), well houses, and WTP.

r Groundwater Drawdown is contained within the Areas of the 1-Foot or Greater Groundwater Drawdown.

munity was not listed by the WDNR NHI results for the alternative.

ow Aquifer and Fox River Alluvium

cts 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.

es: "Temporary" impacts are those only associated with construction. While "Temporary and Permanent" impacts include temporary impacts from construction, in addition to the permanent impacts fro nance 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 im

ernatives

y associated with construction. While "Temporary and Permanent" impacts include temporary impacts from construction, in addition to the permanent impacts from the pipeline maintenance corridors. T only a small subset of the "Temporary and Permanent" total. To be conservative, it is assumed that the temporary impacts occur.

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mmunications from the Vernon Marsh Wildlife Manager no known calcareous fens occur within the groundwater drawdown areas.

& 2010 Habitat Surveys.

	Northern Wet Forest		Southern Dry Forest		Southern Dry-Mesic Forest		Southern Mesic Forest	
	Relative Suitabilty[3]	Type Of Impact[3,4]	Relative Suitabilty[3]	Type Of Impact[3,4]	Relative Suitabilty[3]	Type Of Impact[3,4]	Relative Suitabilty[3]	Type Of Impact[3,4]
	N/A	N/A	Absent	None	Absent	None	Absent	None
	N/A	N/A	High Suitability	No impacts will occur[5]	High Suitability	No impacts will occur[5]	High Suitability	No impacts will occur[5]
	N/A	N/A	High Suitability	No impacts will occur[5]	High Suitability	No impacts will occur[5]	High Suitability	No impacts will occur[5]
um								
	N/A	N/A	Absent	None	Absent	None	Absent	None
	N/A	N/A	High Suitability	No impacts will occur[5]	High Suitability	No impacts will occur[5]	High Suitability	No impacts will occur[5]
	N/A	N/A	High Suitability	No impacts will occur[5]	High Suitability	No impacts will occur[5]	High Suitability	No impacts will occur[5]
	N/A	N/A	N/A	N/A	Low Suitability	Temporary and permanent	Low Suitability	Temporary and permanent
	Low Suitability	Temporary and permanent	N/A	N/A	Low Suitability	Temporary and permanent	Low Suitability	Temporary and permanent
	Low Suitability	Temporary and permanent	Low Suitability	Temporary and permanent	Low Suitability	Temporary and permanent	Low Suitability	Temporary and permanent
	N/A	N/A	N/A	N/A	Absent	None	Absent	None
	N/A	N/A	N/A	N/A	Low Suitability	Temporary and permanent	Low Suitability	Temporary and permanent
	N/A	N/A	N/A	N/A	Low Suitability	Temporary and permanent (Impacts are unlikely to occur)	Low Suitability	Temporary and permanent (Impacts are unlikely to occur)

ss roads (15 feet wide), well houses, and WTP.

oundwater Drawdown is contained within the Areas of the 1-Foot or Greater Groundwater Drawdown.

ity was not listed by the WDNR NHI results for the alternative, and was not observed during the 2010 Habitat Surveys.

<u>Aquifer and Fox River Alluvium</u>

ssociated 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.

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 ac
e 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 impac

<u>tives</u>

sociated with construction. While "Temporary and Permanent" impacts include temporary impacts from construction, in addition to the permanent impacts from the pipeline maintenance corridors. The p
subset of the "Temporary and Permanent" total. To be conservative, it is assumed that the temporary impacts occur.

sociated with construction. While "Temporary and Permanent" impacts include temporary impacts from construction, in addition to the permanent impacts from the pipeline maintenance corridors. The p
subset of the "Temporary and Permanent" total. To be conservative, it is assumed that the temporary impacts occur.

d forested habitats as a result of the groundwater drawdowns.

pposed Alternatives (Acres)
Community, and Endangered Resources

	Residential		Commercial & Industrial		Transportation		Utilities (Power & Comm.)		Government & Institutional		Recreational Areas		Agricultural Lands		Open Lands		
	mporary Land ffected[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)	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)	Temp La Affe (a
	11	<0.1	2	0	76	<1	1	0	1	0	1	0	47	27	6	<0.1	
	3,996	0	150	0	1,341	0	5	0	98	0	226	0	6,183	0	1,252	0	1,(
	1,616	0	74	0	419	0	4	0	81	0	32	0	1,977	0	387	0	3
	4,007	<0.1	152	0	1,417	<1	6	0	99	0	227	0	6,230	27	1,258	<0.1	1,(
uvium																	
	11	<0.1	2	0	76	1	1	0	1	0	1	0	74	47	6	<0.1	
	4,216	0	176	0	1,419	0	12	0	99	0	256	0	6,968	0	1,339	0	1,2
	2,114	0	91	0	604	0	7	0	84	0	149	0	3,342	0	610	0	5
	4,227	<0.1	178	0	1,495	1	13	0	100	0	257	0	7,042	47	1,345	<0.1	1,2
s																	
	3	0	3	0	67	0	31	0	<1	0	2	0	0	0	8	0	
	10	0	3	0	101	0	59	0	1	0	5	0	4	0	31	0	
	9	0	4	0	26	0	8	0	<1	0	4	0	213	0	31	0	
	2	0	4	0	24	0	51	0	1	0	3	0	0	0	6	0	
	2	0	2	0	41	0	51	0	1	0	9	0	0	0	20	0	
	5	0	10	0	92	0	63	0	4	0	5	0	0	0	11	0	<

impacted by the construction of the supply and return flow alternatives.
rmanently for groundwater drawdowns and the operation of the alternatives, which includes new access roads, new aboveground structures, and pipeline maintenance corridors.
d flats/unvegetated wet soil areas.
cess roads (15 feet wide), well houses, and WTP.
Groundwater Drawdown is contained within the Areas of the 1-Foot or Greater Groundwater Drawdown.
ructures and Areas of 1-Foot or Greater Groundwater Drawdown.

	Wetlands									
	Emergent/Wet Meadow		Scrub/Shrub		Forested		Open Water		Other[3]	
	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)
[4]	4	2	5	1	2	1	0	0	<1	0
water	710	710	1,294	1,294	932	932	89	89	62	62
water	241	241	419	419	307	307	11	11	14	14
	714	712	1,299	1,295	934	933	89	89	63	62
lluvium										
[4]	4	2	7	2	11	3	0	0	<1	0
water	1,079	1,079	1,558	1,558	1,279	1,279	103	103	87	87
water	475	475	871	871	548	548	37	37	33	33
vium	1,083	1,081	1,565	1,560	1,290	1,282	103	103	88	87
es										
	1	0	2	<1	4	1	<1	0	0	0
	3	0	4	1	6	1	<1	0	0	0
	16	0	22	4	7	1	2	0	6	0
n[7]	2	0	2	0	5	1	<1	0	0	0
	2	0	3	<0.1	7	1	<1	0	0	0
	2	0	2	0	1	<1	<1	0	<1	0

ily impacted by the construction of the supply and return flow alternatives.

permanently for groundwater drawdowns and the operation of the alternatives, which includes new access roads, new aboveground structures, and pipeline maintenance corridors.

nd flats/unvegetated wet soil areas.

access roads (15 feet wide), well houses, and WTP.

r Groundwater Drawdown is contained within the Areas of the 1-Foot or Greater Groundwater Drawdown.

Structures and Areas of 1-Foot or Greater Groundwater Drawdown.

s follow previously disturbed areas and maintained utility corridors. Forested wetlands are generally not present in maintained utility corridors. Potential permanent wetland impacts are consequently co
mental Report are consequently estimated to be less than 5 acres, minor adverse impact.

WWI

ely due to the sensitive nature of the potential habitat locations for threatened and endangered species.

ely due to the sensitive nature of the potential habitat locations for threatened and endangered species.

derally-Listed Species per Land Use for Each Proposed Alternative

al Community, and Endangered Resources

	Residential	Commercial & Industrial	Transportation	Utilities (Power & Communication)	Government & Institutional	Recreational Areas	Agricultural Lands	Open Lands	Woodlands	Surface Water	Wetlands
	0%	0%	2%	0%	0%	0%	2%	9%	8%	19%	61%
vium[2]	0%	0%	2%	0%	0%	0%	2%	9%	8%	19%	61%
	0%	0%	2%	0%	0%	0%	3%	10%	14%	14%	57%
	0%	0%	1%	<1%	0%	0%	3%	11%	14%	14%	57%
	0%	0%	3%	0%	0%	0%	1%	11%	17%	13%	55%
n	0%	0%	3%	0%	0%	0%	3%	12%	15%	14%	52%
	0%	0%	2%	0%	0%	0%	4%	12%	15%	13%	54%
	0%	1%	3%	1%	0%	0%	3%	13%	13%	13%	52%

ng, emergent/wet meadow, scrub-shrub, forested, open water, and other. See Exhibit 6.

wells, and WTP, as well as the areas of 1-foot and greater, and areas of 5-foot and greater groundwater drawdown areas.

n and Wisconsin Dept. of Natural Resources, Natural Heritage Inventory Results

Attachment 6-6
NHI Species

Contents

Attachments

Tables

1.0 References

USFWS (U.S. Fish and Wildlife Service). 2010. Correspondence from Jill Utrupp/USFWS to Corey Wilcox/CH2M HILL. January 26.

WDNR (Wisconsin Department of Natural Resources). 2010c. E-mails from Shari Koslowsky/WDNR to Corey Wilcox/CH2M HILL. January 29, April 6, and April 8.

WDNR (Wisconsin Department of Natural Resources). 2010d. Vernon Wildlife Area. http://www.dnr.state.wi.us/org/land/wildlife/wildlife_areas/vernon.htm. Accessed February 25, 2010.

TABLE 1
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	*Asclepias purpurascens*	Purple milkweed	E	—	7/13/1912
	Astragalus neglectus	Cooper's milkvetch	E	—	6/22/1939
	Carex crus-corvi	Ravenfoot sedge	E	—	6/22/1988
	Carex lupuliformis	False hop sedge	E	—	7/22/1988 1995
	Conioselinum chinense	Hemlock parsley	E	—	8/25/1897
	Platanthera leucophaea	Prairie white-fringed orchid	E	T	7/9/1890
	Erigenia bulbosa	Harbinger-of-spring	E	—	4/25/1897
	Prenanthes aspera	Rough rattlesnake root	E	—	1845
	Cypripedium arietinum	Ram's-head lady's slipper	T	—	6/1897
	Cypripedium candidum	Small white lady's slipper	T	—	1850
	Aster furcatus	Forked aster	T	—	6/7/1999
	Cacalia muehlenbergii	Great Indian plantain	SC	—	7/1/1937
	Lithospermum latifolium	American gromwell	SC	—	5/29/1976 4/30/1992 5/11/1992
	Platanthera hookeri	Hooker orchid	SC	—	7/9/1899
	Scutellaria ovata	Heart-leaved skullcap	SC	—	5/12/1980 8/1/2000
	Trillium recurvatum	Reflexed trillium	SC	—	5/28/2000 5/23/2002
	Calamagrostis stricta	Slim-stem small reedgrass	SC	—	6/30/1940
	Carex tenuiflora	Sparse-flowered sedge	SC	—	6/3/1882
	Cypripedium parviflorum	Northern yellow lady's slipper	SC	—	6/3/1932
	Liatris spicata	Marsh blazing star	SC	—	9/1875
	Thalictrum revolutum	Waxleaf meadowrue	SC	—	8/8/1933 6/30/1940
	Triglochin maritime	Common bog arrow-grass	SC	—	1800s
	Ptelea trifoliate	Wafer-ash	SC	—	10/3/2000
	Viburnum prunifolium	Smooth black-haw	SC	—	12/2/1999
	Platanthera dilatata	Leafy white orchid	SC	—	7/1884

TABLE 1
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	*Acris crepitans*	Northern cricket frog	E	—	5/10/1946 5/1/1955
	Thamnophis butleri	Butler's gartersnake	T	—	7/13/2007 10/23/2007 6/2008 10/23/2008
	Emydoidea blandingii	Blanding's turtle	T	—	5/3/1988 6/26/1996 2002
	Lithobates catesbeianus	American bullfrog	SC	—	7/20/1988
Fish	*Luxilus chrysocephalus*	Striped shiner	E	—	1920
	Lythrurus umbratilis	Redfin shiner	T	—	7/11/1924
	Clinostomus elongates	Redside dace	SC	—	3/20/1910
	Erimyzon sucetta	Lake chubsucker	SC	—	3/29/1977 5/10/1979
Insects	*Pompeius verna*	Little glassy wing	SC	—	7/12/1988
	Archilestes grandis	Great spreadwing	SC	—	9/20/1984
Crustaceans	*Procambarus gracilis*	Prairie crayfish	SC	—	3/28/1910 5/11/1970

[a]E, Endangered; T, Threatened; SC, Species of Concern (not legally protected).

TABLE 2
Lake Michigan—Oak Creek 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	—	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	*Asclepias purpurascens*	Purple milkweed	E	—	8/20/1905 7/13/1912 7/4/1928
	Solidago caesia	Bluestem goldenrod	E	—	9/16/1991 8/30/2000 6/4/2003 9/20/2003
	Platanthera leucophaea	Prairie white-fringed orchid	E	T	7/9/1890
	Carex lupuliformis	False hop sedge	E	—	1995 5/1/2003
	Carex crus-corvi	Ravenfoot sedge	E	—	6/22/1988
	Trisetum melicoides	Purple false oats	E	—	8/4/1940
	Astragalus neglectus	Cooper’s milkvetch	E	—	6/22/1939
	Conioselinum chinense	Hemlock parsley	E	—	8/25/1897
	Erigenia bulbosa	Harbinger-of-spring	E	—	4/25/1897
	Prenanthes aspera	Rough rattlesnake root	E	—	1845
	Aster furcatus	Forked aster	T	—	5/1/1992 1997

TABLE 2
Lake Michigan—Oak Creek 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
	Tofieldia glutinosa	Sticky false-asphodel	T	—	7/31/2003
	Cypripedium arietinum	Ram's-head lady's slipper	T	—	6/1897
	Cypripedium candidum	Small white lady's slipper	T	—	1850
	Scutellaria ovata	Heart-leaved skullcap	SC	—	5/12/1980 8/1/2000
	Carex tenuiflora	Sparse-flowered sedge	SC	—	6/3/1882
	Cacalia muehlenbergii	Great Indian plantain	SC	—	7/1/1937
	Medeola virginiana	Indian cucumber-root	SC	—	6/6/1908
	Platanthera hookeri	Hooker orchid	SC	—	7/9/1899
	Trillium recurvatum	Reflexed trillium	SC	—	5/18/1941 5/11/1992 4/30/1999 5/28/2000 7/11/2000 5/23/2002 5/1/2003
	Viburnum prunifolium	Smooth black-haw	SC	—	9/16/1991 4/26/2000 7/11/2000 5/1/2003
	Cypripedium parviflorum	Northern yellow lady's slipper	SC	—	5/30/1889 7/9/1890 6/3/1932
	Liatris spicata	Marsh blazing star	SC	—	9/1875
	Epilobium strictum	Downy willow-herb	SC	—	8/19/1983
	Triglochin maritime	Common bog arrow-grass	SC	—	1800s
	Platanthera dilatata	Leafy white orchid	SC	—	7/1884
	Glycyrrhiza lepidota	Wild licorice	SC	—	8/13/1940
	Thalictrum revolutum	Waxleaf meadowrue	SC	—	6/30/1940 7/5/1963 6/15/2000
	Lithospermum latifolium	American gromwell	SC	—	5/27/1897 5/29/1976 4/30/1992 5/11/1992 10/19/2005
	Calamagrostis stricta	Slim-stem small reedgrass	SC	—	6/30/1940

TABLE 2
Lake Michigan—Oak Creek 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
	Cakile lacustris	American sea-rocket	SC	—	7/26/1975
	Cypripedium reginae	Showy lady's slipper	SC	—	6/17/1939
	Equisetum variegatum	Variegated horsetail	SC	—	6/30/1995
	Gentianopsis procera	Lesser fringed gentian	SC	—	9/22/2000
	Solidago ohioensis	Ohio goldenrod	SC	—	10/20/2000
	Triglochin palustris	Slender bog arrow-grass	SC	—	8/11/1981
	Ptelea trifoliata	Wafer-ash	SC	—	10/3/2000
Birds	*Sterna forsteri*	Forster's tern	E	—	2004
	Nycticorax nyticorax	Black-crowned night heron	SC	—	1962
	Pandion haliaetus	Osprey	SC	—	5/2008
	Spiza Americana	Dickissel	SC	—	7/7/2000
Reptiles & Amphibians	*Acris crepitans*	Northern cricket frog	E	—	5/10/1946 5/1/1955
	Thamnophis butleri	Butler's gartersnake	T	—	7/14/2006 5/14/2007 7/13/2007 10/23/2007 4/2008 6/2008 10/23/2008
	Emydoidea blandingii	Blanding's turtle	T	—	5/3/1988 6/4/1996 5/9/2000 2002
	Lithobates catesbeianus	American bullfrog	SC	—	7/20/1988
Fish	*Luxilus chrysocephalus*	Striped shiner	E	—	1920
	Lythrurus umbratilis	Redfin shiner	T	—	7/11/1974
	Lepomis megalotis	Longear sunfish	T	—	4/4/2000
	Etheostoma microperca	Least darter	SC	—	7/11/1924
	Erimyzon sucetta	Lake chubsucker	SC	—	3/29/1977 5/10/1979
Insects	*Somatochlora ensigera*	Lemon-faced emerald	SC	—	6/25/1978
	Pompeius verna	Little glassy wing	SC	—	7/12/1988
Crustaceans	*Procambarus gracilis*	Prairie crayfish	SC	—	5/11/1970 8/7/1982

[a]E, Endangered; T, Threatened; SC, Spaecies of Concern (not legally protected).

TABLE 3
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	*Asclepias purpurascens*	Purple milkweed	E	—	7/13/1912
	Astragalus neglectus	Cooper's milkvetch	E	—	6/22/1939
	Carex crus-corvi	Ravenfoot sedge	E	—	6/22/1988
	Carex lupuliformis	False hop sedge	E	—	1995
	Conioselinum chinense	Hemlock parsley	E	—	8/25/1897
	Platanthera leucophaea	Prairie white-fringed orchid	E	T	7/9/1890
	Erigenia bulbosa	Harbinger-of-spring	E	—	4/25/1897
	Prenanthes aspera	Rough rattlesnake root	E	—	1845
	Cypripedium arietinum	Ram's-head lady's slipper	T	—	6/1897
	Aster furcatus	Forked aster	T	—	1997
	Cypripedium candidum	Small white lady's slipper	T	—	1850
	Cacalia muehlenbergii	Great Indian plantain	SC	—	7/1/1937
	Lithospermum latifolium	American gromwell	SC	—	5/27/1897 5/29/1976 4/30/1992 4/28/1993
	Platanthera hookeri	Hooker orchid	SC	—	7/9/1899
	Scutellaria ovata	Heart-leaved skullcap	SC	—	5/12/1980 8/1/2000
	Trillium recurvatum	Reflexed trillium	SC	—	5/12/2002 5/23/2002
	Calamagrostis stricta	Slim-stem small reedgrass	SC	—	6/30/1940
	Carex tenuiflora	Sparse-flowered sedge	SC	—	6/3/1882
	Cypripedium parviflorum	Northern yellow lady's slipper	SC	—	6/3/1932 8/11/1992

TABLE 3
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
	Liatris spicata	Marsh blazing star	SC	—	9/1875
	Thalictrum revolutum	Waxleaf meadowrue	SC	—	6/30/1940
	Triglochin maritime	Common bog arrow-grass	SC	—	1800s
	Platanthera dilatata	Leafy white orchid	SC	—	7/1884
	Calylophus serrulatus	Yellow evening primose	SC	—	7/26/2002
	Thaspium trifoliatum	Purple meadow parsnip	SC	—	5/30/1930
	Jeffersonia diphylla	Twinleaf	SC	—	4/28/1993
Birds	*Nycticorax nycticorax*	Black-crowned night heron	SC	—	1974
Reptiles & Amphibians	*Acris crepitans*	Northern cricket frog	E	—	5/10/1946 5/1/1955
	Thamnophis butleri	Butler’s gartersnake	T	—	7/2007 10/23/2007 2008
	Emydoidea blandingii	Blanding’s turtle	T	—	5/3/1988 6/26/1996
	Lithobates catesbeianus	American bullfrog	SC	—	7/20/1988
Fish	*Luxilus chrysocephalus*	Stride shiner	E	—	1920
	Lythrurus umbratilis	Redfin shiner	T	—	7/11/1924
	Etheostoma microperca	Least darter	SC	—	11/17/1901
	Erimyzon sucetta	Lake chubsucker	SC	—	3/29/1977
	Clinostomus elongates	Redside dace	SC	—	11/17/1901
Insects	*Pompeius verna*	Little glassy wing	SC	—	7/12/1988
Crustaceans	*Procambarus gracilis*	Prairie crayfish	SC	—	5/11/1970

[a]E, Endangered; T, Threatened; SC, Species of Concern (not legally protected).

TABLE 4
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	*Asclepias purpurascens*	Purple milkweed	E	—	8/20/1905 7/13/1912 7/4/1928
	Aster furcatus	Forked aster	T	—	8/19/2001 1997
	Astragalus neglectus	Cooper's milkvetch	E	—	6/22/1939
	Cacalia muehlenbergii	Great Indian plantain	SC	—	7/1/1937
	Cakile lacustris	American sea-rocket	SC	—	1950s?
	Calamagrostis stricta	Slim-stem small reedgrass	SC	—	6/30/1940
	Carex tenuiflora	Sparse-flowered sedge	SC	—	6/3/1882
	Conioselinum chinense	Hemlock parsley	E	—	8/25/1897
	Cypripedium arietinum	Ram's-head lady's slipper	T	—	6/1897
	Cypripedium candidum	Small white lady's slipper	T	—	1850
	Cypripedium parviflorum	Northern yellow lady's slipper	SC	—	5/30/1889 7/9/1890 6/3/1932
	Cypripedium reginae	Showy lady's slipper	SC	—	6/17/1939
	Equisetum variegatum	Variegated horsetail	SC	—	6/30/1995
	Erigenia bulbosa	Harbinger-of-spring	E	—	1850 1920
	Euphorbia polygonifolia	Seaside Spurge	SC		1872
	Gentianopsis procera	Lesser fringed gentian	SC	—	9/9/1991
	Glycyrrhiza lepidota	Wild licorice	SC	—	8/19/1940
	Liatris spicata	Marsh blazing star	SC	—	9/1875 1872

TABLE 4
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
	Lithospermum latifolium	American gromwell	SC	—	5/27/1897
	Medeola virginiana	Indian cucumber-root	SC	—	6/6/1908
	Penstemon hirsutus	Hairy Beardtongue	SC		6/18/1939
	Platanthera dilatata	Leafy white orchis	SC	—	7/1884
	Platanthera hookeri	Hooker orchis	SC	—	7/9/1899
	Platanthera leucophaea	Prairie white-fringed orchid	E	T	7/9/1890
	Solidago caesia	Bluestem goldenrod	E	—	9/20/1872 9/25/2001 12/10/2000
	Solidago ohioensis	Ohio goldenrod	SC	—	9/20/1975 9/9/1991
	Thalictrum revolutum	Waxleaf meadowrue	SC	—	8/8/1933 6/30/1940
	Tofieldia glutinosa	Sticky false-asphodel	T	—	6/30/1995
	Triglochin maritime	Common bog arrow-grass	SC	—	1800s
	Triglochin palustris	Slender bog arrow-grass	SC	—	8/11/1981
	Trillium recurvatum	Reflexed trillium	SC	—	5/14/1991 1846 5/23/1945 5/17/1963 5/28/2000 5/11/1938
	Trisetum melicoides	Purple false oats	E	—	8/4/1940
Birds	*Spiza Americana*	Dickissel	SC	—	2/8/2000
Reptiles & Amphibians	*Acris crepitans*	Northern cricket frog	E	—	5/10/1946 5/1/1955
	Thamnophis butleri	Butler's gartersnake	T	—	10/25/1915 4/14/1910 2003 5/14/2007 10/10/1938 10/18/1987
	Emydoidea blandingii	Blanding's turtle	T	—	5/3/1988 6/4/1996 5/9/2000 2002

TABLE 4
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
	Lithobates catesbeianus	American bullfrog	SC	—	7/20/1988
Fish	*Luxilus chrysocephalus*	Striped shiner	E	—	3/2/1910
	Lythrurus umbratilis	Redfin shiner	T	—	7/11/1974
	Moxostoma valenciennesi	Greater Redhorse	T		9/13/1996
	Fundulus diaphanus	Banded Killfish	SC	—	4/20/1902
	Pompeius verna	Little glassy wing	SC	—	7/12/1988
Crustaceans	*Procambarus gracilis*	Prairie crayfish	SC	—	3/28/1910 5/2/1910 7/9/1983 2/7/1982 7/11/1982 7/8/1982

[a]E, Endangered; T, Threatened; SC, Species of Concern (not legally protected).

TABLE 5
Deep and Shallow Wells & Shallow Aquifer and Fox River Alluvium - 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	SC	—	1994
	—	Calcerous Fen	NA	—	9/10/1992
	—	Emergent Marsh	N/A	—	5/30/1992
	—	Mesic Prairie	N/A	—	7/26/2002
	—	Southern dry forest	N/A	—	4/30/1992
	—	Southern dry-mesic forest	N/A	—	4/30/1992
	—	Southern mesic forest	N/A	—	4/29/1992
Plants	*Agrimonia parviflora*	Swamp Agrimony	SC	—	6/3/1882 1999
	Asclepias Purpurascens	Purple Milkweed	E	—	4/7/1928
	Aster furcatus	Forked aster	T	—	6/8/1999 8/18/1998
	Cacalia tuberosa	Prairie Indian plantain	T	—	7/25/1925
	Carex Crawei	Crawe Sedge	SC	—	1852
	Cypripedium candidum	Small White Lady's Slipper	T	—	6/9/1997 6/10/1898 5/31/1948
	Cypripedium parviflorum	Northern yellow lady's slipper	SC	—	8/11/1982
	Gentiana alba	Yellow Gentain	T	—	8/30/1938
	Gentianopsis procera	Lesser Fringed Gentain	SC	—	9/10/1992
	Jeffersonia diphylla	Twinleaf	SC	—	1852 6/24/1930
	Liatris spicata	Marsh blazing star	SC	—	7/8/1933 10/8/1897
	Myriophyllum farewelii	Farwell's Water-milfoil	SC	—	5/31/1931
	Polygala cruciata	Crossleaf Milkwort	SC	—	8/1875
	Prenanthes aspera	Rough rattlesnake root	E	—	1845
	Ptelea trifoliata	Wafer ash	SC	—	9/10/1992
	Solidago ohioensis	Ohio Goldenrod	SC	—	8/30/1928 9/10/1992 6/9/1997
	Thaspium trifoliatum var. flavum	Purple Meadow-Parsnip	SC	—	5/30/1930

TABLE 5
Deep and Shallow Wells & Shallow Aquifer and Fox River Alluvium - 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	*Acris crepitans*	Northern cricket frog	E	—	5/1/1955
	Emydoidea blandingii	Blanding's turtle	T	—	5/1993
	Thamnophis butleri	Butler's gartersnake	T	—	4/5/1955 4/17/1998 6/7/2007 2/10/2007 10/2007 2004 2003 4/17/1998
Fish and Mussels	*Alasmidonta marginata*	Elktoe	SC	—	8/15/2001
	Alasmidonta virdis	Slippershell Mussel	T	—	8/15/2001
	Erimyzon sucetta	Lake chubsucker	SC	—	11/7/1978 7/13/1978
	Lepomis megalotis	Longear Sunfish	T	—	3/10/1996
	Luxilus chrysocephalus	Striped shiner	E	—	1920
Birds	*Chlidonias niger*	Black tern	SC	—	5/30/1992
	Gallinula Chloropus	Common Moorhen	SC	—	5/30/1992
Mammals	*Spermophilus frankilinii*	Franklin's ground Squirrel	SC	—	1980

[a]E, Endangered; T, Threatened; SC, Species of Concern (not legally protected).

TABLE 6
Root River 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	—	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	*Asclepias purpurascens*	Purple Milkweed	E		8/20/1905 7/13/1912
	Aster furcatus	Forked Aster	T	—	5/1/1992
	Astragalus neglectus	Cooper's Milkvetch	E	—	6/22/1939
	Cacalia muehlenbergii	Great Indian Plantain	SC	—	7/1/1937
	Calamagrostis stricta	Slim-stem Small reedgrass	SC	—	6/30/1940
	Carex lupuliformis	False Hop Sedge	E	—	1995
	Carex tenuiflora	Sparse-flowered Sedge	SC	—	6/3/1882
	Conioselinum chinense	Hemlock parsley	E	—	8/25/1897
	Cypripedium arietinum	Ram's-head Lady's slipper	T	—	6/1897
	Cypripedium parviflorum	Northern Yellow Lady's slipper	SC	—	6/3/1932 8/11/1992
	Liatris spicata	Marsh Blazing Star	SC	—	9/1875
	Lithospermum latifolium	American Gromwell	SC	—	5/27/1897 6/11/1991 4/30/1992 5/11/1992
	Platanthera dilatata	Leafy white orchid	SC	—	7/1884
	Platanthera hookeri	Hooker orchid	SC	—	7/9/1899
	Platanthera leucophaea	Prairie white-fringed orchid	E	T	7/9/1890
	Prenanthes aspera	Rough Rattlesnake-root	E	—	1845
	Ptelea trifoliata	Wafer-ash	SC	—	10/3/2000
	Scutellaria ovata	Heart-leaved skullcap	SC	—	8/1/2000
	Solidago caesia	Bluestem goldenrod	E	—	9/20/2003
	Thalictrum revolutum	Waxleaf Meadowrue	SC	—	8/8/1933 6/30/1940
	Triglochin maritime	Common Bog Arrow-grass	SC	—	1800s
	Trillium recurvatum	Reflexed Trillium	SC	—	1846 5/18/1941 5/23/1944 5/23/1945

TABLE 6
Root River 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
					5/14/1991 5/1/1992 5/28/2000 5/12/2002 5/23/2002
	Viburnum prunifolium	Smooth black-haw	SC	—	6/11/1991
Birds	*Spiza Americana*	Dickcissel	SC	—	7/7/2000
Reptiles & Amphibians	*Acris crepitans*	Northern Cricket Frog	E	—	5/10/1946 5/1/1955
	Emydoidea blandingii	Blanding's Turtle	T	—	5/3/1988 5/9/2000
	Lithobates catesbeianus	American Bullfrog	SC	—	7/20/1988
	Thamnophis butleri	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	*Luxilus chrysocephalus*	Striped shiner	E	—	1920
	Lythrurus umbratilis	Redfin shiner	T	—	7/11/1924
	Lepomis megalotis	Longear sunfish	T	—	4/4/2000
	Etheostoma microperca	Least darter	SC	—	7/11/1924
	Erimyzon sucetta	Lake chubsucker	SC	—	5/10/1979
Insects	*Pompeius verna*	Little Glassy Wing	SC	—	7/12/1988
Crustaceans	*Procambarus gracilis*	Prairie Crayfish	SC	—	3/28/1910 5/11/1970

[a]E, Endangered; T, Threatened; SC, Species of Concern (not legally protected).

TABLE 7
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	*Adlumia fungosa*	Climbing Fumitory	SC	—	1861?
	Arethusa bulbosa	Swamp-pink	SC	—	6/13/1888
	Asclepias purpurascens	Purple Milkweed	E	—	7/19/1879 7/4/1928 8/20/1905
	Asclepias sullivantii	Prairie Milkweed	T	—	6/14/1905 9/1880

TABLE 7
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
	Aster furcatus	Forked Aster	T	—	6/12/1905 9/10/1992 8/29/1990
	Cacalia muehlenbergii	Great Indian-plantain	SC	—	6/16/1905
	Cacalia tuberosa	Prairie Indian Plantain	T	—	7/1995 7/30/1898
	Calamintha arkansana	Low Calamint	SC	—	10/3/1891
	Carex crawei	Crawe Sedge	SC	—	6/15/1901 1/25/1905
	Carex crus-corvi	Ravenfoot Sedge	E	—	9/9/1996
	Carex formosa	Handsome Sedge	T	—	1980s
	Carex lupuliformis	False Hop Sedge	E	—	6/12/1905
	Carex richardsonii	Richardson Sedge	SC	—	6/12/1901
	Carex tenuiflora	Sparse-flowered Sedge	SC	—	7/1/1932
	Cirsium hillii	Hill's Thistle	T	—	8/17/1897
	Cypripedium candidum	Small White Lady's-slipper	T	—	6/1876
	Cypripedium parviflorum var. makasin	Northern Yellow Lady's-slipper	SC	—	5/23/1897 3/14/1905 5/30/1889 5/7/1938 6/3/1932
	Cypripedium reginae	Showy Lady's-slipper	SC	—	3/17/1905
	Deschampsia cespitosa	Tufted Hairgrass	SC	—	6/30/1900
	Echinacea pallida	Pale-purple Coneflower	T	—	6/9/1905
	Etheostoma microperca	Least Darter	SC	—	7/10/1924
	Festuca paradoxa	Cluster Fescue	SC	—	1930s?
	Fraxinus quadrangulata	Blue Ash	T	—	7/9/1995
	Gentiana alba	Yellow Gentian	T	—	8/1992
	Gentianopsis procera	Lesser Fringed Gentian	SC	—	5/9/1897 9/28/1968

TABLE 7
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
	Jeffersonia diphylla	Twinleaf	SC	—	6/24/1930
	Liatris spicata	Marsh Blazing Star	SC	—	9/5/1990 6/12/1905
	Lithospermum latifolium	American Gromwell	SC	—	5/8/1992 10/2/1991 5/29/1976 10/21/2000 12/11/1993
	Medeola virginiana	Indian Cucumber-root	SC	—	6/6/1908
	Pandion haliaetus	Osprey	SC	—	6/30/1905
	Panicum wilcoxianum	Wilcox Panic Grass	SC	—	7/23/1944
	Parthenium integrifolium	American Fever-few	T	—	9/25/1900 6/12/1905
	Plantago cordata	Heart-leaved Plantain	E	—	7/17/2002
	Platanthera leucophaea	Prairie White-fringed Orchid	E	—	7/9/1980
	Polystichum acrostichoides	Christmas Fern	SC	—	1861?
	Prenanthes aspera	Rough Rattlesnake-root	E	—	1/18/1905
	Ptelea trifoliata	Wafer-ash	SC	—	10/17/ 1940 7/6/1966
	Ranunculus cymbalaria	Seaside Crowfoot	T	—	7/1/1898 8/1878
	Scutellaria ovata	Heart-leaved Skullcap	SC	—	5/24/2000
	Solidago caesia	Bluestem Goldenrod	E	—	10/21/2000 10/18/1991 9/10/1992 9/25/2001
	Solidago ohioensis	Ohio Goldenrod	SC	—	9/5/1990 6/12/1905 9/13/1991 10/2/1992 8/30/1928 9/13/1991 10/2/1992 9/10/1992
	Thalictrum revolutum	Waxleaf Meadowrue	SC	—	7/6/1906 9/5/1990

TABLE 7
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
					6/12/1905
	Tofieldia glutinosa	Sticky False-asphodel	T	—	7/2/1898
	Tomanthera auriculata	Earleaf Foxglove	SC	—	8/18/1900
	Triglochin maritima	Common Bog Arrow-grass	SC	—	1800s
	Trillium recurvatum	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
	Viburnum prunifolium	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	*Emydoidea blandingii*	Blanding's Turtle	T	—	7/1/1989 5/3/2006
	Thamnophis butleri	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
	Regina septemvittata	Queensnake	E	—	8/21/1971
	Acris crepitans	Northern Cricket Frog	E	—	5/1/1955
Birds	*Haliaeetus*	Bald Eagle	SC	R	5/2008

TABLE 7
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
	leucocephalus				
	Nycticorax nycticorax	Black-crowned Night-heron	SC	—	1950s 5/15/1905
	Buteo lineatus	Red-shouldered Hawk	T	—	4/1982
	Bartramia longicauda	Upland Sandpiper	SC		6/10/1987
Fish and Mussels	*Fundulus diaphanus*	Banded Killifish	SC	—	6/20/1995 7/11/1978 11/9/1978
	Opsopoeodus emiliae	Pugnose Minnow	SC	—	6/26/1995
	Notropis anogenus	Pugnose Shiner	T	—	10/8/1971
	Luxilus chrysocephalus	Striped Shiner	E	—	7/12/1978
	Erimyzon sucetta	Lake Chubsucker	SC	—	7/11/1978 3/29/1977
	Lythrurus umbratilis	Redfin Shiner	T	—	7/11//1924 7/10/1924
	Lepomis megalotis	Longear Sunfish	T	—	1/9/1900 7/10/1924 11/9/1978

[a]E, Endangered; T, Threatened; SC, Species of Concern (not legally protected); R, Recovery

City of Waukesha Water Supply

Attachment A – Public Agency Correspondance

Prepared for

City of Waukesha Water Utility

February 2012

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 <u>and</u> 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,

CH2M HILL

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

CH2MHILL

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 <u>and</u> 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,

CH2M HILL

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

CH2MHILL

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

Corey Wilcox
Associate Scientist

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

Corey Wilcox
Associate Scientist

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)

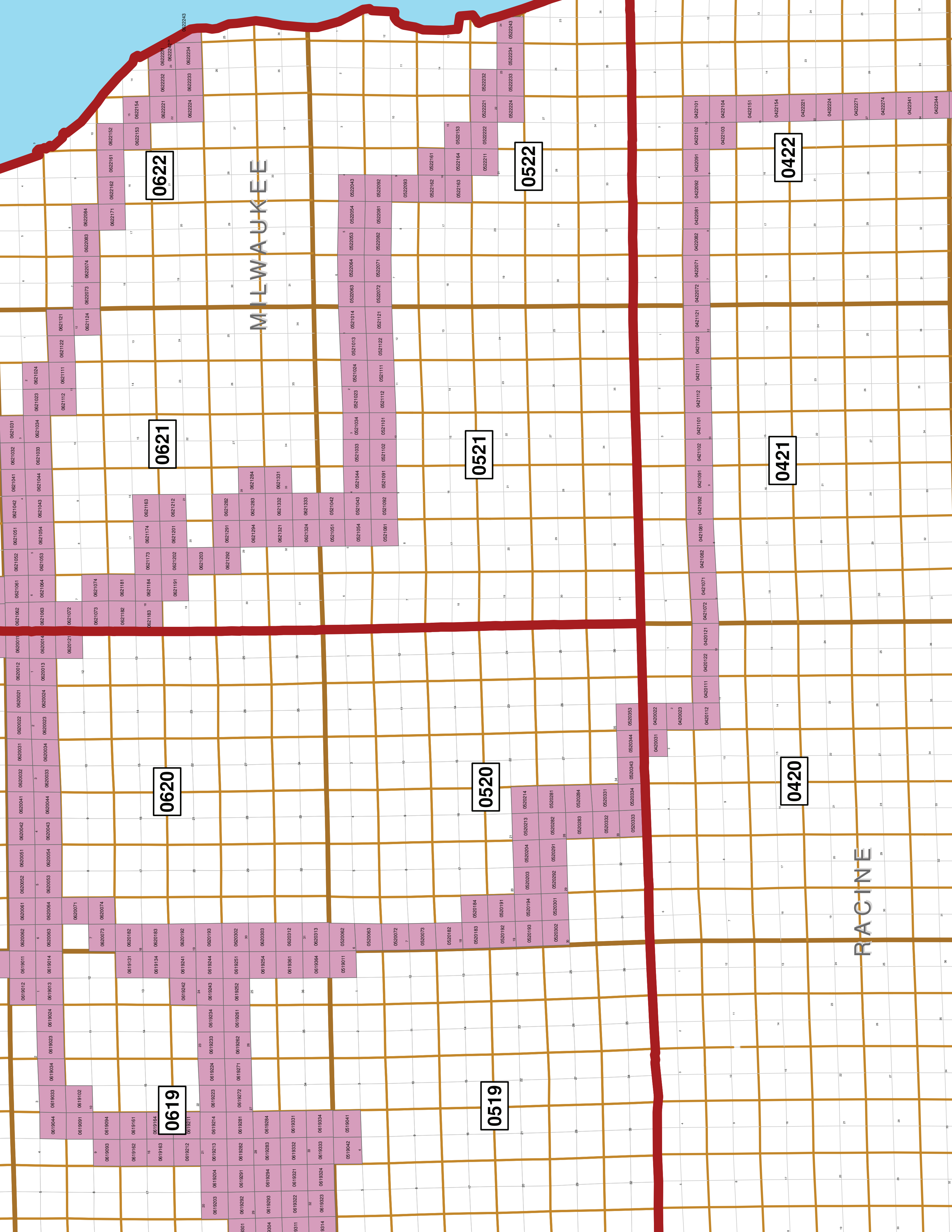
TWN	RNG	SEC	QUARTER_SEC_ID
06	19	01	1
06	19	01	2
06	19	01	3
06	19	01	4
06	19	02	3
06	19	02	4
06	19	03	3
06	19	03	4
06	19	04	4
06	19	09	1
06	19	10	2
06	20	01	1
06	20	01	2
06	20	01	3
06	20	01	4
06	20	02	1
06	20	02	2
06	20	02	3
06	20	02	4
06	20	03	1
06	20	03	2
06	20	03	3
06	20	03	4
06	20	04	1
06	20	04	2
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


MILWAUKEE
RACINE
0622
0522
0422
0621
0521
0421
0620
0520
0420
0619
0519

Attachment 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

CIES
2 (Shallow Aquifer and Fox River Alluvium)

Scientific Name	Common Name	State Status[a]	Federal Status[a]	Habitat Description
	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 fev to many different species of birds. Sites can include rare and non-rare species. The breeding time will vary based on the are typically located in inaccessible locations including forests, shrub communities, wetlands adjacent to water (lakes, riv 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 acres, and are often associated and can intergrade with more abundant and widespread wetland communities such as s shrub-carr, emergent marsh, and southern tamarack swamp. An accumulation of peat can raise the fen surface to a heig lands. Common or representative plants include sedges, marsh fern, shrubby cinquefoil, shrubby St. John's wort, Ohio g brook lobelia, boneset, swamp thistle, and asters. Many fens have a significant number of prairie or sedge meadow comp associated with bogs, such as tamarack, bog birch and pitcher plant. Fens occur in several landscape settings, including sloping deposits of glacial outwash, in the headwaters regions of spring runs and small streams, and on the shores of alk
	Emergent marsh	N/A	—	These open, marsh, lake, riverine and estuarine communities with permanent standing water are dominated by robust en single species or in various mixtures. Dominants include cattails, bulrushes (particularly *Scirpus acutus*, *S. fluviatilis*, and pickerel-weed, water-plantains, arrowheads, the larger species of spikerush (such as *Eleocharis smallii*), 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. T bluestem. The grasses little bluestem, Indian grass, needle grass, prairie dropseed, and switch grass are also frequent. T size, and physiognomy of the species. Common taxa include the prairie docks, lead plant, heath and smooth asters, prai rattlesnake-master, flowering spurge, bee-balm, prairie coneflower, and spiderwort.
	Southern dry forest	N/A	—	Oaks (*Quercus* spp.) are the dominant species in this upland forest community of dry sites. White oak and black oak are northern red and bur oaks and black cherry. In the well-developed shrub layer, brambles (*Rubus* spp.), gray dogwood, ar Frequent herbaceous species are wild geranium, false Solomon's-seal, hog-peanut, and rough-leaved sunflower. This co woodland, which has similar canopy composition but a more open forest floor due to relatively frequent ground fires and 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 lo oak is a common dominant tree of this upland forest community type. White oak, basswood, sugar and red maples, white cherry are also important. The herbaceous understory flora is diverse and includes many species listed under southern d 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 oaks and black cherry. In the well-developed shrub layer, brambles (*Rubus* spp.), gray dogwood, and American hazelnut species are wild geranium, false Solomon's-seal, hog-peanut, and rough-leaved sunflower.
rviflora	Swamp agrimony	SC	—	Found in wet woodland patches and ditches, oak-hickory forests, southern mesic forests, wet prairies, and margins of ca throughout July; fruiting occurs early August through early September. The optimal identification period for this species is
rpurascens	Purple milkweed	E	—	Found in open oak forest (i.e. southern dry mesic forests) margins and roadsides; it has wide soil moisture tolerances. Pi occurs early June through late July; fruiting occurs early July through late August. The optimal identification period for thi
s	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 clustered at the very top of stem. Blooming occurs early August through early October; fruiting occurs late August throug identification period for this species is late August through late September.
rosa	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 Ma June through late July. The optimal identification period for this species is late May through late July.
i	Crawe sedge	SC	—	Found in calcareous wetlands and dolomitic pavement, often near Lake Michigan, as well as fens, moist calcareous prair calcareous soils. Blooming occurs late April through late May; fruiting occurs late May through late June. The optimal ide throughout May.
candidum	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 Jur September. The optimal identification period for this species is late May through early June.
parviflorum	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 through late June; fruiting occurs late June through late July. The optimal identification period for this species is late May
a	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 mesic prairies) and roadside ditches. Blooming occurs late August through early October; fruiting occurs early Septembe

CIES
2 (Shallow Aquifer and Fox River Alluvium)

Scientific Name	Common Name	State Status[a]	Federal Status[a]	Habitat Description
procera	Lesser fringed gentian	SC	—	Found on wet dolomite pavement near Lake Michigan, as well as cold fens, seeps, and meadows (i.e. northern sedge me Deep blue flowers with fringed edges. Blooming occurs late August through early October; fruiting occurs early Septembe identification period for this species is late August through early October.
iphylla	Twinleaf	SC	—	Found in very rich hardwood forests (i.e. southern mesic forests), often with dolomite near the surface. White cupped flov symmetrical parts. Blooming occurs throughout May; fruiting occurs early July through early September. The optimal ider May through early June.
a	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 through early August; fruiting occurs throughout August. The optimal identification period for this species is early August
farewelii	Farwell's water-milfoil	SC	—	A submergent aquatic, native-invasive plant found in lakes, streams, and ponds. It is especially common in small shallow Wisconsin. Blooming occurs from mid June-mid August mid July-mid October. The optimal identification period for this sp September.
ciata	Crossleaf milkwort	SC	—	Found in moist acidic peaty ditches, oak and pine barrens, and bogs in the bed of glacial Lake Wisconsin. Occurs in mois tiered purple flowers at the top of the stem (ground cover). Blooming occurs early July through early September; fruiting c September. The optimal identification period for this species is early July through early August.
spera	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 plan early October; fruiting occurs throughout September. The optimal identification period for this species is late August throu
ta	Wafer ash	SC	—	Found on dry dolomite ledges in oak forests (i.e. southern dry and wet mesic forests). Blooming occurs late May through July. The optimal identification period for this species is late May through late September.
ensis	Ohio goldenrod	SC	—	Found most commonly on wet dolomite lake flats in Door County, and in fens, moist calcareous prairies, and sedge mead state with moist soils. Yellow, flat-topped flowers. Blooming occurs early August through late September; fruiting occurs t identification period for this species is late August through early September.
oliatum var. flavum	Purple meadow-parsnip	SC	—	Found in moist prairies (wet mesic and mesic prairies) and woodlands (including oak openings); it is also naturalized on r flowers clustered at the flat top. Blooming occurs late May through late June; fruiting occurs early July through early Octo this species is early July through late September.
ns	Northern cricket frog	E	—	Prefer ponds, lakes, and a variety of habitats along and adjacent to streams and rivers including, marshes, fens, sedge m flats. The species tends to breed in quiet water (no or low flow) and may also move from streams and rivers to adjacent w active from late-March through November. Breeding occurs from mid-May through mid-August, with some larvae not tran
landingii	Blanding's turtle	T	—	Utilize a wide variety of aquatic habitats including deep and shallow marshes, shallow bays of lakes and impoundments w submergent vegetation exists, sluggish streams, oxbows and other backwaters of rivers, drainage ditches (usually where sedge meadows and wet meadows adjacent to these habitats. This species is semi-terrestrial and individuals may spend move between a variety of wetland types during the active season, which can extend from early March to mid-October. B summer or fall. Nesting occurs from about mid-May through June depending on spring temperatures. They strongly prefe well over a mile from preferred habitat to find suitable soils. Hatching occurs from early August through early September overwinter in the nest, emerging the following late April or May.
butleri	Butler's gartersnake	T	—	Prefer almost any open-canopy wetland type (not open water) and adjacent open to semi-open canopy upland, including lots. They also prefer low-canopy vegetation (<24"), although they will occupy habitats with taller vegetation, such as reed can be active from mid-March through early November, usually emerging shortly after frost-out and remaining active until below 50 deg. F. Breeding usually occurs in April and early May, but can occur in the fall, in which case live young are bo
marginata	Elktoe	SC	—	Found in various-sized streams with flowing water and sand, gravel, or rock substrates that are stable. The known host fi including redhorse, sucker species and rockbass.
virdis	Slippershell mussel	T	—	Found buried in the sandy or fine gravelly bottoms of shallow, small to medium-sized streams with flowing hard water. Als bottom. It is presently found only in the eastern and southern parts of Wisconsin. The known hosts are banded and mottle probably infested from February through April.
cetta	Lake chubsucker	SC	—	Prefers moderately clear lakes, oxbow lakes, sloughs of weedy lakes and their associated marshy streams that are dens cobble, sand, boulders, mud or silt. Spawning occurs from mid May through early July.
alotis	Longear sunfish	T	—	Prefers clear, shallow, moderately warm, still waters of streams, rivers or occasionally lakes over rubble, gravel and sand present. Found in or near vegetation. Spawning occurs from late May through mid-July, sporadic to August.

CIES

2 (Shallow Aquifer and Fox River Alluvium)

Scientific Name	Common Name	State Status[a]	Federal Status[a]	Habitat Description
ocephalus	Striped shiner	E	—	Prefers clear to slightly turbid waters of runs and shallow pools of the lower Milwaukee River, with dense aquatic vegetati silt, sand, mud or bedrock. Sometimes present in large schools at the foot of riffles and shallow, hard-bottomed pools wit May through June.
ger	Black tern	SC	—	Prefers large, shallow marshes with abundant vegetation adjacent to open water. Black body with white on the tail and wi the end of July.
ropus	Common moorhen	SC	—	Prefers shallow marshes (freshwater and brackish), especially where shallow lakes are rimmed with dense, emergent ma open water. Black and gray colored body with a red beak piece. The breeding season extends from mid-May to late July.
s frankilinii	Franklin's ground squirrel	SC	—	A semi-colonial species that prefers brushy and partly wooded areas, dense grassy, shrubby marshland, as well as prairi Mating occurs from the late April to mid-May and young are born between late May to mid-June.

es of Concern (not legally protected).

CIES

Scientific Name	Common Name	State Status[a]	Federal Status[a]	Habitat Description
	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 loe Red oak is a common dominant tree of this upland forest community type. White oak, basswood, sugar and red maples, black cherry are also important. The herbaceous understory flora is diverse and includes many species listed under sout 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 many different species of birds. Sites can include rare and non-rare species. The breeding time will vary based on the Rookeries are typically located in inaccessible locations including forests, shrub communities, wetlands adjacent to water 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 bur oaks and black cherry. In the well-developed shrub layer, brambles (*Rubus* spp.), gray dogwood, and American haze herbaceous species are wild geranium, false Solomon's-seal, hog-peanut, and rough-leaved sunflower.
rpurascens	Purple milkweed	E	—	Found in open oak forest (i.e. southern dry mesic forests) margins and roadsides; it has wide soil moisture tolerances. Pi Blooming occurs early June through late July; fruiting occurs early July through late August. The optimal identification per through late July.
eglectus	Cooper's milkvetch	E	—	Found on riverbanks, ravines, and lakeshores, especially on dolomite near Lake Michigan, with calcareous soils. It can al forests. White flowers at top of stem, with alternate leaves. Blooming occurs throughout June; fruiting occurs throughout period for this species is early June through late July.
orvi	Ravenfoot sedge	E	—	Found along ephemeral woodland (i.e. southern wet forests with moist soils) ponds. Blooms are clustered at the top. Blo fruiting occurs throughout July. The optimal identification period for this species is late June through early July.
ormis	False hop sedge	E	—	Found in floodplain forests (i.e. southern wet and mesic wet forests) and ephemeral woodland ponds, and have wet soils through early October; fruiting occurs late July through early October. The optimal identification period for this species is September.
n chinense	Hemlock parsley	E	—	Found in discharge areas in forested seeps, calcareous fens, and tamarack swamps (including northern wet forests) with August through late September; fruiting occurs throughout September. The optimal identification period for this species is September.
eucophaea	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 tama White flowers with large fringed petals at the bottom of the bloom. Blooming occurs early June through early August; fruit optimal identification period for this species is late June through late July.
osa	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. Bloom May; fruiting occurs throughout May. The optimal identification period for this species is late April through early May.
nspera	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 plan through early October; fruiting occurs throughout September. The optimal identification period for this species is late Aug
arietinum	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 soils. Blooming occurs late May through early June; fruiting occurs late June through late July. The optimal identification through early June.
candidum	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 Ju September. The optimal identification period for this species is late May through early June.
s	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 clustered at the very top of plant. Blooming occurs early August through early October; fruiting occurs late August through identification period for this species is late August through late September.
nlenbergii	Great Indian plantain	SC	—	Found in mesic hardwood forests (i.e. southern wet and wet mesic forests) and adjacent mesic prairies, often with dolom occurs late June through late July; fruiting occurs late July through late August. The optimal identification period for this s September.
m latifolium	American gromwell	SC	—	Found in upland hardwood forests (southern wet mesic forests), often with dolomite near the surface, and dry, calcareou petals at top of plant. Blooming occurs throughout June; fruiting occurs early July through late August. The optimal identif early June through late August.
ookeri	Hooker orchis	SC	—	Found in a variety of dry to moist, mostly mixed coniferous-hardwood forests (i.e. southern and northern dry mesic forest

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Scientific Name	Common Name	State Status[a]	Federal Status[a]	Habitat Description
vata	Heart-leaved skullcap	SC	—	Found in dry-mesic forests. Purple flowers in rows along the upper portions of the stem (above the leaves). Blooming occ fruiting occurs late July through late August. The optimal identification period for this species is early June through late Ju
vatum	Reflexed trillium	SC	—	Found in rich hardwood forests (i.e. southern mesic and dry mesic forests), with rich, moist soils. Blooming occurs late Ap occurs throughout June. The optimal identification period for this species is late April through late May.
is stricta	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 calcare meadows, and occasionally pine barrens. Occurs in wet, sandy soils. Blooming occurs throughout June; fruiting occurs ea optimal identification period for this species is early July through late August.
ora	Sparse-flowered sedge	SC	—	Found in open- to closed canopy cold, wet, coniferous forests (northern wet mesic and mesic forests), usually on neutral occurs late May through early June; fruiting occurs late June through late July. The optimal identification period for this sp July.
parviflorum	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 May through late June; fruiting occurs late June through late July. The optimal identification period for this species is late
a	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 July through early August; fruiting occurs throughout August. The optimal identification period for this species is early Aug
volutum	Waxleaf meadowrue	SC	—	Found in moist, often calcareous meadows (i.e. southern sedge meadows) and mesic prairies. It is also naturalized on ra occurs throughout June; fruiting occurs throughout July. The optimal identification period for this species is throughout Ju
aritime	Common bog arrow-grass	SC	—	Found on fen mats, calcareous fens, bogs, open neutral to calcareous conifers swamps, northern wet forests, and Great Blooming occurs late June through early August; fruiting occurs late July through early September. The optimal identificat July through late August.
te	Wafer-ash	SC	—	Found on dry dolomite ledges in oak forests (i.e. southern dry and wet mesic forests). Blooming occurs late May through throughout July. The optimal identification period for this species is late May through late September.
unifolium	Smooth black-haw	SC	—	Found in rich hardwood forests (i.e. southern wet mesic and mesic forests), often with dolomite near the surface. Bloomin June; fruiting occurs early July through early September. The optimal identification period for this species is late May thro
ilatata	Leafy white orchis	SC	—	Found on neutral to calcareous bog and fen mats (or calcareous fens), or northern wet forests (sometimes with scattered wet, neutral to calcareous soils. White flowers down the length of the stem. Blooming occurs early June through early Jul The optimal identification period for this species is early June through early July.
ns	Northern cricket frog	E	—	Prefer ponds, lakes, and a variety of habitats along and adjacent to streams and rivers including, marshes, fens, sedge m mud flats. The species tends to breed in quiet water (no or low flow) and may also move from streams and rivers to adjac frogs are active from late-March through November. Breeding occurs from mid-May through mid-August, with some larva September.
butleri	Butler's gartersnake	T	—	Prefer almost any open-canopy wetland type (not open water) and adjacent open to semi-open canopy upland, including vacant lots. They also prefer low-canopy vegetation (<24"), although they will occupy habitats with taller vegetation, such gartersnakes can be active from mid-March through early November, usually emerging shortly after frost-out and remaini fall consistently below 50 deg. F. Breeding usually occurs in April and early May, but can occur in the fall, in which case li July and mid-August.
landingii	Blanding's turtle	T	—	Utilize a wide variety of aquatic habitats including deep and shallow marshes, shallow bays of lakes and impoundments w submergent vegetation exists, sluggish streams, oxbows and other backwaters of rivers, drainage ditches (usually where sedge meadows and wet meadows adjacent to these habitats. This species is semi-terrestrial and individuals may spend often move between a variety of wetland types during the active season, which can extend from early March to mid-Octo spring, late summer or fall. Nesting occurs from about mid-May through June depending on spring temperatures. They st and may travel well over a mile from preferred habitat to find suitable soils. Hatching occurs from early August through ea successfully overwinter in the nest, emerging the following late April or May.
tesbeianus	American bullfrog	SC	—	Found throughout Wisconsin in any permanent body of water - lakes, ponds, rivers, and creeks. They have a very patchy typically favor oligotrophic (waters with low algal production; thus very clear) to mesotrophic (generally clear water with be tend to breed where dense submergent vegetation filters out the majority of the suspended solids. Bullfrogs are active fro breed from mid-May through late July or later.

CIES

Scientific Name	Common Name	State Status[a]	Federal Status[a]	Habitat Description
ocephalus	Striped shiner	E	—	Prefers clear to slightly turbid waters of runs and shallow pools of the lower Milwaukee River, with dense aquatic vegetati boulders, silt, sand, mud or bedrock. Sometimes present in large schools at the foot of riffles and shallow, hard-bottomed Spawning occurs from late May through June.
bratilis	Redfin shiner	T	—	Prefers turbid waters of pools in low-gradient streams over substrates of boulders, cobble, sand, silt or detritus. Spawning mid-August in sunfish nests.
elongates	Redside dace	SC	—	Prefers cool water pools and quiet riffles of small streams (usually adjacent to meadows or pastures) with substrate of co Spawning occurs from May to early June.
cetta	Lake chubsucker	SC	—	Prefers moderately clear lakes, oxbow lakes, sloughs of weedy lakes and their associated marshy streams that are dense of cobble, sand, boulders, mud or silt. Spawning occurs from mid May through early July.
rna	Little glassy wing	SC	—	Found in grassy openings in wooded areas near swamps, streams, bogs. Host plants appear to include grasses, especia Flight period is from late June-July.
randis	Great spreadwing	SC	—	This dragonfly prefers slow, small streams (with alder or willows present along banks), wetlands, ponds and temporary po extends from early August to mid-October.
gracilis	Prairie crayfish	SC	—	Typically restricted to prairie regions of southeastern Wisconsin and is the rarest crayfish in Wisconsin. This species frequ roadside ditches, small sluggish creeks, marshes, swamps, and small artificial lakes, as well as wet pastures and flat fiel quite deep and branching, with a characteristic mud chimney. Breeding occurs and young hatch in early spring, as early a through spring and summer. Females move to open water for a relatively short period in the summer where the newly ha

es of Concern (not legally protected).

CIES

Scientific Name	Common Name	State Status[a]	Federal Status[a]	Habitat Description
	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 loes oak is a common dominant tree of this upland forest community type. White oak, basswood, sugar and red maples, white a cherry are also important. The herbaceous understory flora is diverse and includes many species listed under southern dry 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 w oaks and black cherry. In the well-developed shrub layer, brambles (*Rubus* spp.), gray dogwood, and American hazelnut a 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. Th bluestem. The grasses little bluestem, Indian grass, needle grass, prairie dropseed, and switch grass are also frequent. Th size, and physiognomy of the species. Common taxa include the prairie docks, lead plant, heath and smooth asters, prairie 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, calcarec communities. The wet prairies' more wetland-like character can mean that sometimes very few obligate prairie species are grass species may include Canada bluejoint grass, cordgrass, and marsh wild-timothy, plus several sedge species includi woolly sedge. Many of the herbs are shared with the wet-mesic prairies, but the following species are often prevalent: New 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 eme single species or in various mixtures. Dominants include cattails, bulrushes (particularly *Scirpus acutus*, *S. fluviatilis*, and *S* pickerel-weed, water-plantains, arrowheads, the larger species of spikerush (such as *Eleocharis smallii*), and wild rice.
	Southern sedge meadow	N/A	—	Widespread in southern Wisconsin, this open wetland community is most typically dominated by tussock sedge and Canad of relatively undisturbed sedge meadows are other sedges (*Carex diandra*, *C. sartwellii*), marsh bellflower, marsh wild-timo swamp aster, blue flag, spotted Joe-Pye weed, marsh fern, and swamp milkweed. Reed canary grass may be dominant in sometimes to the exclusion of virtually all other species. Sedge meadows are most common in glaciated landscapes, wher drainage lakes. Many sedge meadows in southeastern Wisconsin are influenced by alkaline groundwater, and occur in co 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 a acres, and are often associated and can intergrade with more abundant and widespread wetland communities such as sou shrub-carr, emergent marsh, and southern tamarack swamp. An accumulation of peat can raise the fen surface to a heigh lands. Common or representative plants include sedges, marsh fern, shrubby cinquefoil, shrubby St. John's wort, Ohio gol brook lobelia, boneset, swamp thistle, and asters. Many fens have a significant number of prairie or sedge meadow compo associated with bogs, such as tamarack, bog birch and pitcher plant. Fens occur in several landscape settings, including t sloping deposits of glacial outwash, in the headwaters regions of spring runs and small streams, and on the shores of alka
	Shrub-carr	N/A	—	This wetland community is dominated by tall shrubs such as red-osier dogwood, silky dogwood, meadowsweet, and variou often very common. This type occupies areas that are transitional between open wetlands such as wet prairie, calcareous forested wetlands such as floodplain forest or southern hardwood swamp. This type often occurs in bands around lakes or floodplains, or, more extensively, in glacial lakebeds. It is common and widespread in southern Wisconsin but also occurs
	Northern wet forest	N/A	—	Northern wet forest encompasses a group of weakly minerotrophic, conifer-dominated, acid peatlands located mostly north trees are black spruce and tamarack. Jack pine is a significant component in parts of the type's range. This community is f partially filled basins, on glacial outwash landforms, moraines, and till plains, where the water table is near the surface or w The community also occurs along the margins of lakes and low-gradient streams. On the wetter side of the moisture gradie muskeg, open bog, or poor fen. On the drier side, the spruce-tamarack swamps may grade into "rich" swamp forests of no 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 dom maple, river birch, green and black ashes, hackberry, swamp white oak, and eastern cottonwood. Black willow, basswood, associated tree species found in these forests. Understory composition is also quite variable, and follows the pattern exhib most extensive stands and highest plant species diversity occurring in southwestern Wisconsin. Buttonbush is a locally do thickets on the margins of oxbow lakes, sloughs and ponds, which are often important aquatic habitats within these forests (e.g., *Carex grayii*, *C. lupulina*, *C. hystericina*, *C. tuckermanii*), native grasses (e.g., *Cinna arundinacea*, *Elymus villosus*, *L* green-headed coneflower are important understory herbs, and lianas such as Virginia creepers, grapes, Canada moonsee 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.
rpurascens	Purple milkweed	E	—	Found in open oak forest (i.e. southern dry mesic forests) margins and roadsides; it has wide soil moisture tolerances. Pin occurs early June through late July; fruiting occurs early July through late August. The optimal identification period for this

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Scientific Name	Common Name	State Status[a]	Federal Status[a]	Habitat Description
sia	Bluestem goldenrod	E	—	Found in open forests, forest edges, clearings, and/or thickets. Occur on level ground, side slopes and protected ravine en Lake Michigan. Yellow clusters of flowers along the majority of the mid to upper portion of the stem. Blooming occurs from
eucophaea	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 tamar White flowers with large fringed petals at the bottom of the bloom. Blooming occurs early June through early August; fruitin optimal identification period for this species is late June through late July.
ormis	False hop sedge	E	—	Found in floodplain forests (i.e. southern wet and mesic wet forests) and ephemeral woodland ponds, and have wet soils. early October; fruiting occurs late July through early October. The optimal identification period for this species is early Aug
orvi	Ravenfoot sedge	E	—	Found along ephemeral woodland (i.e. southern wet forests with moist soils) ponds. Blooms are clustered at the top. Bloom occurs throughout July. The optimal identification period for this species is late June through early July.
icoides	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 do and rocky soils. Blooming occurs from June. The optimal identification period for this species is mid-July to late August.
eglectus	Cooper's milkvetch	E	—	Found on riverbanks, ravines, and lakeshores, especially on dolomite near Lake Michigan, with calcareous soils. It can als forests. White flowers at top of stem, with alternate leaves. Blooming occurs throughout June; fruiting occurs throughout Ju this species is early June through late July.
n chinense	Hemlock parsley	E	—	Found in discharge areas in forested seeps, calcareous fens, and tamarack swamps (including northern wet forests) with through late September; fruiting occurs throughout September. The optimal identification period for this species is late Aug
osa	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. Bloomi fruiting occurs throughout May. The optimal identification period for this species is late April through early May.
spera	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. early October; fruiting occurs throughout September. The optimal identification period for this species is late August throug
inosa	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 June and August.
arietinum	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 o soils. Blooming occurs late May through early June; fruiting occurs late June through late July. The optimal identification pe through early June.
candidum	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 September. The optimal identification period for this species is late May through early June.
vata	Heart-leaved skullcap	SC	—	Found in dry-mesic forests. Purple flowers in rows along the upper portions of the stem (above the leaves). Blooming occu occurs late July through late August. The optimal identification period for this species is early June through late July.
ora	Sparse-flowered sedge	SC	—	Found in open- to closed canopy cold, wet, coniferous forests (northern wet mesic and mesic forests), usually on neutral to occurs late May through early June; fruiting occurs late June through late July. The optimal identification period for this spe
nlenbergii	Great Indian plantain	SC	—	Found in mesic hardwood forests (i.e. southern wet and wet mesic forests) and adjacent mesic prairies, often with dolomite late June through late July; fruiting occurs late July through late August. The optimal identification period for this species is
iniana	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 sta flower extends out of. Blooming occurs early May through late June; fruiting occurs late July through late August. The optim is early May through late August.
ookeri	Hooker orchis	SC	—	Found in a variety of dry to moist, mostly mixed coniferous-hardwood forests (i.e. southern and northern dry mesic forests) late July; fruiting occurs early July through late August. The optimal identification period for this species is early June throu
vatum	Reflexed trillium	SC	—	Found in rich hardwood forests (i.e. southern mesic and dry mesic forests), with rich, moist soils. Blooming occurs late Apr throughout June. The optimal identification period for this species is late April through late May.
unifolium	Smooth black-haw	SC	—	Found in rich hardwood forests (i.e. southern wet mesic and mesic forests), often with dolomite near the surface. Blooming fruiting occurs early July through early September. The optimal identification period for this species is late May through ear
parviflorum	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

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a	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 w through early August; fruiting occurs throughout August. The optimal identification period for this species is early August th
ictum	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. Bl September; fruiting occurs late July through early October. The optimal identification period for this species is late July thro
aritime	Common bog arrow-grass	SC	—	Found on fen mats, calcareous fens, bogs, open neutral to calcareous conifers swamps, northern wet forests, and Great L occurs late June through early August; fruiting occurs late July through early September. The optimal identification period f late August.
dilatata	Leafy white orchis	SC	—	Found on neutral to calcareous bog and fen mats (or calcareous fens), or northern wet forests (sometimes with scattered t neutral to calcareous soils. White flowers down the length of the stem. Blooming occurs early June through early July; fruit optimal identification period for this species is early June through early July.
epidota	Wild licorice	SC	—	Found in moist prairies and other grasslands and stream banks. It has been found naturalized on cinders of railroads and c throughout July; fruiting occurs early August through late October. The optimal identification period for this species is early
volutum	Waxleaf meadowrue	SC	—	Found in moist, often calcareous meadows (i.e. southern sedge meadows) and mesic prairies. It is also naturalized on rail throughout June; fruiting occurs throughout July. The optimal identification period for this species is throughout June.
m latifolium	American gromwell	SC	—	Found in upland hardwood forests (southern wet mesic forests), often with dolomite near the surface, and dry, calcareous petals at top of plant. Blooming occurs throughout June; fruiting occurs early July through late August. The optimal identific June through late August.
is stricta	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 calcare meadows, and occasionally pine barrens. Occurs in wet, sandy soils. Blooming occurs throughout June; fruiting occurs ea optimal identification period for this species is early July through late August.
ris	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. E early September; fruiting occurs late July through late September. The optimal identification period for this species is early
reginae	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 u dry clay bluffs with moist, neutral to calcareous soils. White and purple/pinkish flower. Blooming occurs late June through l through late August. The optimal identification period for this species is late June through early August.
ariegatum	Variegated horsetail	SC	—	Found most characteristically on wet dolomite flats and gravelly swales near Lake Michigan but also in other wet, open, ne dunes, beach, and northern sedge meadows). The optimal identification period for this species is late May through late Se
procera	Lesser fringed gentian	SC	—	Found on wet dolomite pavement near Lake Michigan, as well as cold fens, seeps, and meadows (i.e. northern sedge mea Deep blue flowers with fringed edges. Blooming occurs late August through early October; fruiting occurs early September identification period for this species is late August through early October.
oensis	Ohio goldenrod	SC	—	Found most commonly on wet dolomite lake flats in Door County, and in fens, moist calcareous prairies, and sedge meado state with moist soils. Yellow, flat-topped flowers. Blooming occurs early August through late September; fruiting occurs th identification period for this species is late August through early September.
lustris	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 o throughout August. The optimal identification period for this species is early July through late August.
ta	Wafer-ash	SC	—	Found on dry dolomite ledges in oak forests (i.e. southern dry and wet mesic forests). Blooming occurs late May through e July. The optimal identification period for this species is late May through late September.
ri	Forster's tern	E	—	Prefers large semi-permanent and permanently flooded wetlands (i.e. marshes) that support extensive growths of cattail a lake islands. These habitats are also are common for breeding. White and light gray body with a black colored cap on hea mid May to late July.
yticorax	Black-crowned night heron	SC	—	Prefers freshwater wetlands dominated by bulrush and cattail with small groves of alder, willow, or other brush. Their bree through mid-September.
aetus	Osprey	SC	—	Prefer large trees in isolated areas in proximity to large areas of surface water, large complexes of deciduous forest, conife communities. Areas are usually forested with second growth pine, aspen, and hardwood forests. Breed mainly in forested central Wisconsin. A few nest along the Wisconsin River, in swamps and inland lakes in the central part of the state. Large trees are preferred for nesting. Most frequent nest sites are super-canopy snags and dead-topped pines located along lake

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ana	Dickissel	SC	—	Prefers open pasture and fields of clover and alfalfa. Grasslands, meadows, and savanna are also important nesting areas medium to tall height-density and a significant component of forbs (i.e. herbaceous flowering plants that are not graminoids stiff-stemmed. Breeding occurs from late May to early August.
ns	Northern cricket frog	E	—	Prefer ponds, lakes, and a variety of habitats along and adjacent to streams and rivers including, marshes, fens, sedge me flats. The species tends to breed in quiet water (no or low flow) and may also move from streams and rivers to adjacent we active from late-March through November. Breeding occurs from mid-May through mid-August, with some larvae not trans
butleri	Butler's gartersnake	T	—	Prefer almost any open-canopy wetland type (not open water) and adjacent open to semi-open canopy upland, including p lots. They also prefer low-canopy vegetation (<24"), although they will occupy habitats with taller vegetation, such as reed can be active from mid-March through early November, usually emerging shortly after frost-out and remaining active until c below 50 deg. F. Breeding usually occurs in April and early May, but can occur in the fall, in which case live young are bor
landingii	Blanding's turtle	T	—	Utilize a wide variety of aquatic habitats including deep and shallow marshes, shallow bays of lakes and impoundments wh submergent vegetation exists, sluggish streams, oxbows and other backwaters of rivers, drainage ditches (usually where w sedge meadows and wet meadows adjacent to these habitats. This species is semi-terrestrial and individuals may spend a move between a variety of wetland types during the active season, which can extend from early March to mid-October. Bla summer or fall. Nesting occurs from about mid-May through June depending on spring temperatures. They strongly prefer well over a mile from preferred habitat to find suitable soils. Hatching occurs from early August through early September bu overwinter in the nest, emerging the following late April or May.
tesbeianus	American bullfrog	SC	—	Found throughout Wisconsin in any permanent body of water - lakes, ponds, rivers, and creeks. They have a very patchy d typically favor oligotrophic (waters with low algal production; thus very clear) to mesotrophic (generally clear water with bed to breed where dense submergent vegetation filters out the majority of the suspended solids. Bullfrogs are active from Apr from mid-May through late July or later.
ocephalus	Striped shiner	E	—	Prefers clear to slightly turbid waters of runs and shallow pools of the lower Milwaukee River, with dense aquatic vegetatio silt, sand, mud or bedrock. Sometimes present in large schools at the foot of riffles and shallow, hard-bottomed pools with May through June.
bratilis	Redfin shiner	T	—	Prefers turbid waters of pools in low-gradient streams over substrates of boulders, cobble, sand, silt or detritus. Spawning August in sunfish nests.
galotis	Longear sunfish	T	—	Prefers clear, shallow, moderately warm, still waters of streams, rivers or occasionally lakes over rubble, gravel and sand w present. Found in or near vegetation. Spawning occurs from late May through mid-July, sporadic to August.
microperca	Least darter	SC	—	Prefers clear, warm, quiet waters of overflow ponds, pools, lakes and streams over substrates of gravel, silt, sand, boulder or filamentous algal beds. Spawning occurs from late April into July.
cetta	Lake chubsucker	SC	—	Prefers moderately clear lakes, oxbow lakes, sloughs of weedy lakes and their associated marshy streams that are dense cobble, sand, boulders, mud or silt. Spawning occurs from mid May through early July.
a ensigera	Lemon-faced emerald	SC	—	Found in small streams with forested riparian areas lining them. The flight period is in late June.
rna	Little glassy wing	SC	—	Found in grassy openings in wooded areas near swamps, streams, bogs. Host plants appear to include grasses, especiall Flight period is from late June-July.
gracilis	Prairie crayfish	SC	—	Typically restricted to prairie regions of southeastern Wisconsin and is the rarest crayfish in Wisconsin. This species frequ roadside ditches, small sluggish creeks, marshes, swamps, and small artificial lakes, as well as wet pastures and flat fields deep and branching, with a characteristic mud chimney. Breeding occurs and young hatch in early spring, as early as Marc spring and summer. Females move to open water for a relatively short period in the summer where the newly hatched you

es of Concern (not legally protected).

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	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 fe to many different species of birds. Sites can include rare and non-rare species. The breeding time will vary based on the are typically located in inaccessible locations including forests, shrub communities, wetlands adjacent to water (lakes, ri 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 fen few acres, and are often associated and can intergrade with more abundant and widespread wetland communities such prairie, shrub-carr, emergent marsh, and southern tamarack swamp. An accumulation of peat can raise the fen surface adjoining lands. Common or representative plants include sedges, marsh fern, shrubby cinquefoil, shrubby St. John's w parnassus, twig-rush, brook lobelia, boneset, swamp thistle, and asters. Many fens have a significant number of prairie some contain plants often associated with bogs, such as tamarack, bog birch and pitcher plant. Fens occur in several la morainal slopes, on sloping deposits of glacial outwash, in the headwaters regions of spring runs and small streams, an lakes.
	Emergent marsh	N/A	—	These open, marsh, lake, riverine and estuarine communities with permanent standing water are dominated by robust e single species or in various mixtures. Dominants include cattails, bulrushes (particularly *Scirpus acutus*, *S. fluviatilis*, an pickerel-weed, water-plantains, arrowheads, the larger species of spikerush (such as *Eleocharis smallii*), 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 do maple, river birch, green and black ashes, hackberry, swamp white oak, and eastern cottonwood. Black willow, basswoo associated tree species found in these forests. Understory composition is also quite variable, and follows the pattern ex most extensive stands and highest plant species diversity occurring in southwestern Wisconsin. Buttonbush is a locally thickets on the margins of oxbow lakes, sloughs and ponds, which are often important aquatic habitats within these fore (e.g., *Carex grayii*, *C. lupulina*, *C. hystericina*, *C. tuckermanii*), native grasses (e.g., *Cinna arundinacea*, *Elymus villosus* green-headed coneflower are important understory herbs, and lianas such as Virginia creepers, grapes, Canada moons 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 lake.
	Mesic prairie	N/A	—	This grassland community occurs on rich, moist, well-drained sites, usually on level or gently rolling glacial topography. bluestem. The grasses little bluestem, Indian grass, needle grass, prairie dropseed, and switch grass are also frequent. size, and physiognomy of the species. Common taxa include the prairie docks, lead plant, heath and smooth asters, pra 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 no trees are black spruce and tamarack. Jack pine is a significant component in parts of the type's range. This community or partially filled basins, on glacial outwash landforms, moraines, and till plains, where the water table is near the surfac impeded. The community also occurs along the margins of lakes and low-gradient streams.
	Southern dry forest	N/A	—	Oaks (*Quercus* spp.) are the dominant species in this upland forest community of dry sites. White oak and black oak are northern red and bur oaks and black cherry. In the well-developed shrub layer, brambles (*Rubus* spp.), gray dogwood, a Frequent herbaceous species are wild geranium, false Solomon's-seal, hog-peanut, and rough-leaved sunflower. This c woodland, which has similar canopy composition but a more open forest floor due to relatively frequent ground fires and 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 l Red oak is a common dominant tree of this upland forest community type. White oak, basswood, sugar and red maples cherry are also important. The herbaceous understory flora is diverse and includes many species listed under southern 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, ofte bur oaks and black cherry. In the well-developed shrub layer, brambles (*Rubus* spp.), gray dogwood, and American haz 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. Th than 500 square miles and mean annual flow rates of less than 200 cubic feet per second. These streams are common and east-central Wisconsin. A rich fish fauna, dominated by warmwater species in the families Cyprinidae, Catostomida found in warmwater streams.
osa	Climbing fumitory	SC	—	Found in dry to moist hardwood or coniferous woods (i.e. boreal forests, northern mesic forests, or shaded cliffs), often on dolomite and, less commonly, on basalt. Blooming occurs late June through late September; fruiting occurs late July identification period for this species is early July through early October

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posa	Swamp-pink	SC	—	Found on neutral bog and fen mats with a mix of sedges, Ericads, and Sphagnum (i.e. northern sedge meadows), along Purple/pinkish flowers that form an arrow shape at the top of the plant. Blooming occurs late May through early July; fru optimal identification period for this species is early June through early July.
rpurascens	Purple milkweed	E	—	Found in open oak forest (i.e. southern dry mesic forests) margins and roadsides; it has wide soil moisture tolerances. F occurs early June through late July; fruiting occurs early July through late August. The optimal identification period for th
livantii	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. E early July; fruiting occurs throughout July. The optimal identification period for this species is early June through early J
s	Forked aster	T	—	Found in dry to mesic hardwoods (i.e. southern wet and wet mesic forests), often on stream-sides or slopes with dolomi clustered at the very top of stem. Blooming occurs early August through early October; fruiting occurs late August throu identification period for this species is late August through late September.
nlenbergii	Great Indian plantain	SC	—	Found in mesic hardwood forests (i.e. southern wet and wet mesic forests) and adjacent mesic prairies, often with dolor late June through late July; fruiting occurs late July through late August. The optimal identification period for this species
rosa	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 M late June through late July. The optimal identification period for this species is late May through late July.
rkansana	Low calamint	SC	—	Found most typically on wet dolomite flats on Lake Michigan (Door County), as well as fens (calcareous), wet prairies, c late June through late September; fruiting occurs late July through late September. The optimal identification period for August.
	Crawe sedge	SC	—	Found in calcareous wetlands and dolomitic pavement, often near Lake Michigan, as well as fens, moist calcareous pra moist, calcareous soils. Blooming occurs late April through late May; fruiting occurs late May through late June. The opt is throughout May.
orvi	Ravenfoot sedge	E	—	Found along ephemeral woodland (i.e. southern wet forests with moist soils) ponds. Blooms are clustered at the top. Bl occurs throughout July. The optimal identification period for this species is late June through early July.
sa	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 t Blooming occurs throughout June; fruiting occurs throughout July. The optimal identification period for this species is lat
rmis	False hop sedge	E	—	Found in floodplain forests (i.e. southern wet and mesic wet forests) and ephemeral woodland ponds, and have wet soil early October; fruiting occurs late July through early October. The optimal identification period for this species is early A
dsonii	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 e May. The optimal identification period for this species is late April through early May.
ora	Sparse-flowered sedge	SC	—	Found in open- to closed canopy cold, wet, coniferous forests (northern wet mesic and mesic forests), usually on neutra occurs late May through early June; fruiting occurs late June through late July. The optimal identification period for this s
	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 fruiting occurs late July through late August. The optimal identification period for this species is late July through late Au
candidum	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 Ju September. The optimal identification period for this species is late May through early June.
parviflorum var. makasin	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 through late June; fruiting occurs late June through late July. The optimal identification period for this species is late Ma
reginae	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 ric dry clay bluffs with moist, neutral to calcareous soils. White and purple/pinkish flower. Blooming occurs late June throug through late August. The optimal identification period for this species is late June through early August.
a cespitosa	Tufted hairgrass	SC	—	Found in fens, sandstone and dolomite splash pools on the Great Lakes; it is also found in springs, marly bog pools, no swamps. Blooming occurs late June through early July; fruiting occurs throughout July. The optimal identification period July.
allida	Pale-purple coneflower	T	—	Found in prairies (i.e. dry to mesic prairies) and prairie remnants along roads and railroads. Blooming occurs early June July through late August. The optimal identification period for this species is early June through early August.

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doxa	Cluster fescue	SC	—	Found in moist, sandy or peaty sedge meadows near the lower Wisconsin River (with moist, sandy or peaty soils). Bloo occurs early July through late August. The optimal identification period for this species is early July through late August.
drangulata	Blue ash	T	—	Found in rich upland hardwoods (i.e. southern mesic forests), often with dolomite near the surface and moist, calcareou June; fruiting occurs early July through late August. This species can be identified year-round.
a	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 dry mesic prairies) and roadside ditches. Blooming occurs late August through early October; fruiting occurs early Septe optimal identification period for this species is throughout September.
procera	Lesser fringed gentian	SC	—	Found on wet dolomite pavement near Lake Michigan, as well as cold fens, seeps, and meadows (i.e. northern sedge m Deep blue flowers with fringed edges. Blooming occurs late August through early October; fruiting occurs early Septem identification period for this species is late August through early October.
iphylla	Twinleaf	SC	—	Found in very rich hardwood forests (i.e. southern mesic forests), often with dolomite near the surface. White cupped flo symmetrical parts. Blooming occurs throughout May; fruiting occurs early July through early September. The optimal ide early May through early June.
a	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 wit July through early August; fruiting occurs throughout August. The optimal identification period for this species is early A
m latifolium	American gromwell	SC	—	Found in upland hardwood forests (southern wet mesic forests), often with dolomite near the surface, and dry, calcareo petals at top of plant. Blooming occurs throughout June; fruiting occurs early July through late August. The optimal iden June through late August.
iniana	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 flower extends out of. Blooming occurs early May through late June; fruiting occurs late July through late August. The o species is early May through late August.
oxianum	Wilcox panic grass	SC	—	Found in dry gravelly hillside prairies. Blooming occurs late May through early June; fruiting occurs late June through la for this species is late June through late July.
ntegrifolium	American fever-few	T	—	Found in prairies (dry to wet mesic prairies) and remnants along roads and railroads with dry soils. It is sometimes plant a native plant is present. Small white flowers at top of plant (flat top) with large leaves. Blooming occurs late June throu August through early October. The optimal identification period for this species is late July through late September.
data	Heart-leaved plantain	E	—	An emergent aquatic plant found on cold calcareous streambanks shaded by mesic hardwood forests with wet, calcare through late June; fruiting occurs early June through early July. The optimal identification period for this species is late M
eucophaea	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 tam White flowers with large fringed petals at the bottom of the bloom. Blooming occurs early June through early August; fru optimal identification period for this species is late June through late July.
acrostichoides	Christmas fern	SC	—	Found in rich mesic woods (i.e. southern mesic forests), rocky upland woodlands (deciduous), bluffs, slopes of wooded especially likely to be found where either limestone or sandstone comes close to the ground surface. Typically occur in soils. This species can be identified year-round.
spera	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 pla through early October; fruiting occurs throughout September. The optimal identification period for this species is late Au
ta	Wafer-ash	SC	—	Found on dry dolomite ledges in oak forests (i.e. southern dry and wet mesic forests). Blooming occurs late May throug July. The optimal identification period for this species is late May through late September.
cymbalaria	Seaside crowfoot	T	—	An emergent aquatic plant found in sandy or muddy shores and marshes (i.e. northern sedge meadows), ditches and ha roadsides near the city of Superior, with wet and sometimes sandy soils. Pale yellow flowers with cone in the middle of through late August; fruiting occurs late July through late August. The optimal identification period for this species is ear
vata	Heart-leaved skullcap	SC	—	Found in dry-mesic forests. Purple flowers in rows along the upper portions of the stem (above the leaves). Blooming oc fruiting occurs late July through late August. The optimal identification period for this species is early June through late J
sia	Bluestem goldenrod	E	—	Found in open forests, forest edges, clearings, and/or thickets. Occur on level ground, side slopes and protected ravine Lake Michigan. Yellow clusters of flowers along the majority of the mid to upper portion of the stem. Blooming occurs fr

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Scientific Name	Common Name	State Status[a]	Federal Status[a]	Habitat Description
pensis	Ohio goldenrod	SC	—	Found most commonly on wet dolomite lake flats in Door County, and in fens, moist calcareous prairies, and sedge mea state with moist soils. Yellow, flat-topped flowers. Blooming occurs early August through late September; fruiting occurs identification period for this species is late August through early September.
volutum	Waxleaf meadowrue	SC	—	Found in moist, often calcareous meadows (i.e. southern sedge meadows) and mesic prairies. It is also naturalized on r throughout June; fruiting occurs throughout July. The optimal identification period for this species is throughout June.
inosa	Sticky false-asphodel	T	—	Found in moist calcareous bogs, fens and wet locations. White flowers clustered at the top of the plant with reddish/purp June and August.
auriculata	Earleaf foxglove	SC	—	Found in prairies (i.e. wet mesic prairies) or open upland woods in or near serpentine soils (meaning (derived from serp August through early September. The optimal identification period for this species is late August through early Septemb
ritima	Common bog arrow-grass	SC	—	Found on fen mats, calcareous fens, bogs, open neutral to calcareous conifers swamps, northern wet forests, and Grea occurs late June through early August; fruiting occurs late July through early September. The optimal identification peric late August.
vatum	Reflexed trillium	SC	—	Found in rich hardwood forests (i.e. southern mesic and dry mesic forests), with rich, moist soils. Blooming occurs late A throughout June. The optimal identification period for this species is late April through late May.
nifolium	Smooth black-haw	SC	—	Found in rich hardwood forests (i.e. southern wet mesic and mesic forests), often with dolomite near the surface. Bloom fruiting occurs early July through early September. The optimal identification period for this species is late May through
landingii	Blanding's turtle	T	—	Utilize a wide variety of aquatic habitats including deep and shallow marshes, shallow bays of lakes and impoundments submergent vegetation exists, sluggish streams, oxbows and other backwaters of rivers, drainage ditches (usually wher sedge meadows and wet meadows adjacent to these habitats. This species is semi-terrestrial and individuals may spen often move between a variety of wetland types during the active season, which can extend from early March to mid-Oct spring, late summer or fall. Nesting occurs from about mid-May through June depending on spring temperatures. They s may travel well over a mile from preferred habitat to find suitable soils. Hatching occurs from early August through early successfully overwinter in the nest, emerging the following late April or May.
butleri	Butler's gartersnake	T	—	Prefer almost any open-canopy wetland type (not open water) and adjacent open to semi-open canopy upland, includin lots. They also prefer low-canopy vegetation (<24"), although they will occupy habitats with taller vegetation, such as re can be active from mid-March through early November, usually emerging shortly after frost-out and remaining active un below 50 deg. F. Breeding usually occurs in April and early May, but can occur in the fall, in which case live young are b
mvittata	Queensnake	E	—	Prefer clear warm-water, spring-fed streams and small rivers in southern, lowland, hardwood forests and shrub carr con with aquatic crayfish, and require both moderate to fast flows and rocky substrates. Queensnakes are rarely found far fr open-canopy habitats where they bask in grasses or in shoreline brush and foraging in water or along the shoreline. Qu through early October and breed mid-May through mid-June. Live young are born in August or early September.
ns	Northern cricket frog	E	—	Prefer ponds, lakes, and a variety of habitats along and adjacent to streams and rivers including, marshes, fens, sedge mud flats. The species tends to breed in quiet water (no or low flow) and may also move from streams and rivers to adja are active from late-March through November. Breeding occurs from mid-May through mid-August, with some larvae no
ucocephalus	Bald eagle	SC	R	Prefers large trees in isolated areas, but in proximity to large areas of surface water, large complexes of deciduous fore communities. Large lakes and rivers with nearby tall pine trees are preferred for nesting. The breeding season extends roosting habitat includes wooded valleys near open water and major rivers from December through March.
ycticorax	Black-crowned night-heron	SC	—	Prefers freshwater wetlands dominated by bulrush and cattail with small groves of alder, willow, or other brush. Their br through mid-September.
aetus	Osprey	SC	—	Prefer large trees in isolated areas in proximity to large areas of surface water, large complexes of deciduous forest, co communities. Areas are usually forested with second growth pine, aspen, and hardwood forests. Breed mainly in foreste central Wisconsin. A few nest along the Wisconsin River, in swamps and inland lakes in the central part of the state. Lar trees are preferred for nesting. Most frequent nest sites are super canopy snags and dead-topped pines located along l clear-cut areas near water, in swamp conifer stands, and on snags in marshes and bogs. The breeding season extends
s	Red-shouldered hawk	T	—	Prefers larger stands of medium-aged to mature lowland deciduous forests, dry-mesic and mesic forest with small wetla bottomland hardwoods, mesic deciduous or mixed deciduous-conifer forests, and wooded margins of marshes. Breedin August.

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Scientific Name	Common Name	State Status[a]	Federal Status[a]	Habitat Description
gicauda	Upland sandpiper	SC	—	Prefers tallgrass prairies, sedge meadows, unmowed alfalfa/timothy fields and scattered woodlands. The breeding seas September.
phanus	Banded killifish	SC	—	Prefers clear water of bays and quiet backwaters of large lakes and medium to large streams with sparse to no vegetati detritus or cobble. Spawning occurs from June through mid-August.
s emiliae	Pugnose minnow	SC	—	Prefers clear, quiet, weedy shoals of glacial lakes, sloughs, and low-gradient rivers/streams over bottoms of sand, mud, vegetation includes pondweed, water milfoil, elodea, eelgrass, coontail, bullrush and filamentous algae. Spawning occu
genus	Pugnose shiner	T	—	Prefers weedy shoals of glacial lakes and low-gradient streams over bottoms of mud, sand, cobble, silt, and clay. Spaw July.
ocephalus	Striped shiner	E	—	Prefers clear to slightly turbid waters of runs and shallow pools of the lower Milwaukee River, with dense aquatic vegeta boulders, silt, sand, mud or bedrock. Sometimes present in large schools at the foot of riffles and shallow, hard-bottome occurs from late May through June.
cetta	Lake chubsucker	SC	—	Prefers moderately clear lakes, oxbow lakes, sloughs of weedy lakes and their associated marshy streams that are den cobble, sand, boulders, mud or silt. Spawning occurs from mid May through early July.
microperca	Least darter	SC	—	Prefers clear, warm, quiet waters of overflow ponds, pools, lakes and streams over substrates of gravel, silt, sand, boul or filamentous algal beds. Spawning occurs from late April into July.
bratilis	Redfin shiner	T	—	Prefers turbid waters of pools in low-gradient streams over substrates of boulders, cobble, sand, silt or detritus. Spawni August in sunfish nests.
galotis	Longear sunfish	T	—	Prefers clear, shallow, moderately warm, still waters of streams, rivers or occasionally lakes over rubble, gravel and sar present. Found in or near vegetation. Spawning occurs from late May through mid-July, sporadic to August.

es of Concern (not legally protected); R, Recovery

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Scientific Name	Common Name	State Status[a]	Federal Status[a]	Habitat Description
	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 loes oak is a common dominant tree of this upland forest community type. White oak, basswood, sugar and red maples, white a cherry are also important. The herbaceous understory flora is diverse and includes many species listed under southern dry 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 w oaks and black cherry. In the well-developed shrub layer, brambles (*Rubus* spp.), gray dogwood, and American hazelnut a 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 dom maple, river birch, green and black ashes, hackberry, swamp white oak, and eastern cottonwood. Black willow, basswood, associated tree species found in these forests. Understory composition is also quite variable, and follows the pattern exhib most extensive stands and highest plant species diversity occurring in southwestern Wisconsin. Buttonbush is a locally do thickets on the margins of oxbow lakes, sloughs and ponds, which are often important aquatic habitats within these forests (e.g., *Carex grayii*, *C. lupulina*, *C. hystericina*, *C. tuckermanii*), native grasses (e.g., *Cinna arundinacea*, *Elymus villosus*, *L* green-headed coneflower are important understory herbs, and lianas such as Virginia creepers, grapes, Canada moonsee 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 Canad of relatively undisturbed sedge meadows are other sedges (*Carex diandra*, *C. sartwellii*), marsh bellflower, marsh wild-timo swamp aster, blue flag, spotted Joe-Pye weed, marsh fern, and swamp milkweed. Reed canary grass may be dominant in sometimes to the exclusion of virtually all other species. Sedge meadows are most common in glaciated landscapes, wher drainage lakes. Many sedge meadows in southeastern Wisconsin are influenced by alkaline groundwater, and occur in co 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. Th bluestem. The grasses little bluestem, Indian grass, needle grass, prairie dropseed, and switch grass are also frequent. Th size, and physiognomy of the species. Common taxa include the prairie docks, lead plant, heath and smooth asters, prairi rattlesnake-master, flowering spurge, bee-balm, prairie coneflower, and spiderwort.
rpurascens	Purple milkweed	E	—	Found in open oak forest (i.e. southern dry mesic forests) margins and roadsides; it has wide soil moisture tolerances. Pin occurs early June through late July; fruiting occurs early July through late August. The optimal identification period for this
eglectus	Cooper's milkvetch	E	—	Found on riverbanks, ravines, and lakeshores, especially on dolomite near Lake Michigan, with calcareous soils. It can als forests. White flowers at top of stem, with alternate leaves. Blooming occurs throughout June; fruiting occurs throughout Ju this species is early June through late July.
orvi	Ravenfoot sedge	E	—	Found along ephemeral woodland (i.e. southern wet forests with moist soils) ponds. Blooms are clustered at the top. Bloo occurs throughout July. The optimal identification period for this species is late June through early July.
ormis	False hop sedge	E	—	Found in floodplain forests (i.e. southern wet and mesic wet forests) and ephemeral woodland ponds, and have wet soils. early October; fruiting occurs late July through early October. The optimal identification period for this species is early Aug
n chinense	Hemlock parsley	E	—	Found in discharge areas in forested seeps, calcareous fens, and tamarack swamps (including northern wet forests) with w through late September; fruiting occurs throughout September. The optimal identification period for this species is late Aug
eucophaea	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 tamar White flowers with large fringed petals at the bottom of the bloom. Blooming occurs early June through early August; fruitin optimal identification period for this species is late June through late July.
osa	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. Bloomi fruiting occurs throughout May. The optimal identification period for this species is late April through early May.
spera	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. early October; fruiting occurs throughout September. The optimal identification period for this species is late August throug
arietinum	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 o soils. Blooming occurs late May through early June; fruiting occurs late June through late July. The optimal identification p through early June.
s	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 clustered at the very top of stem. Blooming occurs early August through early October; fruiting occurs late August through

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Scientific Name	Common Name	State Status[a]	Federal Status[a]	Habitat Description
candidum	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 September. The optimal identification period for this species is late May through early June.
nlenbergii	Great Indian plantain	SC	—	Found in mesic hardwood forests (i.e. southern wet and wet mesic forests) and adjacent mesic prairies, often with dolomi late June through late July; fruiting occurs late July through late August. The optimal identification period for this species is
n latifolium	American gromwell	SC	—	Found in upland hardwood forests (southern wet mesic forests), often with dolomite near the surface, and dry, calcareous petals at top of plant. Blooming occurs throughout June; fruiting occurs early July through late August. The optimal identific June through late August.
ookeri	Hooker orchis	SC	—	Found in a variety of dry to moist, mostly mixed coniferous-hardwood forests (i.e. southern and northern dry mesic forests) late July; fruiting occurs early July through late August. The optimal identification period for this species is early June throu
vata	Heart-leaved skullcap	SC	—	Found in dry-mesic forests. Purple flowers in rows along the upper portions of the stem (above the leaves). Blooming occu occurs late July through late August. The optimal identification period for this species is early June through late July.
vatum	Reflexed trillium	SC	—	Found in rich hardwood forests (i.e. southern mesic and dry mesic forests), with rich, moist soils. Blooming occurs late Apr throughout June. The optimal identification period for this species is late April through late May.
s stricta	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 calcare meadows, and occasionally pine barrens. Occurs in wet, sandy soils. Blooming occurs throughout June; fruiting occurs ea optimal identification period for this species is early July through late August.
ora	Sparse-flowered sedge	SC	—	Found in open- to closed canopy cold, wet, coniferous forests (northern wet mesic and mesic forests), usually on neutral to occurs late May through early June; fruiting occurs late June through late July. The optimal identification period for this spe
parviflorum	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 through late June; fruiting occurs late June through late July. The optimal identification period for this species is late May th
a	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 w through early August; fruiting occurs throughout August. The optimal identification period for this species is early August th
volutum	Waxleaf meadowrue	SC	—	Found in moist, often calcareous meadows (i.e. southern sedge meadows) and mesic prairies. It is also naturalized on rail throughout June; fruiting occurs throughout July. The optimal identification period for this species is throughout June.
ritime	Common bog arrow-grass	SC	—	Found on fen mats, calcareous fens, bogs, open neutral to calcareous conifers swamps, northern wet forests, and Great L occurs late June through early August; fruiting occurs late July through early September. The optimal identification period f late August.
ilatata	Leafy white orchis	SC	—	Found on neutral to calcareous bog and fen mats (or calcareous fens), or northern wet forests (sometimes with scattered t neutral to calcareous soils. White flowers down the length of the stem. Blooming occurs early June through early July; fruit optimal identification period for this species is early June through early July.
errulatus	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 moister prairies. Blooming occurs late June through early September; fruiting occurs early July through early October. The species is late June through early October.
oliatum	Purple meadow parsnip	SC	—	Found in moist prairies (wet mesic and mesic prairies) and woodlands (including oak openings); it is also naturalized on ro flowers clustered at the flat top. Blooming occurs late May through late June; fruiting occurs early July through early Octob this species is early July through late September.
iphylla	Twinleaf	SC	—	Found in very rich hardwood forests (i.e. southern mesic forests), often with dolomite near the surface. White cupped flowe symmetrical parts. Blooming occurs throughout May; fruiting occurs early July through early September. The optimal identi May through early June.
ycticorax	Black-crowned night heron	SC	—	Prefers freshwater wetlands dominated by bulrush and cattail with small groves of alder, willow, or other brush. Their bree through mid-September.
ns	Northern cricket frog	E	—	Prefer ponds, lakes, and a variety of habitats along and adjacent to streams and rivers including, marshes, fens, sedge me flats. The species tends to breed in quiet water (no or low flow) and may also move from streams and rivers to adjacent we active from late-March through November. Breeding occurs from mid-May through mid-August, with some larvae not trans

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Scientific Name	Common Name	State Status[a]	Federal Status[a]	Habitat Description
butleri	Butler's gartersnake	T	—	Prefer almost any open-canopy wetland type (not open water) and adjacent open to semi-open canopy upland, including p lots. They also prefer low-canopy vegetation (<24"), although they will occupy habitats with taller vegetation, such as reed can be active from mid-March through early November, usually emerging shortly after frost-out and remaining active until c below 50 deg. F. Breeding usually occurs in April and early May, but can occur in the fall, in which case live young are bor
landingii	Blanding's turtle	T	—	Utilize a wide variety of aquatic habitats including deep and shallow marshes, shallow bays of lakes and impoundments wh submergent vegetation exists, sluggish streams, oxbows and other backwaters of rivers, drainage ditches (usually where w sedge meadows and wet meadows adjacent to these habitats. This species is semi-terrestrial and individuals may spend a move between a variety of wetland types during the active season, which can extend from early March to mid-October. Bla summer or fall. Nesting occurs from about mid-May through June depending on spring temperatures. They strongly prefer well over a mile from preferred habitat to find suitable soils. Hatching occurs from early August through early September bu overwinter in the nest, emerging the following late April or May.
tesbeianus	American bullfrog	SC	—	Found throughout Wisconsin in any permanent body of water - lakes, ponds, rivers, and creeks. They have a very patchy d typically favor oligotrophic (waters with low algal production; thus very clear) to mesotrophic (generally clear water with bed to breed where dense submergent vegetation filters out the majority of the suspended solids. Bullfrogs are active from Apr from mid-May through late July or later.
ocephalus	Striped shiner	E	—	Prefers clear to slightly turbid waters of runs and shallow pools of the lower Milwaukee River, with dense aquatic vegetatio silt, sand, mud or bedrock. Sometimes present in large schools at the foot of riffles and shallow, hard-bottomed pools with May through June.
bratilis	Redfin shiner	T	—	Prefers turbid waters of pools in low-gradient streams over substrates of boulders, cobble, sand, silt or detritus. Spawning August in sunfish nests.
microperca	Least darter	SC	—	Prefers clear, warm, quiet waters of overflow ponds, pools, lakes and streams over substrates of gravel, silt, sand, boulder or filamentous algal beds. Spawning occurs from late April into July.
cetta	Lake chubsucker	SC	—	Prefers moderately clear lakes, oxbow lakes, sloughs of weedy lakes and their associated marshy streams that are dense cobble, sand, boulders, mud or silt. Spawning occurs from mid May through early July.
elongates	Redside dace	SC	—	Prefers cool water pools and quiet riffles of small streams (usually adjacent to meadows or pastures) with substrate of cob Spawning occurs from May to early June.
rna	Little glassy wing	SC	—	Found in grassy openings in wooded areas near swamps, streams, bogs. Host plants appear to include grasses, especiall Flight period is from late June-July.
gracilis	Prairie crayfish	SC	—	Typically restricted to prairie regions of southeastern Wisconsin and is the rarest crayfish in Wisconsin. This species freque roadside ditches, small sluggish creeks, marshes, swamps, and small artificial lakes, as well as wet pastures and flat fields deep and branching, with a characteristic mud chimney. Breeding occurs and young hatch in early spring, as early as Marc spring and summer. Females move to open water for a relatively short period in the summer where the newly hatched you

es of Concern (not legally protected).

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Scientific Name	Common Name	State Status[a]	Federal Status[a]	Habitat Description
	Mesic prairie	N/A	—	This grassland community occurs on rich, moist, well-drained sites, usually on level or gently rolling glacial topography. T bluestem. The grasses little bluestem, Indian grass, needle grass, prairie dropseed, and switch grass are also frequent. T size, and physiognomy of the species. Common taxa include the prairie docks, lead plant, heath and smooth asters, prai 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 lo oak is a common dominant tree of this upland forest community type. White oak, basswood, sugar and red maples, white cherry are also important. The herbaceous understory flora is diverse and includes many species listed under southern d 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 oaks and black cherry. In the well-developed shrub layer, brambles (*Rubus* spp.), gray dogwood, and American hazelnut species are wild geranium, false Solomon's-seal, hog-peanut, and rough-leaved sunflower.
urpurascens	Purple milkweed	E	—	Found in open oak forest (i.e. southern dry mesic forests) margins and roadsides; it has wide soil moisture tolerances. Pi occurs early June through late July; fruiting occurs early July through late August. The optimal identification period for thi
us	Forked aster	T	—	Found in dry to mesic hardwoods (i.e. southern wet and wet mesic forests), often on stream-sides or slopes with dolomit clustered at the very top of stem. Blooming occurs early August through early October; fruiting occurs late August throug identification period for this species is late August through late September.
neglectus	Cooper's milkvetch	E	—	Found on riverbanks, ravines, and lakeshores, especially on dolomite near Lake Michigan, with calcareous soils. It can a forests. White flowers at top of stem, with alternate leaves. Blooming occurs throughout June; fruiting occurs throughout this species is early June through late July.
ehlenbergii	Great Indian plantain	SC	—	Found in mesic hardwood forests (i.e. southern wet and wet mesic forests) and adjacent mesic prairies, often with dolom late June through late July; fruiting occurs late July through late August. The optimal identification period for this species
tis stricta	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 calcar meadows, and occasionally pine barrens. Occurs in wet, sandy soils. Blooming occurs throughout June; fruiting occurs e optimal identification period for this species is early July through late August.
formis	False hop sedge	E	—	Found in floodplain forests (i.e. southern wet and mesic wet forests) and ephemeral woodland ponds, and have wet soils early October; fruiting occurs late July through early October. The optimal identification period for this species is early Au
flora	Sparse-flowered sedge	SC	—	Found in open- to closed canopy cold, wet, coniferous forests (northern wet mesic and mesic forests), usually on neutral occurs late May through early June; fruiting occurs late June through late July. The optimal identification period for this sp
m chinense	Hemlock parsley	E	—	Found in discharge areas in forested seeps, calcareous fens, and tamarack swamps (including northern wet forests) with through late September; fruiting occurs throughout September. The optimal identification period for this species is late Au
n arietinum	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 soils. Blooming occurs late May through early June; fruiting occurs late June through late July. The optimal identification through early June.
n parviflorum	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 t through late June; fruiting occurs late June through late July. The optimal identification period for this species is late May
ta	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 through early August; fruiting occurs throughout August. The optimal identification period for this species is early August
um latifolium	American gromwell	SC	—	Found in upland hardwood forests (southern wet mesic forests), often with dolomite near the surface, and dry, calcareou petals at top of plant. Blooming occurs throughout June; fruiting occurs early July through late August. The optimal identi June through late August.
dilatata	Leafy white orchis	SC	—	Found on neutral to calcareous bog and fen mats (or calcareous fens), or northern wet forests (sometimes with scattere neutral to calcareous soils. White flowers down the length of the stem. Blooming occurs early June through early July; fru optimal identification period for this species is early June through early July.
hookeri	Hooker orchis	SC	—	Found in a variety of dry to moist, mostly mixed coniferous-hardwood forests (i.e. southern and northern dry mesic forest late July; fruiting occurs early July through late August. The optimal identification period for this species is early June thro

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Scientific Name	Common Name	State Status[a]	Federal Status[a]	Habitat Description
leucophaea	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 tama White flowers with large fringed petals at the bottom of the bloom. Blooming occurs early June through early August; fruit optimal identification period for this species is late June through late July.
aspera	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 plan early October; fruiting occurs throughout September. The optimal identification period for this species is late August throu
ata	Wafer-ash	SC	—	Found on dry dolomite ledges in oak forests (i.e. southern dry and wet mesic forests). Blooming occurs late May through July. The optimal identification period for this species is late May through late September.
ovata	Heart-leaved skullcap	SC	—	Found in dry-mesic forests. Purple flowers in rows along the upper portions of the stem (above the leaves). Blooming occ occurs late July through late August. The optimal identification period for this species is early June through late July.
esia	Bluestem goldenrod	E	—	Found in open forests, forest edges, clearings, and/or thickets. Occur on level ground, side slopes and protected ravine e Lake Michigan. Yellow clusters of flowers along the majority of the mid to upper portion of the stem. Blooming occurs fror
evolutum	Waxleaf meadowrue	SC	—	Found in moist, often calcareous meadows (i.e. southern sedge meadows) and mesic prairies. It is also naturalized on ra throughout June; fruiting occurs throughout July. The optimal identification period for this species is throughout June.
aritime	Common bog arrow-grass	SC	—	Found on fen mats, calcareous fens, bogs, open neutral to calcareous conifers swamps, northern wet forests, and Great occurs late June through early August; fruiting occurs late July through early September. The optimal identification perioc late August.
rvatum	Reflexed trillium	SC	—	Found in rich hardwood forests (i.e. southern mesic and dry mesic forests), with rich, moist soils. Blooming occurs late Ap throughout June. The optimal identification period for this species is late April through late May.
runifolium	Smooth black-haw	SC	—	Found in rich hardwood forests (i.e. southern wet mesic and mesic forests), often with dolomite near the surface. Bloomir fruiting occurs early July through early September. The optimal identification period for this species is late May through ea
cana	Dickcissel	SC	—	Prefers open pasture and fields of clover and alfalfa. Grasslands, meadows, and savanna are also important nesting area medium to tall height-density and a significant component of forbs (i.e. herbaceous flowering plants that are not graminoi stiff-stemmed. Breeding occurs from late May to early August.
ns	Northern cricket frog	E	—	Prefer ponds, lakes, and a variety of habitats along and adjacent to streams and rivers including, marshes, fens, sedge m flats. The species tends to breed in quiet water (no or low flow) and may also move from streams and rivers to adjacent w active from late-March through November. Breeding occurs from mid-May through mid-August, with some larvae not tran
blandingii	Blanding's turtle	T	—	Utilize a wide variety of aquatic habitats including deep and shallow marshes, shallow bays of lakes and impoundments w submergent vegetation exists, sluggish streams, oxbows and other backwaters of rivers, drainage ditches (usually where sedge meadows and wet meadows adjacent to these habitats. This species is semi-terrestrial and individuals may spend move between a variety of wetland types during the active season, which can extend from early March to mid-October. B summer or fall. Nesting occurs from about mid-May through June depending on spring temperatures. They strongly prefe well over a mile from preferred habitat to find suitable soils. Hatching occurs from early August through early September overwinter in the nest, emerging the following late April or May.
atesbeianus	American bullfrog	SC	—	Found throughout Wisconsin in any permanent body of water - lakes, ponds, rivers, and creeks. They have a very patchy typically favor oligotrophic (waters with low algal production; thus very clear) to mesotrophic (generally clear water with be to breed where dense submergent vegetation filters out the majority of the suspended solids. Bullfrogs are active from Ap from mid-May through late July or later.
butleri	Butler's gartersnake	T	—	Prefer almost any open-canopy wetland type (not open water) and adjacent open to semi-open canopy upland, including lots. They also prefer low-canopy vegetation (<24"), although they will occupy habitats with taller vegetation, such as reec can be active from mid-March through early November, usually emerging shortly after frost-out and remaining active until below 50 deg. F. Breeding usually occurs in April and early May, but can occur in the fall, in which case live young are bo
socephalus	Striped shiner	E	—	Prefers clear to slightly turbid waters of runs and shallow pools of the lower Milwaukee River, with dense aquatic vegetati silt, sand, mud or bedrock. Sometimes present in large schools at the foot of riffles and shallow, hard-bottomed pools wit Spawning occurs from late May through June.
nbratilis	Redfin shiner	T	—	Prefers turbid waters of pools in low-gradient streams over substrates of boulders, cobble, sand, silt or detritus. Spawning August in sunfish nests.

CIES

Scientific Name	Common Name	State Status[a]	Federal Status[a]	Habitat Description
galotis	Longear sunfish	T	—	Prefers clear, shallow, moderately warm, still waters of streams, rivers or occasionally lakes over rubble, gravel and sand present. Found in or near vegetation. Spawning occurs from late May through mid-July, sporadic to August.
microperca	Least darter	SC	—	Prefers clear, warm, quiet waters of overflow ponds, pools, lakes and streams over substrates of gravel, silt, sand, boulde or filamentous algal beds. Spawning occurs from late April into July.
cetta	Lake chubsucker	SC	—	Prefers moderately clear lakes, oxbow lakes, sloughs of weedy lakes and their associated marshy streams that are dens cobble, sand, boulders, mud or silt. Spawning occurs from mid May through early July.
erna	Little glassy wing	SC	—	Found in grassy openings in wooded areas near swamps, streams, bogs. Host plants appear to include grasses, especia Flight period is from late June-July.
s gracilis	Prairie crayfish	SC	—	Typically restricted to prairie regions of southeastern Wisconsin and is the rarest crayfish in Wisconsin. This species freq roadside ditches, small sluggish creeks, marshes, swamps, and small artificial lakes, as well as wet pastures and flat fiel deep and branching, with a characteristic mud chimney. Breeding occurs and young hatch in early spring, as early as Ma spring and summer. Females move to open water for a relatively short period in the summer where the newly hatched yo

es of Concern (not legally protected).

CIES

Scientific Name	Common Name	State Status[a]	Federal Status[a]	Habitat Description
	Calcareous fen	N/A	—	Calcareous fens occur mostly in southern Wisconsin, on sites that are fed by carbonate-enriched groundwater. Most fens few acres, and are often associated and can intergrade with more abundant and widespread wetland communities such a prairie, shrub-carr, emergent marsh, and southern tamarack swamp. An accumulation of peat can raise the fen surface to adjoining lands. Common or representative plants include sedges, marsh fern, shrubby cinquefoil, shrubby St. John's wo parnassus, twig-rush, brook lobelia, boneset, swamp thistle, and asters. Many fens have a significant number of prairie o some contain plants often associated with bogs, such as tamarack, bog birch and pitcher plant. Fens occur in several lan morainal slopes, on sloping deposits of glacial outwash, in the headwaters regions of spring runs and small streams, and 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 lo Red oak is a common dominant tree of this upland forest community type. White oak, basswood, sugar and red maples, cherry are also important. The herbaceous understory flora is diverse and includes many species listed under southern d 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 bur oaks and black cherry. In the well-developed shrub layer, brambles (*Rubus* spp.), gray dogwood, and American haze 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.
rpurascens	Purple milkweed	E	—	Found in open oak forest (i.e. southern dry mesic forests) margins and roadsides; it has wide soil moisture tolerances. Pi occurs early June through late July; fruiting occurs early July through late August. The optimal identification period for this
s	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 clustered at the very top of stem. Blooming occurs early August through early October; fruiting occurs late August throug identification period for this species is late August through late September.
eglectus	Cooper's milkvetch	E	—	Found on riverbanks, ravines, and lakeshores, especially on dolomite near Lake Michigan, with calcareous soils. It can al forests. White flowers at top of stem, with alternate leaves. Blooming occurs throughout June; fruiting occurs throughout J for this species is early June through late July.
hlenbergii	Great Indian plantain	SC	—	Found in mesic hardwood forests (i.e. southern wet and wet mesic forests) and adjacent mesic prairies, often with dolom late June through late July; fruiting occurs late July through late August. The optimal identification period for this species
ris	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. early September; fruiting occurs late July through late September. The optimal identification period for this species is earl
is stricta	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 calcar meadows, and occasionally pine barrens. Occurs in wet, sandy soils. Blooming occurs throughout June; fruiting occurs e optimal identification period for this species is early July through late August.
ora	Sparse-flowered sedge	SC	—	Found in open- to closed canopy cold, wet, coniferous forests (northern wet mesic and mesic forests), usually on neutral occurs late May through early June; fruiting occurs late June through late July. The optimal identification period for this sp
n chinense	Hemlock parsley	E	—	Found in discharge areas in forested seeps, calcareous fens, and tamarack swamps (including northern wet forests) with August through late September; fruiting occurs throughout September. The optimal identification period for this species is
arietinum	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 soils. Blooming occurs late May through early June; fruiting occurs late June through late July. The optimal identification through early June.
candidum	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 Jun September. The optimal identification period for this species is late May through early June.
parviflorum	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 through late June; fruiting occurs late June through late July. The optimal identification period for this species is late May
reginae	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 dry clay bluffs with moist, neutral to calcareous soils. White and purple/pinkish flower. Blooming occurs late June through through late August. The optimal identification period for this species is late June through early August.
ariegatum	Variegated horsetail	SC	—	Found most characteristically on wet dolomite flats and gravelly swales near Lake Michigan but also in other wet, open, r

CIES

Scientific Name	Common Name	State Status[a]	Federal Status[a]	Habitat Description
osa	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. Bloor May; fruiting occurs throughout May. The optimal identification period for this species is late April through early May.
lygonifolia	Seaside spurge	SC		Found on sandy beaches and dunes along Lake Michigan. Blooming occurs early July through late August; fruiting occur The optimal identification period for this species is early July through late September.
procera	Lesser fringed gentian	SC	—	Found on wet dolomite pavement near Lake Michigan, as well as cold fens, seeps, and meadows (i.e. northern sedge me Deep blue flowers with fringed edges. Blooming occurs late August through early October; fruiting occurs early Septemb identification period for this species is late August through early October.
epidota	Wild licorice	SC	—	Found in moist prairies and other grasslands and streambanks. It has been found naturalized on cinders of railroads and occurs throughout July; fruiting occurs early August through late October. The optimal identification period for this specie
a	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 July through early August; fruiting occurs throughout August. The optimal identification period for this species is early Au
m latifolium	American gromwell	SC	—	Found in upland hardwood forests (southern wet mesic forests), often with dolomite near the surface, and dry, calcareou petals at top of plant. Blooming occurs throughout June; fruiting occurs early July through late August. The optimal identi June through late August.
iniana	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 s flower extends out of. Blooming occurs early May through late June; fruiting occurs late July through late August. The op species is early May through late August.
irsutus	Hairy beardtongue	SC	—	Found on dry gravelly and sandy prairies (i.e. dry mesic prairies), or in hillside oak openings or woodlands, or pine barre Blooming occurs late May through late June; fruiting occurs late July through late August. The optimal identification perio late June.
ilatata	Leafy white orchis	SC	—	Found on neutral to calcareous bog and fen mats (or calcareous fens), or northern wet forests (sometimes with scattere neutral to calcareous soils. White flowers down the length of the stem. Blooming occurs early June through early July; fru optimal identification period for this species is early June through early July.
ookeri	Hooker orchis	SC	—	Found in a variety of dry to moist, mostly mixed coniferous-hardwood forests (i.e. southern and northern dry mesic forest late July; fruiting occurs early July through late August. The optimal identification period for this species is early June thro
eucophaea	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 tama White flowers with large fringed petals at the bottom of the bloom. Blooming occurs early June through early August; fruit optimal identification period for this species is late June through late July.
sia	Bluestem goldenrod	E	—	Found in open forests, forest edges, clearings, and/or thickets. Occur on level ground, side slopes and protected ravine e Lake Michigan. Yellow clusters of flowers along the majority of the mid to upper portion of the stem. Blooming occurs fror
pensis	Ohio goldenrod	SC	—	Found most commonly on wet dolomite lake flats in Door County, and in fens, moist calcareous prairies, and sedge mea state with moist soils. Yellow, flat-topped flowers. Blooming occurs early August through late September; fruiting occurs t identification period for this species is late August through early September.
volutum	Waxleaf meadowrue	SC	—	Found in moist, often calcareous meadows (i.e. southern sedge meadows) and mesic prairies. It is also naturalized on ra throughout June; fruiting occurs throughout July. The optimal identification period for this species is throughout June.
inosa	Sticky false-asphodel	T	—	Found in moist calcareous bogs, fens and wet locations. White flowers clustered at the top of the plant with reddish/purpl June and August.
aritime	Common bog arrow-grass	SC	—	Found on fen mats, calcareous fens, bogs, open neutral to calcareous conifers swamps, northern wet forests, and Great occurs late June through early August; fruiting occurs late July through early September. The optimal identification perio late August.
lustris	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 throughout August. The optimal identification period for this species is early July through late August.
vatum	Reflexed trillium	SC	—	Found in rich hardwood forests (i.e. southern mesic and dry mesic forests), with rich, moist soils. Blooming occurs late Ap throughout June. The optimal identification period for this species is late April through late May.

CIES

Scientific Name	Common Name	State Status[a]	Federal Status[a]	Habitat Description
icoides	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 c and rocky soils. Blooming occurs from June. The optimal identification period for this species is mid-July to late August.
ana	Dickissel	SC	—	Prefers open pasture and fields of clover and alfalfa. Grasslands, meadows, and savanna are also important nesting area medium to tall height-density and a significant component of forbs (i.e. herbaceous flowering plants that are not graminoi some stiff-stemmed. Breeding occurs from late May to early August.
ns	Northern cricket frog	E	—	Prefer ponds, lakes, and a variety of habitats along and adjacent to streams and rivers including, marshes, fens, sedge m mud flats. The species tends to breed in quiet water (no or low flow) and may also move from streams and rivers to adjac are active from late-March through November. Breeding occurs from mid-May through mid-August, with some larvae not
butleri	Butler's gartersnake	T	—	Prefer almost any open-canopy wetland type (not open water) and adjacent open to semi-open canopy upland, including lots. They also prefer low-canopy vegetation (<24"), although they will occupy habitats with taller vegetation, such as reed can be active from mid-March through early November, usually emerging shortly after frost-out and remaining active until below 50 deg. F. Breeding usually occurs in April and early May, but can occur in the fall, in which case live young are bo
landingii	Blanding's turtle	T	—	Utilize a wide variety of aquatic habitats including deep and shallow marshes, shallow bays of lakes and impoundments w submergent vegetation exists, sluggish streams, oxbows and other backwaters of rivers, drainage ditches (usually where sedge meadows and wet meadows adjacent to these habitats. This species is semi-terrestrial and individuals may spend often move between a variety of wetland types during the active season, which can extend from early March to mid-Octo spring, late summer or fall. Nesting occurs from about mid-May through June depending on spring temperatures. They st may travel well over a mile from preferred habitat to find suitable soils. Hatching occurs from early August through early S successfully overwinter in the nest, emerging the following late April or May.
tesbeianus	American bullfrog	SC	—	Found throughout Wisconsin in any permanent body of water - lakes, ponds, rivers, and creeks. They have a very patchy typically favor oligotrophic (waters with low algal production; thus very clear) to mesotrophic (generally clear water with be to breed where dense submergent vegetation filters out the majority of the suspended solids. Bullfrogs are active from Ap from mid-May through late July or later.
ocephalus	Striped shiner	E	—	Prefers clear to slightly turbid waters of runs and shallow pools of the lower Milwaukee River, with dense aquatic vegetati boulders, silt, sand, mud or bedrock. Sometimes present in large schools at the foot of riffles and shallow, hard-bottomed occurs from late May through June.
bratilis	Redfin shiner	T	—	Prefers turbid waters of pools in low-gradient streams over substrates of boulders, cobble, sand, silt or detritus. Spawning August in sunfish nests.
alenciennesi	Greater redhorse	T	—	Prefers clear water of medium to large rivers (moderately rapid), reservoirs and large lakes at depths of less than 3 feet (Spawning occurs in May or June.
phanus	Banded killfish	SC	—	Prefers clear water of bays and quiet backwaters of large lakes and medium to large streams with sparse to no vegetatio detritus or cobble. Spawning occurs from June through mid-August.
rna	Little glassy wing	SC	—	Found in grassy openings in wooded areas near swamps, streams, bogs. Host plants appear to include grasses, especia Flight period is from late June-July.
gracilis	Prairie crayfish	SC	—	Typically restricted to prairie regions of southeastern Wisconsin and is the rarest crayfish in Wisconsin. This species freq roadside ditches, small sluggish creeks, marshes, swamps, and small artificial lakes, as well as wet pastures and flat field quite deep and branching, with a characteristic mud chimney. Breeding occurs and young hatch in early spring, as early a through spring and summer. Females move to open water for a relatively short period in the summer where the newly ha

ecies of Concern (not legally protected).

tate-Listed Species tables:

f Natural Resources Endangered Resources, Species and Natural Communities, Natural Heritage Inventory Working List Animals and Animal Species of Greatest Conservation Need. Available at: ndex.asp?mode=TaxaList&Taxa=A, accessed June 2010.

f 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.

f 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.

Dominant Species			Invasive Species		Type of Maintenance	Access Type		Wildlife Species Observed	Wetlands/Waterbodies	Stream Conditions			P Nu
y	Understory	Herbaceous	Species Observed	Percent Dominance		Direct	Indirect			Width	Depth	Quality	
e, w, ' n nd r,	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 (7/7/ Phot 10, 1
ck - d d, le,	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 (7/7/ Phot 3

Dominant Species			Invasive Species		Type of Maintenance	Access Type		Wildlife Species Observed	Wetlands/Waterbodies	Stream Conditions			P Nu
y	Understory	Herbaceous	Species Observed	Percent Dominance		Direct	Indirect			Width	Depth	Quality	
een - 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 (7/7/ Phot 7

ver Alluvium)

	Dominant Species		Invasive Species			Access Type				Stream Conditions			
ory	Understory	Herbaceous	Species Observed	Percent Dominance	Type of Maintenance	Direct	Indirect	Wildlife Species Observed	Wetlands/ Waterbodies	Width	Depth	Quality	F Nu
ood, r, lack	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 (7/9 Pho
lnut, r, ple, od, h, aple, n and elm, our e en,	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 (7/7 Pho 13, Day (7/9 Pho 3
sh, ple, r, n od, low nt)	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 (7/7 Pho 16

Dominant Species			Invasive Species			Access Type				Stream Conditions			
rstory	Understory	Herbaceous	Species Observed	Percent Dominance	Type of Maintenance	Direct	Indirect	Wildlife Species Observed	Wetlands/ Waterbodies	Width	Depth	Quality	
ican nwood, oak, bark ry, ash, 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	D (F 5 T f a N r a D
n ash, lder, nwood	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	D (F t
ern red black t, white bark ry, ng n, ican nwood, 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	D (F t

Dominant Species			Invasive Species			Access Type				Stream Conditions		
…rstory	Understory	Herbaceous	Species Observed	Percent Dominance	Type of Maintenance	Direct	Indirect	Wildlife Species Observed	Wetlands/ Waterbodies	Width	Depth	Quality
…ican …black …eeping …, box	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
… willow, … 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

Dominant Species			Invasive Species			Access Type				Stream Conditions			
rstory	Understory	Herbaceous	Species Observed	Percent Dominance	Type of Maintenance	Direct	Indirect	Wildlife Species Observed	Wetlands/ Waterbodies	Width	Depth	Quality	
ing , green black t, ern red box nwood ican black t, box green black , nwood, rack ed, ative)	Washington hawthorn Lacking in understory vegetation	RCG, hedge nettle, sweet pea, wild parsnip, thistle, Queen Anne's lace, tall goldenrod, riverbank and cat grape, common milkweed, bindweed Garlic mustard, wood violets, dames's rocket, bindweed, bull and Canada thistle, tall goldenrod, Virginia creeper, RCG, riverbank grape, jewelweed	RCG RCG Garlic mustard	95% Not dominant Not dominant	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. Root River on the east side of the parkway, plus forested floodplain (potential PFO)	4-8 feet 20 feet at parkway edge, but 8 feet as it flows east	4-12 inches 4-5 inches	Potentially low; silty/mucky bottom, good wooded riparian area, but eroding banks and garbage present; PEM adjacent is a monotypic stand of RCG Potentially low to moderate as it moves east; silty/mucky bottom	D (F t
n ash, nwood, 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	D (F t

Dominant Species			Invasive Species			Access Type				Stream Conditions			
...rstory	Understory	Herbaceous	Species Observed	Percent Dominance	Type of Maintenance	Direct	Indirect	Wildlife Species Observed	Wetlands/ Waterbodies	Width	Depth	Quality	
... walnut, ...lder, ...nwood, ... ash, ...ring ...pple, ...cedar, ...ak	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	D... (... R... t...

Dominant Species			Invasive Species		Type of Maintenance	Access Type		Wildlife Species Observed	Wetlands/ Waterbodies	Stream Conditions			Phot Numbe
erstory	Understory	Herbaceous	Species Observed	Percent Dominance		Direct	Indirect			Width	Depth	Quality	
en ash, elder, erican black w,	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 (7/7/201 Photos 1
e, black st, green black w, black ut, nwood, elder, ern red ar	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/com mercial development heavily trafficked roadways	Day 2 (7/7/201 Photos 1 thru 22

Dominant Species			Invasive Species			Access Type				Stream Conditions			
erstory	Understory	Herbaceous	Species Observed	Percent Dominance	Type of Maintenance	Direct	Indirect	Wildlife Species Observed	Wetlands/ Waterbodies	Width	Depth	Quality	Phot Numbe
k ut, r maple, ar le, box r, swood, hern red green 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 2 24, 25
e oak, n ash, ar maple ninant), gbark ory, swood, k ut, erican black ry	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 92nd 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
hern red gbark ory, n ash, e oak, ut, black ry, bur sugar le, black ut, erican 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 92nd Street, along with the golf course located west of 92nd Street.	Direct access from 92nd 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

Dominant Species			Invasive Species		Type of Maintenance	Access Type		Wildlife Species Observed	Wetlands/ Waterbodies	Stream Conditions			Photo Numbe
erstory	Understory	Herbaceous	Species Observed	Percent Dominance		Direct	Indirect			Width	Depth	Quality	
en ash, onwood, elm d), box r, sian e	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 68th 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 (7/8/201C Photos 6 9
er maple er le, box r	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 (7/8/201C Photos 1(thru 14

Dominant Species			Invasive Species			Access Type				Stream Conditions			
erstory	Understory	Herbaceous	Species Observed	Percent Dominance	Type of Maintenance	Direct	Indirect	Wildlife Species Observed	Wetlands/ Waterbodies	Width	Depth	Quality	Phot Numbe
er le, box r, swood, k 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 1
en ash, swood, elder, k cherry, king en, ar le, silver le	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
	--	--	--	--	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 1 Taken at power lin substatio of Ryan Road, approxim 0.15 mile south of t site.

	Dominant Species		Invasive Species			Access Type				Stream Conditions			
ry	Understory	Herbaceous	Species Observed	Percent Dominance	Type of Maintenance	Direct	Indirect	Wildlife Species Observed	Wetlands/ Waterbodies	Width	Depth	Quality	Photo Nu
low, ox od, h	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 (7/8/201 Photo 4
low, r	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 (7/8/201 Photos
sh, low, n er ur	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 (7/8/201 Photos
sh, low, n er ur	Buckthorn, honeysuckle, red osier dogwood	Blue vervain, bee balm/ bergamot, narrowleaf cattail, RCG, thistle, spotted joe-pye weed, common milkweed, swamp milkweed, cow	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 (7/8/201 Photos

Dominant Species			Invasive Species			Access Type				Stream Conditions			
...ory	Understory	Herbaceous	Species Observed	Percent Dominance	Type of Maintenance	Direct	Indirect	Wildlife Species Observed	Wetlands/ Waterbodies	Width	Depth	Quality	Photo Nu...
red k h, r, n te ck d,	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 (7/8/201 Photo 3 Taken fr Hidden
red k h, r, n te ck d,	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 (7/8/201 Photos
r, d nt), n ck k , red te	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 (7/8/201 Photos 29, 30
	--	--	--	--	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		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 (7/8/201 Photo 2 Taken fr Lawnsd Road.

	Dominant Species		Invasive Species			Access Type				Stream Conditions			
ory	Understory	Herbaceous	Species Observed	Percent Dominance	Type of Maintenance	Direct	Indirect	Wildlife Species Observed	Wetlands/ Waterbodies	Width	Depth	Quality	Photo Nu
sh, n ck oox r red ck ood	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 (7/8/201 Photo 2
	--	--	--	--	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 (7/8/201 Photo 2 Taken fr Parker F across a agricultu field (co towards forested (in backgro
sh, r	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 (7/8/201 Photos Taken fr Muskeg Dam Dr north alo power li corridor.

Dominant Species			Invasive Species		Type of Maintenance	Access Type		Wildlife Species Observed	Wetlands/ Waterbodies	Stream Conditions			Photo Nu
ory	Understory	Herbaceous	Species Observed	Percent Dominance		Direct	Indirect			Width	Depth	Quality	
h, r,	--	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 76th 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 (7/8/201 Photo 2 Taken fr 76th Stre east alo power li corridor.
h, r,	--	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 76th 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 (7/8/201 Photo 2 Taken fr 76th Stre east alo power li corridor.
r, h, low, od, n ood	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 (7/8/201 Photos

Dominant Species			Invasive Species		Type of Maintenance	Access Type		Wildlife Species Observed	Wetlands/ Waterbodies	Stream Conditions			Pho Numb
erstory	Understory	Herbaceous	Species Observed	Percent Dominance		Direct	Indirect			Width	Depth	Quality	
pine, willow, n ash, nwood, e,	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 Underwoo d 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 (7/6/2 Photo 58, 60
n ash, rican box , black w, nwood	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 (7/6/2 Photo thru 5

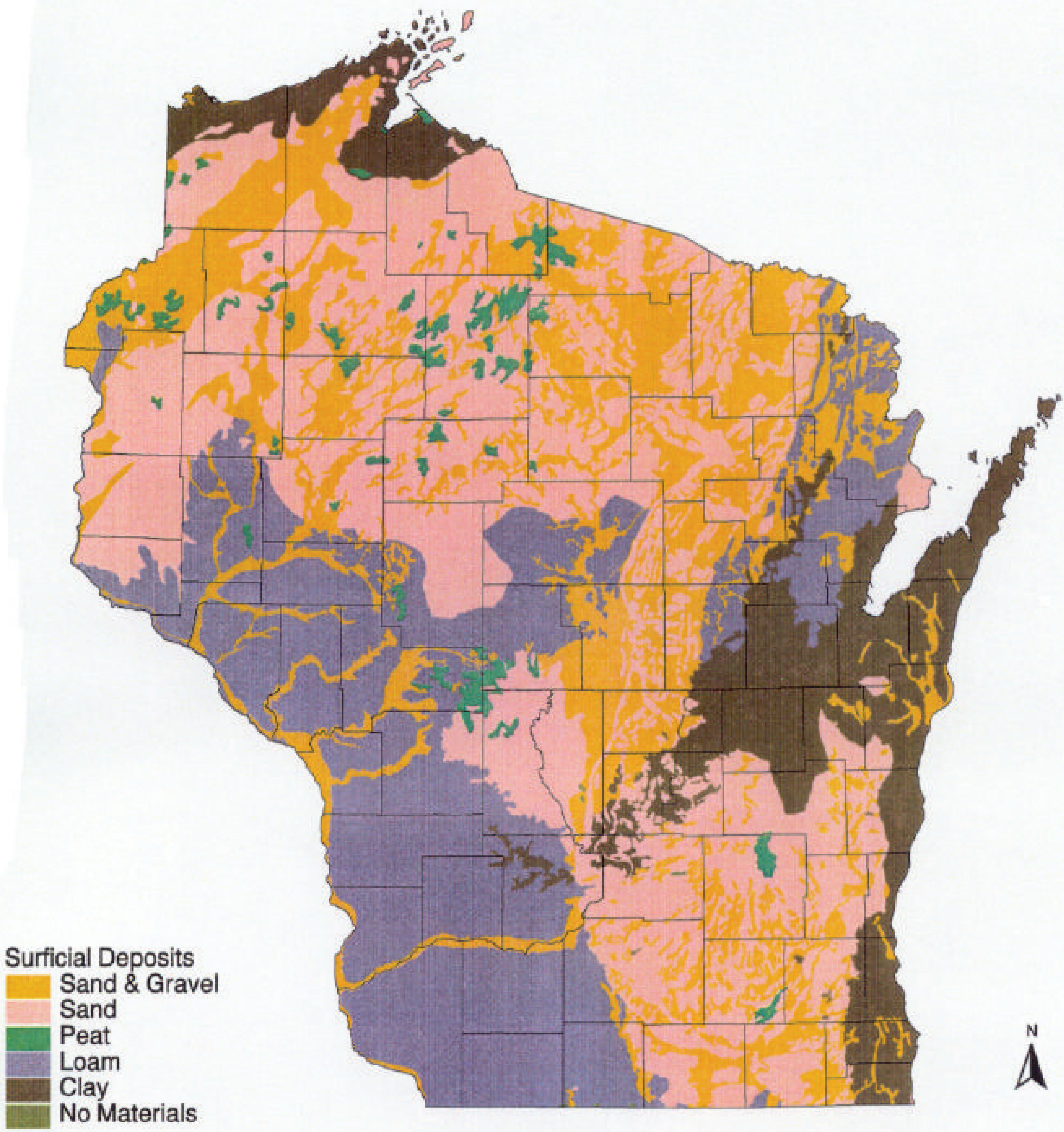
Dominant Species			Invasive Species		Type of Maintenance	Access Type		Wildlife Species Observed	Wetlands/ Waterbodies	Stream Conditions			
rstory	Understory	Herbaceous	Species Observed	Percent Dominance		Direct	Indirect			Width	Depth	Quality	

n)

rstory	Dominant Species: Understory	Dominant Species: Herbaceous	Invasive Species: Species Observed	Invasive Species: Percent Dominance	Type of Maintenance	Access Type: Direct	Access Type: Indirect	Wildlife Species Observed	Wetlands/ Waterbodie	Stream Conditions: Width	Stream Conditions: Depth	Stream Conditions: Quality	
Willow, lder, ern red black t, black , green can hybrid r, silver ugar e, white ington horn	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	D (7 Pl th

Attachment 6-8
Wisconsin Geology Maps

SURFICIAL DEPOSITS



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.

Cartography by Bill Shockley

BEDROCK GEOLOGY OF WISCONSIN

UNIVERSITY OF WISCONSIN–EXTENSION

Geological and Natural History Survey

APRIL 1981
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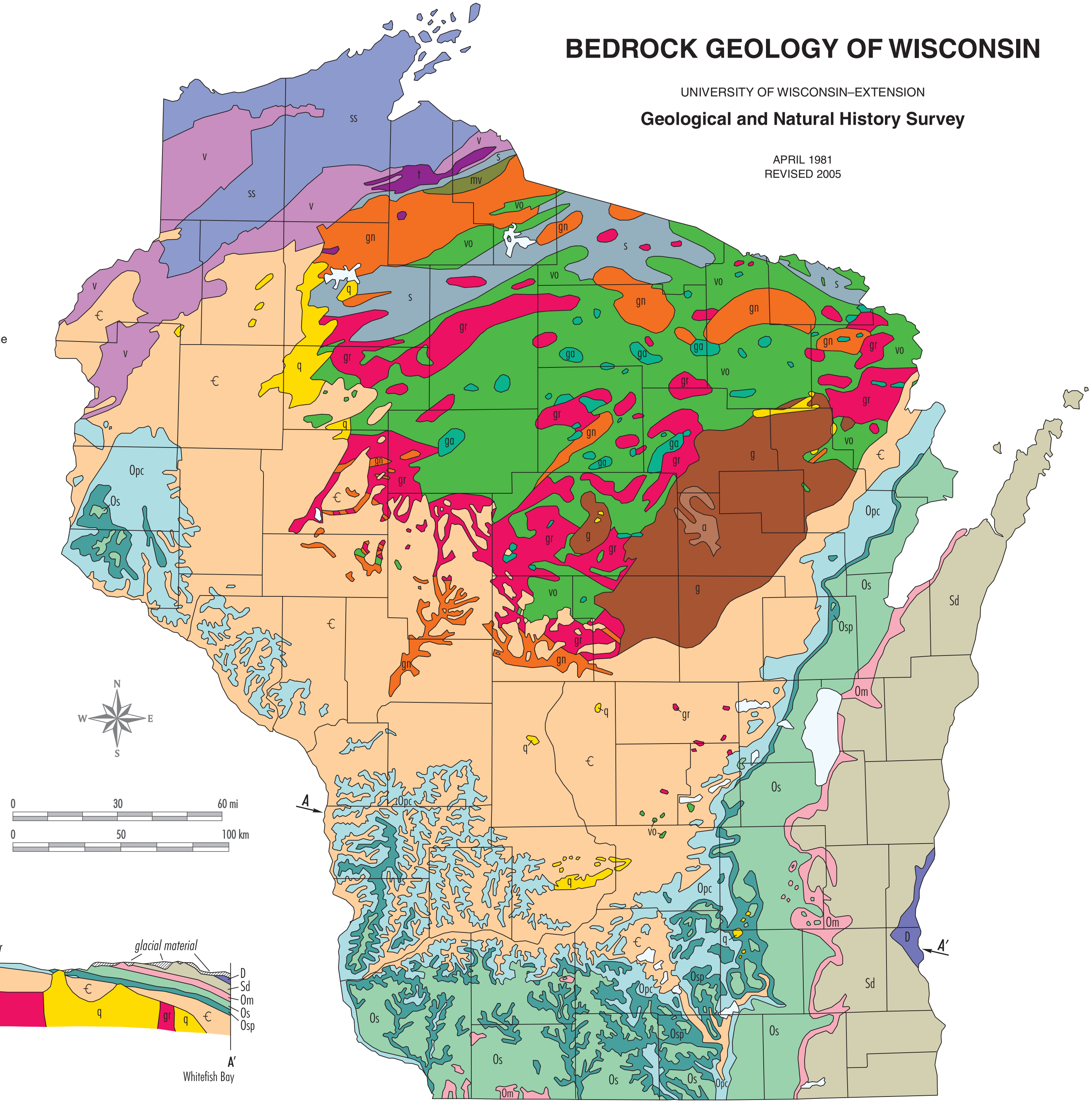


EXPLANATION

DEVONIAN

- D — dolomite and shale

SILURIAN

- Sd — dolomite

ORDOVICIAN

- Om — Maquoketa Formation—shale and dolomite
- Os — Sinnipee Group—dolomite with some limestone and shale
- Osp — St. Peter Formation—sandstone with some limestone shale and conglomerate
- Opc — Prairie du Chien Group—dolomite with some sandstone and shale

CAMBRIAN

- € — sandstone with some dolomite and shale

MIDDLE PROTEROZOIC

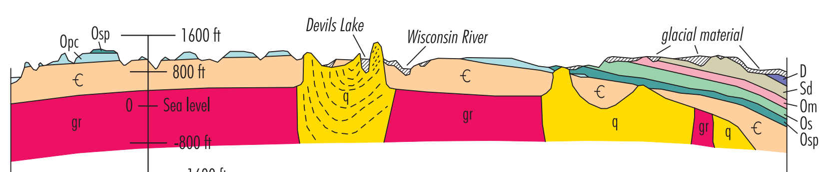
- Keweenawan rock—
  - ss, sandstone
  - v, basaltic to rhyolitic lava flows
  - t, gabbroic, anorthositic and granitic rock
- Wolf River rock—
  - g, rapakivi granite, granite, and syenite
  - a, anorthosite and gabbro

LOWER PROTEROZOIC

- q — quartzite
- gr — granite, diorite, and gneiss
- s, metasedimentary rock, argillite, siltstone, quartzite, greywacke, and iron formation
- vo, basaltic to rhyolitic metavolcanic rock with some metasedimentary rock
- ga, meta-gabbro and hornblende diorite

LOWER PROTEROZOIC OR UPPER ARCHEAN

- mv, metavolcanic rock
- gn, granite, gneiss, and amphibolite



Vertical scale exaggerated 50x
Horizontal scale is same as map.

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 rockswas 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 Keweenawan 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. Keweenawan 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 (Opc, 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 to that vertical thicknesses are expanded 50 times compared to horizontal distances. The Paleozoic rocks are show 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 fines 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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