Alternative Water Source Evaluation

Part 1 - Preliminary Discussion of Water Source Availability and Alternatives

Village of Oswego, Illinois

January 13, 2022

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Village of Oswego, IL
Alternative Water Source Evaluation - Part 1

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LIST OF ABBREVIATIONS

avg	-	average
CDWM	-	Chicago Department of Water Management
CMAP	-	Chicago Metropolitan Agency for Planning
DWC	-	DuPage Water Commission
EPA	-	Environmental Protection Agency
ft	-	feet
ft2	-	square feet
ft3	-	cubic feet
gpd	-	gallons per day
gpm	-	gallons per minute
IAWC	-	Illinois American Water Company
IDNR	-	Illinois Department of Natural Resources
IEPA	-	Illinois Environmental Protection Agency
ISWS	-	Illinois State Water Survey
max	-	maximum
MG	-	million gallons (or mil gal)
MGD	-	million gallons per day
mg/L	-	milligrams per liter (parts per million in dilute solutions)
min	-	minimum
PRV	-	pressure reducing valve
psi	-	pounds per square inch
WRT	-	Water Remediation Technology LLC

1. INTRODUCTION

Water scarcity presents a real and difficult challenge for communities to provide a sustainable supply of treated water. Though water shortages may appear temporary in cases such as a drought, the long term impacts on source water conditions are much more difficult to observe directly and may leave some communities more vulnerable to the need for a long term change in their primary source of water.

1.1 Alternative Water Source Evaluation Background and Purpose

The objective of the Alternative Water Source Evaluation (Study) is to update and align the previous source water analyses completed for the Fox River Option (Engineering Enterprise, Inc., 2017) and Lake Michigan Water via DuPage Water Commission Option (AECOM, 2018) with two new Lake Michigan Water alternatives: the proposed Joliet Water Commission Option and the Illinois American Water Option. The specific design recommendations from the previous Fox River and DWC studies have not been altered as part of this study.

The Village is partnering with the Village of Montgomery and United City of Yorkville to evaluate several alternative water supply sources. The Illinois State Water Survey has projected that these communities , even with Joliet leaving the aquifer, will be at severe risk of well depletion and unable to meet their continued population growth and water demands through 2050 and beyond. The alternatives evaluated in the Study are sized to meet the 2050 demands of Montgomery, Oswego, and Yorkville, with consideration given to the ultimate demand when the three communities are fully developed.

Several studies have been completed over the past decade to evaluate alternative water supply sources to replace the existing deep groundwater aquifer supply in the region. Two major alternative water supply sources have been identified to supply water to the three communities: the Fox River and Lake Michigan, which will be described in detail in later sections of this memo.

The key studies performed to assess these alternative water supply sources include:

- *Water Study* dated July 2014 by HR Green, Inc., which evaluated the needed water main improvements, water supply requirements, and a water source evaluation for the future expansion of Village of Oswego.

- *Sub-Regional Water Supply and Treatment Planning*, last updated January 2017 by Engineering Enterprises, Inc. (EEI), which evaluated the Fox River as a surface water alternative for the Village of Oswego, the Village of Montgomery, and the United City of Yorkville.

- *Feasibility Study to Receive Lake Michigan Water via the DuPage Water Commission* in October 2017 by AECOM Technical Services, Inc., which evaluated Lake Michigan water purchased through the DuPage Water Commission as an alternative for the Village of Oswego and the United City of Yorkville.

- *An Addendum to the Feasibility Study to Receive Lake Michigan Water via the DuPage Water Commission (Draft Report)* to include an assessment of the Village of Montgomery in addition to the Village of Oswego and the United City of Yorkville in September 2018 by AECOM Technical Services, Inc.

Part 1 of the Study (this report) provides the following:

- A summary of the existing water source in Montgomery, Oswego, and Yorkville,
- An analysis of population and water demand projections and water conservation efforts,
- A summary of Oswego's existing water system,
- The results of the Illinois State Water Survey analysis,
- An overview of the Fox River and Lake Michigan alternative water sources,
- A description of the comprehensive Study approach and next steps

Future parts of the Study will address the following:

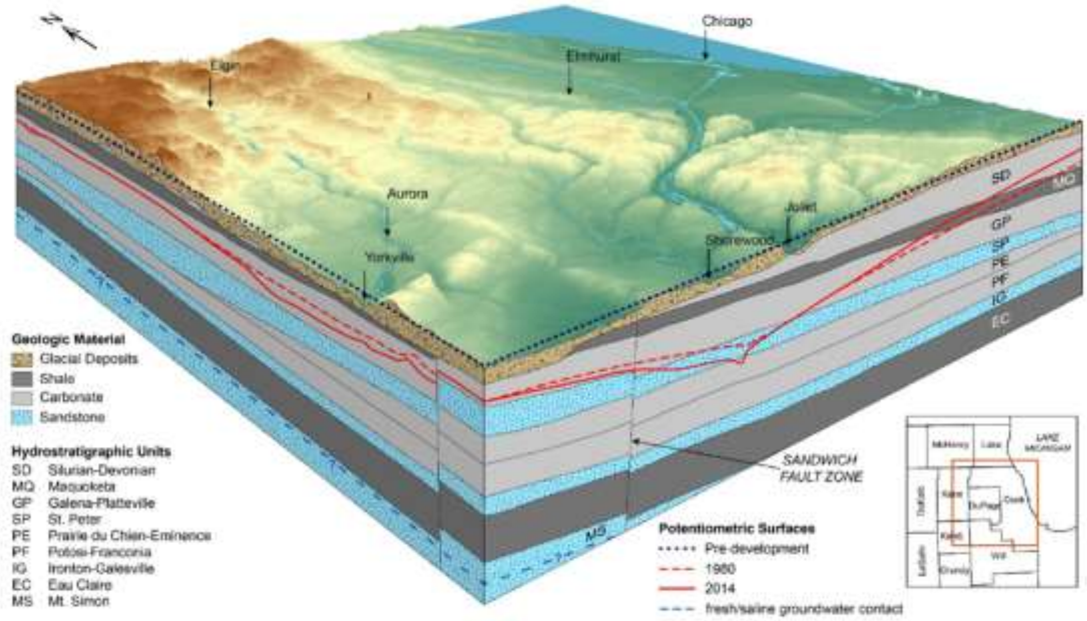
- An overview of the identified water source options,
- The key considerations used for evaluation,
- The internal system improvements necessary when changing water sources,
- Cost estimates and funding alternatives

1.2 Regional Water Source Background

Montgomery, Oswego, and Yorkville currently rely on the Ironton-Galesville aquifer for their primary source of water. Naturally occurring Radium-226 and Radium-228 are found in the Ironton-Galesville aquifer and is being treated and removed by the three communities. According to the Illinois Stater Water Survey (ISWS), the deep sandstone aquifer is being pumped beyond its sustainable yield and water levels in the aquifer are dropping, putting many supply wells in the area at risk. The aquifer is projected to be at severe risk of depletion and may no longer able to meet the regional maximum day water demands in the near future.

FIGURE 1

Changing Groundwater Levels in the Sandstone Aquifers of Northern Illinois and Southern Wisconsin (ISWS, 2015)



Many other communities in the area utilize the deep sandstone aquifer and are evaluating their water supply sources. The City of Joliet has decided to abandon the use of the deep sandstone aquifer due to the lack of long term sustainability and has selected a new Lake Michigan Water supply via the City of Chicago.

Montgomery, Oswego, and Yorkville have been diligent in evaluating and planning for the long term water supply for their residents. The three communities are partnering to evaluate several water supply source alternatives in an effort to develop a regional solution.

The Village of Montgomery's potable water supply system consists of nine wells from the deep sandstone and shallow sand and gravel aquifers. Montgomery has two cation exchange water treatment plants for softening and radium removal and a lime softening treatment plant for softening and radium removal.

The Village of Oswego's potable water supply system consists of eight deep sandstone wells with Water Remediation Technology (WRT) treatment at each well for radium removal.

The United City of Yorkville's potable water supply system consists of four deep sandstone wells with three cation exchange water treatment plants for softening and radium removal.

2. POPULATION AND WATER DEMAND

2.1 Water Demand Overview

Water consumption in communities is strongly correlated to population. When reliable population forecasts are combined with historical water consumption data, it is possible to reasonably plan for future water demands and recommend facilities to meet those needs. While population projections are never 100% accurate, they do provide for a sound basis on which to estimate and quantify future water supply needs and trends. Several water use parameters are detailed in this study:

- Average day demand - calculated by dividing the total yearly water pumpage divided by the number of days in the year.

- Maximum day demands - highest recorded total pumpage over a 24-hour period in a given year. The historical data is reviewed with Village staff to remove erroneous data. Water systems must be sized to meet maximum day demands.

- Maximum day demand to average day demand (MDD:ADD) ratio - calculated ratio used to compare supply, treatment, and storage requirements to normal demands. This value should be minimized as much as possible to reduce excess capacity requirements. This ratio is influenced by factors such as seasonal water use (irrigation, construction activities, etc.) and customer-base (residential, commercial, industrial, etc.).

- Average per capita demand - calculated by dividing the average day pumpage by the estimated population for the year. Established residential communities with strict conservation practices observe lower per capita demands than communities with a significant industrial or commercial customer-base.

2.2 Water Demand Projections

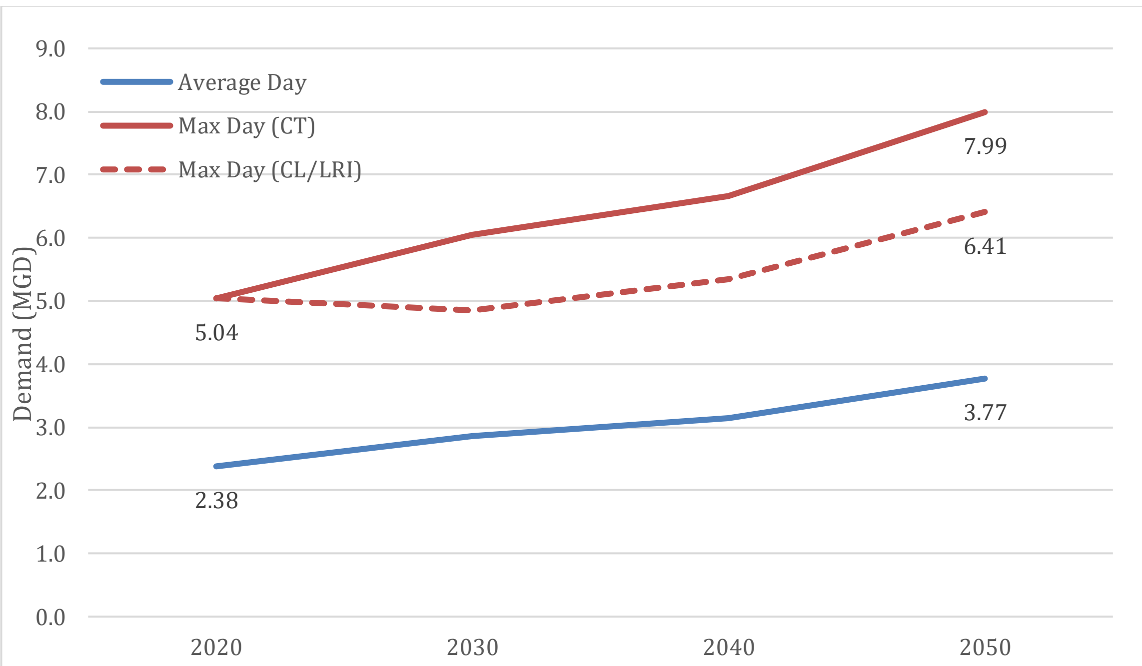
Historical water use records (January 2015 through December 2020) from Montgomery, Oswego, and Yorkville were analyzed to establish current water use trends. Two demand scenarios were developed to project water demands to 2050. The Current Trends (CT) scenario assumes that per capita water demand trends remain constant through 2050. The Contractual Limit/Less Resource Intensive (CL/LRI) scenario reflects the general downward trend in per capita water consumption in the region and contractual limitations on the MDD:ADD ratio, a common requirement of Lake Michigan water suppliers.

In 2018, Chicago Metropolitan Agency for Planning (CMAP) released its ON TO 2050 Comprehensive Plan providing detailed growth projections for Illinois communities through 2050, which provides reasonable growth and development projections. It is difficult to accurately project growth and development beyond a 30-year planning period. In order to accommodate potential long term growth, typical engineering practice is to size facilities with more conservative factors that can provide capacity for increased demand.

According to ON TO 2050, Oswego's population is estimated to reach 53,853 in 2050. These population projections were used to project water demands to 2050. The water demand projections for Oswego and combined water demands for Montgomery, Oswego, and Yorkville are shown in Figure 2 and Figure 3, respectively.

FIGURE 2

Oswego Population and Water Demand Projections

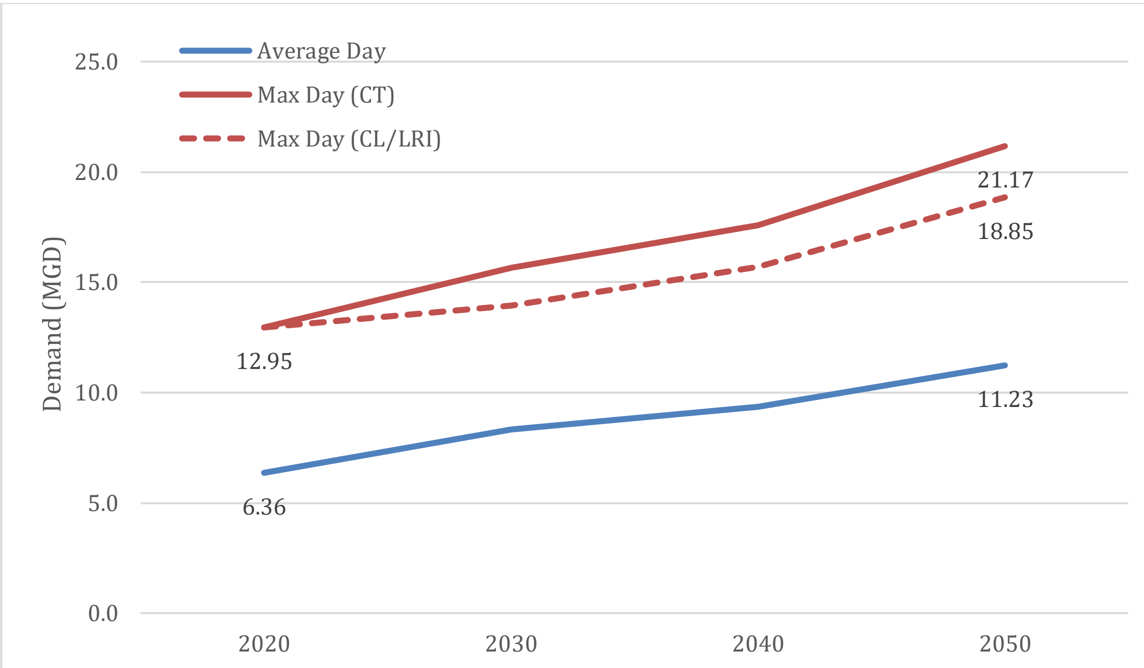


The combined water demands for the three communities are expected to increase by more than 75% by 2050. This poses a significant risk to the reliability of the deep sandstone aquifer that is used by Montgomery, Oswego, and Yorkville and many other neighboring communities.

As described above, the Current Trends projection assumes that water use trends remain the same throughout the planning period, while the Contractual Limit/LRI projection assumes the implementation of water conservation practices. Figures 2 and 3 demonstrates the impact of water conservation on the maximum day demand. For Oswego alone, the difference between the CT and CL/LRI projections is 1.58 MGD, a difference of just over 20%. For the three communities combined, the maximum day demand is reduced by 2.32 MGD under the CL/LRI scenario. The benefits and applications of water conservation are detailed in the following section.

FIGURE 3

Montgomery, Oswego, and Yorkville Water Demand Projections



2.3 Oswego Water Conservation Trends

Water is an essential and finite resource and water use demands are impacted by climate, population growth, and development growth. Conservation of this valuable resource is critical to ensuring water availability for regional prosperity and economic development. Acting as good water stewards creates long term cost savings for the Village and its residents.

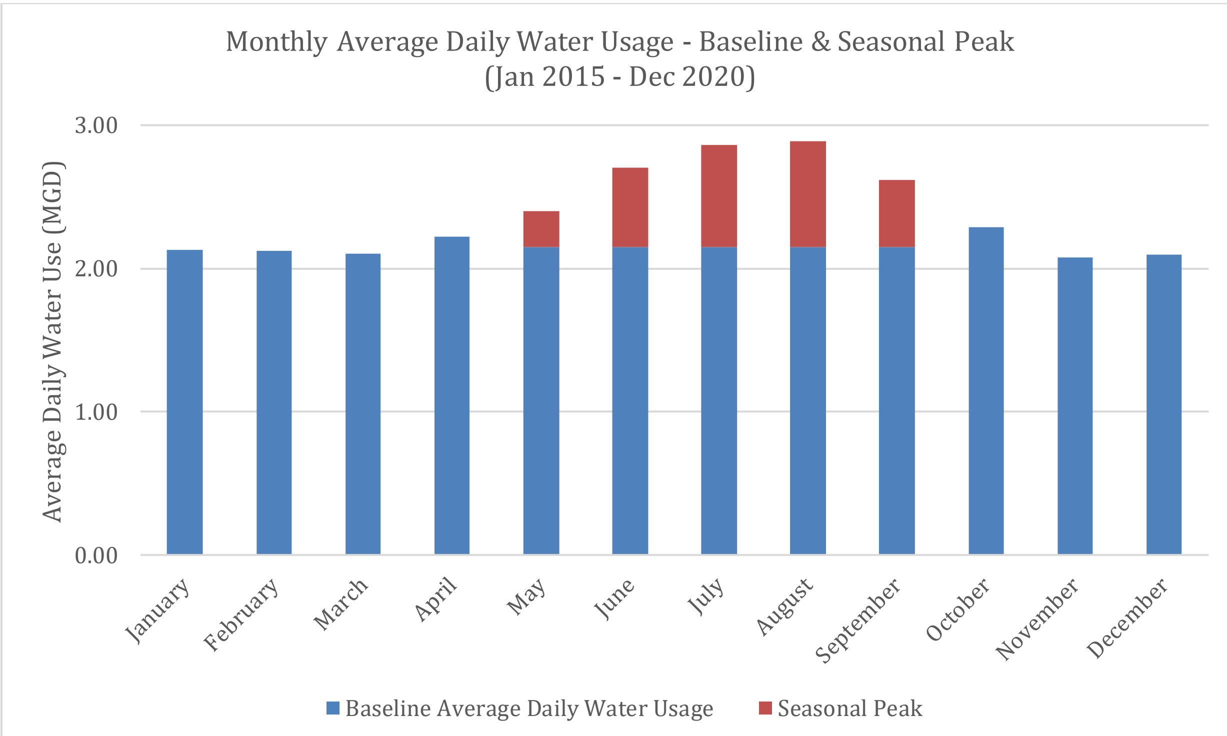
Simply put, using less water can reduce residential water bills. A substantial portion of the Village's existing customer base is residential. Conservation programs that specifically address residential water use include incentive programs for efficient plumbing and appliances, education on sustainable water use, and landscaping/irrigation restrictions. Plumbing and appliance incentive programs may not have a significant impact in Oswego, as a large portion of the Village was developed within the last 30 years and was likely constructed with efficient plumbing.

Water usage trends were analyzed to develop an understanding of the Village's baseline water usage, as shown in Figure 4. Based on the historical water usage for 2015-2020, Oswego's baseline water usage was calculated at 2.15 MGD. Conservation practices used to reduce baseline usage include high efficiency plumbing and appliances and public education.

Peak season water usage is the increased demand during warmer months when more water is being used due to landscaping, irrigation, and seasonal construction water use. Oswego's average daily demands increase by up to 0.75 MGD over the baseline water usage during this seasonal peak, accounting for nearly 10% of usage. Conservation practices that address seasonal peak demands include the implementation and enforcement of even/odd lawn sprinkling requirements and restriction of laying new sod or lawn seeding.

FIGURE 4

Oswego Baseline and Seasonal Peak Water Usage



Conservation of water may allow Oswego to defer costly capital improvements like a new well, which will be needed in the near-term to meet increasing water demands. Section 4 details the Oswego's potential need for a new well. Conservation practices may be able to defer improvements in the short term but with the Oswego's growth projections, conservation alone will not be enough to address the Oswego's need for an alternative water source.

3. OSWEGO EXISTING WATER SYSTEM

3.1 Oswego Water System

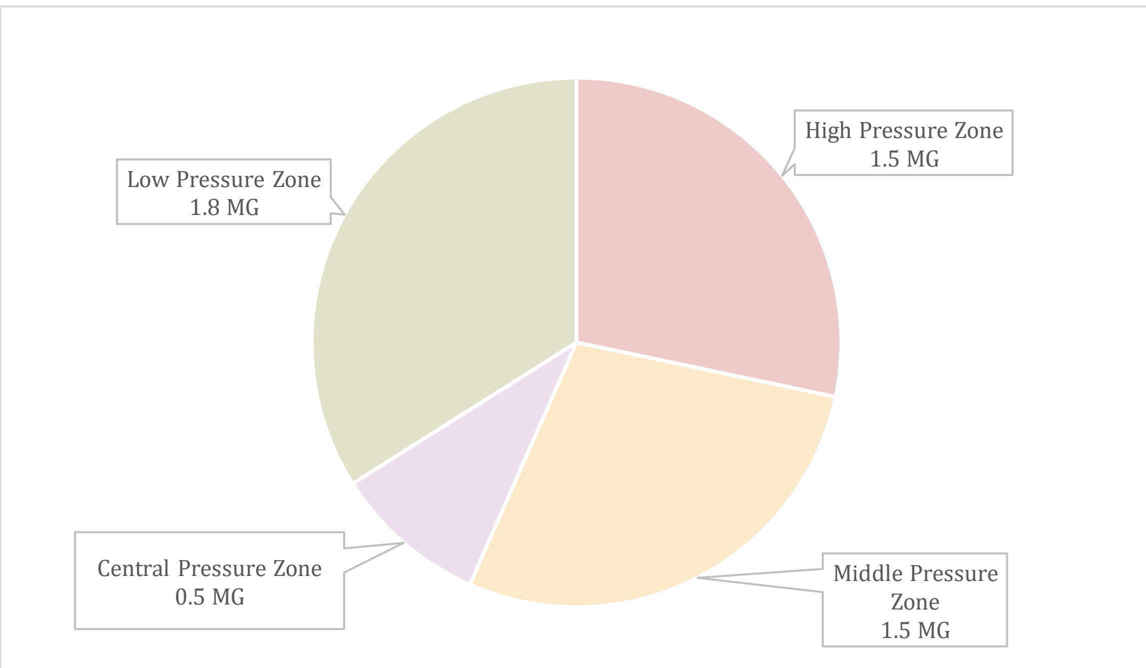
Oswego's water system consists of eight deep wells and five elevated storage tanks that are separated into four hydraulic pressure zones. Oswego has eight water treatment plants, located at each of the well sites, to treat the raw water for radium removal and leases radium selective ion exchange treatment vessels from Water Remediation LLC. The WRT plants do not soften the water. A map of Oswego's existing system is included as Exhibit A.

The High Pressure Zone is on the east side of the Oswego and includes two wells and one elevated storage tank. The Middle Pressure Zone is the largest zone, and includes three wells and one elevated storage tank. The Central Pressure Zone is the smallest zone in the center of Oswego and includes one well and one elevated storage tank. The Low Pressure Zone is on the west side of the Fox River and includes two wells and two elevated storage tanks.

A summary of the Oswego's water storage tanks in million gallons (MG) is included as Figure 5.

FIGURE 5

Oswego Storage Volume by Zone



The system's typical operations allow for water to be transferred across the pressure zones on the east side of the Fox River. A hydraulic profile of the system representing the four pressure zones is included as Exhibit B.

4. ILLINOIS STATE WATER SURVEY ANALYSIS

4.1 ISWS Studies

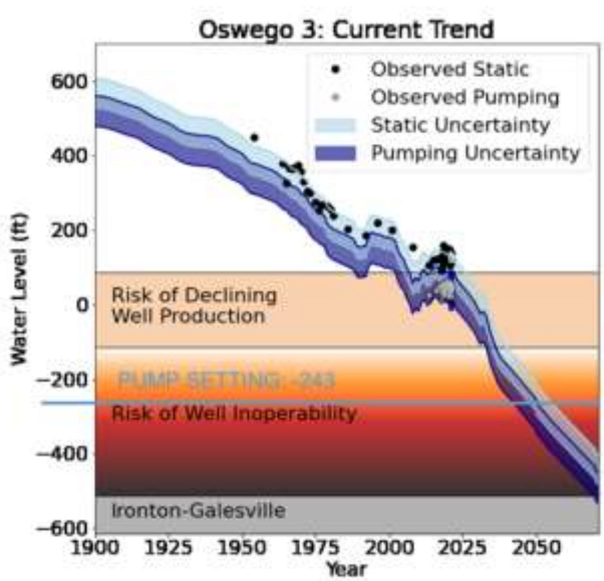
The ISWS conducted a survey of wells that withdrew water from the Cambrian-Ordovician Sandstone aquifer system near Southern Wisconsin and Illinois in 2014-2015. The survey was intended to track the changes in the groundwater levels and impacts on the available water supply. The study included a localized analysis of the Kane, Kendall, and Will County areas, which includes the Montgomery, Oswego, and Yorkville as well as several other neighboring communities that rely on the sandstone aquifer in the area. The results of the ISWS study are summarized in the "Changing Groundwater Levels in the Sandstone Aquifers of Northern Illinois and Southern Wisconsin: Impacts on Available Water Supply" Report published by the ISWS. Although no definitive date can be calculated to determine the finite limitations of the aquifer withdrawal, a range was estimated of remaining time left before the aquifer is no longer able to supply the dependent communities with water.

4.2 Oswego ISWS Analysis

As part of the Study, the Village of Oswego contracted the Illinois State Water Survey to perform an updated model analysis based on the most recent and available data from the Montgomery, Oswego, and Yorkville. The ISWS produced a letter report titled "Oswego, IL: Sandstone Water Supply Summary" dated March 2021, attached as Appendix A. Hydrographs plot the observed water level over time and are used to compare risk thresholds. The hydrograph for Well 3 is included as Figure 6 and hydrographs for each well are included as Appendix B.

FIGURE 6

Well 3 ISWS Hydrograph (March 2021)



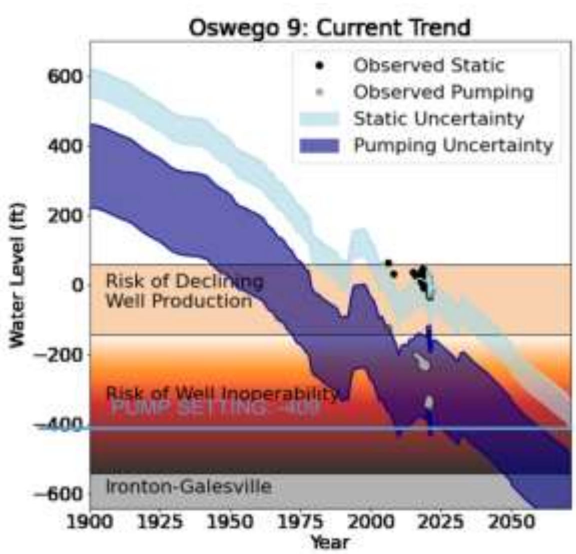
The static water level shows the level of water in the well under non-pumping conditions. Static water levels can be influenced by the pumping of nearby wells and climate conditions. Pumping water level shows the level of water in the well while it is pumping. These levels are recorded over time to identify trends and observe how the aquifer reacts to climate change and development. Well 3 was constructed in 1957 and ISWS records show a clear decline in static water levels over the last 70 years.

The pump setting was added to the ISWS hydrographs to show the depth of the well pump. The Village monitors the distance between the pumping water level and pump setting for each well because pump performance is affected as the pumping water level approaches the pump setting level. As pumping water levels drop, the Village must consider lowering the pump setting depths at significant cost in order to continue using the wells.

Under existing operations, all of Oswego's wells are observing pumping levels within the range of Risk of Declining Well Production, as illustrated in the hydrographs. Declining Well Production is generally identified as a decreasing ability to reliably pump water. Wells operating in this range may experience increased sand or grit collection, requiring additional maintenance and repairs that may take them out of service more frequently.

FIGURE 7

Well 9 ISWS Hydrograph (March 2021)



The ISWS report also identifies a more severe Risk of Well Inoperability that generally indicates insufficient well capacity to meet water demand. As shown in Figure 7, Oswego's Well 9, constructed in 2004, currently observes pumping water levels within the range of Risk of Well Inoperability. As water levels at Well 9 continue to drop, the well will produce less water and will eventually become inoperable.

The ISWS report states "Oswego's sandstone withdrawals are not sustainable. Future water level declines pose a risk to Oswego's sandstone water supply, and the community will eventually require a new water supply source."

5. ALTERNATIVE WATER SOURCES

More than 1,300 communities in Illinois rely on different water sources, including groundwater, surface water such as rivers, reservoirs, and lakes, or a combination of sources. A map displaying community water sources throughout the state is included as Appendix C. As mentioned in Section 1, the Fox River and Lake Michigan were identified as possible water source alternatives for Montgomery, Oswego, and Yorkville. While both alternatives are surface water, there are significant differences in the operations and maintenance requirements, agency permitting, governance structures, and implementation timelines between them.

5.1 Fox River

The Fox River flows from Wisconsin through northeastern Illinois and joins the Illinois River at Ottawa. The Fox River drains 938 square miles in Wisconsin, and 1720 square miles in Illinois. The main stem of the Fox River and the Chain of Lakes region are used for recreation and provide aesthetic attractions. The Fox River is used as a source of potable water for public water supply for the City of Elgin and the City of Aurora. Both communities use a combination of water from the Fox River and wells. The Fox River and its tributaries carry storm water and are the receptors of effluents from numerous wastewater treatment plants. Rain and snow melt from urban areas can carry pollutants like lawn fertilizer and weed killer, vehicle fluids, winter road salt, pet waste, and chemicals that are illegally dumped into drains out to the Fox River. The Illinois EPA has played a significant role in improving the Fox River Water quality by placing regulations on dischargers. The raw river water has a hardness ranging from 260 to 400 milligrams per liter (15 to 24 grains per gallon) and requires filtration, softening, and disinfection.

The Fox River was identified as a sustainable water source to supply water to Montgomery, Oswego, and Yorkville. An intake in the Fox River would deliver water to a new water treatment plant then treated water could be distributed to each of the communities through a series of transmission mains. Montgomery, Oswego, and Yorkville would be jointly responsible for the treatment, operations, and maintenance of the water source and water supply infrastructure.

Generally, the Illinois Department of Natural Resource (IDNR) governs the flow withdrawal of the Fox River whereas the IEPA governs the water quality of the Fox River.

As detailed in the 2016 EEI report, the ISWS has conducted water modeling for the Fox River and has determined the river to be a sustainable water source. However, there may be times when withdrawals from the Fox River are restricted due to poor water quality or times of drought. During these times, the communities would need to rely on water produced from the network of backup wells. The 2016 EEI study recommended a network of 11 backup wells: four existing wells from Oswego, and two existing wells and one additional well each from Montgomery and Yorkville.

The IEPA does not currently have exact rules or procedures that govern the permitting process of a new Fox River water treatment plant. Any municipality's interest in the construction of new surface water plants must undergo a detailed case review by the IEPA for water quality data and testing, and would be subject to continuous process and dialogue with the agency. One year of monitoring and sampling is believed to be sufficient for most contaminants.

The proposed water source intake for a new Fox River Water Treatment Plant is located approximately two miles downstream from the Fox Metro Water Reclamation district's outfall. The IEPA noted that there are no rules that require a set distance from the Fox Metro outfall.

It is projected that a Fox River water source and regional water treatment plant could be available and online in approximately nine to 11 years. As noted above, Oswego's current wells will not be able to meet the maximum day demands by 2030. If the Fox River is selected as the Village's new water source, an additional well will likely be required prior to the Fox River source coming online.

5.2 Lake Michigan

The Lake Michigan watershed covers 45,600 square miles in Wisconsin, Michigan, and Illinois. While Illinois only accounts for 100 square miles of the Lake Michigan watershed, nearly 6.6 million Illinois residents receive Lake Michigan water.

Lake Michigan has been an important source of drinking water for Chicago-area residents since the mid-1800s. At that time, sewage discharged directly to the Chicago River, which flowed into Lake Michigan. As the City grew and the river became more polluted, contamination of the lake water supply caused repeated outbreaks of cholera and typhus in Chicago. In response, the water intake point was moved farther out into the lake, which did improve drinking water quality for a time. At that point, the Sanitary District of Chicago began a project to reverse the flow of the Chicago River so that instead of flowing into Lake Michigan, it would flow away from the lake toward the Mississippi River system, carrying sewage away from Chicago's water supply. This project, completed in January 1900, necessitated a diversion of water from Lake Michigan.

Legal action over Chicago's diversion from Lake Michigan culminated in a 1967 Supreme Court Decree, which limited the Illinois diversion to not exceed 3,200 cubic feet per second (cfs) – the equivalent of 2,068 million gallons per day (mgd) – over a 40-year averaging period. The Decree further indicated that to increase its diversion Illinois would have to demonstrate that all reasonable and foreseeable water conservation practices were in place.

Illinois' diversion consists of three major components: domestic pumpage from Lake Michigan used for potable water supply and not returned to the lake; storm water from the 673 square mile diverted Lake Michigan watershed; and the direct diversion of Lake Michigan water into the Chicago Sanitary and Ship Canal (CSSC). The IDNR administers water allocation permits to manage the domestic pumpage portion of the state's diversion. If a Lake Michigan option is selected, the Village of Oswego will need to apply for a Lake Michigan water allocation.

As described in Section 4, the regional deep sandstone aquifer has been slowly depleted over the last century. One of IDNR's methods to reduce the over-pumping and prevent eventual depletion of the deep aquifer is to give preference when granting allocations to communities who would otherwise use deep well water.

The IDNR administers the Lake Michigan allocation process in the state of Illinois. Allocation permit applications are submitted to IDNR, which then reviews the application and holds a public allocation hearing for each applicant. After review of the permit application, the IDNR determines anticipated water needs for each applicant based on the following criteria:

- Current and projected population; current and projected per capita consumption,
- The nature and extent of industrial uses; municipal and hydrant uses, and
- Implementation of conservation practices; and non-revenue water flows (required to be 10% or less of net annual pumpage)

Water utilities that do not comply with the non-revenue water standard are required to submit a water system improvement and/or compliance plan with the goal of meeting the 10% non-revenue water goal. The Village of Oswego's non-revenue water was calculated as part of this Study and found to be at 11% using 2019 data. At 11% non-revenue water, the Village of Oswego is right on the cusp of compliance with IDNR, and it is expected that minor operational modifications can be made to meet the compliance requirement.

IDNR also determines the duration of each allocation permit (typical permit duration is 20 years). Compliance with Lake Michigan allocation requirements is reviewed annually by IDNR. The conditions of an allocation permit can be modified if a permittee demonstrates a substantial change in circumstances resulting in a change in water needs.

Lake Michigan is considered a high quality surface water source. The reversal of the Chicago River's flow and the diversion of storm water runoff away from the lake in the Chicago area have significantly reduced pollution of this water supply. Lake Michigan water does not contain detectable levels of radium or other radioactive elements, and has lower hardness, typically 140 milligrams per liter (approximately eight grains per gallon), which means that softening of any kind may not be necessary with this source.

Three options are being evaluated to bring Lake Michigan to Oswego, Montgomery, and Yorkville; all of which receive Lake Michigan water treated by the City of Chicago, either at Jardine Water Purification Plant or Eugene Sawyer Water Purification Plant. Both facilities use intake cribs approximately two miles off the shore of Lake Michigan. Treated water is distributed to Chicago and more than 120 surrounding suburbs, either directly from the City of Chicago or from other communities or public water distributors.

With any of the Lake Michigan options, Montgomery, Oswego, and Yorkville would be indirect customers and would not have control over the treatment of the water source nor the operations and maintenance of the water supply infrastructure.

The first Lake Michigan Water supply option is through the DuPage Water Commission (DWC), an existing commission that receives water from the City of Chicago and provides water to 27 wholesale customers. The second Lake Michigan Water Supply option is through the new Joliet Water Commission, a proposed commission that will receive water from the City of Chicago. The Joliet Water Commission is being formed over the course of 2021 and is targeting to come online in 2030. This option requires a commitment from Montgomery, Oswego, and Yorkville by the end of 2021. The third potential Lake Michigan Water Supply option is from Illinois American Water, a private water utility that receives water from Bedford Park. Bedford Park receives water from the City of Chicago.

The projected timelines for the Lake Michigan options range from four or five years (DWC Option and Illinois American Water Option) to nine years (Joliet Water Commission Option). As noted above, Oswego's current wells will not be able to meet the maximum day demands by 2030. If the Joliet Water Commission Option is selected as the Village's new water source, an additional well will likely be required prior to the Joliet Water Commission coming online.

6. STUDY APPROACH AND NEXT STEPS

6.1 Study Approach

The purpose of the Alternative Water Source Evaluation Study is to update and align the previous analyses completed for the Fox River Option and Lake Michigan Water via DuPage Water Commission Option with two new Lake Michigan Water alternatives: the Joliet Water Commission Option and the Illinois American Water Option. Future parts of this Study will detail the four water source options, key considerations, internal system improvements, and estimated costs.

As mentioned in Section 1.1, the specific design recommendations from the previous Fox River and DWC studies have not been altered as part of this study. The sizing and locations of water supply facilities and pipe routes have been kept constant but the approach for evaluating and developing cost estimates has been updated to provide a uniform comparison between the alternatives. The following key considerations will be used to evaluate the four water source alternatives:

- Sustainability of Water Source – The water source alternative must have sufficient water quantity to supply Montgomery, Oswego, and Yorkville to 2050 and beyond. The evaluation includes the source's redundancy and backup well requirements.

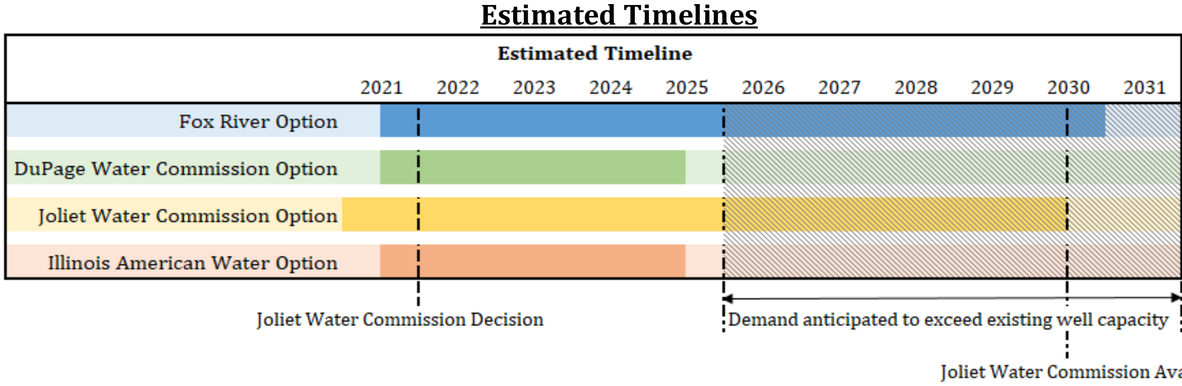
- Water Quality and Permitting – Water quality parameters, operator licensing and agency permitting requirements, and seasonal variability of the water source.

- Governance and Operational Responsibility – The ability of Montgomery, Oswego, and Yorkville to maintain control of elements of the water source, including involvement in decision-making, and operations and maintenance.

- Timeline – Estimates of the total project schedule, including design, permitting, easement acquisition, contract negotiations, and construction each alternative. A comparison of project timelines is included as Figure 8.

FIGURE 8

Estimated Timelines



6.2 Next Steps

Future parts of this Study will detail the four water source options and key considerations, internal system improvements, and estimated costs. One of the major next steps will be to finalize and present each of the alternatives. The Study will include a summary of the key considerations for the Board's review and consideration.

Recommendations and cost estimates for required internal system improvements will be finalized for the four water source options. Estimates will be finalized for each option to compare the expected operations and maintenance costs of each option. In addition to cost estimates, the Study will identify sources of funding including the Water Infrastructure Finance Investment Act (WIFIA), IEPA State Revolving Fund (SRF), and revenue bonds. Conservation ordinances, schedules for permits, and state legislative initiatives are under review.

To align the previously studied Fox River Option and DWC Option with the two new alternatives, the cost estimates from the original studies were reviewed and inflated to 2021 dollars. While design recommendations were not changed, the previous costs for transmission mains were adapted into per foot unit costs and evaluated using a Corridor Classification methodology. Six classifications were developed to represent the various construction scenarios expected along the routes. The corridor classifications consider the cost impacts of pipe material, method of construction and restoration, utility conflicts, and easements.

A public information meeting will be held this summer and feedback from the Board and public will be incorporated before finalizing the Study.

6.3 Part 1 Conclusion

Part 1 of the Study established the existing regional water source limitations and risk of well depletion. Without the selection of a new water source, the three communities will be unable to meet their continued population growth and water demands through 2050 and beyond according to studies by ISWS. There are two viable alternative water sources available for a regional solution for Montgomery, Oswego, and Yorkville: the Fox River and Lake Michigan. Now is the time to evaluate and select a long term water source alternative to provide reliable, safe drinking water for the future of Montgomery, Oswego, and Yorkville.

APPENDICES

APPENDIX A

BAXTER & WOODMAN
Consulting Engineers

Oswego, IL: Sandstone Water Supply Summary

Cecilia Cullen and Daniel Abrams, Illinois State Water Survey

5/25/2021

Risk to Oswego's deep Sandstone Water Supply

Oswego, Montgomery, and Yorkville (OSMOYO) are, like many communities in northeast Illinois, evaluating their water supply source in anticipation of the growth, challenges, and climate of the twenty-first century. These communities have contracted the Illinois State Water Survey (ISWS) to evaluate local risk to the deep sandstone aquifer. ISWS evaluations are based on a groundwater model calibrated to historic water levels. This model has been in development for years and has been used to simulate risk to the same sandstone aquifer in Will County[1]. **The updated scientific modeling indicates that in all scenarios provided here, the sandstone aquifer will no longer be a reliable source of water for Oswego within a few decades.**

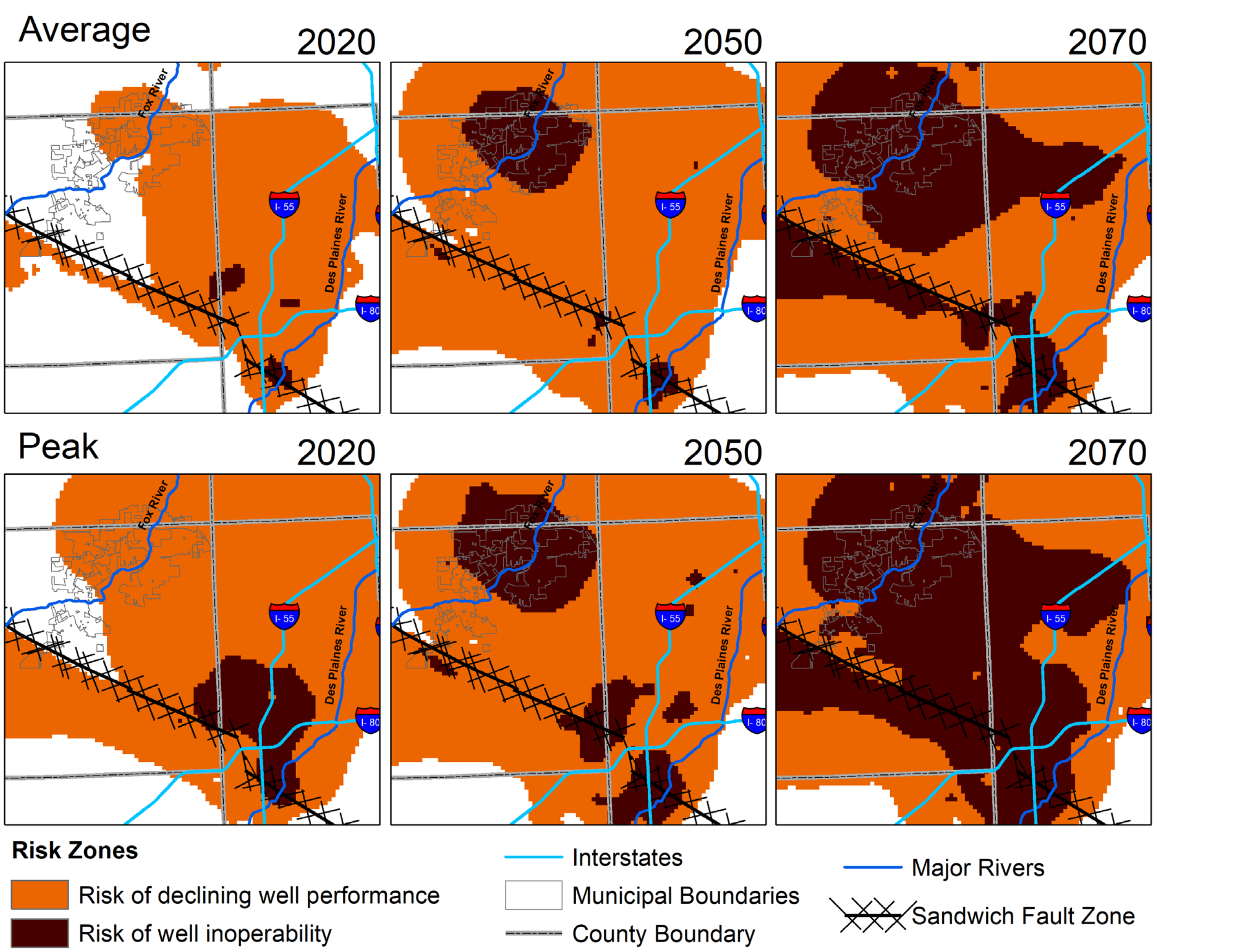


Figure 1. Risk associated with average and peak conditions in the deep sandstone aquifer in the OSMOYO area. The maps depict Current Trend scenario for the following years: 2020, 2050, and 2070.

Discussion of the Maps

The maps in Figure 1 show where sandstone water supply risk is currently present and where it will grow in the future under the Current Trend scenario, under both average and peak pumping conditions *. Wells located in the orange zone are at-risk of declining performance as water levels fall. Every OSMOYO community with active sandstone wells reaches this category by the year 2030. Additionally, most OSMOYO community supply wells reach the severe risk zone, where wells are at severe risk of being unable to meet demands and becoming inoperable. **The model simulation indicates large areas of the OSMOYO region will experience this risk by 2050. This is true for both average and peak pumping conditions.**

* The Current Trend scenario for the OSMOYO region is on based data provided to ISWS modelers by Environmental Engineering Enterprises and Baxter & Woodman consultants.

Water levels at Well 7 and Well 9: Current Trend

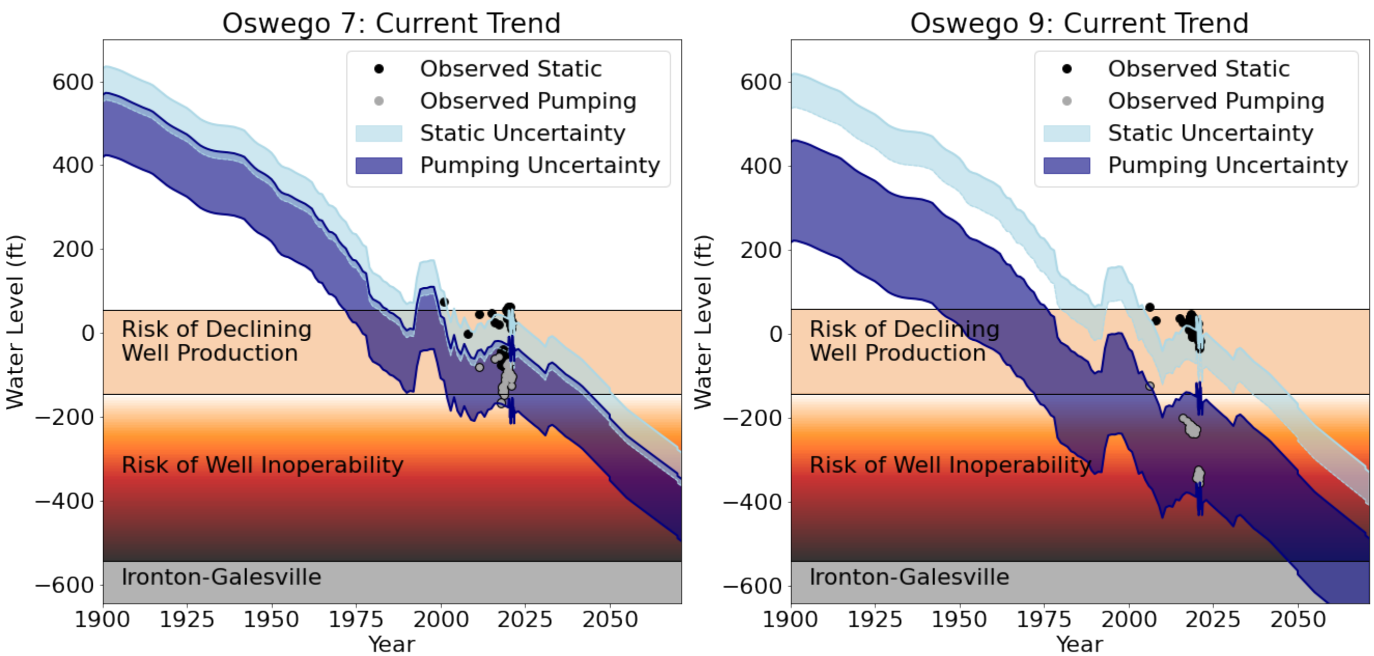


Figure 2. Hydrographs for Oswego 7 (left) and Oswego 9 (right). Under the Current Trend scenario, water levels in Oswego will continue to decline and be at-risk of well inoperability. The uncertainty of static and pumping water levels is highlighted in light blue and navy, respectively.

Hydrographs are used to plot the water level of a well through time and compare to risk thresholds, shown in Figure 2. Because uncertainty accompanies projecting static and pumping water levels, we represent the possible range of future water levels in the hydrographs with highlighted bands based on observed data. The light blue band represents the static, or non-pumping, water level in the well; the upper bound of this light blue band represents average pumping conditions, while the lower bound represents peak pumping.

When the light blue band reaches the top of the orange risk zone, the well is at-risk of declining well performance. Oswego wells 7 and 9, shown in Figure 2, have already reached this threshold under average pumping conditions. Greater risk occurs when static water levels fall into the most severe risk zone. Under peak demands (the lower bound of the light blue band), water levels in both wells enter the well inoperability risk zone by 2041. It is important to note that all Oswego wells, in this model simulation and others, also exhibit severe risk before 2070 (Table 1).

Pumping water levels, shown by the navy band, are not used to explictly define risk but are included in the hydrographs for additional perspective. The upper bound of the navy band is determined by the minimum drawdown observed (and assumes no change in future specific capacity); this would be the equivalent of maintaining the current pumping distribution, frequently rehabilitating a well, and potentially even redrilling older wells to avoid loss in specific capacity. The lower bound is determined by the lowest observed pumping water level at each well and assumes a declining trend in specific capacity (minimal well rehabilitation) as determined by empirical data from wells in the region. Oswego wells show a range of offset between static and pumping levels, Oswego 4 in the attached hydrograph folder even has overlap between static and pumping. The deeper a pumping water level falls into the severe risk zone, the greater the risk of well inoperability. **Oswego's Public Works Department is to be commended for continually providing both static and pumping water level data to the ISWS; this information will be used to periodically reassess risk and improve the model.**

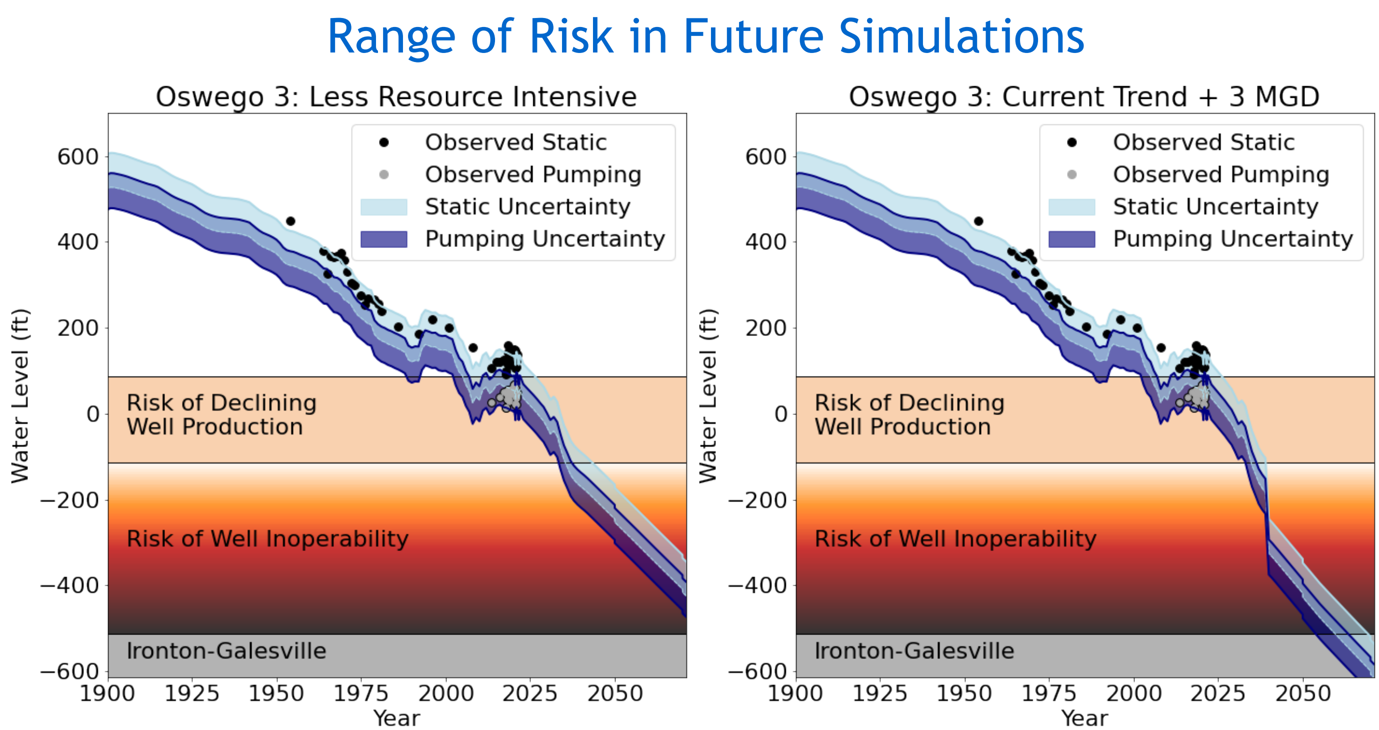


Figure 3. Hydrographs indicating the least severe (LRI) and most severe (CT+3 MGD) simulations for Oswego 3.

Because future water level simulations will vary with different amounts of water pumped, the ISWS evaluated a suite of model scenarios:

- LRI – *less resource intensive* scenario that simulates less average/maximum daily pumping than CT outside of OSMOYO, equal average pumping to CT in OSMOYO, equal maximum daily pumping to CT in Montgomery, and less maximum daily pumping demands in Oswego and Yorkville.
- CT – *current trend* scenario projects the current trend of growth out over the next fifty years. In Oswego the CT (peak) uses 1.44 MGD (million gallons per day) more water than the LRI (peak) in 2050.
- CT + 3 MGD – simulates the CT with a 3.0 MGD user added in 2039 near the community. This hypothetical new user is not anticipated, but rather is intended to demonstrate the sensitivity of the aquifer to new demands. This new user is 2.1 miles from Oswego 3, 1.7 miles from Oswego 4, 3.0 miles from Oswego 6, 3.1 miles from Oswego 7, 1.5 miles from Oswego 8, 2.6 miles from Oswego 9, 2.3 miles from Oswego 10, and 4.3 miles from Oswego 11.

The highest future water levels for Oswego 3 are associated with the LRI simulation, while the lowest future water levels are from the CT + 3 MGD scenario, shown in Figure 3. The simulated range in future water levels is caused by the uncertainty associated with future pumping in the OSMOYO area. However, both scenarios considered here reach the 'Risk of Well Inoperability' zone.

Risk Tables

*Table 1. Risk table for the model simulations representing **a) average conditions** and **b) peak conditions**.*

a)

	LRI		CT		CT + 1.5 MGD[a]		CT + 3 MGD[a]	
	Risk of declining production	*Risk of inoperability*	*Risk of declining production*	*Risk of inoperability*	*Risk of declining production*	*Risk of inoperability*	*Risk of declining production*	*Risk of inoperability*
3	2026	2043	2026	2039	2026	2039	2026	2039
4	2007	2045	2007	2041	2007	2039	2007	2039
6	2008	2044	2008	2040	2008	2039	2008	2039
7	2002	2058	2002	2051	2002	2045	2002	2039
8	2008	2049	2008	2045	2008	2039	2008	2039
9	2005	2052	2005	2047	2005	2039	2005	2039
10	2008	2052	2008	2047	2008	2040	2008	2039
11	2010	2045	2010	2042	2010	2039	2010	2039

b)

	LRI		CT		CT + 1.5 MGD[a]		CT + 3 MGD[a]	
	Risk of declining production	*Risk of inoperability*	*Risk of declining production*	*Risk of inoperability*	*Risk of declining production*	*Risk of inoperability*	*Risk of declining production*	*Risk of inoperability*
3	2006	2035	2006	2034	2006	2034	2006	2034
4	1990	2035	1990	2034	1990	2034	1990	2034
6	1990	2034	1990	2033	1990	2033	1990	2033
7	1982	2046	1982	2041	1982	2039	1982	2039
8	2004	2038	2004	2036	2004	2036	2004	2036
9	1980	2040	1980	2036	1980	2036	1980	2036
10	2006	2041	2006	2038	2006	2038	2006	2038
11	2006	2036	2006	2034	2006	2034	2006	2034

[a] Additional pumping is added in the year 2039.

[b] Indicates that water levels are close to the "Risk of well inoperability" zone and would likely enter that zone in the years following 2070.

The hydrographs presented previously are for the well with the most-severe risk as simulated in the models, but long-term planning should account for risk to all wells. The risk table (Table 1) presents when wells become at-risk in each of the model scenarios. As pumping increases, the length of time that Oswego can safely withdraw water from the sandstone shortens, but all wells under all scenarios are at risk of inoperability by 2058. Additionally, as one or more wells become at-risk, communities will need to consider the possibility of wells that fail to meet supply.

Oswego has eight wells over which pumping can be distributed. It is possible that a couple of wells can become inoperable before the village can no longer meet demand from the aquifer. As a result, a few questions should be asked when considering this risk table:

- Can the local water system withstand a well that temporarily cannot meet demands during peak pumping conditions?
- What wells can absorb the additional pumping of a failed well?
- How will redistributed pumping from failed wells exacerbate risk at operating wells?

Technical Discussion of Maps, Hydrographs, and Tables

Take-Home: As sandstone water levels decline, uncertainty is magnified. The small sample of wells with static water levels approaching the "Risk of Well Inoperability" zone have struggled to meet supply, particularly those in the hydrogeologically complex Sandwich Fault Zone.

The maps (Figure 1) and hydrographs (Figures 2 and 3) depict simulated water level conditions through time under the Current Trend scenario. The light blue band in Figures 2 and 3 represents the range of **static** levels—the water level in a well when the pump is off. When the pump is turned on, water levels generally fall an additional 200 to 400 ft for most high capacity wells in this region (**pumping** level) —represented by the navy band. The offset between the static and pumping levels in the hydrographs was based on observed measurements of those water levels. The model was adjusted until the simulated values matched observed static water levels (via a process known as calibration).

Another uncertainty in the model is the distribution of future pumping, complicated by the addition of possible not-yet-drilled community wells. Moving or shifting pumping would redistribute risk. While this would likely extend the life of the aquifer at one well, it could cost years of the estimated time left for another. We also removed multi-aquifer wells in southern Kane County based on historic trends extrapolated to the future, this results in an additional loss of water to the deep Ironton-Galesville. These well removals usually only affect water levels at nearby neighboring wells.

As both static and pumping levels approach the top of the Ironton-Galesville aquifer, a few issues have been observed. A predominent concern is that the most extreme drops in water levels when pumps are turned on occur in wells with the lowest static observations. The extreme depth of pumping may exacerbate this extreme drop in pumping water level. It is important to note that other issues can occur as water levels decline, including: 1) limits on pump settings (specifically, whether a pump can even be lowered into the Ironton-Galesville aquifer), 2) costs associated with lifting water over a greater distance, 3) the need to rehabilitate wells more frequently and aggressively, 4) the increased risk of pumping sand, 5) potential for caving the deeper sandstone formation, and 6) reduced production capacity of the well. **Continued water level monitoring by Oswego will help greatly to constrain some of this uncertainty.**

What do these results mean for Oswego's water supply?

Q1: Will Oswego's withdrawals ever be sustainable?

A: No. Withdrawals from the sandstone aquifer in the OSMOYO region have been unsustainable for over a century. Over the decades, the aquifer has slowly depleted and now many supply wells are threatened. If withdrawals continue to exceed sustainable supply, irreparable declines in water levels will occur, impacting the already limited timeline of availability for this water source.

Q2: How long can Oswego meet needed supply from the sandstone?

A: **Planning based on a time-horizon of available water from an aquifer is challenging due to how water levels are sensitive to minor changes in uncertain future demands.** Risk increases as demands increase, but for all scenarios simulated here, all Oswego wells have water levels dropping into the zone of severe risk for well inoperability. In the best-case scenario considered here, Oswego's first well enters this risk zone in 2043 for average pumping conditions and 2034 for peak pumping conditions. These results indicate the village of Oswego will eventually need an alternative primary supply of water.

Take Home:

Oswego's sandstone withdrawals are not sustainable. Future water level declines pose a risk to Oswego's sandstone water supply, and the community will eventually require a new water supply source.

Bottom Line: Uncharted Territory

Sandstone water levels in the OSMOYO region have never been as low as they are now. How further declines will manifest is difficult to say for certain, but the ISWS has observed that previously modeled time-ranges for the usable life of the region's deep sandstone aquifer appear to converge on the having a shorter amount of time left. In other words, as water levels decline, previously unforeseen complexities emerge that are disadvantageous for well productivity, and this is the real danger of water levels declining into "uncharted territory". As a result, it is critical not to immediately dismiss the model results as overly conservative. **It is imperative that monitoring and modeling continue as water levels decline into this uncharted territory over the next decade to improve our understanding of the uncertainty associated with these depths.**

References

[1]Abrams, Daniel B.; Cullen, Cecilia. 2020. Analysis of Risk to Sandstone Water Supply in the Southwest Suburbs of Chicago. Available at https://www.ideals.illinois.edu/handle/2142/109174

[2]Chicago Metropolitan Agency for Planning. 2018. 2050 Forecast of Population, Households, and Employment. Available at: https://www.cmap.illinois.gov/data/demographics/population-forecast

ACKNOWLEDGEMENTS:

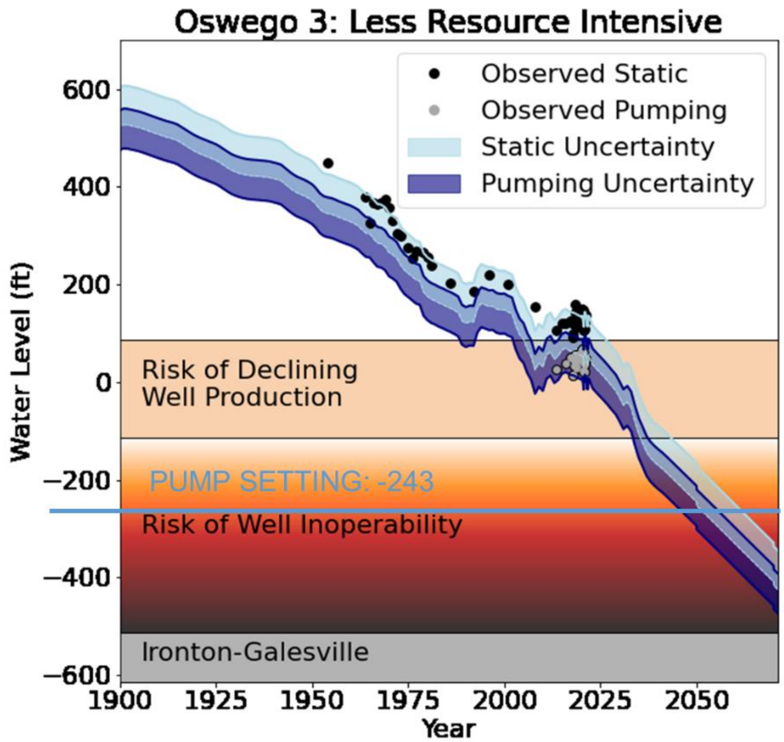
This analysis is a regional collaboration with local input, which is essential to understanding risk. We thank:

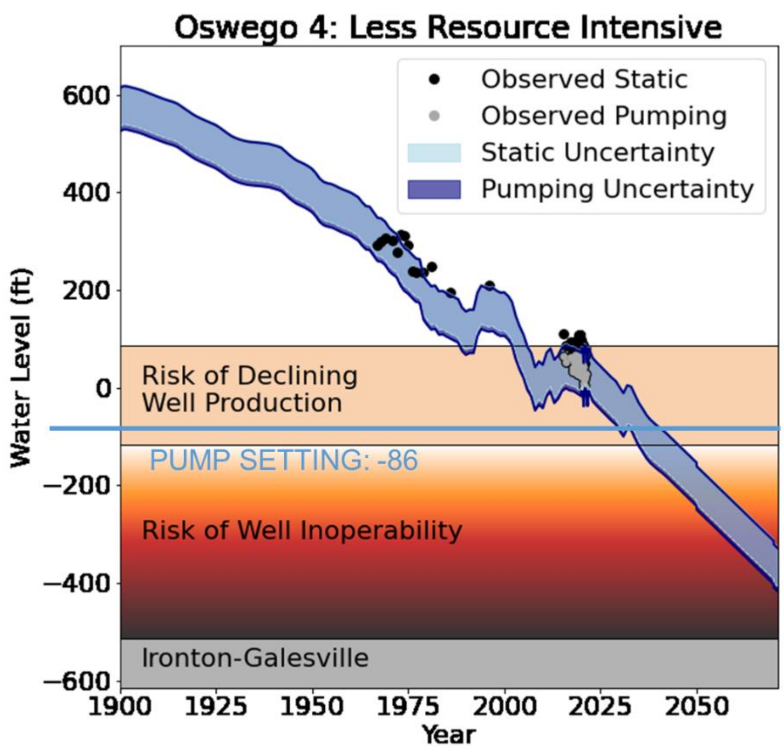
- Oswego, Yorkville, and Montgomery for collaborating in this study
- Water operators at Oswego and Montgomery for providing monthly water level data for over a two year period; this information is essential to conducting planning.
- Baxter & Woodman and Engineering Enterprises Inc for collaborating on future demands
- The Lower Des Plaines Watershed Group for providing future demands and insight into water supply in Will and Grundy Counties.

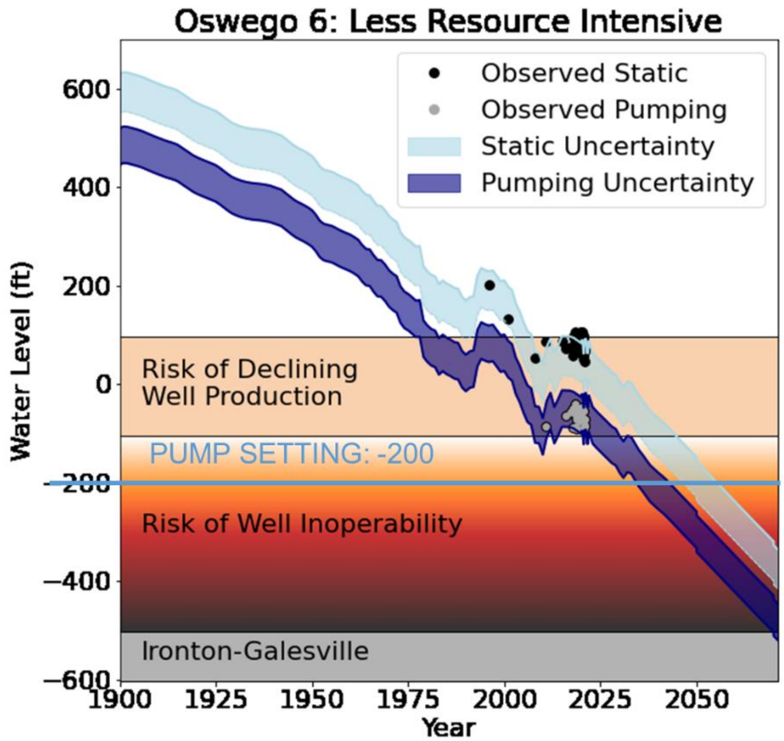
APPENDIX B

BAXTER & WOODMAN
Consulting Engineers

- Hydrographs from the Illinois State Water Survey (ISWS) report titled "Oswego, IL: Sandstone Water Supply Summary" dated May 2021.
- Well Pump Setting data provided by the Village of Oswego's Master Drawdown Sheet dated July 1, 2020.



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Pumping Uncertainty
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Risk of Declining
Well Production
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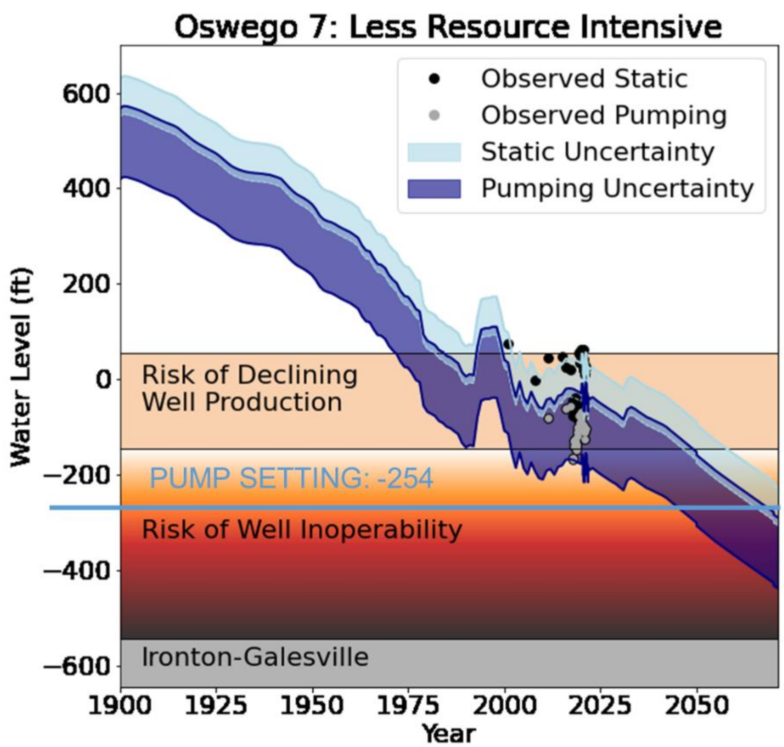
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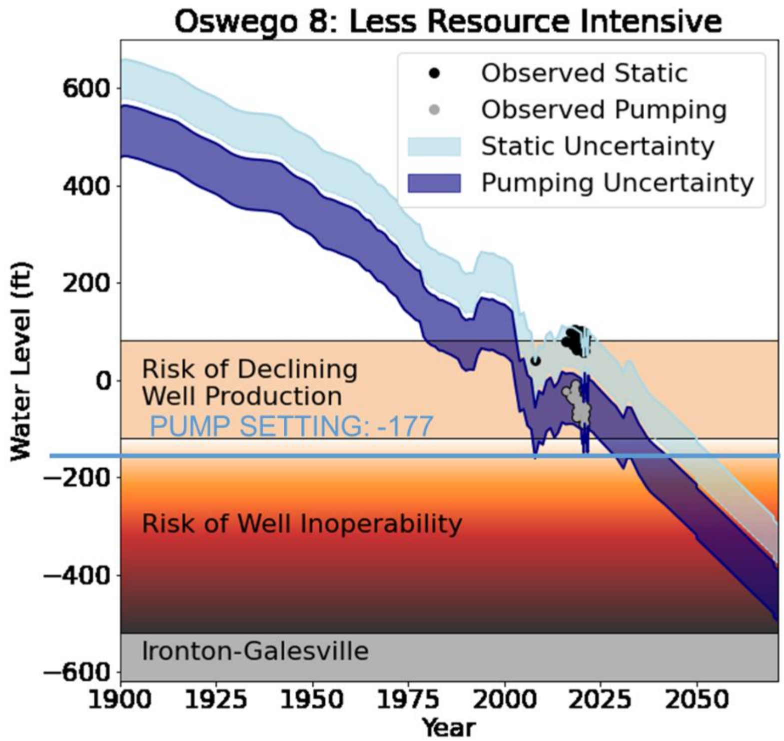
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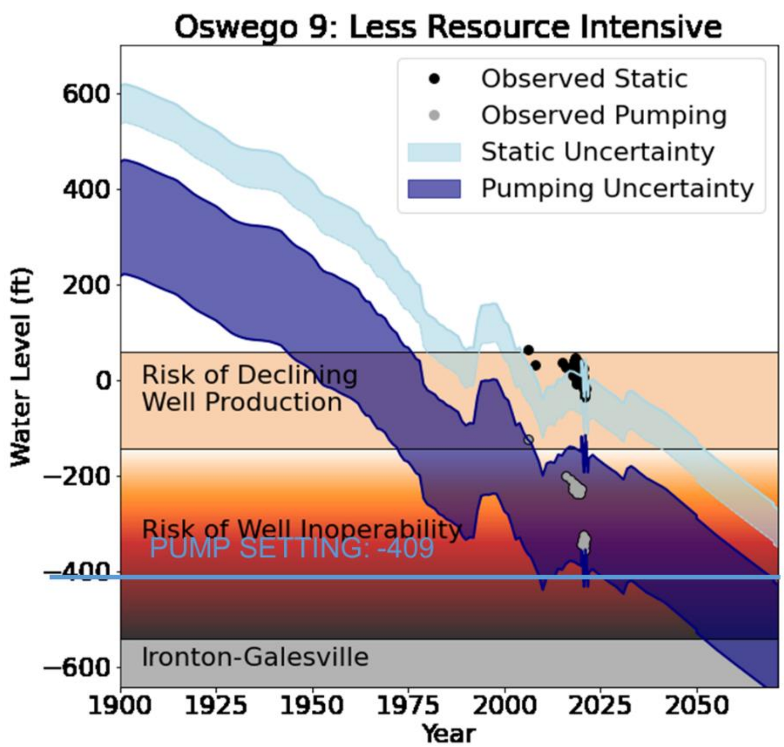
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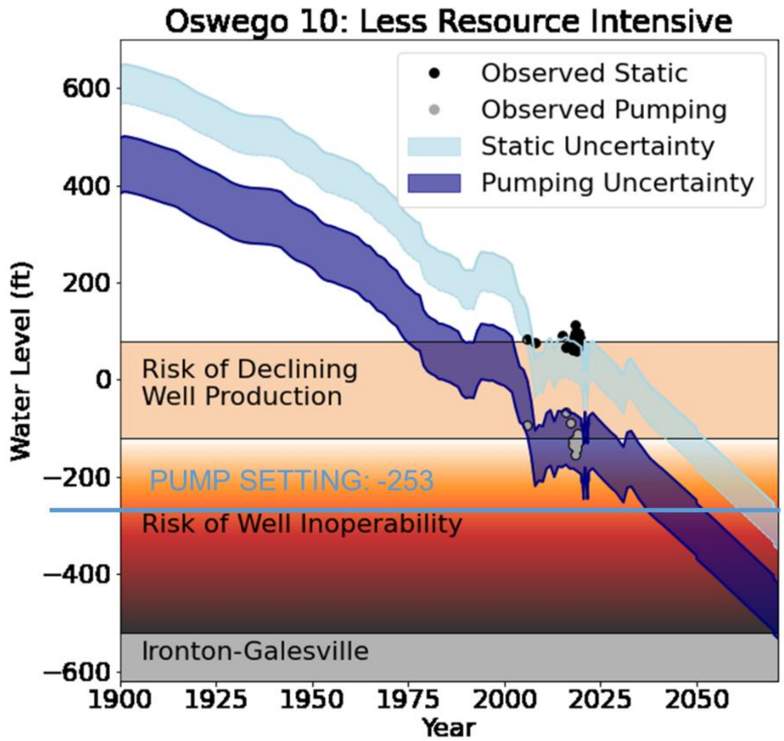
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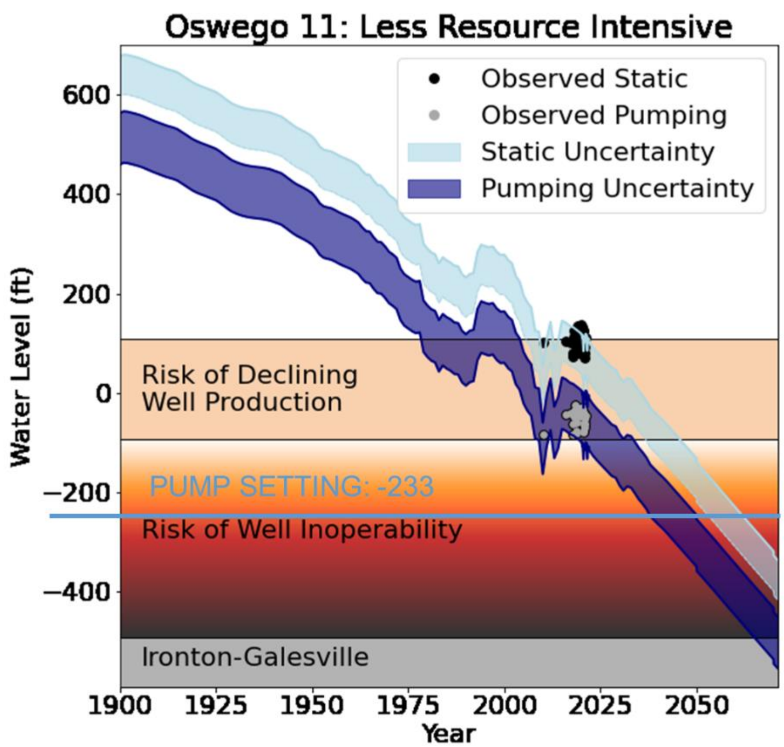
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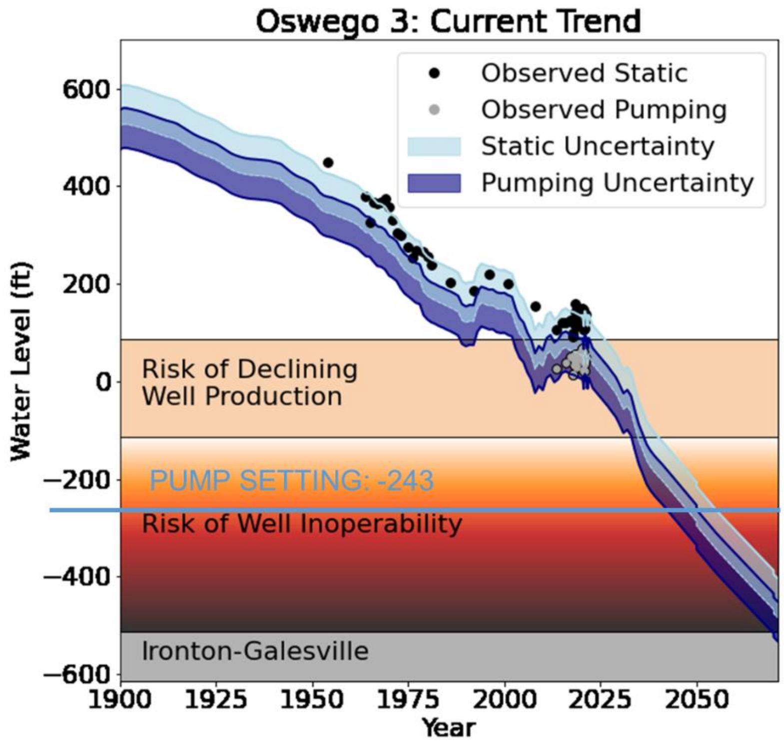
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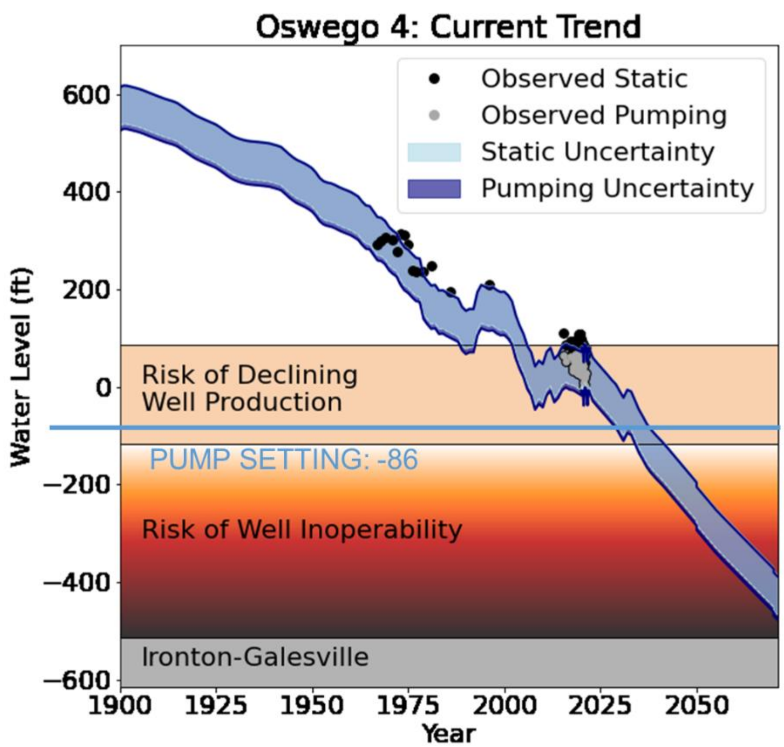
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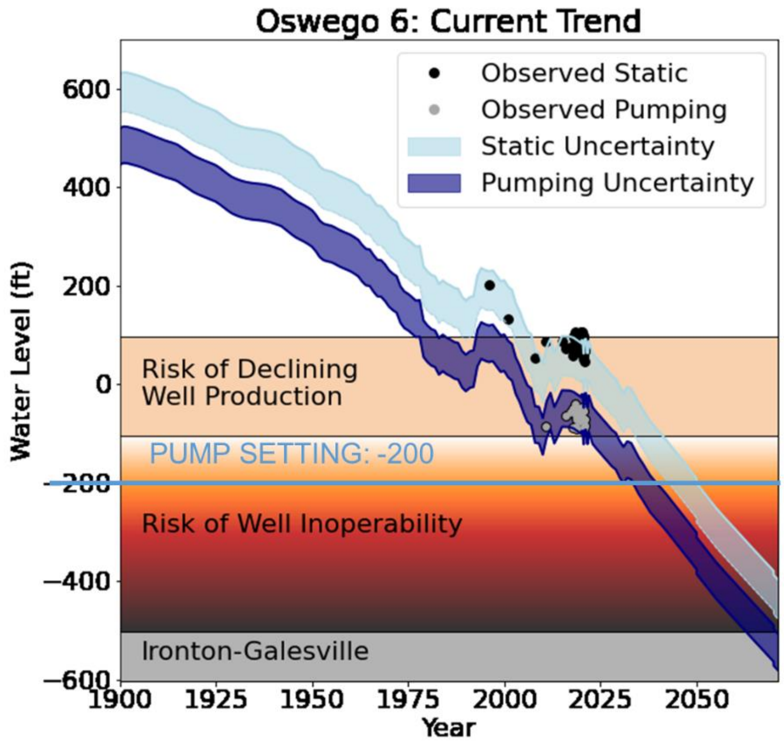
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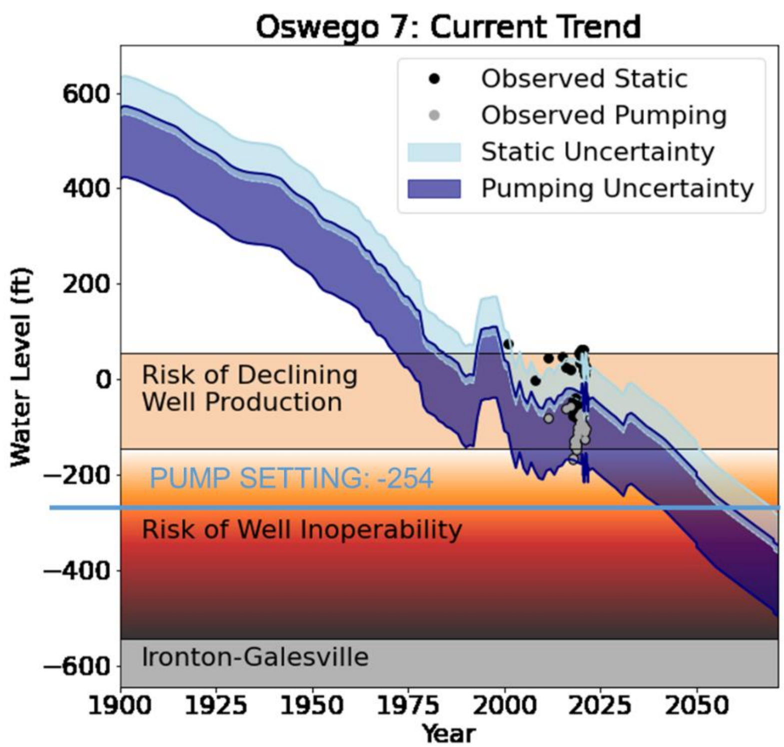
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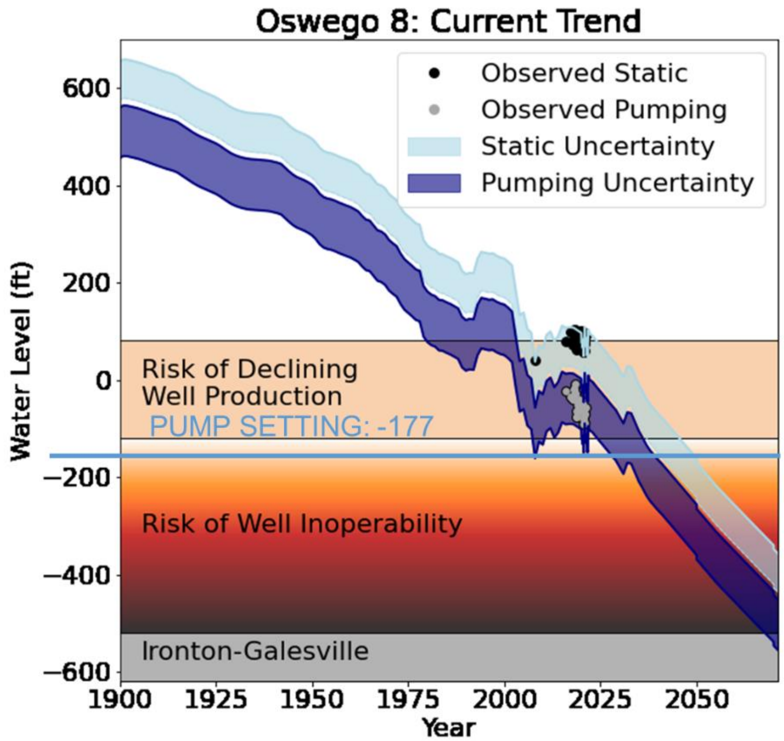
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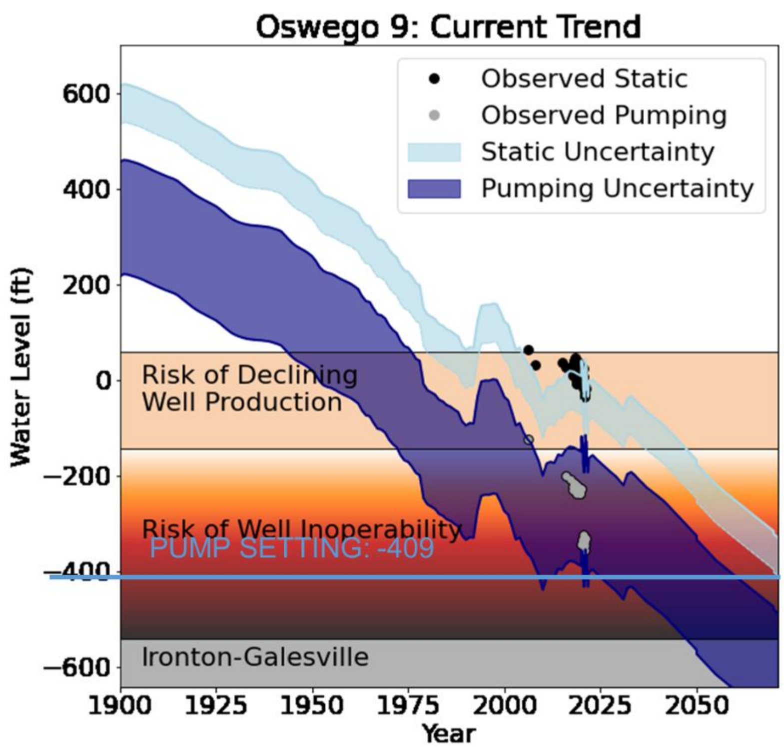
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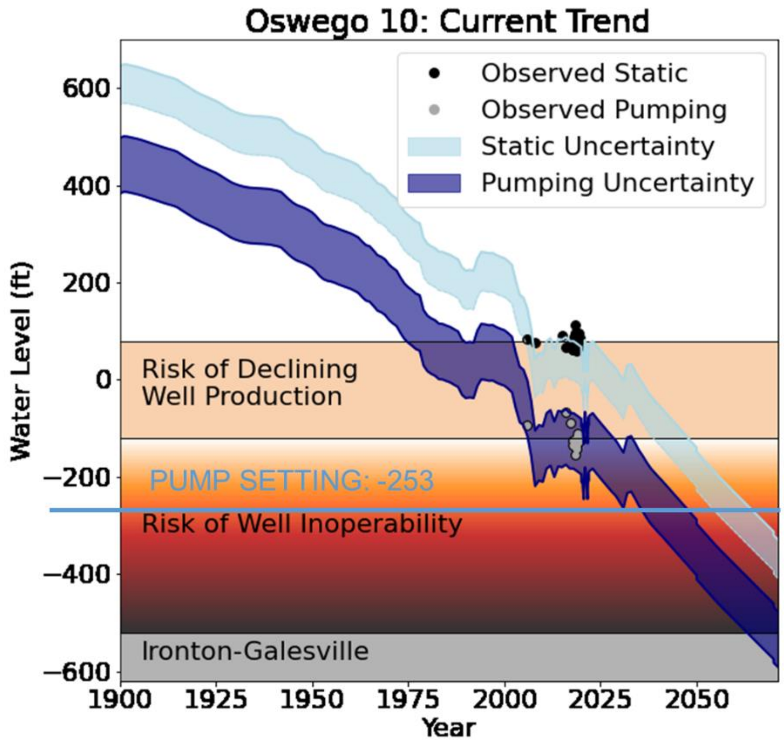
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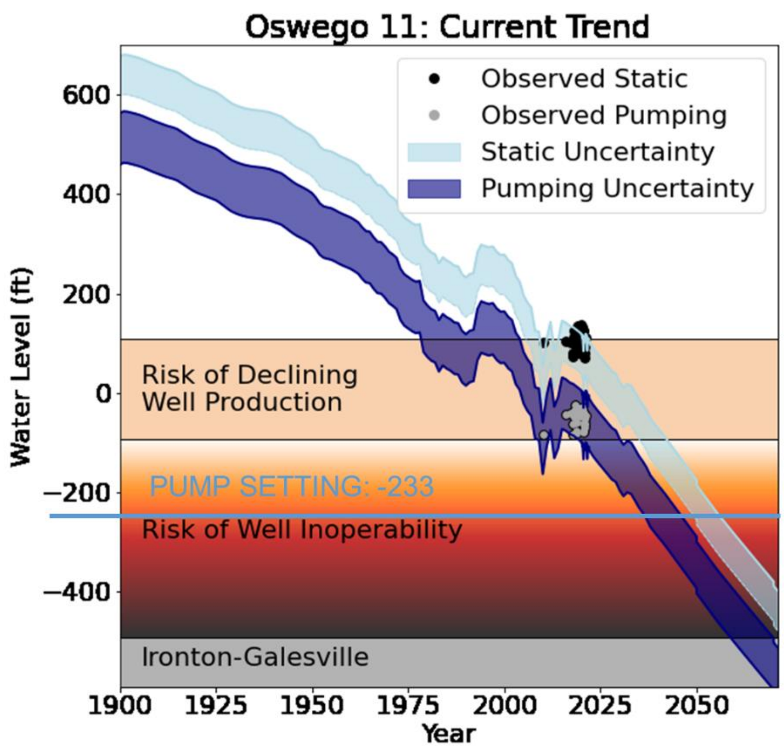
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APPENDIX C

ISWS Map Series 2017-01
Published June 2017

The Distribution of Water Use in Illinois

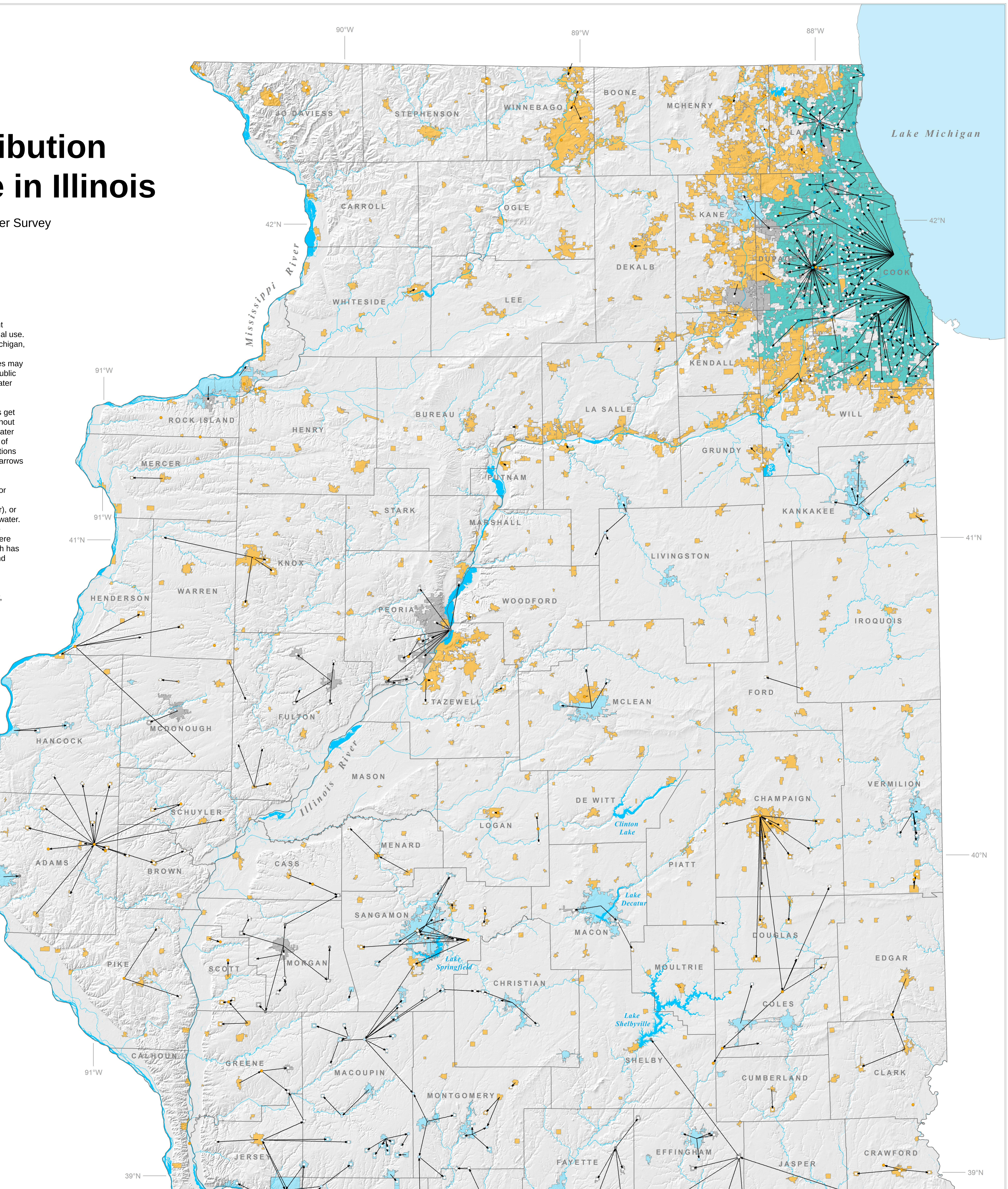
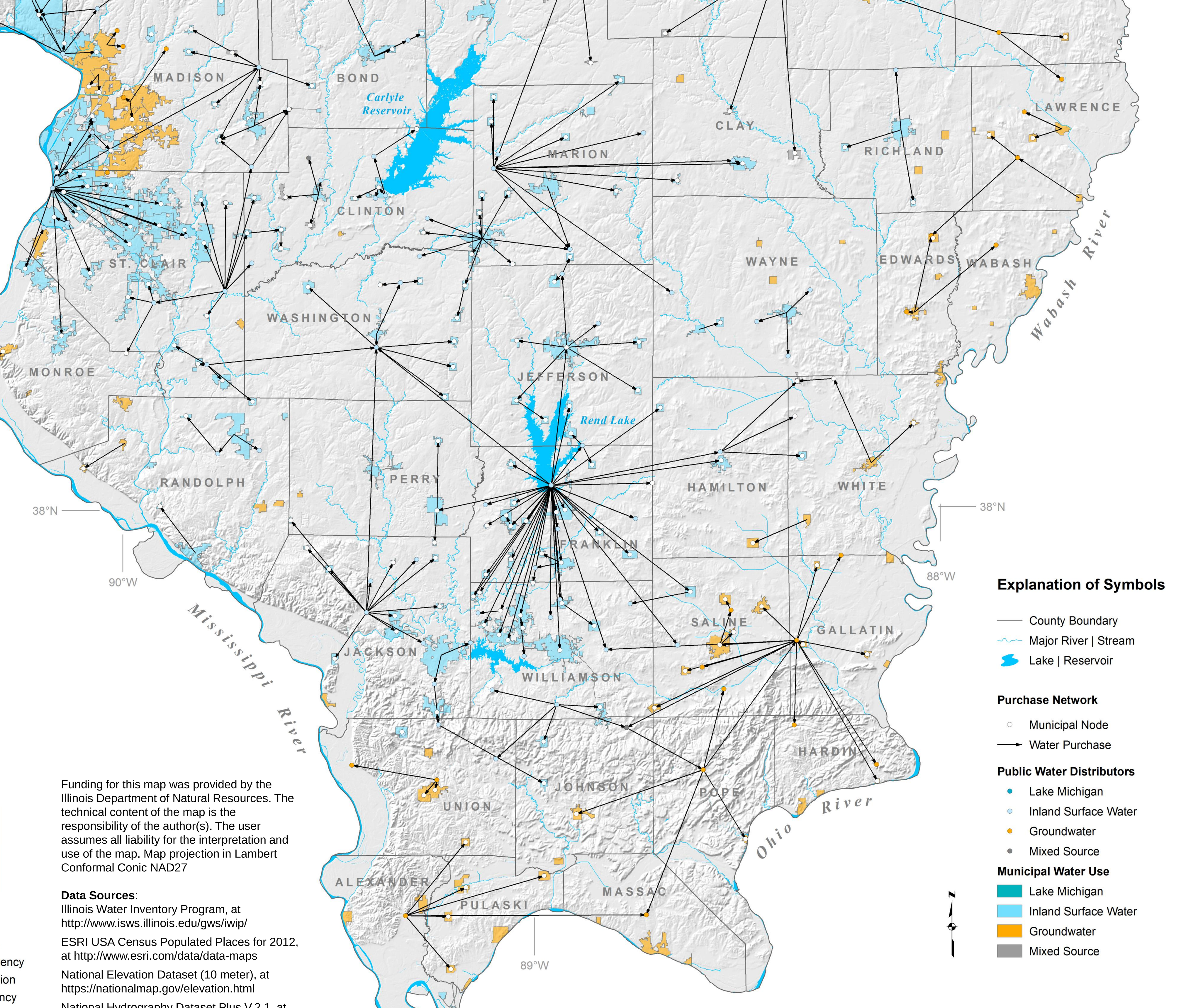
Illinois State Water Survey

More than 1,300 communities in Illinois rely on different sources of water for municipal, industrial, and residential use. Sources of water throughout the state include Lake Michigan, inland surface waters such as rivers and reservoirs, groundwater, or a combination of sources. Communities may also purchase water from other communities or from public water distributors, which include private companies, water commissions, water districts, or water agencies.

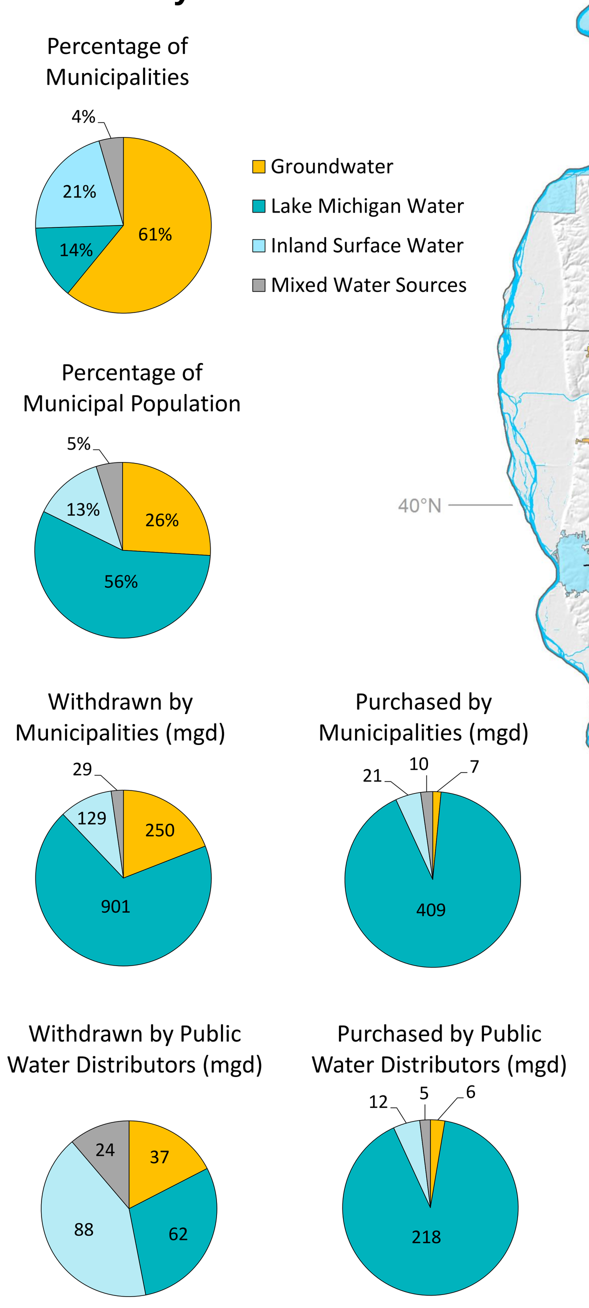
This map depicts the complexity of where communities get their water and the network of water purchases throughout the state for the year 2012. Municipalities and public water distributors are colored-coded according to the source of water they use. The purchase network depicts transactions between communities or public water distributors with arrows going from seller to purchaser.

Some communities extract water from their own wells or intakes (withdrawn water), or buy water from another community or public water distributor (purchased water), or may have a combination of withdrawn and purchased water. In 2012, over 1,510 million gallons per day (mgd) were withdrawn for public consumption. Data for this map were gathered by the Illinois Water Inventory Program, which has tracked water use at high-capacity community wells and intakes (over 70 gallons per minute) throughout the state since 1979.

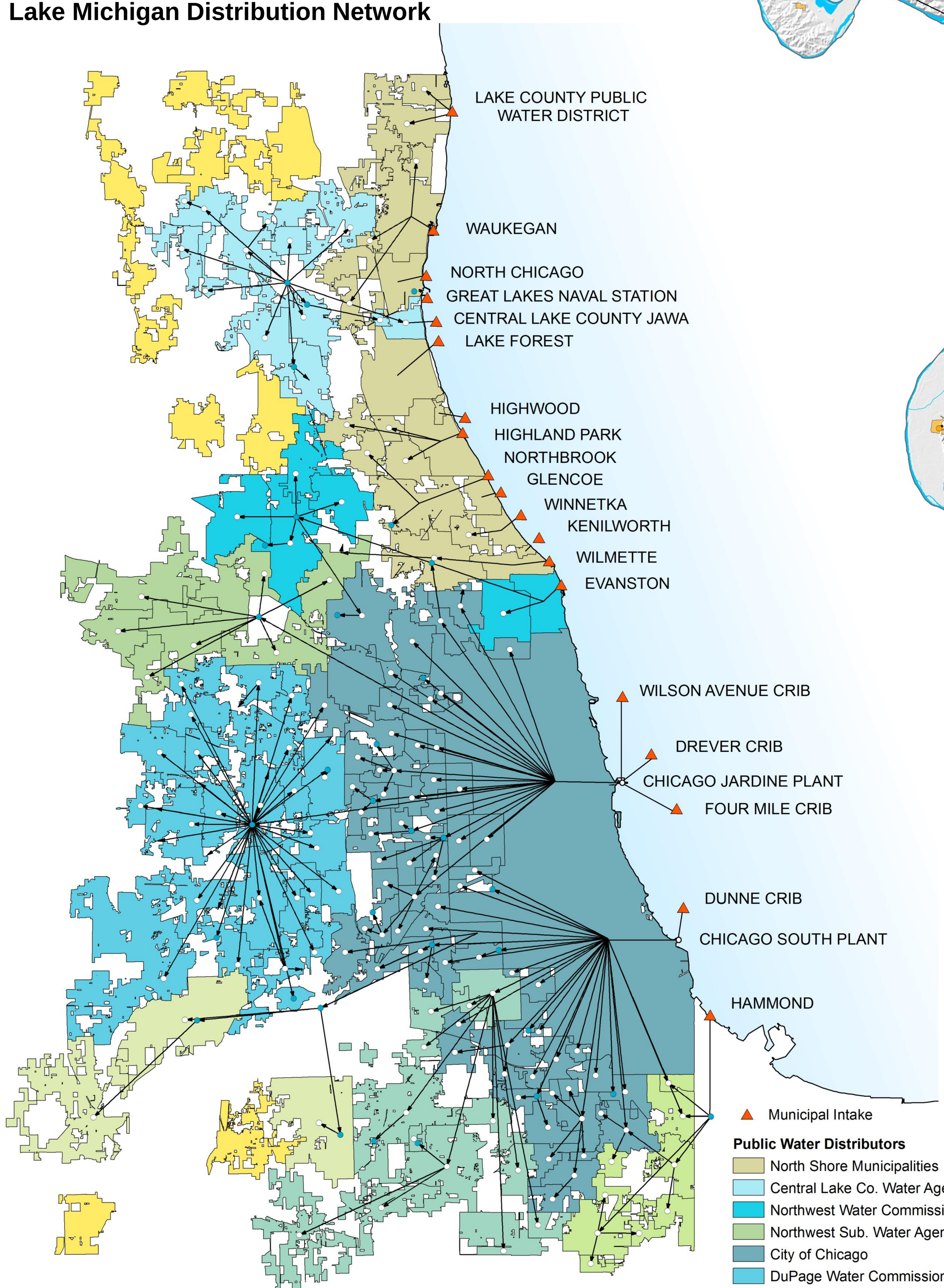
Map compiled by Daniel R. Hadley, Joanna A. Krueger, George S. Roadcap, and Conor R. Healy.

Summary of Water Use



Lake Michigan Distribution Network



Funding for this map was provided by the Illinois Department of Natural Resources. The technical content of the map is the responsibility of the author(s). The user assumes all liability for the inclusion and use of the map. Map projection in Lambert Conformal Conic NAD27

Data Sources:
Illinois Water Inventory Program, at http://www.isws.illinois.edu/gws/iwip/
ESRI USA Census Populated Places for 2012, at http://www.esri.com/data/data-maps
National Elevation Dataset (10 meter), at https://nationalmap.gov/elevation.html
National Hydrography Dataset Plus V.2.1, at http://www.horizon-systems.com/NHDPlus/NHDPlusV2_home.php

Illinois State Water Survey
www.isws.illinois.edu
217-244-5459

University of Illinois
www.illinois.edu

ILLINOIS STATE WATER SURVEY
PRAIRIE RESEARCH INSTITUTE

ILLINOIS DEPARTMENT OF NATURAL RESOURCES

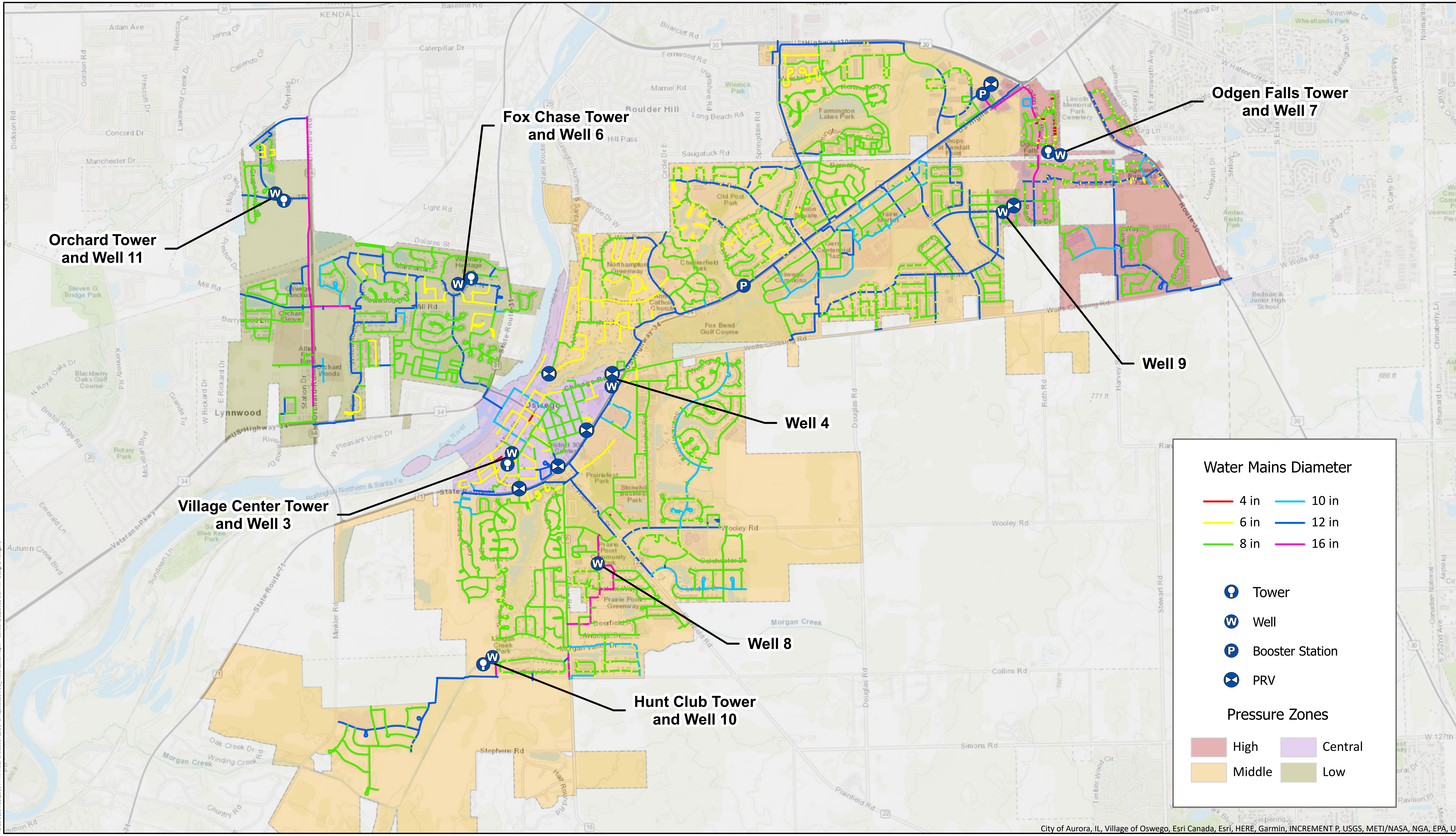
EXHIBITS

EXHIBIT A

SYSTEM MAP

BAXTER & WOODMAN
Consulting Engineers

OSWEGO EXISTING SYSTEM

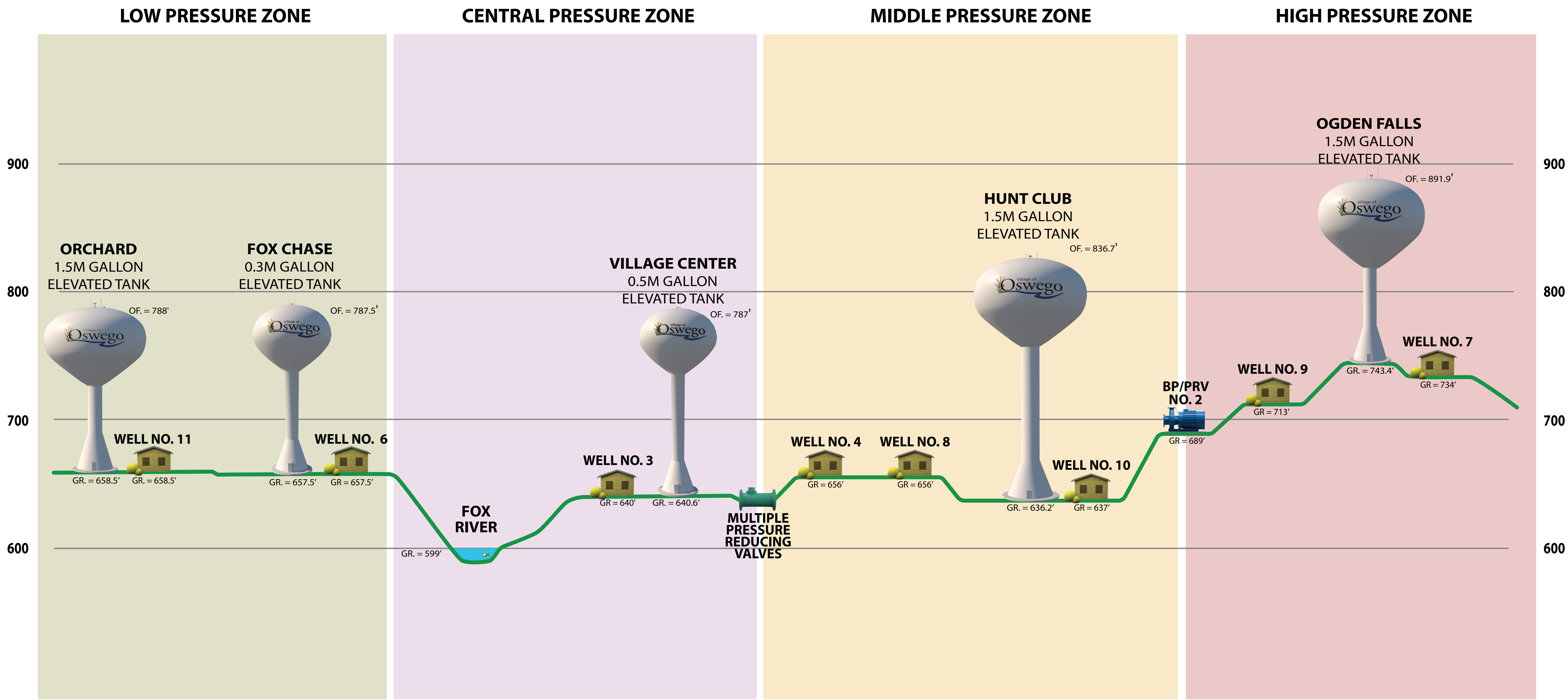


Source(s): Water Data received from Village, Aug 2020. Pressure Zones revised and Water Towers added per B&W April 2021.

EXHIBIT B

HYDRAULIC PROFILE

BAXTER & WOODMAN
Consulting Engineers



OSWEGO HYDRAULIC PROFILE
EXHIBIT B