

TECHNICAL MEMORANDUM

To: Greg Johnson, PE, MCES

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Date: June 26th, 2026

Subject: White Bear Lake Comprehensive Plan: Study 11
Non-/Less-Potable or Potable Water Reuse for Irrigation & Process Water (Vadnais Heights & White Bear Lake)

1.0 EXECUTIVE SUMMARY

Study 11 evaluates the feasibility of supplying non- or less-potable water and potable water (treated surface water) to selected commercial, residential, and industrial users for irrigation, residential, and/or process uses, to reduce groundwater pumping in the Vadnais Heights and White Bear Lake areas. Since the project was kicked off, business surveys were issued in Vadnais Heights and White Bear Lake, initial demand indicators were compiled, preliminary watermain alignments were established for a dedicated distribution system with pressure management (tower/booster) options, and regulatory considerations were documented. Survey results show seasonally peaking demand, mixed willingness to adopt reuse or alternate-source water, and the need for additional outreach and code clarification. Two models were evaluated for the implementation of a new surface water distribution system focused on supplying water for industrial, commercial, and irrigation purposes, as well as select residential communities. The two models were designed as follows: the Infrastructure-Based Model focused on supplying as many commercial and industrial users as possible. In contrast, the User-Based Model concentrates on supplying the largest-volume demand users and other users directly on the distribution path.

The Infrastructure-Based Model and User-Based Model includes supplying approximately 1.2 million gallons per day (MGD) and 0.850 MGD, respectively, during irrigation seasons. It is also anticipated that capital costs associated with the Infrastructure-Based model will be approximately \$48,000,000-\$52,000,000, with an estimated annual operations and maintenance cost of approximately \$ 364,000 over the 50-year lifespan. The User-Based Model anticipates a capital cost between \$27,000,000-32,000,000 and an estimated annual operations and maintenance cost of approximately \$260,000 over the 50-year lifespan.

When comparing the total infrastructure associated with each model, the User-Based Model captures approximately 73% of demand of the Infrastructure Model and requires approximately 56% of the infrastructure, resulting in approximately 71% of O&M costs.

Preliminary evaluation of the East Vadnais Lake water quality was completed to identify potential treatment system options. When evaluating the treatment options, special consideration was placed on combining the treatment proposed in the lake augmentation study (7B) with the Study 11's water use study. It was assumed that there are three treatment options, which are dependent on application, but all options employ the front-end treatment of enhanced coagulation and filtration. Study 7B looked at applying treatment options in a non-potable water applications from various lakes to White Bear Lake with a treatment capacity of 6,000 gpm (8.64 MGD). By potentially including the augmentation of East Lake Vadnais to White Bear Lake, supplying surface water to Commercial, industrial, and to a lesser degree residential customers, the treatment facility will remain in operation year-round, which will limit stagnant water and potential operational issues associated with long downtime of the facility.

When evaluating the non-potable water treatment system proposed in study 7B, the first treatment option would be purely lake augmentation using said front-end treatment. The second option would implement the front-end treatment followed by disinfection and contact time for non-potable purposes. The third would implement advanced carbon polishing and disinfection to potable water standards. Conceptual level cost estimates for the potable treatment option is approximately \$48,000,000-\$50,000,000 with annual operations and maintenance at about \$600,000. Conceptual level cost estimates for the non-potable treatment option is approximately \$22,000,000-\$24,000,000 with annual operations and maintenance at about \$500,000. The level of treatment is primarily dependent on the acceptance of a less-potable plumbing code.

Preliminary groundwater assessment completed by the DNR shows an increase of approximately 0.46-0.50 ft to the surface water elevation in White Bear Lake with the implementation of the Infrastructure-based model and an increase of approximately 0.37-0.41 ft to White Bear Lake's surface water elevation with the implementation of the User-Based Model.

2.0 PURPOSE AND SCOPE

2.1 Purpose of the Study

- Identify and evaluate whether a non-/less-potable or potable reuse system can serve the targeted White Bear and Vadnais Heights area reliably and cost-effectively, thereby lowering groundwater withdrawals in Vadnais Heights and White Bear Lake area and thus improving water elevations in White Bear Lake.

2.2 Scope of the Study

- Analyze the feasibility of non-/less-potable water use and (where applicable) potable reuse for specific user classes.
- Evaluated multiple distribution networks:
 - An Infrastructure-Based Model - Evaluate a robust distribution system network to serve as many commercial/industrial and select residential properties as practical, including large quantity water users (see Attachment A for the distribution network and businesses served).
 - A User-Based Model – Evaluate a targeted distribution network designed to serve large quantity water users (see Attachment B for the distribution network and businesses served).
- Screen potential effects on the overall surface-water/groundwater balance and White Bear Lake management strategies.
- Aid the DNR in the evaluation and modeling of the transitioning of portions of groundwater demand to surface water.
- Evaluate concept-level costs, Operations and Maintenance (O&M) needs, regulatory path, and ownership/management structures.
- Further evaluate the inclusion of the water reuse study and the White Bear Lake Augmentation Study by others. As these studies have separate purposes, during portions of the year or during years when lake augmentation is not needed, the lake augmentation supply and treatment system may be able to supply the industrial water supply to provide continuous use of the lake augmentation system.

3.0 WORK PERFORMED

3.1 Stakeholder Survey

- Distribution ~110 businesses in Vadnais Heights (sent Sept 25, 2025) and ~100 in White Bear Lake (sent Oct 2, 2025)
- Responses to date - 18 completed (as of June 27, 2026)
- Content:
 - Current water uses/volumes, quality needs, on-site treatment, pressure/flow/fire-protection, and willingness to accept a separate non-potable service.

Table 1. Summary Table of Survey Responses

Question	Summary of Responses
Usage Type*	Irrigation (9), Cooling Towers (2), Boilers/Steam (4), Rinsing (4), Sanitation (4), Machinery (2)
Estimated Monthly Usage	No Estimate Known (9), Provided Estimate (8), No Response (1)
Estimated Peak Hour Demand	No Estimate Known (18)
Minimum Flow Rate	No Requirement (17), Provided Minimum (1)
Water Pressure Requirements	No Requirement (17), Provided Minimum (1)
Current Treatment	None (12), Yes (6)
Impact of Changes to Water Chemistry	None (13), Unsure (3), Provided Required Chemistry (2)
Desired Changes to Water* Chemistry	Currently Satisfied (11), Desired Changes to Odor (3), Hardness (3), PFAS (1), Iron (1)
Existing Separate Fire Suppression	Yes (5), No (8), Unsure (5)
Desire for Non-Potable Service	Yes, with Additional Information (4), No (8), Unsure (5), No Response (1)
Current Wastewater Pre-Treatment	No (17), Yes (1)
Interest in Water Reuse/Treated Surface Water Use	Yes (5), Yes with Additional Information (3), Potentially in the Future (3), No (7)

Notes: Values within parentheses indicate the number of responses.

** Multiple responses were allowed.*

3.2 Demand Indicators

- Compiled initial annual and peak-season demand snapshots for target areas using recent utility data (WBL 2024; VH 2022–2024) and a simple demand calculator to translate reported uses into preliminary sizing ranges. All data were categorized by usage type (irrigation, residential, commercial, and industrial) to enable more accurate demand forecasting.
- Created two potential model versions and distribution systems for serving customers that would allow for two different demand scenarios –
 1. An “Infrastructure-Based Model,” in which infrastructure is constructed to reach as many customers as feasible,
 2. A “User-Based Model,” in which the distribution network is built to reach the largest users and other users on the same distribution routes.
- The City of Gem Lake was included in this study as it is situated along the proposed water main route and has been in discussions with White Bear Lake and Vadnais Heights to potentially provide potable water to the community, which would make logistical sense to evaluate its inclusion in the study. Gem Lake also potentially has more suitable locations for a proposed water tower that have been assessed.

3.3 Annual Water Demands

- Tables 2 and 3 outline the annual demand associated with the Infrastructure-Based Model and User-Based Model, respectively. The estimated annual water demand for the Infrastructure-Based model is approximately 369 million GPY, and for the User-Based model, it is 268 million GPY.
- Both models account for 2050 projections for Gem Lake's residential demands and growth.
- Attachments C – Infrastructure-Based Model and D- User-Based Model outline the various business types and their locations in reference to the proposed distribution networks.

Table 2: Annual Water Demand – Infrastructure-Based Model

	WBL and VH Commercial /Industrial**	Gem Lake Commercial /Industrial**	Irrigation*	WBL Residential	VH Residential	Gem Lake Residential	Estimated Demand Including Irrigation	Estimated Demand Excluding Irrigation
Total Annual Water Demand*** (GPY)	216,890,893	25,206,900	70,075,404	35,616,750	2,738,216	18,269,345	368,797,508	298,722,104
Average Water Demand (GPM)	413	48	665	68	5	35	1,234	568
Avg. Daily Demand (GPD)	594,222	69,060	359,361	97,580	7,502	50,053	1,177,778	818,417

*Based on 9 hours of daily usage and 6.5 months of irrigation per year

**Based on 24 hours of use for commercial users

***The WaterGem model accounts for the diurnal demand pattern

Table 3: Annual Water Demand – User-Based Model

	WBL and VH Commercial /Industrial**	Gem Lake Commercial /Industrial**	Irrigation*	WBL Residential	VH Residential	Gem Lake Residential	Estimated Demand Including Irrigation	Estimated Demand Excluding Irrigation
Total Annual Water Demand*** (GPY)	157,769,210	25,206,900	47,691,948	18,559,500	554,162	18,269,345	268,051,06	220,359,110
Water Demand (GPM)	300	48	453	35	1	35	872	419
Avg. Daily Demand (GPD)	432,244	69,060	244,574	50,848	1,518	50,053	848,298	603,724

*Based on 9 hours of daily usage and 6.5 months of irrigation per year

**Based on 24 hours of use for commercial users

***The WaterGem model accounts for the diurnal demand pattern

3.4 Current Annual Reduction in Water Demand

To further evaluate the effect on the local groundwater table, the reductions in pumping from various supply wells and private wells are outlined in Tables 4 and 5. Additionally, a visual representation of the wells affected is shown in Attachments E and F. Based on current demands, the infrastructure and user-based models would yield groundwater pumping reductions of 341.8 and 249.8 Million Gallons per Year (MGY), respectively, if implemented based on current infrastructure demands.

Table 4: Estimated Annual Aquifer Reduction from WBL and VH Water Demand – Infrastructure-Based Model

Well	City	Establishments	Commercial and Industrial Demand (GPY)	Irrigation Demand (GPY)	Residential and Mixed-Use Demand (GPY)	Total GPY Reduced
Vadnais Heights Supply Wells	Vadnais Heights	Businesses and Domestic	64,068,809	20,165,45	--	341,808,310
White Bear Lake City Supply Wells	White Bear Lake	Businesses and Domestic	68,548,000	13,503,75	--	
White Bear Lake City Supply Wells	Gem Lake ¹	Existing Residential Services	--	--	9,986,400	
Vadnais Heights Supply Wells	Gem Lake ¹	Existing Residential Services	--	--	18,706,250	
151584	Vadnais Heights	Gem Lake Hills Inc.	--	14,589,000	--	
127293	White Bear Lake	Manitou Ridge Golf Course	--	21,817,200	--	
151562	Vadnais Heights	H. B. Fuller	4,721,250	--	--	
233149	White Bear Lake	Saputo	105,702,000	--	--	

¹The City of Gem Lake is currently supplied by both the City of Vadnais Heights and the City of White Bear Lake. The numbers shown are current average yearly demands. The projected 2050 demand totals 43,476,245 GPY, with an estimated 22,857,395 GPY from White Bear Lake supply wells and 20,618,850 GPY from Vadnais Heights supply wells.

Table 5: Estimated Annual Aquifer Reduction from WBL and VH Water Demand – User-Based Model

Well	City	Establishments	Commercial and Industrial Demand (GPY)	Irrigation Demand (GPY)	Residential and Mixed-Use Demand (GPY)	Total GPY
Vadnais Heights Supply Wells	Vadnais Heights	Businesses and Domestic	24,443,572	4,550,748	--	249,781,720
White Bear Lake City Supply Wells	White Bear Lake	Businesses and Domestic	36,520,100	6,735,000	--	
White Bear Lake City Supply Wells	Gem Lake ¹	Existing Residential Services	--	--	9,986,400	
Vadnais Heights Supply Wells	Gem Lake ¹	Existing Residential Services	--	--	18,706,250	
151584	Vadnais Heights	Gem Lake Hills Inc.	--	14,589,000	--	
127293	White Bear Lake	Manitou Ridge Golf Course	--	21,817,200	--	
151562	Vadnais Heights	H. B. Fuller	4,721,250	--	--	
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3.5 Water Distribution Network Overview

A detailed hydraulic distribution system model was developed to adequately evaluate the water distribution network. The water mains were modeled using WaterGEMS software to assess the distribution system's performance and storage. The model used three diurnal demand patterns based on AWWA reference patterns to emulate 24-hour demand variation, to model varying demand estimates, and to account for daily variations. The distribution network was developed in the model to predict and evaluate maximum daily water demands during the irrigation months. Additionally, storage was sized to hold approximately a single day's demand, which equates to approximately 1.2 MGD for the Infrastructure-Based Model and 0.850 MGD for the User-Based Model. The diurnal demand patterns used to evaluate the residential, irrigation, and commercial/industrial demands over 24 hours are shown in Figures 1, 2, and 3, and are based on average demand patterns presented by the American Water Works Association (AWWA). Fire demands were not modeled as the existing distribution systems and hydrants would continue to provide fire protection for all customers.

Figure 1. Irrigation Diurnal Pattern

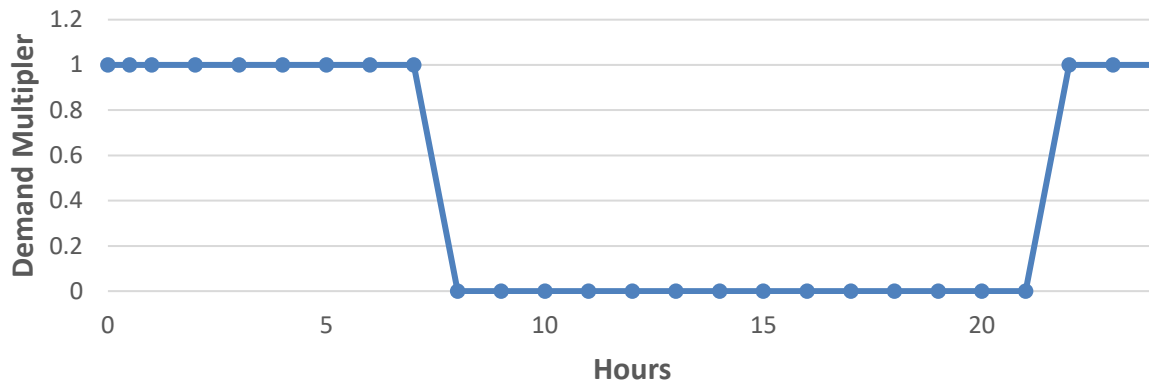


Figure 2. Commercial/Industrial Diurnal Pattern

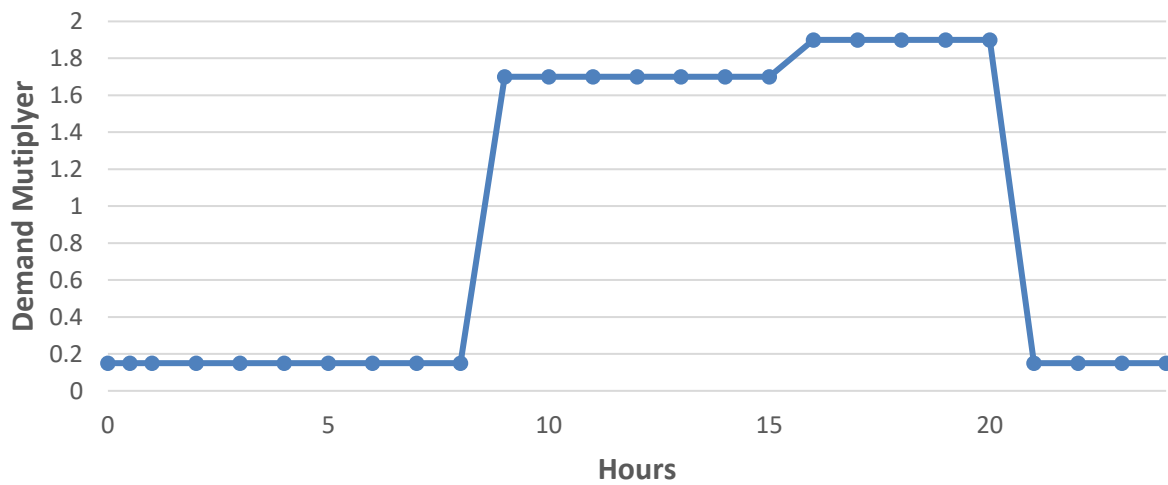


Figure 3. Residential Diurnal Pattern

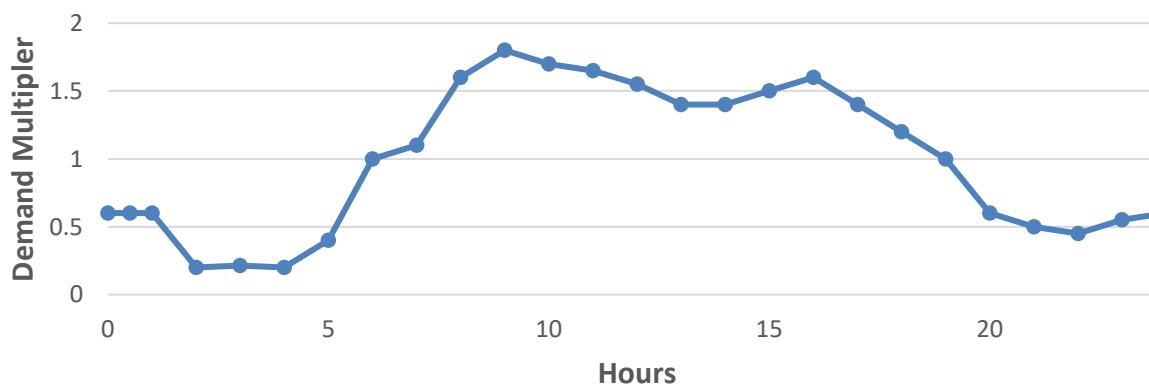


Table 6: Estimated Distribution Network Design

	8-Inch Water Main	12-Inch Water Main	16-Inch Water Main	Water Tower Height	Water Tower Capacity	Pressure Zones	Pressure Zone 1 Range	Pressure Zone 2 Range
	<i>(Linear ft)</i>	<i>(Linear ft)</i>	<i>(Linear ft)</i>	<i>ft</i>	<i>Million Gallons</i>	<i>#</i>	<i>PSI</i>	<i>PSI</i>
Infrastructure- Based Model	53,423	24,446	7,721	170	1.25	2	46-84	68-78
User-Based Model	2,653	33,209	573	170	1.5	1	48-83	--

Table 7: Model Comparison

	Commercial Industrial Demand (GPM)	Irrigation Demand (GPM)	Residential Demand (GPM)	Average Annual Water Demand (Gal)	Average Day Demand (Gal)	Total Water Main Length (ft)
Infrastructure-Based Model	445.2	670.8	98.4	368,797,508	1,177,778	85,905
User-Based Model	337.4	493.4	49.1	268,051,065	848,298	36,706
Percent served by User-Based Model	76%	74%	50%	73%	72%	43%

3.6 East Vadnais Heights Water Quality

As part of the overall WBL Comprehensive Planning effort, SEH completed a water quality analysis of the surface water in East Vadnais Lake as part of Study 7B, summarized in Table 8. The target treatment level presented as part of Study 11 aims at bringing the augmented surface water quality to drinking water standards. Additional analysis of the surface water quality is required to more accurately design the proposed treatment system's size, media type, and operational equipment.

Table 8: Model Comparison

Constituents	East Vadnais Lake Concentration*	Target Treatment Levels
Total Phosphorus	0.023 mg/L	NA
Total Nitrogen	0.77 mg/L	10mg/L / 1 mg/L**
Total Organic Carbon	8.63 mg/L	<1 mg/L
Total Suspended Solids	1.8 mg/L	0.3 NTU***
Total Dissolved Solids	223 mg/L	500 mg/L
Manganese	0.097 mg/L	0.05 mg/L
PFOS	1.9 ng/L	4.0 ng/L

*Completed as part of WBL Study 7B by SEH

**Measured as Nitrate and Nitrite, respectively

***Measured in Turbidity

3.7 Potential Treatment Pathways for East Vadnais Lake Water:

Based on the WBL Comprehensive Planning groups, water withdrawn from East Vadnais Lake could potentially be used in three distinct ways depending on the ultimate project objectives chosen:

- augmentation of White Bear Lake (Study 7B),
- supply to industrial and commercial users for non-potable applications, and
- supply to industrial, commercial, and residential users, including potable or near-potable community water service.

Because each end use has a different regulatory basis, public health consideration, and water quality objective, the treatment requirements should be evaluated using a modular approach rather than assuming that a single treatment train will necessarily satisfy all three applications.

The augmentation treatment schematic currently being considered by others (under Study 7B) includes intake screening, raw water pumping, chemical addition, clarification, mechanical pre-filtration, membrane filtration, and treated water storage and pumping prior to discharge to White Bear Lake. This treatment train provides a strong front-end basis for particulate removal, turbidity reduction, algae and solids control, and partial natural organic matter reduction. For an augmentation-only application, this may represent an appropriate baseline treatment approach, subject to confirmation of final water quality objectives for discharge to White Bear Lake. However, if treated water is also to be conveyed through a pressurized distribution system for delivery to customers, additional treatment and finished-water conditioning requirements would be expected. Accordingly, three treatment scenarios are described below.

- **Scenario 1 – Lake Augmentation Only**

Under the first scenario, water withdrawn from East Vadnais Lake would be treated solely for discharge to White Bear Lake to provide augmentation storage and support water level management objectives. In this case, the principal treatment objectives are removal of suspended solids and algae, reduction of turbidity and color, management of natural organic matter, and production of treated water

that will not adversely affect White Bear Lake water quality or aquatic conditions.

A treatment train consisting of intake screening, enhanced coagulation, clarification, and membrane filtration would likely provide the core physical treatment needed for this scenario. However, additional process elements should still be evaluated. These include disinfection to address microbial concerns, pH and alkalinity adjustment to ensure chemically stable discharge water. Therefore, while enhanced coagulation and membrane filtration form a sound treatment basis for augmentation, augmentation-only treatment should not be viewed as complete until discharge chemistry, microbial considerations, and lake response criteria are addressed.

- **Scenario 2 – Industrial and Commercial Non-Potable Supply**

Under the second scenario, treated East Vadnais Lake water would be delivered only to industrial and commercial users for non-potable applications such as irrigation, car washing, cooling water, washdown, and other process-water uses. This scenario imposes a higher treatment requirement than augmentation because the water would be conveyed through a dedicated distribution system, potentially including storage, booster pumping, or elevated storage, and would enter customer plumbing or industrial equipment. Even when the end use is non-potable, the water must be suitable for storage and pressurized distribution and must not create unacceptable public health, operational, or aesthetic issues.

For this scenario, the augmentation treatment train should be considered the front-end treatment module only. Additional treatment requirements would include final disinfection, provision of a disinfectant residual for the reuse distribution system and finished-water stabilization. Final disinfection may include chlorination, via chloramination used to maintain a residual in the distribution network. With the proposed water distribution system and holding vessels (an elevated tank), the design would need to provide adequate contact time, turnover, and operational controls to maintain acceptable water quality in the reuse mains.

In addition, pH and alkalinity adjustment should be evaluated to ensure that treated water is not chemically aggressive or otherwise unstable in pipelines, tanks, valves, and customer plumbing. Although central treatment could produce a high-quality non-potable supply, some industrial or commercial users may still require site-specific polishing depending on their process-water needs. For example, car wash facilities may have water quality preferences related to spotting or dissolved solids, while certain industrial users may require additional conditioning for equipment compatibility. Accordingly, the central treatment system under this scenario should be designed to deliver a reliable, microbiologically controlled, chemically stable non-potable supply, while recognizing that some customers may maintain supplemental point-of-use treatment.

- **Scenario 3 – Industrial, Commercial, and Residential Community Supply**

Under the third scenario, East Vadnais Lake water would be treated not only for augmentation and non-potable industrial/commercial use, but also for residential community supply, including potable or near-potable service. This scenario results in the most stringent treatment requirements because the finished water would need to satisfy community water supply expectations and function as a fully protected drinking water source or a system readily convertible to potable use.

Under this scenario, the intake, enhanced coagulation, clarification, and membrane filtration processes remain valuable as the common front-end treatment module. However, additional finished-water treatment processes would be expected beyond those needed for augmentation or less-potable water. These additional processes would likely include final disinfection meeting potable supply objectives, finished-water storage and contact time, stabilized disinfectant residual in the distribution system, and comprehensive finished-water stabilization and corrosion control. Activated carbon polishing or Advanced Oxidation processes (AOP) should also be evaluated to improve taste and odor control, reduce remaining dissolved organic constituents, and provide additional protection against customer acceptance issues and distribution system water quality concerns. Even in the absence of PFAS treatment needs, activated carbon may provide meaningful operational and finished-water quality

benefits for a surface water-derived community supply.

Finished-water stabilization becomes particularly important under this scenario because enhanced coagulation and membrane treatment may alter pH, alkalinity, and overall water chemistry. Therefore, pH adjustment, alkalinity control, and corrosion-control evaluation would be needed to ensure compatibility with transmission mains, storage facilities, distribution piping, and premise plumbing. If residential use is contemplated, the treatment system should be considered a true drinking water treatment system rather than an extension of the augmentation-only treatment process.

3.8 Modular Treatment Approach

From a planning perspective, the most practical way to evaluate East Vadnais Lake as a source is to consider the treatment process in modules. The first component would be the common front-end treatment system, consisting of intake screening, enhanced coagulation, clarification, and membrane filtration. This front-end treatment would provide the principal solids, turbidity, and organics removal needed under all three scenarios. The following can be the 3 modular steps that may be taken:

- The first module would consist of augmentation-specific conditioning, including disinfection, finished-water chemistry adjustment, and any nutrient or discharge-quality controls needed to protect White Bear Lake.
- The second module would consist of non-potable distribution conditioning, including final disinfection, disinfectant residual, treated-water storage/contact time, and stabilization for industrial and commercial reuse service.
- The third module would consist of potable or near-potable upgrade components, including activated carbon polishing, finished-water stabilization and corrosion control, and the additional finished-water handling and distribution safeguards required for residential community supply.

This modular framework allows the project to distinguish between the treatment needed for White Bear Lake augmentation and the additional treatment needed to support customer-facing water service. It also provides a rational basis for comparing capital cost, operational complexity, regulatory requirements, and implementation flexibility among the three potential use scenarios. In summary, the treatment process currently being considered for lake augmentation represents an appropriate front-end treatment, but additional treatment processes would be required if East Vadnais Lake water is to be supplied to industrial, commercial, or residential users through a pressurized distribution system.

From a planning and implementation standpoint, the most practical approach may be to develop the East Vadnais Lake treatment system around a common initial treatment module consisting of intake screening, enhanced coagulation, clarification, and membrane filtration. This front-end treatment module could be sized on an ultimate-capacity basis to support any of the three potential use scenarios, i.e.,

- lake augmentation only,
- non-potable supply to industrial and commercial users, or
- broader supply to industrial, commercial, and residential users

The project can be allowed for phasing overtime. Under an augmentation-only scenario, only the treatment processes and pumping facilities necessary to meet augmentation water quality objectives would be operated. If future project objectives expand to include non-potable reuse or potable/community supply, additional downstream treatment modules, finished-water storage, disinfection systems, stabilization processes, and distribution-related redundancies could be added to the common front-end treatment system rather than requiring a separate new plant. Site selection should be mindful of the potential expansion of the facility to ease the future construction if the second or third modules are being considered. This modular approach would preserve long-term flexibility, reduce the risk of stranded infrastructure, and enable the treatment facility to evolve in ways consistent with future regulatory requirements, customer demands, and water supply objectives.

3.9 Opinion of Probable Costs

An overview of the opinion of probable construction costs (OPCC) associated with the distribution network and storage system is outlined in Table 9. The annual maintenance is based on an estimated lifespan of 50 years. The OPCC does not include the cost for treatment or the treatment system design. The OPCC shall consist of the following components:

- **Infrastructure Capital Costs**
- **Engineering & Design Costs**
- **Easements & Land Acquisition Costs**
- **Annual Operations and Maintenance (O&M) Costs**

Table 9: Preliminary Opinion of Probable Cost

	Infrastructure-Based Model	User-Based Model	Potable Water Treatment System	Non-Potable Water Treatment System	Less-Potable Water Treatment System
Capital Costs	\$ 48,000,000- \$ 50,000,000	\$ 27,000,000- \$ 30,000,000	\$53,000,000- \$55,000,000	\$22,000,000- \$24,000,000	\$26,000,000- \$30,000,000
Annual O&M Costs	\$ 364,000	\$ 260,000	\$600,000	\$500,000	\$520,000

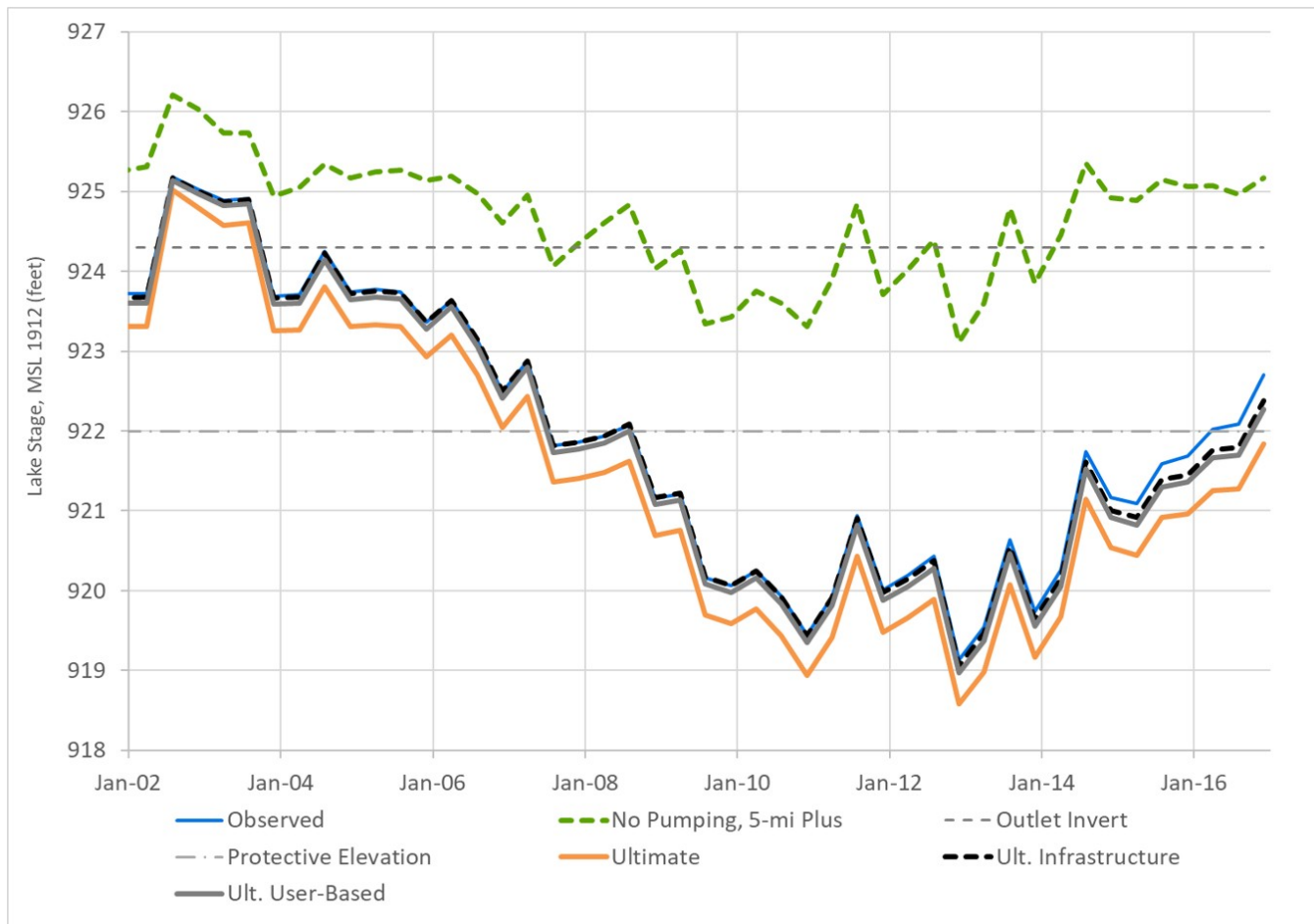
Notes: The Engineer has no control over the cost of labor, materials, equipment, or the Contractor's methods of determining prices or over competitive bidding or market conditions. The opinion of probable construction costs provided herein are based on information known to the Engineer at the time and represents only the Engineer's judgement as a design professional familiar with the construction industry. The Engineer cannot and does not guarantee that the proposals, bids, or actual construction costs will not vary from its opinion of probable costs.

3.10 Effects of the White Bear Lake Area's Water Table

The Minnesota Department of Natural Resources (DNR) conducted groundwater modeling to estimate the improvements to White Bear Lake's water elevations if either the Infrastructure-Based or User-Based water distribution system was implemented. For these modeling scenarios, the projected water demands for the businesses and high-capacity well customers connected to these systems were removed (subtracted) from the projected municipal water demands for Vadnais Heights and White Bear Lake in the groundwater model. The Ultimate (Hugo 1) development scenario for the White Bear Lake area was used as the starting point, reducing pumping in Vadnais Heights and White Bear Lake from that baseline. The calculated hydrographs for these two scenarios are plotted below. The differences between the Ultimate scenario and the two new scenarios over the period 2008 through 2015 are also summarized below. In general, the impacts of reducing groundwater pumping from the Prairie du-Chien aquifer decrease as the overall pumping impacts are reduced as follows:

- Infrastructure-based vs. Ultimate (Hugo 1): 0.46 to 0.50 feet increase in White Bear Lake water elevations.
- User-based vs. Ultimate (Hugo 1): 0.37 to 0.41 feet increase in White Bear Lake water elevations.

Figure 4. Modeled Effects of Groundwater Pumping Reduction on White Bear Lake's Water Elevation



3.11 Distribution System Ownership

The cities of White Bear Lake, Vadnais Heights, and Gem Lake are being consulted over the watermain design and storage sites. These cities could consider the creation of a partnership agreement over the maintenance and operation of the facilities, as well as additional discussion over service rates.

3.12 Network & Siting (GIS)

A working basemap with candidate customers, Infrastructure Based (Attachments A & C) and User Based (Attachments B & D) model scenarios, potential locations for major infrastructure, and proposed pressure zones were evaluated and prepared. Mapping of areas suitable for reuse is currently in progress as survey data arrives.

3.13 Regulatory Scan

- Core principle - Maintain complete separation between existing potable and proposed non-potable or potable systems.
- Plumbing Code - Minnesota's Universal Plumbing Code Chapter (reuse standards) has not yet been adopted statewide. The Plumbing Board is currently evaluating the adoption of Chapter 15 non-potable standards with input from relevant local state agencies. This limits the viability of a solely reuse-based system. This study evaluated the option for alternative sources of water in addition to reuse.
- Special Discharge – There are twelve special discharge permit holders in White Bear Lake and Vadnais Heights, with three that are located within the current reused footprint. These users will need to be investigated further if included in wastewater interception and reuse technologies, as their discharge may exceed the standard discharge concentration.

4.0 FINDINGS & IMPLICATIONS

1. Seasonal peak demands matter. Reuse/Alternative demand is strongly seasonal (irrigation and wash water), which affects the sizing of watermain, tower/booster needs, and storage turnover. A tower can buffer peaks, but it must be balanced with wintertime operations when water demands are lower.
2. Adoption will require more engagement. Survey returns suggest mixed willingness to switch to reuse or alternative water sources. Targeted follow-ups with high-volume users (dealerships, R&D/manufacturing) are needed to define quality/pressure thresholds and conversion hurdles.
3. Regulatory pathways are pivotal. The plumbing code's adoption of reuse standards and local enforcement details (backflow, dual plumbing) will drive schedule and cost.
4. Irrigation runoff constraints. MPCA requires irrigation practices that prevent off-site runoff when using recycled water; this affects site-level design standards and outreach messaging.

5.0 REGULATORY AND OWNERSHIP

- Regulatory coordination: The non potable language is still being discussed and under consideration for addition to the new MN plumbing code.
- Ownership Model: The level of treatment will define the ownership requirements between the three municipalities potentially being served by the treated water. If augmentation is included in the treatment system

6.0 RISKS & MITIGATION STEP

- Low survey response rate could bias sizing; mitigation is to provide a more robust survey if the surface water treatment system advances in the remediation options for WBL.
- Code adoption timing is uncertain; if reuse language is not adopted, the full treatment will likely be required. This does not limit the applicability for over-treatment of the irrigation water.

7.0 CONCLUSIONS

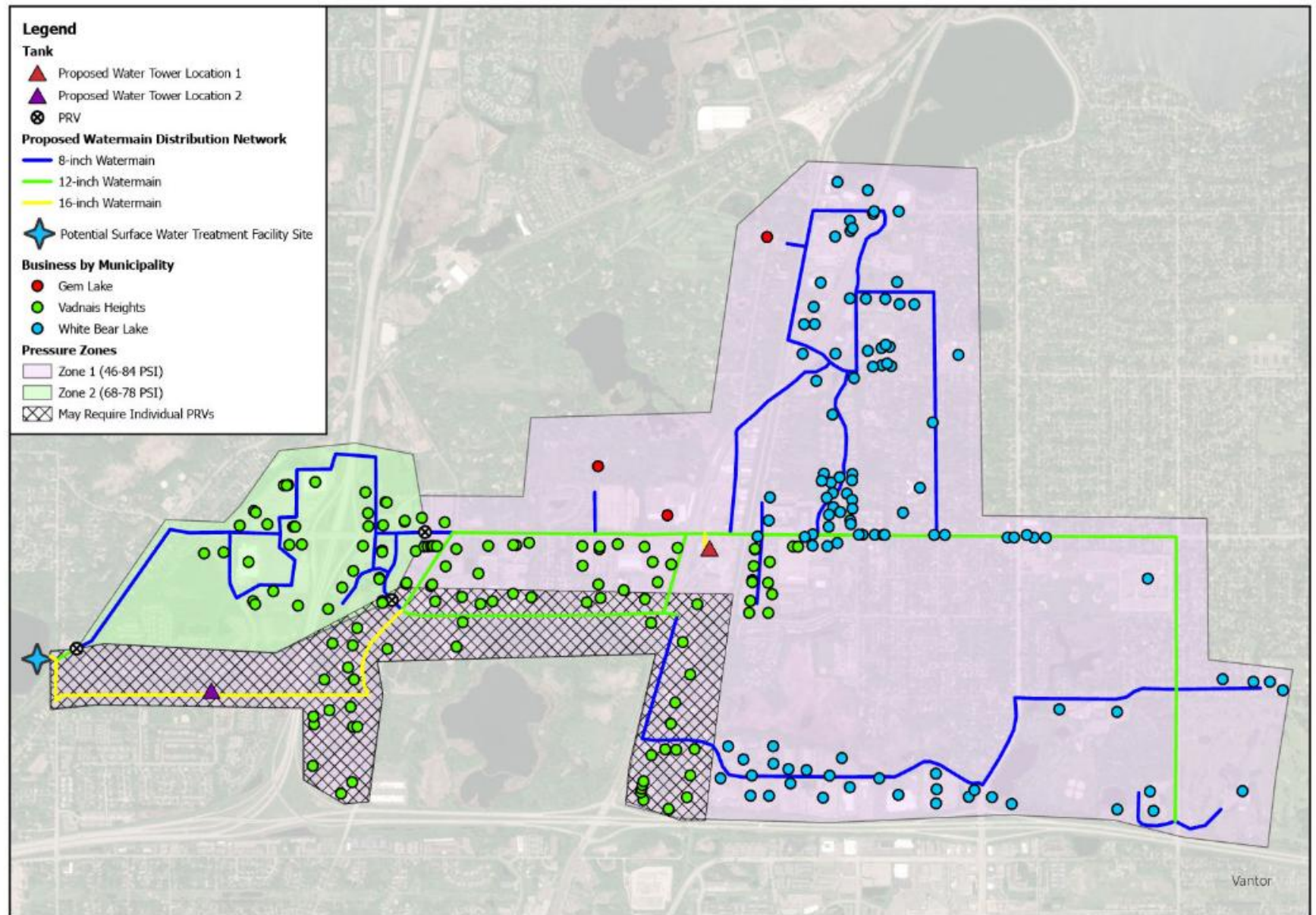
- A reuse / alternative source water distribution system serving targeted corridors remains feasible in concept, but regulatory confirmation, and customer readiness are the controlling factors.
- Additional community acceptance and more robust surface water sampling is required to provide a more detailed treatment guidance (from additional surface water sampling) is needed to finalize sizing, costs, and adoption strategy.

8.0 Recommendations

- Based on Table 7, the User-Based Model supplies approximately 268 MGY compared to the 369 MGY, which equates to approximately 73% of the service demand of the Infrastructure-Based Model.
- The total capital costs associated with the Infrastructure-Based Model and User-Based Model are between \$48,000,000 - \$50,000,000 and \$27,000,000- \$30,000,000, respectively.
- When used in conjunction with the lake augmentation front-end treatment, there are two options for treatment for application for Study 11, potable water treatment or non-potable water treatment for industrial and commercial use. The capital costs associated with potable water treatment and less/non-potable water treatment are between \$53,000,000 - \$55,000,000 and \$22,000,000- \$30,000,000, respectively.
- The operations and maintenance costs associated with the distribution system are approximately \$364,000 and \$260,000 annually for the Infrastructure-Based Model and User-Based Model, respectively.
- The annual operations and maintenance costs associated with potable water treatment, less potable water treatment and non-potable water treatment are \$600,000, \$520,000 and \$500,000, respectively.
- The increased annual maintenance costs associated with the Infrastructure-Based Model are primarily due to the increased linear feet of the distribution network.
- Further discussion over plumbing code is required to fully identify if non/less potable treatment will be accepted under the current plumbing code.
- Based on the capital costs, O&M costs, and percent of demand captured by the User-Based Model, it is the most cost-effective model with limited O&M needs and infrastructure oversight required.

APPENDICES

- Attachment A – Infrastructure-Based Model with Watermain Sizing Map
- Attachment B – User-Based Model with Watermain Sizing Map
- Attachment C – Infrastructure-Based Model with Business Type Map
- Attachment D – User-Based Model with Business Type Map
- Attachment E – Infrastructure-Based Model with Well Locations Map
- Attachment F – User-Based Model with Well Locations Map
- Attachment G – Infrastructure-Based Model Opinion of Probable Costs
- Attachment H – User-Based Model Opinion of Probable Costs
- Attachment I – Infrastructure-Based Model O&M Opinion of Probable Costs
- Attachment J – User-Based Model O&M Opinion of Probable Costs



Kimley»Horn

0 0.5 1 Miles

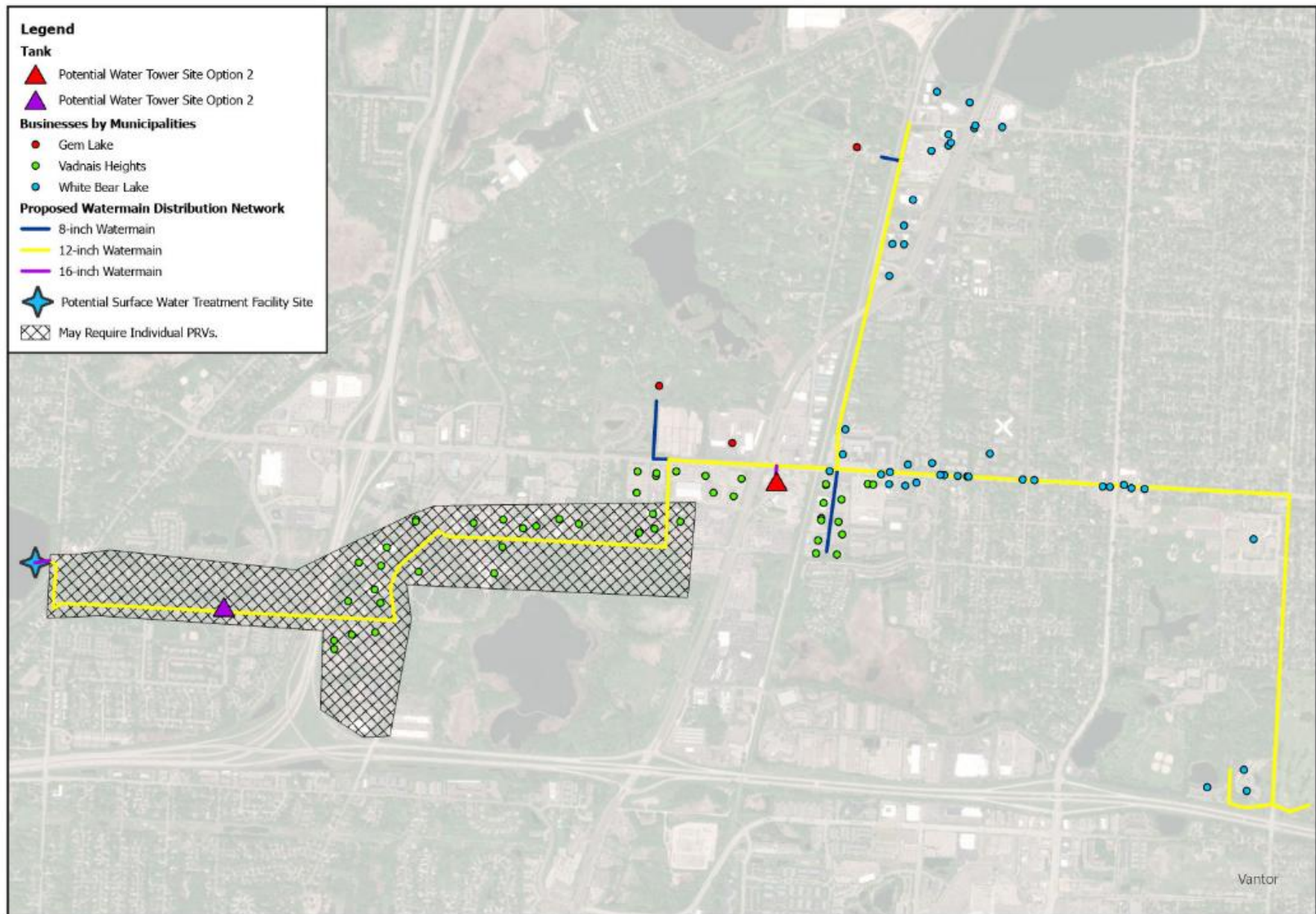


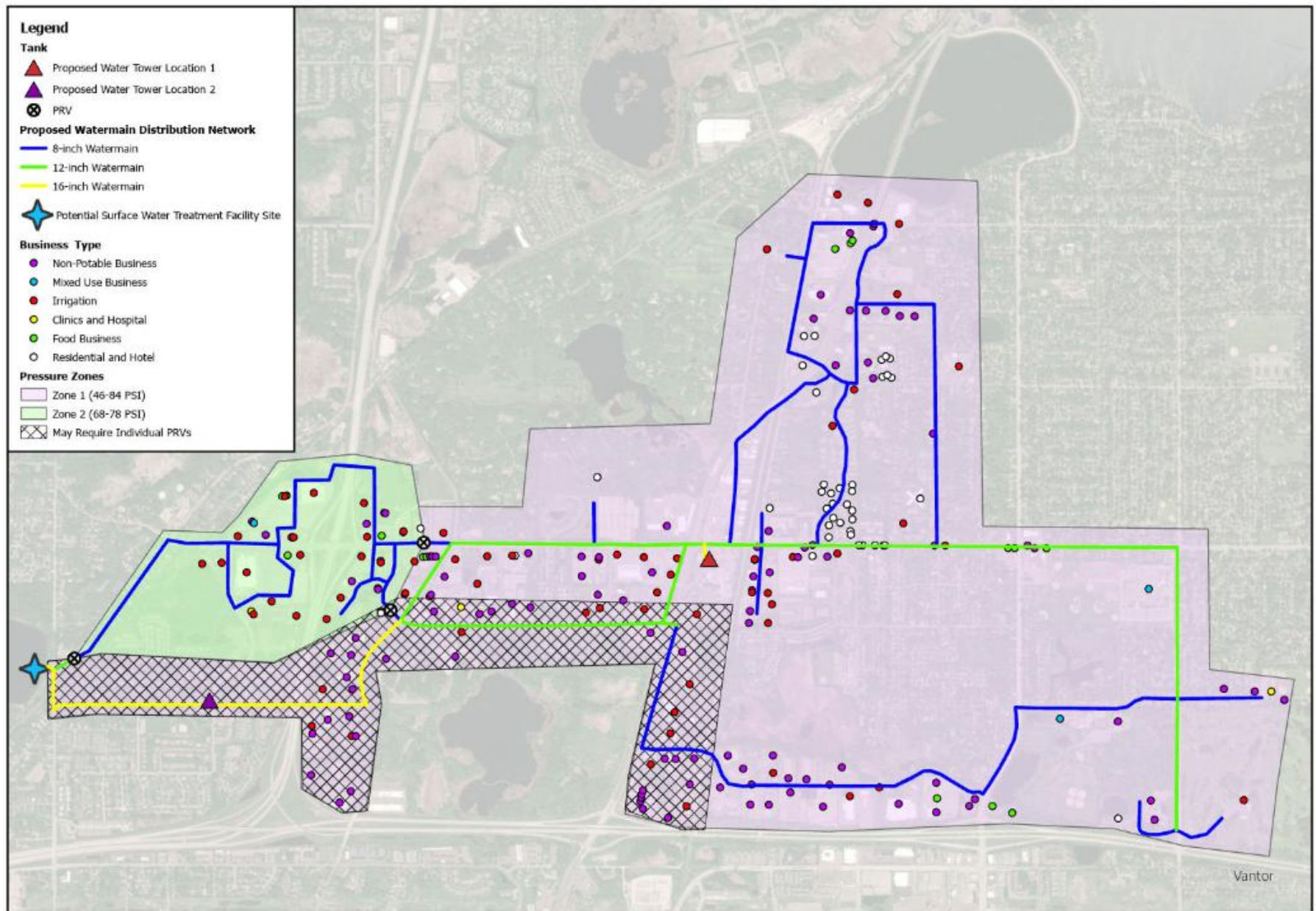
Attachment A. Infrastructure Based Model with Watermain Sizing

White Bear Lake and Vadnais Heights, MN

White Bear Lake Study 11

Attachment A: Infrastructure-Based Model with Watermain





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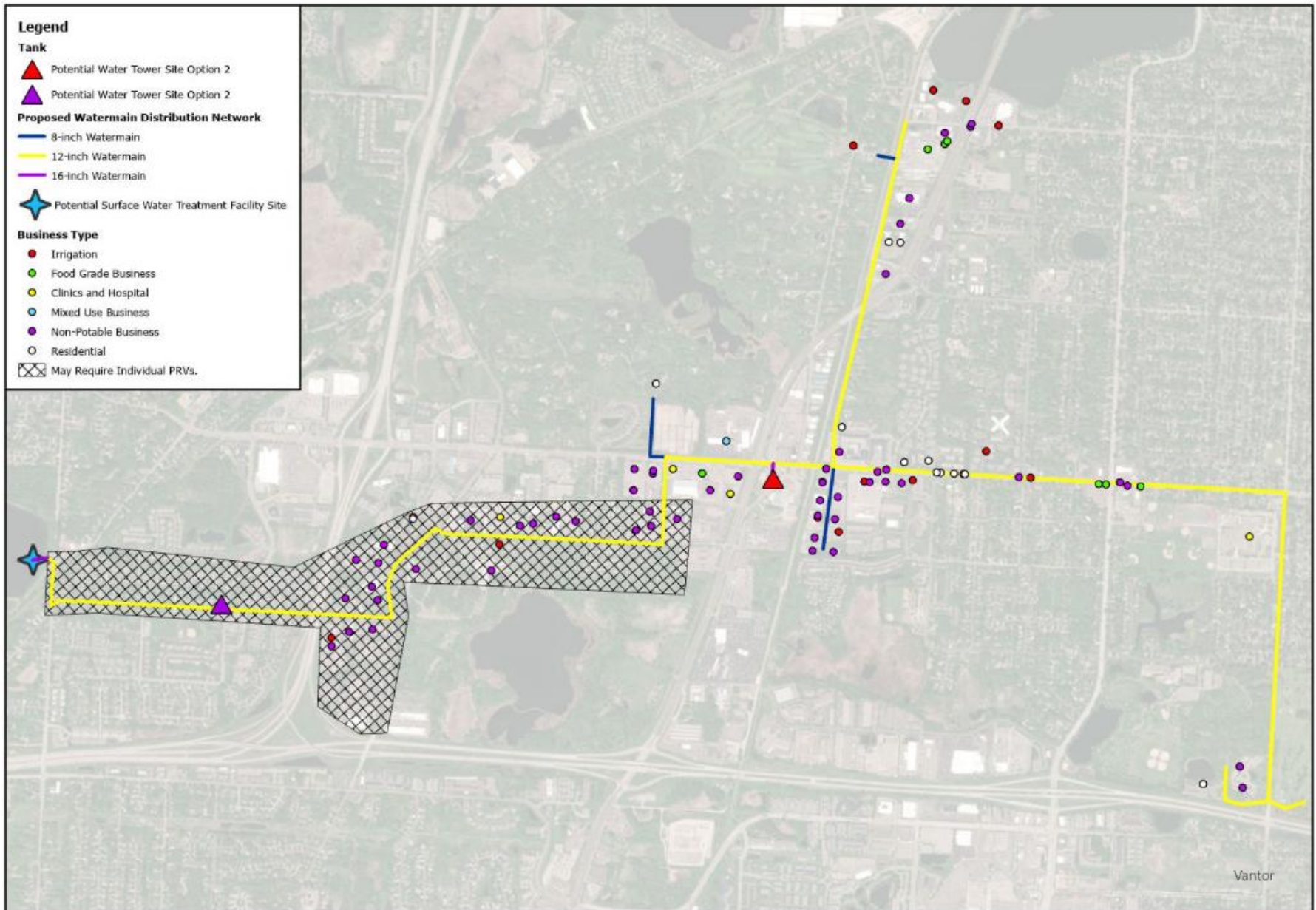
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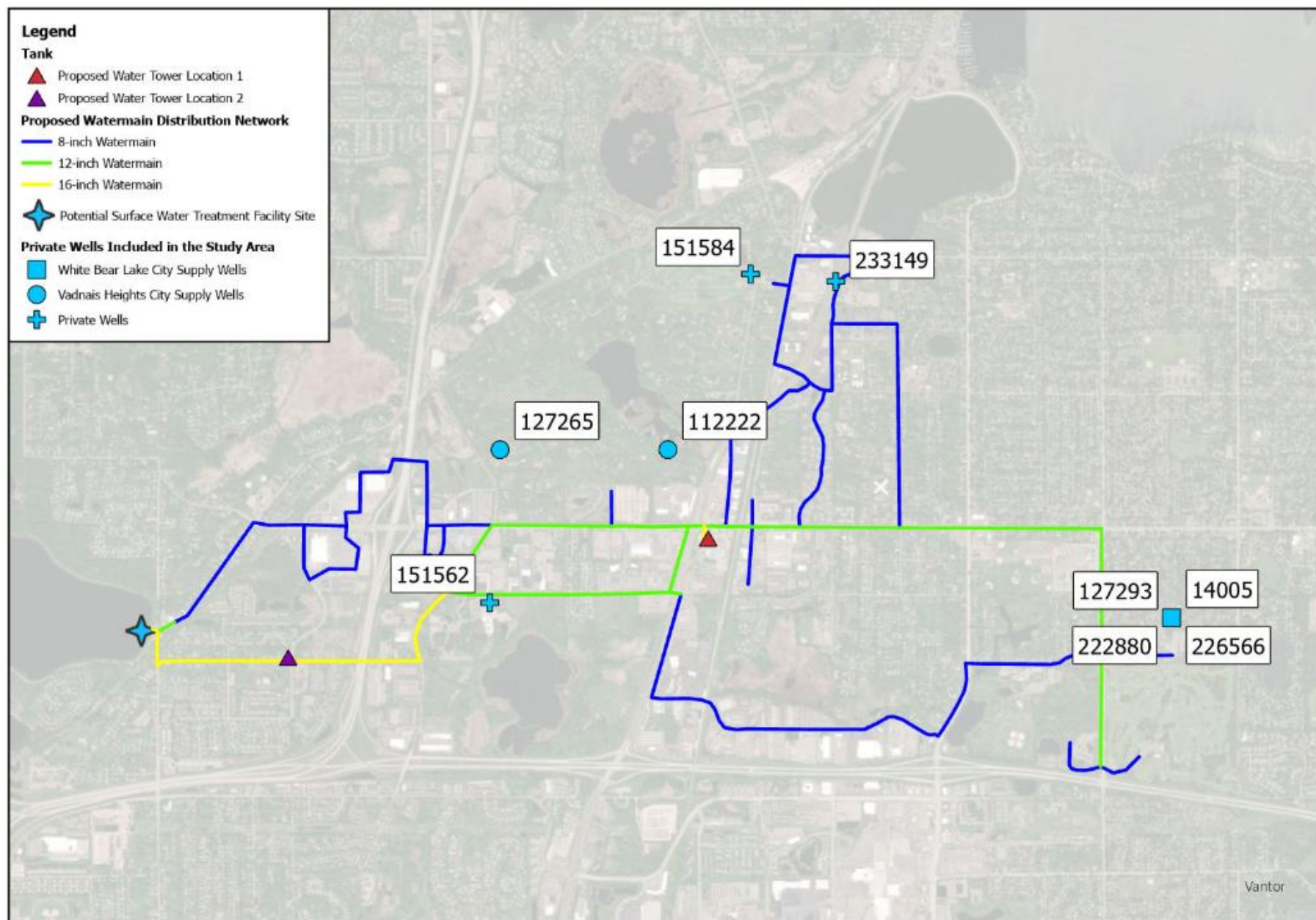


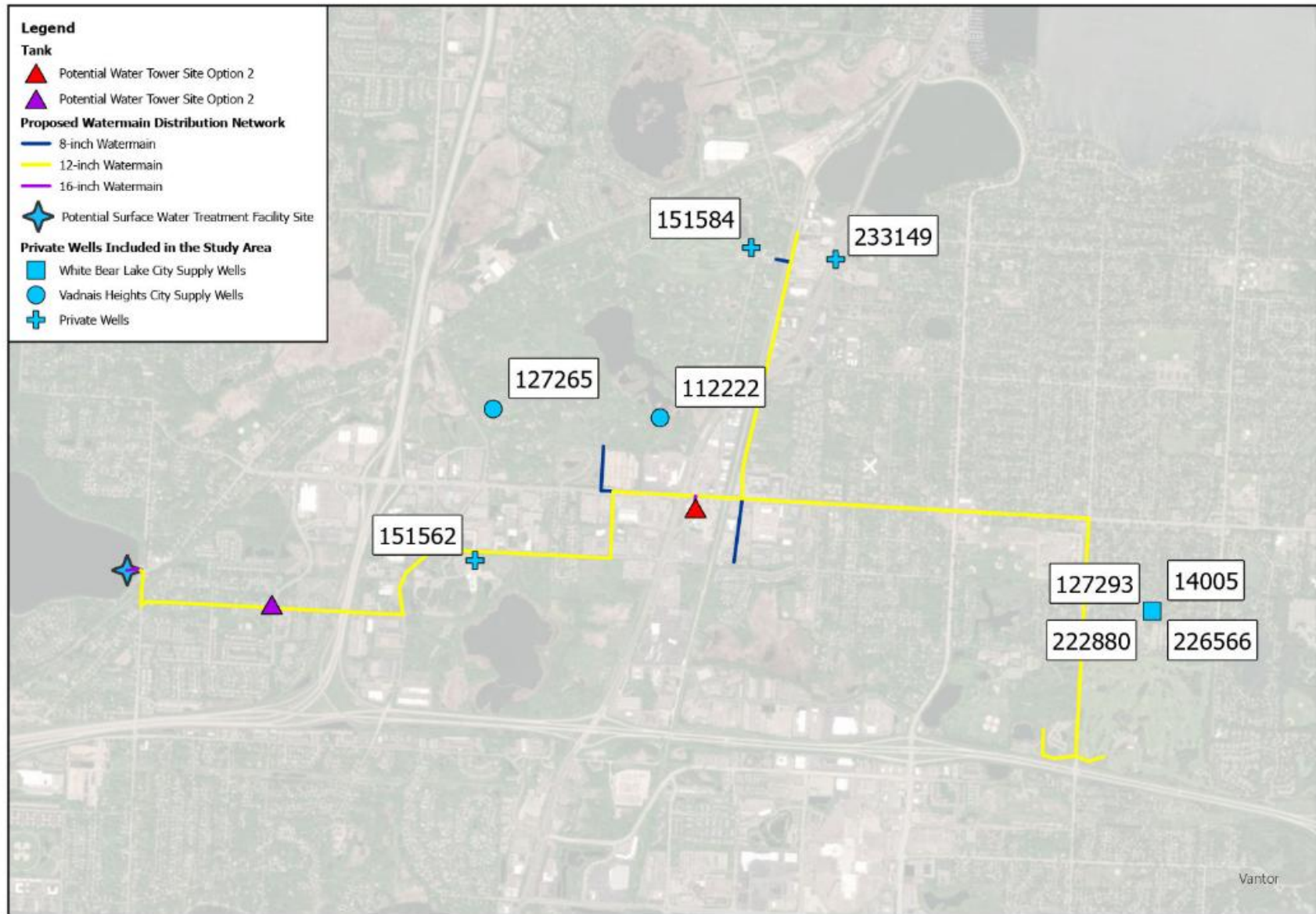
Attachment C. Infrastructure Based Model with Business Type

White Bear Lake and Vadnais Heights, MN
White Bear Lake Study 11

Attachment C: Infrastructure-Based Model with Business Type







Attachment F. User Based Model with Well Locations
 White Bear Lake and Vadnais Heights, MN
 White Bear Lake Study 11

Attachment F: User-Based Model with Well Locations