

LINDON CITY

2017 CULINARY WATER SYSTEM UPGRADES PLAN (50% REPORT)



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EXECUTIVE SUMMARY

The Lindon City Culinary Water System Upgrades Plan presents the findings and recommendations of a study of possible sites for a future culinary tank analyzed. J-U-B Engineering commissioned the study to understand the available land for a culinary storage tank and its effect on existing pressure zones. This report will only cover what MaRS Engineering has completed up to this point, with the final design being completed by April 10. All suggestions and designs in this report are not final, are subject to change based on further analysis, and should not be used as the final design.

The design standards were set by J-U-B Engineering in their report to Lindon city, "Lindon City: 2015 Culinary Water System Master Plan and Capital Facilities Plan." The total max day demand anticipated for Lindon city by the year 2025 is 3,138 gpm with an average day demand of 1,687 gpm (peaking factor set as 1.86). Focus areas for a new culinary tank were parks and the expansion of the 0.5 million gallon (MG) tank to 1.38 MG. A map including all areas that have had preliminary testing can be found in the Appendix.

The primary objective of MaRS has been to become familiar with the modeling software EPA Net, determine possible locations for future tanks, and model these locations in EPA Net. The only working model up to this point has been the expansion of the 0.5 MG tank. The expansion of the tank would require the connection of the 18" pipe to the main water line on center street to be moved to 400 E; a total of 1,900 ft. Other preliminary models have been analyzed thoroughly with no successful runs.

The main roadblock in analysis is that adding an additional tank drains the upper 2 MG tank quicker than it can be filled, which results in negative pressures in the Canberra pressure zone. To help resolve this, MaRS has attempted to add pumps to the system to increase the head in the system, but this results in higher pressures in the pressure zone or prove ineffective in filling the upper tank. Another area of concern is the lack of elevated areas that allow tank water to build up enough pressure through gravity head to enter the mains. The pipeline must either extend past the existing PRVs extensively or a pump must be installed to increase its pressure sufficiently. Other problems exist when Well #4 begins to pump; there is significant increase in pressure in the middle zone which exceeds the limits set forth.

Recently, a loop was discovered in the system where the existing 0.5 MG and 1.0 MG tanks empty into a pipeline used to refill the 2 MG tank and supply the upper zone – see Appendix A for a graphic showing this loop. This results in the lower zones primarily being supplied by the nearby wells rather than the tanks. A significant amount of head is lost in this process because it is creating a loop. Further analysis will be focused on resolving this issue in hopes that the number of PRVs may be reduced and provide working models to J-U-B.

CULINARY WATER SYSTEM UPGRADE PLAN

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INTRODUCTION

Purpose

This document is intended to present MaRS engineers' recommended plan for the location of a new culinary tank in Lindon city. It discusses the City's current culinary water system and the advantages and disadvantages of different plausible locations for the new tank. The conclusions are based on the use of a computer model of Lindon's culinary water system provided by J-U-B Engineering, available land, and immediate and future costs.

Background

Lindon's culinary water originates from four wells spread throughout the city, with an additional amount from a mountain spring. This water is stored in three culinary tanks in two locations in the city. An analysis by J-U-B of the City's future culinary needs recommends a minimum of 0.88 million gallons (MG) of additional storage by the year 2024. The main purpose of MaRS Engineers is to assess and analyze possible locations for a future tank and its effect on the current pressure zones, and also examine other possibilities of meeting the needed capacity.

In J-U-B's report to the City, "Lindon City: 2015 Culinary Water System Master Plan and Capital Facilities Plan", their recommendation for additional storage was to upsize the half MG tank to 1.38 MG tank. J-U-B commissioned this study to examine other possible locations for storage that would reduce the amount of energy loss in the culinary system while not negatively impacting the current pressure zones. It was also acknowledged that additional storage may require more flow in the system and an investigation into the possibilities of a new well or upgrading an existing well would be included in the research. The analysis model provided by J-U-B assumed an upgraded well was already in place and design values based on buildout values.

Scope

This plan discusses the model used for analysis and summary results, and the costs associated with each option. A review of each analysis is included with comments on which options are the most viable.

Objectives

The objectives of this analysis are listed below:

1. Obtain information for possible locations for a new culinary tank.
2. Model the locations in EPA Net with at-buildout parameters.
3. Make adjustments to the new system as needed to meet standards of pressure and flow.
4. Estimate cost of the new systems.
5. Rate each system based on their cost and feasibility.
6. Make recommendations for the most viable option.

APPROACH

Existing Conditions

A map of the culinary water system for Lindon in 2015 is provided in the Appendix. The system currently has six pressure zones, four wells and four culinary tanks. There is also a spring that feeds into the Canberra tank and all of its flow is utilized.

The data used to perform analysis was provided for by J-U-B. Their data was based on 2014's calendar year actual water use data and locations and used tank and well supervisory control and data acquisition (SCADA) data for their evaluations. J-U-B analyzed the existing culinary system with this data and their results can be found in their report "Lindon City: 2015 Culinary Water System Master Plan and Capital Facilities Plan" to the city.

Levels of Service

Demand

The total max day demand anticipated for Lindon in 2025 is 3,138 gpm, with an average day demand of 1,687 gpm (daily peaking factor set as 1.86).

Pressure

As per discussion with J-U-B, the desired pressure for the city for normal days is between 50 psi and 150 psi. However, the minimum value may be waived based on certain conditions consistent with the Utah Administrative Code Section 309-105-09, Minimum Water Pressure requirements. The levels of service required for analysis are listed here:

- a. Minimum of 20 psi with fire flow during peak day demand
- b. Minimum of 30 psi during peak instantaneous demand
- c. Minimum of 40 psi during peak day demand

Storage

Based on the expertise of the local fire authority representative for Lindon, the amount of fire suppression storage is equal to 4,500 gpm for 3 hours, which accumulates to 810,000 gallons.

Due to communication between J-U-B and the Lindon City staff, emergency storage should be provided for 12 hours of average day demand, which amounts to 782,000 gallons.

Fire flow

While maintaining 20 psi system-wide during fire flow, the system must also provide the following minimum requirements:

- a. 1,000 gpm per minute in temporary and permanent dead end lines in residential zones.
- b. 1,500 gpm in residential zones
- c. 2,000 gpm in commercial and industrial zones

Tank Locations

A focus for MaRS was to find locations that would reduce the need for PRV's or provide storage at lower elevations than the existing tanks to reduce the current energy lost in pumping uphill. A working model of any of these locations would result in long-term savings for Lindon city.

In order to save Lindon city the expense of purchasing new property, the first models focused on placing tanks in parks. The elevation of each location was determined through the webpage Free Map Tools – Elevation Finder. We related these elevations with the ones in J-U-B's model and verified them to be accurate. Parks low in elevation (throughout Zone 1) were avoided since they cannot create enough head to be beneficial to the lower zones.

Modeling

A model in EPANET was provided by J-U-B for the Lindon's culinary water distribution. It included some of the future improvements (such as upgrading well #3 to 1900 gpm) to the existing system and was fit to analyze the future needs of Lindon city at the time of buildout. The model had the peak daily factor set for 1.86. This value was determined by J-U-B in their analysis of Lindon's current water status and future needs. This factor was used as per their instruction with the assumption it would not significantly change after buildout.

The models analyzed are modified versions of the original J-U-B model. Each copy embodies a different location and all changes necessary to make the culinary system operable. Efforts were initially concentrated on areas other than J-U-B's recommendation to the city of expanding the 0.5-million-gallon tank, but this area was given considerable attention as well.

The success of a model depends on its ability to meet the levels of service mentioned above for the 1.86 peak factor. To ensure the system will work indefinitely, tests should be able to work for up to 200 hours with clear signs of sustainability.

FUTURE CULINARY WATER SYSTEM AT BUILDOUT OPTIONS

Overview

A review of the tested models and their associated costs are found in the following sections. The models are placed in the order of options found most favorable for Lindon.

0.5 MG Expansion

The 0.5 MG tank expansion focuses on expanding the 0.5 MG tank to a 1.38 MG tank. The existing 0.5 MG tank is located in a park on 835 E near 300 N, next to a 1.0 MG tank. These tanks receive their water from several wells and empty into the 18" main along Center street at about 700 E. Contents from this tank are pumped up to the 2.0 MG tank above as needed to supply the Canberra zone.

The new tank would be approximately 128 ft. in diameter and 15 ft. in height. Due to the increased pressure in the system at the time of buildout from higher demands and upgrades to the wells, the connection point to the Center street main would need to be relocated west to the intersection of Center street and 400 E. Approximately 1900 ft. of 18" pipe would need to be installed between 700 E to 400 E. The extension would increase head between these points by 40ft (about 17 psi).

The advantages of this option are the cost and simplicity of it. The land is already owned by Lindon and there is enough space available for the expansion – see the appendix for the approximate size of the new tank in comparison to the existing. There is no need for major modifications to the existing culinary system and only a 3 block extension of the 18" pipe is required, which results in less interference with the public's day to day activities from less construction. The cost is relatively cheap compared to extensive piping and land acquirement required for a new tank in a new area.

A possible issue with this tank would be its infringement on the existing space. The current parcel containing the two tanks is somewhat small and an extended tank would take away about 8450 ft² (.19 acres) of grass space away. However, this does not appear to be a significant issue because this is not considered a park and the public would not be as concerned with changes to this area.

Other Preliminary Tests

The appendix contains a map of all locations with a tested model so far. Currently, no other model meets the required levels of service. The current models all have the same or similar problems, which are summarized below:

1. The 2 MG tank drains quicker than it can be filled, which results in negative pressures in the Canberra pressure zone
2. A lack of elevation usually require a pipeline that must either extend past the existing PRVs an extensive distance or a pump must be installed to increase its pressure sufficiently

3. Well #4 adds considerable pressure to the lower zone, causing it to exceed the limit of 150 psi static pressure

To resolve these issues, MaRS has attempted adding a pump for each prospective tank to assist their ability to contribute to the zones, but this usually results in higher pressures or prove ineffective in filling the upper tank. One solution that seems to help, but not completely resolve the issue, is relocating the Center street connection point of the 1.0 MG and 0.5 MG from 700 E to 400 E. This option allows the 1.0 MG and 0.5 MG tanks to contribute more to the system and reduces the flow from the 2 MG tank. However, the pressure issues of the middle zone remain.

Recently, a loop was discovered in the main lines where the existing 0.5 MG and 1.0 MG tanks empty into a pipeline used to refill the 2 MG tank and supply the upper zone. This means the 0.5 and 1.0 MG tanks are doing very little for supplying the lower zones and instead focuses on the upper zone. A significant amount of head is lost in this process because it is looping instead of draining. More analysis will be focused on resolving this issue in hopes that the number of PRVs may be reduced and provide working models to J-U-B.

CONCLUSION AND RECOMMENDATIONS

Based on analysis up to this point, the recommended option for a storage tank is to expand the 0.5 MG tank and extend its connection to the intersection of 400 E and Center street. The expansion of the tank does not require any pumps and allows Lindon to fulfill their water need without significant new construction. The estimated cost is \$2,530,000, which includes the expansion of the tank and the extension of the 18" pipeline. This cost does not include any future maintenance this system may require, but because it does not require any power other than what the city currently uses, it has longer-term cost savings than other options. Our analysis so far with this model does not reduce the amount of PRVs in the system, but further research will reveal more on the matter.

APPENDIX A

MAPS

Figure A 1 – Preliminary Contour Map of Lindon with Pipes, Tanks, and Wells

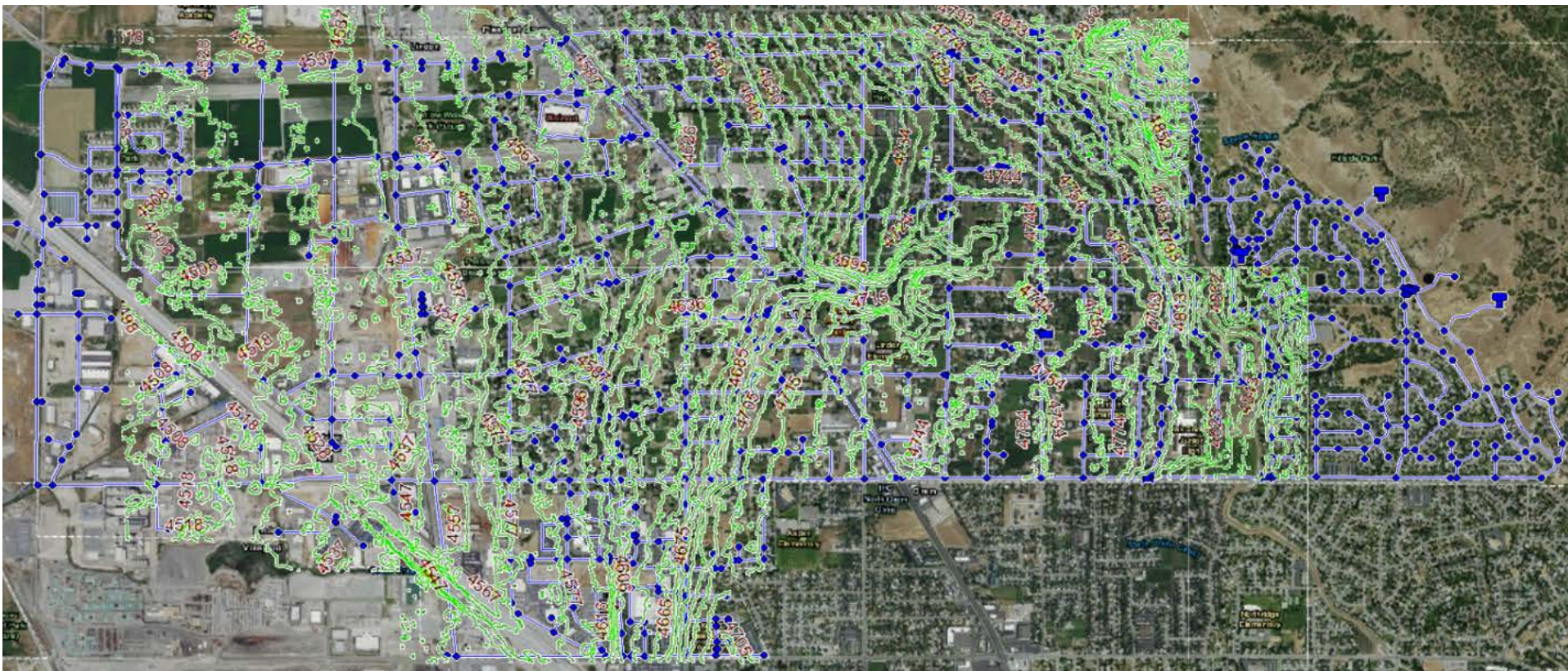


Figure A 2 - Preliminary Tested Locations

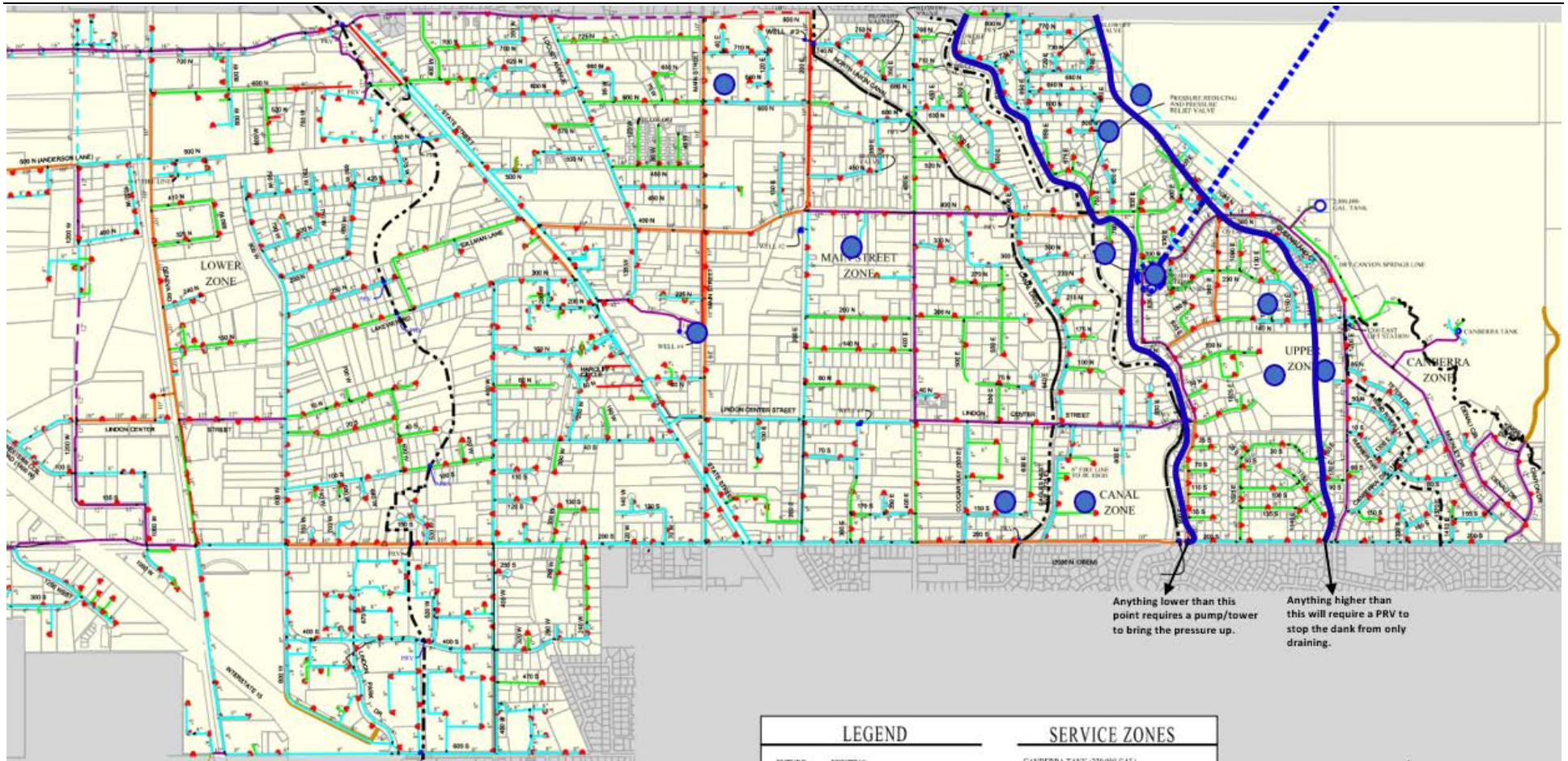


Figure A 3 – Existing and Future Expansion of 0.5 MG Tank

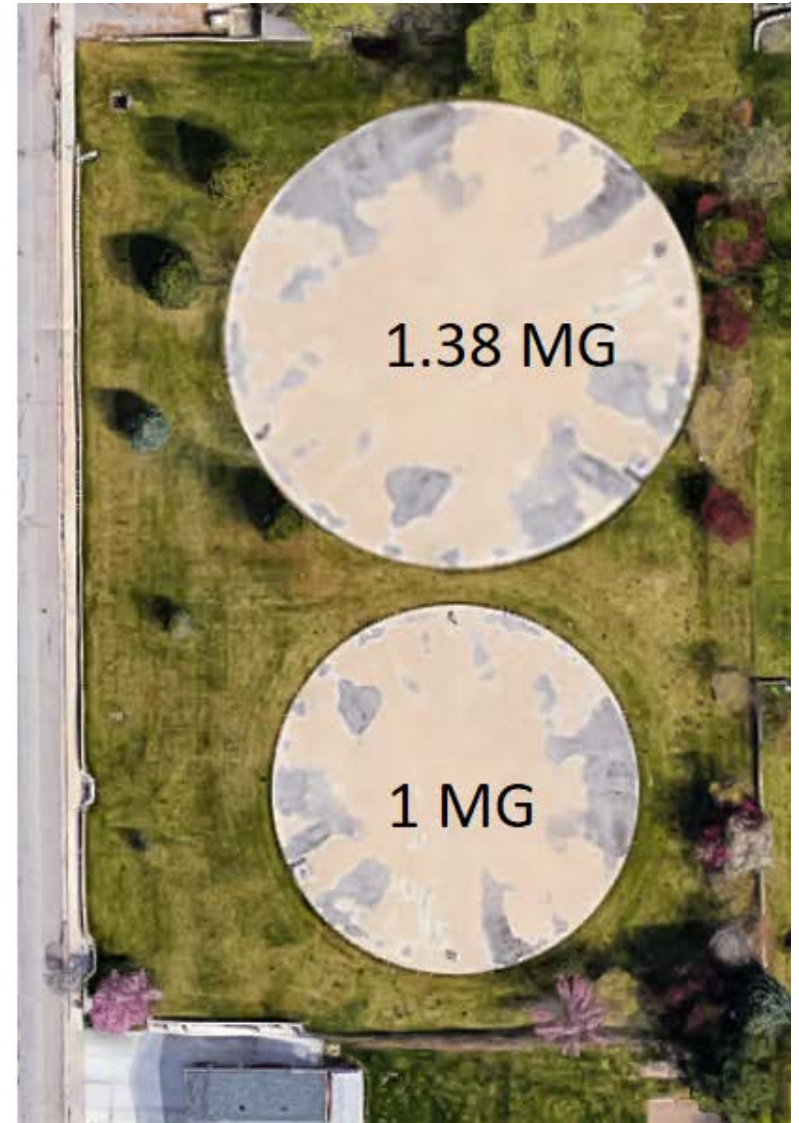
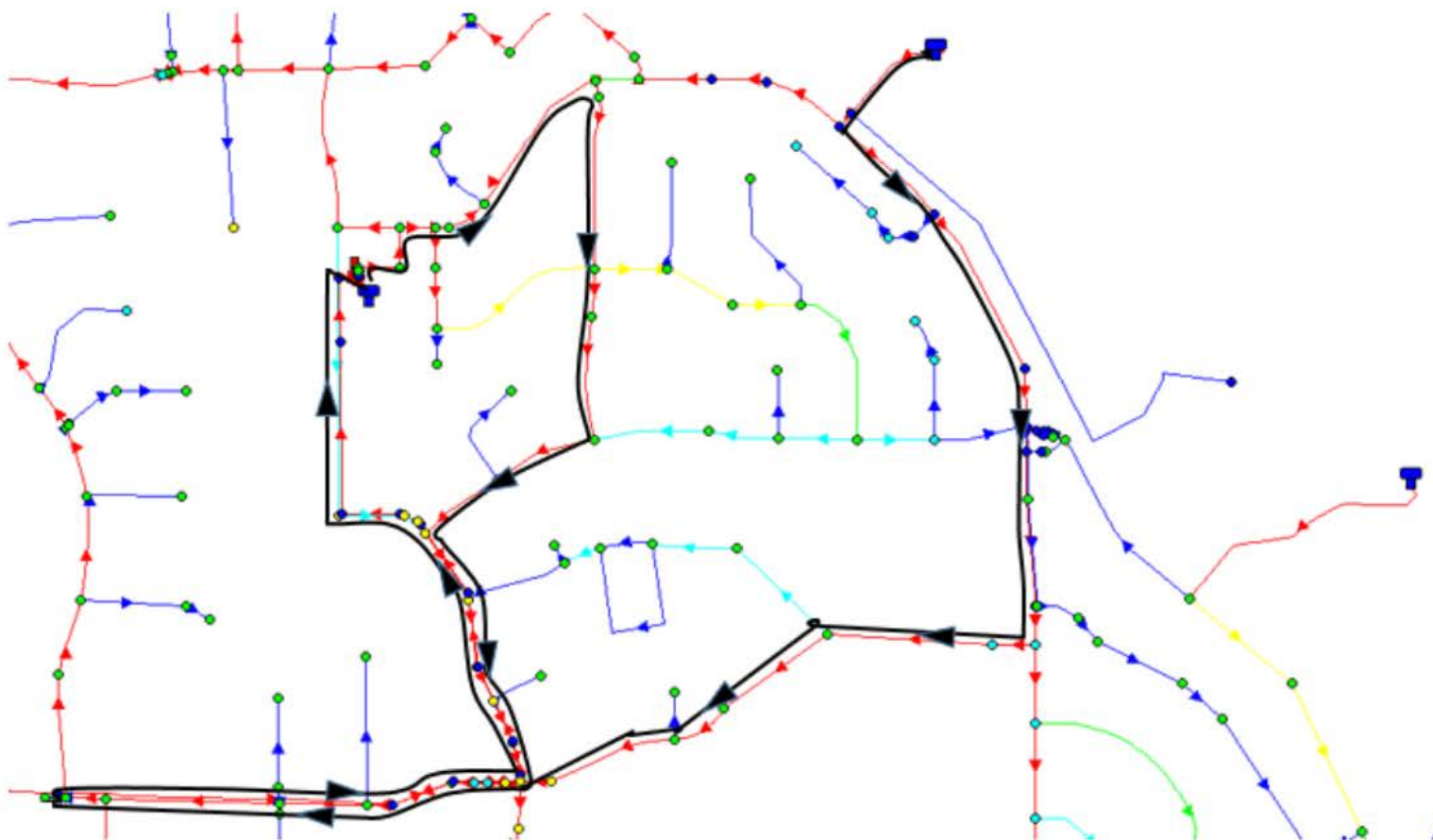


Figure A 4 – Flow Loop Discovered between the 2 MG and 0.5 and 1.0 MG tanks.



APPENDIX B

Opinion of Projected Costs

Present-day costs were based on estimates provided and established by J-U-B for their projects. Some of the values were slightly modified to reflect inflation that have occurred since their 2015 estimates. Lot specific values were determined based on J-U-B estimates, interpolation, and research of current construction costs. J-U-B's opinion of 25% total costs for preliminary engineering, construction engineering, materials testing, construction inspection, administrative, legal, and bonding was used without modification.

Table B 1 – Miscellaneous Costs Used for Project Cost Analysis and Interpolation of Other Related Costs

Item	Unit	Amount
Remove existing pump and motor	lot	\$ 5,000
Video inspection of well	lot	\$ 2,000
Brush and bail well casing and perforations	hour	\$ 250
Test pump well (24 hours test)	lot	\$ 15,000
Re-install existing pump and motor	lot	\$ 5,000
1900 gpm pump and 300 hp motor	lot	\$ 125,000
300 hp variable frequency drive	lot	\$ 20,000
650 gpm pump and 100 hp motor	lot	\$ 75,000
100 hp variable frequency drive	lot	\$ 10,000
Chlorination equipment and appurtenances	lot	\$ 40,000
Drinking Water Source Protection Plan update	lot	\$ 10,000
Preliminary evaluation report and drinking water source protection	lot	\$ 75,000
Well drilling 16" casing	lot	\$ 500,000
Well house	lot	\$ 250,000
Mechanical piping, fittings, valves, meter	lot	\$ 50,000
Electrical service entrance improvements and capacity upgrades	lot	\$ 125,000
Mechanical piping, fittings, valves, flow meter and appurtenances	lot	\$ 75,000
Telemetry and SCADA equipment	lot	\$ 65,000
Land acquisition	acre	\$ 100,000
Earthwork (cut)	C.Y.	\$ 11
Earthwork (fill)	C.Y.	\$ 10
Remove and dispose of existing tank	lot	\$ 55,000
New tank (1.38 MG)	each	\$ 1,300,000
Kilowatt hr	hr	\$ 0.0803
Asphalt repair	L.F.	\$ 35
Other Fees: Engineering, Legal Administrative, Finance 25%	% of total costs	

Table B 2 – Costs Used for Estimated Pipe Installation

Item	Unit	Unit Price
8" Water main	L.F.	\$ 20
10" Water main	L.F.	\$ 25
12" Water main	L.F.	\$ 30
14" Water main	L.F.	\$ 40
18" Water main	L.F.	\$ 65
8" Gate valve	each	\$ 1,500
10" Gate valve	each	\$ 2,500
12" Butterfly valve	each	\$ 3,000
14" Butterfly valve	each	\$ 4,000
18" Butterfly valve	each	\$ 6,500
8" Bend/Reducer	each	\$ 500
10" Bend/Reducer	each	\$ 650
12" Bend/Reducer	each	\$ 800
14" Bend/Reducer	each	\$ 1,000
18" Bend/Reducer	each	\$ 1,600
10" Cross	each	\$ 1,500
12" Cross	each	\$ 1,800
14" Cross	each	\$ 2,200
18" Cross	each	\$ 3,200
Culinary line bedding material	L.F.	\$ 2
Culinary line backfill material	L.F.	\$ 16

Table B 3 – Estimated Cost for the 0.5 MG Tank Expansion

0.5 MG Tank Expansion and 18" Pipeline				
0.5 MG Tank Expanded to 1.38 MG Tank				
Item Description	Quantity	Unit	Unit Price	Amount
Earthwork (cut)	13200	C.Y.	\$ 11	\$ 145,200
Earthwork (fill)	6600	C.Y.	\$ 10	\$ 66,000
Remove and dispose of existing 0.5 MG tank	1	LS	\$ 55,000	\$ 55,000
1.38 MG tank	1	each	\$ 1,300,000	\$ 1,300,000
Piping, fittings, valves, meters, etc.	1	each	\$ 55,000	\$ 55,000
Telemetry/Control/Monitoring	1	each	\$ 55,000	\$ 55,000
18" Extension to 400 E				
18-inch Main Line	1900	L.F.	\$ 148	\$ 281,200
Asphalt repair in PG 1000 South	1900	L.F.	\$ 35	\$ 66,500
Other Fees: Engineering, Legal Administrative, Finance 25%				\$ 505,975
Total Cost				\$ 2,530,000