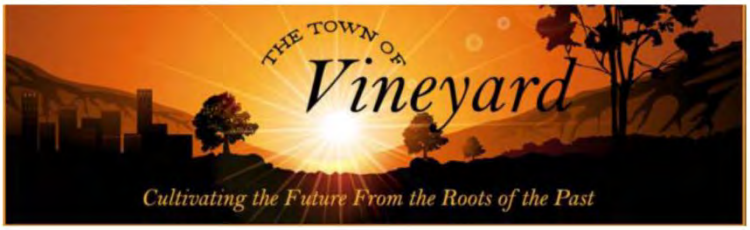
CENTRAL UTAH WATER
CONSERVANCY DISTRICT

OREM



STORAGE TANK EVALUATION AND LOCATION STUDY

(HAL Project No.: 207.15.100)

FINAL

February 2017

HANSEN ALLEN & LUCE inc
ENGINEERS

CENTRAL UTAH WATER CONSERVANCY DISTRICT
CITY OF OREM
TOWN OF VINEYARD

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(HAL Project No.: 207.15.100)

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Bill Peatross – CWP Systems Manager

City of Orem

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Town of Vineyard

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EXECUTIVE SUMMARY

The purpose of this report is to evaluate the finished water storage tank needs and possible tank locations for the City of Orem (Orem) and Town of Vineyard (Vineyard) drinking water systems. Some of the existing water storage for each system is co-located with Central Utah Water Conservancy District (CUWCD) treated water storage that provides operational storage for its Don A. Christiansen Regional Water Treatment Plant (DACRWTP) and allows CUWCD to provide reliable and safe water deliveries to all of its wholesale customers.

Recently, as growth has occurred in Orem and Vineyard, water demands during peak season have increased and have caused water levels in the combined storage facility (Figure E-1) to drop below acceptable operating minimums. Orem and Vineyard seek to evaluate storage needs and to properly locate storage tank(s) to be built in the near future. CUWCD would like alternatives evaluated that would maintain operational storage minimums in the combined facility.

Figure E-1: CUWCD Storage Tanks

EXISTING WATER SYSTEMS

The CUWCD is a regional wholesale water supplier to numerous cities and agencies, including Orem and Vineyard. CUWCD supplies treated water from the DACRWTP to Orem, Provo, Vineyard, Lehi, Saratoga Springs, Eagle Mountain, and Jordan Valley Water Conservancy District. The DACRWTP (formerly known as the Utah Valley Water Treatment Plant) was constructed by the CUWCD during 1977-1979. The initial capacity of the plant was 42 million gallons. From 1985 through 1989, the CUWCD designed and constructed a new 15 MG storage tank to provide critical operational storage capacity. In 2001, an expansion of the treatment plant to 80 MGD was completed. In 2004, Orem and CUWCD jointly recognized that Orem was utilizing critical operational storage and that additional distribution and operational storage would be required. Orem and CUWCD began a joint storage evaluation and concluded to jointly construct a new 20 MG storage reservoir (both Orem and CUWCD desired a larger tank, but site constraints only permitted the construction of a 20 MG tank). All plant and storage reservoir construction and expansion, with the exception of Orem's 10 MG capacity of the CUWCD-owned 20 MG tank, was paid for by the District using District funds--no federal funds

were involved. Upon completion of the 20 MG reservoir, Orem sold 0.5 MG of storage capacity to the Town of Vineyard.

Currently, the DACRWTP has a treatment capacity of 80 MGD and there is 37 MG of storage on site—27 MG of operational storage for the CUWCD, 9.5 MG of storage for Orem and 0.5 MG of storage for the Town of Vineyard. The CUWCD storage facilities at the treatment plant were constructed to provide operational storage for the treatment plant, not distribution storage for individual customers. This operational storage provides an additional benefit to the users, (provided that the storage levels are not regularly fluctuating), which allows customers to have a sufficient amount of time to reduce usage or switch sources in the event of an emergency that disrupts operation of the plant. The treatment plant is designed to produce approximately 80 MGD. This would require 27-40 MG of operational storage. Currently, the plant has approximately 27 MG of operational storage. This volume of storage provides just over 8 hours of operational storage.

In 2006 CUWCD purchased from the former Geneva Steel certain water rights and other assets. These water rights were combined with other water rights owned by CUWCD to develop a project known as the Central Utah Water Conservancy District Water Development Project, or CWP. The CWP delivers about 53,000 AF of high quality culinary water to northern Utah County and southern Salt Lake County. In 2008, CUWCD entered into an agreement with Anderson Geneva, developer of the former Geneva Steel site, for the purchase of well sites, easements, and other rights. This agreement assumed CUWCD would supply water to all of the Geneva Steel property. As part of the compensation for this purchase, CUWCD agreed to reserve 8,000 AF of water for the Geneva Steel property in Vineyard and provide up to 4 MG of temporary water storage until April 2021, after which CUWCD will construct or provide 2 MG of storage for the Geneva property.

In 2009, Vineyard entered into an agreement with CUWCD to purchase CWP water for the Vineyard area. Vineyard also entered into an agreement with Orem. This new agreement modified the service area of the 2008 Anderson Geneva/CUWCD agreement (all of the Geneva Steel property), and provided that Orem would supply water service to a portion of Vineyard (all of Vineyard south of 400 North) and CUWCD, through the CWP, would provide water service to the remainder of Vineyard (north of 400 North). This agreement also required Vineyard to maintain a certain volume of storage in proportion to the on-going development in the south area of Vineyard served by Orem.

In order to address operational and storage concerns of Orem, Vineyard and CUWCD, a Memorandum of Understanding (MOA) was executed in 2013 between Orem, the Town of Vineyard, CUWCD, the Metropolitan Water District of Orem, and the developers of the Geneva Property (Anderson Geneva LLC, Ice Castle Retirement Fund LLC, and Anderson Geneva Development, Inc.). This MOA noted the necessity of additional study of required storage volumes for both Vineyard and Orem.

The Orem water system currently provides drinking water to approximately 92,000 people. The Orem water system is divided in 12 separate pressure zones from high on the benches to homes near Utah Lake. The Vineyard water system consists of a single pressure zone, but, as is explained above, is divided into two separate water systems—Vineyard North and Vineyard South. It is anticipated that the Vineyard North system would ultimately serve a population equivalent of approximately 15,000 people and the Vineyard South would serve a population equivalent of approximately 20,000 people. The source of water for the Vineyard North area is from metered connections with the CWP drinking water system and the source of water for the Vineyard South area is from metered connections with the Orem drinking water system. Vineyard North and Vineyard South are interconnected by two normally closed valving

arrangements along 400 North. In an emergency the valving can be opened and the two systems connected.

STORAGE REQUIREMENTS

Orem and Vineyard currently have 22.4 MG of reservoir storage capacity serving their water systems (Orem has 21.9 MG and Vineyard has 0.5 MG). Existing required reservoir storage in accordance with recent master plans completed by both Orem and Vineyard is 34.4 MG (Orem existing required storage is 31.7 MG and Vineyard is 2.7 MG). Thus, Orem needs an additional 9.8 MG and Vineyard an additional 2.2 MG to meet existing requirements. These storage requirements include equalization storage, fire flow storage, and emergency storage. Thus, the existing storage deficit is 12.0 MG. Build-out required storage is 52.5 MG (44.3 MG for Orem and 8.2 MG for Vineyard). The buildout storage deficit is 30.1 MG, with Orem requiring an additional 22.4 MG and Vineyard 7.7 MG. Of the existing 22.4 MG of storage capacity, 13.9 MG is located at an elevation that can serve the Upper General Storage Area within Orem (see Figure 2-2 of the report). The build-out storage requirement for the Upper General Storage Area in Orem is 13.9 MG. Thus, the existing and build-out storage deficits apply to the central and western areas of Orem and to the Town of Vineyard.

STORAGE LOCATIONS

While Orem maintains multiple pressure zones (i.e. twelve pressure zones) within its water system, four general storage areas have been identified that make sense when evaluating required reservoir storage for the Orem and Vineyard water systems. The four storage areas are referred to herein as the Upper Area, the Central Area, the West Area, and the Lake Area. The pressure zones included in each area are listed in Table 2-1 of the report. The locations of the existing water system pressure zones are illustrated on Figure 2-1 of the report. The locations of the general storage areas are illustrated on Figure 2-2 of the report.

Potential water storage tank locations were identified by comparing required elevations for the tanks to serve the general storage areas by gravity with potentially available properties. From this comparison, Orem and Vineyard initially selected six potential sites for more detailed analysis. These sites include Site 1 – 600 West 400 North (Geneva Park), Site 2 - 600 West Center St.(Mountain View High School), Site 3 - 600 West 400 South (Orem Community Park), Site 4 – 800 East 1200 North (Lower Cemetery Field), Site 5 – 800 East 1600 North (Cascade Drive), Site 6a – 400 South 1500 West, and Site 6b – 400 North 1500 West, and Site 7 400 North Main Street, Vineyard. Based on subsequent input from Orem and Vineyard, an additional tank site was added within the Town of Vineyard for required Vineyard storage (Site 7 – 800 North, Immediately West of Geneva Road), and a second alternative to the Site 5 Tank (Site 5a) was added which includes demolition of the existing 8 MG of storage that serves the Orem Central and West General Storage Areas and replacement of that storage with a larger tank. The locations of these sites are illustrated on Figure 4-10 of the report.

Reconnaissance level geotechnical/geologic, structural, and constructability reviews were completed for each site. In general, from a geotechnical/geologic standpoint all of the sites with the exception of Sites 6a and 6b, and Site 7 are more favorable for tank construction. There are no mapped active faults through the sites, and the sites are mapped as having “very low” potential for liquefaction (except for Sites 6 and 7 which have a “high” to “moderate” potential for liquefaction). Slope stability is a concern for Site 5 and a geotechnical study should be performed to evaluate required slope stabilization measures. Again, with the exception of Sites 6 and 7, none of the other sites contained issues that would cause structural concerns in designing the tank. The structural engineer did not recommend construction at the Sites 6a, 6b, and 7 due to the high groundwater potential, low soil bearing pressure, and the high to

moderate potential for liquefaction without mitigation of these issues at the sites. The structural engineer indicated that if a tank site is constructed in this area, there would be increased costs for soil modification/improvement and increased cost for larger footings to support a tank on the lower soil bearing pressure ground. There are varying issues with constructability of the tanks on the selected sites. Three of the sites (sites 1 through 3) are located in existing parks or school areas. These three sites have existing surface improvements that must be addressed during tank design. Site ownership could be an issue for Sites 2 and 5. Alpine School District owns Site 2 and CUWCD owns Site 5. Due to site conditions, Sites 5 and 5a will most likely require slope stabilization during construction such as a soil nail wall.

MODELING AND ALTERNATIVES DEVELOPMENT

Hydraulic models of the water systems were obtained from CUWCD, Orem, and Vineyard. These models were all "Static" models. They were combined into a single model and converted into a dynamic extended period simulation model. This combined model was utilized to identify optimal storage tank locations and sizes, and to develop and evaluate four tank combination alternatives. Four alternatives were developed for evaluation to identify optimal storage tank locations and sizes. These alternatives include the following:

Alternative 1 focuses on locating tanks where they can serve the general storage areas identified previously via gravity (i.e. pumping is not required to pressurize the water from the tank into the system). Under Alternative 1, filling the tanks is assumed to be controlled via flow control valves at a constant peak day flow rate.

Alternative 2 locates all additional required storage at the sites located within the Orem Central zone that can serve the Lake Area by gravity, but would have to be pumped into the Central/West Area to serve that storage area. Under Alternative 2, tanks would have to fill during non-peak demand hours and then required storage for the Central/West Areas would be pumped out of the tanks into this area during peak demand hours.

Alternative 3 is a hybrid of Alternative 1 and Alternative 2. Initially, there is an immediate need to provide additional storage for the Central/West Area. Similar to Alternative 2, storage tanks would be located within the Central./West Area at an elevation and constructed to a size that will be conducive for gravity feed at a future date for the Lake Area as the Lake Area develops. Initially, however these tanks or tank can be used to provide storage for the Central/West Area by constructing a booster pumping station at the site(s) capable of pumping into the pressure of the Central/West Area. Under Alternative 3, the booster pumping station(s) would be temporary and would not be required once the additional storage and large diameter transmission piping, identified under Alternative 1, is constructed. Alternative 3 is identical to Alternative 1, but in the near term it provides ground level storage at Site 3 to serve the current deficiencies in the Central zone with pumping.

Alternative 4 is similar to Alternative 1 for Orem, but assumes that all of the Vineyard storage is located within the Town of Vineyard. Storage located inside of Vineyard cannot serve the Town by gravity, but will require pumping out of the tanks into the Vineyard system. Under this alternative, it has been assumed that all of the water supplied to the Vineyard system will be directly from the CUWCD system, and not through Orem. If the tanks are located inside of the Town of Vineyard, Vineyard can take advantage of the transmission capacity already in the CUWCD system and would not need to participate in creating additional transmission capacity in the Orem system. Thus, transmission pipelines pertaining to Orem can be smaller than proposed in Alternative 1.

Alternatives 1, 2, 3, and 4 facilities (including tanks, transmission pipelines and booster pumping stations) are illustrated on Figures 5-1, 5-3, 5-5, and 5-7 respectively, of the report.

In identifying which tanks should be built where, and the volumes of the tanks that should be built at the identified sites in each alternative, several factors have been considered in the evaluation. These include the following:

1. There are some minor differences in elevation between Sites 1 – 600 West 400 North, Site 2 – 600 West Center Street, and Site 3 – 600 West 400 South. While they are close in elevation, due to the existing surface features at these sites it will be difficult to construct tanks at the same elevation that could work in parallel to serve the Lake Area via gravity. For example, Site 1 is at elevation 4745 to 4746 feet, Site 2 at 4740 to 4741 feet, and Site 3 is at elevation 4738 to 4739 feet, existing ground surface elevation.
2. A storage tank can be constructed large enough at Site 3 to serve all of the storage needs for the Vineyard South and Orem Southwest areas of the Lake Area via gravity. This site is also located at the best location to serve this area.
3. Since a storage tank can be constructed at Site 3 large enough to meet build-out needs for the Lake Area (minus Vineyard North), a storage tank can be constructed at Site 2 at a different elevation than the tank at Site 3. This storage tank at Site 2 would be used for the Central/West Area under Alternative 2 along with a booster pumping station.
4. Site 1 is at an elevation that can be used exclusively for the Vineyard North area of the Lake Storage Area. A larger segmented tank can also be constructed at this site where a portion of the tank can be used to meet Orem Central/West Area needs under Alternative 2 with a booster pumping station.
5. Site 4 - Lower Cemetery Field, is located at an elevation lower than the existing 8 MG Lower Tank that serves the Central/West Area. A tank located at this site would therefore require a booster pumping station to match the elevation provided by the Lower Tanks. However, the tank would be located very close to the existing Lower Tanks, and it will be very difficult, due to this proximity, to make these two tanks function efficiently in parallel. Therefore, the Lower Cemetery Field site has been excluded from further consideration in the analysis.
6. Due to the construction related issues with siting at tank at Site 6 – 4565 Contour, the fact that this site is too low in elevation to serve the Lake General Storage Area via gravity (i.e. pumping would be required), and the inclusion of Alternative 4 that assumes Vineyard storage would be located lower in elevation within Vineyard, Site 6 has been excluded from further consideration in the analysis. As indicted previously, the structural engineer does not recommend sites in this area due to the high groundwater potential, low soil bearing pressure, and the high to moderate potential for liquefaction.
7. While the site conditions referenced for Site 6 would apply to most if not all of the sites located within the Town of Vineyard, costs associated with addressing these concerns have been included in evaluation of Site 7, including energy costs associated with pumping from the tanks into the Vineyard water system.

ALTERNATIVES EVALUATION

Economic Analysis

An economic analysis of the alternatives was prepared based on a comparison of costs, including capital construction costs and annual operation, maintenance, and replacement costs. Since all of the alternatives provide the same level of service, there is no evaluation of benefits. Construction, operation and maintenance, and replacement costs are based on current (2016) price levels. For future project phases, costs were escalated using an assumed annual inflation rate of three percent. All costs are then compared on a future value (FV) and present value

(PV) basis. Present values of future costs are based on a discount rate of three percent per year.

A planning level opinion of probable construction costs (OPCC) was prepared for each of the three alternatives described above. These OPCCs include estimates for tanks and transmission pipelines associated with each alternative. Each site was evaluated for special conditions that could affect the construction cost.

A construction phasing plan was developed for each alternative. Under the phasing plans, the timing of tank and transmission pipeline construction is based on future requirements for additional storage as determined by population projections. Table E-1 summarizes the phasing plan for each alternative.

Table E-1: Construction Phasing Plan for Alternatives

	Year		
	2017	2021	2024
Alternative 1	Site 5: Orem 15.9 MG Vineyard 0.0 MG Total - 15.9 MG	Site 1: Orem 0.0 MG Vineyard 2.4 MG Total 2.4 MG	Site 3: Orem 6.5 MG Vineyard 5.3 MG Total 11.8 MG
Alternative 2	Site 2: Orem 10.8 MG Vineyard 0.0 MG Total 10.8 MG	Site 1: Orem 4.6 MG Vineyard 2.4 MG Total 7.0 MG	Site 3: Orem 7.0 MG Vineyard 5.3 MG Total 12.3 MG
Alternative 3	Site 3: Orem 6.5 MG Vineyard 5.3 MG Total 11.8 MG	Site 1: Orem 0.0 MG Vineyard 2.4 MG Total 2.4 MG	Site 5: Orem 15.9 MG Vineyard 0.0 MG Total - 15.9 MG
Alternative 4	Site 5: Orem 15.9 MG Vineyard 0.0 MG Total - 15.9 MG	Site 7: Orem 0.0 MG Vineyard 7.7 MG Total 7.7 MG	Site 3: Orem 6.5 MG Vineyard 0.0 MG Total 6.5 MG

Costs for routine operation, maintenance, and replacement of tanks, pumps, and pipelines are assumed to be essentially equal for all of the alternatives. These regular costs include items such as tank inspection and cleaning, maintenance of automated valves and electrical equipment, and repair of pipeline leaks. However, the cost of pumping energy varies considerable among the alternatives. Therefore, annual pumping energy was estimated for each alternative. Energy requirements over a 50-year period were estimated. Alternative 1 is an all gravity system and no pumping energy is required. Under Alternative 2, energy requirements vary each year for Orem according to the phasing of construction and projected future demand growth. Under Alternative 3 pumping is required for Orem until 2024 when the tank at Site 5 is scheduled to come on line. At that time the system would convert to gravity pressure operation. Under Alternative 4, energy requirements vary each year for Vineyard according to the phasing of construction and projected future demand growth.

Table E-2 provides a summary economic comparison of alternatives based on construction costs and annual energy costs. Supporting data for Table 6-7 are provided in Appendix C by year. As shown in the table, Alternative 2 has the lowest total capital cost for Orem, but the highest for Vineyard. Alternative 4 has the lowest total capital cost for Vineyard. Alternatives 2

and 3 have the lowest initial capital outlay (2017) for Orem, whereas Alternatives 1 and 4 have the lowest for Vineyard. Alternative 4 is the lowest present value and future value cost for the Town of Vineyard, but not for Orem. The lowest present value cost for Orem is Alternative 2, followed by Alternative 1. When power costs are factored into future costs for Alternative 2, Alternative 1 is the lowest future-cost alternative for Orem.

Table E-2: Economic Comparison of Alternatives

	Tank Capital Cost	Transmission Pipeline Capital Cost	Total Capital Cost	Initial Capital Outlay (2017)	PV of Energy Cost	PV of Total Cost	FV of Total Cost
Alternative 1							
Orem[1]	$32,279,000	$30,975,000	$63,254,000	$48,319,000	$0	$63,255,000	$67,239,000
Vineyard	$11,295,000	$3,072,000	$14,367,000	$573,000	$0	$14,367,000	$17,406,000
Total	**$43,574,000**	**$34,047,000**	**$77,621,000**	**$48,892,000**	**$0**	**$77,622,000**	**$84,645,000**
Alternative 2							
Orem[2]	$30,969,000	$21,891,000	$52,860,000	$18,280,000	$3,656,000	$56,516,000	$70,615,000
Vineyard	$10,975,000	$9,765,000	$20,740,000	$3,241,000	$0	$20,740,000	$24,791,000
Total	**$42,634,000**	**$31,656,000**	**$73,600,000**	**$21,521,000**	**$3,656,000**	**$77,256,000**	**$95,406,000**
Alternative 3							
Orem	$34,421,000	$30,975,000	$65,396,000	$17,078,000	$609,000	$66,006,000	$78,970,000
Vineyard	$11,316,000	$3,072,000	$14,388,000	$7,859,000	$0	$14,388,000	$15,489,000
Total	**$46,428,000**	**$32,838,000**	**$79,784,000**	**$24,937,000**	**$609,000**	**$80,394,000**	**$94,459,000**
Alternative 4							
Orem	$33,711,000	$30,975,000	$64,686,000	$48,319,000	$0	$64,687,000	$69,053,000
Vineyard	$10,884,000	$797,000	$11,681,000	$0	$432,000	$12,113,000	$14,704,000
Total	**$44,595,000**	**$31,772,000**	**$76,367,000**	**$48,319,000**	**$432,000**	**$76,800,000**	**$83,757,000**

[1] If Vineyard does not select Alternative 1, then Orem's Alternative 1 costs are the same as Alternative 4.

[2] If Vineyard does not select Alternative 2, then Orem's Alternative 2 costs increase as follows: Tank Capital Cost = $32,401,000, Total Capital Cost = $54,292,000, PV of Total Cost = $57,948,000, and FV of Total Cost = $72,429,000.

Both present value and future value Alternative 2 costs for Vineyard are significantly higher than the other alternatives because under Alternative 2 all of Orem's new tanks are located within the Central Zone area, thereby reducing Orem's required transmission pipeline size from the existing Lower Tanks to the proposed sites in the Central Zone area. Thus, Vineyard's required flow becomes a larger portion or percentage of the transmission pipeline, thereby increasing Vineyard's percentage share of the total pipeline cost.

Alternative 3 has the lowest initial capital outlay for Orem, but in the end the highest total future cost. This is due to the cost escalation of delayed construction of the more expensive tank (site 5), the cost of constructing a booster pump station at Site 3, and pumping energy costs associated with Site 3.

Alternative 1 and Alternative 4 are the same for Orem, with the exception of Vineyard's participation in a tank at Site 3. Under Alternative 4, only Orem builds a tank at Site 3. Without Vineyard's participation at this site, all of the costs for site restoration, etc. are attributable to Orem and not shared. Thus, the cost to build a tank at this site is greater for Orem under Alternative 4. If Alternative 1 is not selected by Vineyard as their best option, then Alternative 4 costs are applicable for Orem and not Alternative 1. The same situation applies to Alternative 2.

If Vineyard chooses a different alternative than Alternative 2, then Orem's costs for the tank at Site 3 are higher. See the footnote to Table 6-7 for Orem's costs in this scenario.

Variations In Alternatives

Potential exists for variations of each of the alternatives. For example, a booster pump station could be added to the Site 3 tank under Alternative 1 as a backup means of providing water to the Orem Central Area if the main transmission pipeline needs to be taken out of service for maintenance. However, these variations are not evaluated in this report.

Under Alternatives 1, 2, and 3 it would be economical for Vineyard if it could acquire storage in CUWCD's North Shore Terminal Reservoir (NSTR) for the Vineyard North Area in lieu of constructing storage at Site 1. About 6,000 lineal feet of 18-inch-diameter transmission pipeline could also be eliminated under Alternatives 1, 2, and 3 since water could be delivered to Vineyard through the North Shore Aqueduct. Preliminary estimates for the cost of NSTR storage range from $1.00 to $1.25 per gallon. This would likely provide a more economical solution than constructing storage at Site 1. However, locating Vineyard storage at the NSTR would require significant contract, infrastructure, and operating modifications with CUWCD and it cannot be guaranteed that these modifications could be achieved.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

All four alternatives provide similar levels of service and are viable solutions for Orem's and Vineyard's current and future water system operations. Initial site reviews have identified no insurmountable constructability issues for tanks at any of the sites selected for the alternatives.

The least cost solution for the Town of Vineyard is Alternative 4, constructing their tanks within the Town's boundaries and using booster pumps to pump the water from the tanks to their distribution system. This is the least cost solution when considering total capital cost, initial capital outlay, present value of total cost, and future value of total cost.

Orem's least cost solution is either Alternative 2 or Alternative 1. Alternative 2 is least cost in total capital cost, within $1.2 million of the least cost for initial capital outlay, and least cost for present value of total cost. Alternative 1 is the least cost for future value of total cost. However, if Vineyard selects Alternative 4, then the total future cost difference between Alternative 1 and Alternative 2 is only approximately $3.4 out of approximately $70 million.

Regardless of which alternative is selected, a critical issue in the Orem water system is transmission capacity from the principal water sources of supply from the northeastern part of the City to the central and western areas of the City. Addressing this transmission capacity deficit has been included in all four alternatives addressed herein. The system is currently relying on the head of the CUWCD tank, which in effect forces the equalization storage to occur there.

Recommendations

Our recommendations are as follows:

1. Alternative 4 is the least cost alternative for the Town of Vineyard. Even though Vineyard will have to pump long term from the tank(s) located in Vineyard, it is recommended that

Vineyard pursue Alternative 4 (see the additional recommendation for Vineyard in Recommendation 4 below).

2. It is recommended that Orem select Alternative 2. Alternative 1 has the lowest future value of total cost (assuming Vineyard does not select Alternative 1), which is almost $3.4 million less than Alternative 2. However, Alternative 2 has a much lower initial capital outlay, only marginally higher than Alternative 3, which will probably be more politically favorable than the more significant capital outlay required for Alternative 1.
3. Due to existing deficiencies in transmission capacity in the Orem water system, it is recommended that the Orem address the transmission system upgrades identified in the four alternatives along with tank construction.
4. It is recommended that the Town of Vineyard enter into discussions with CUWCD to investigate the feasibility of purchasing storage in the CUWCD North Shore Terminal Reservoir for the Vineyard North Area. As discussed previously, this appears to be significantly more cost effective for Vineyard than constructing a tank at Site 1 to supply the Vineyard North Area. This would also allow Vineyard to reduce the total tank size in Alternative 4 from 7.7 MG to 5.3 MG and would provide a two tank option instead of a single tank.

CHAPTER 1 - INTRODUCTION

PURPOSE

The purpose of this study is to provide direction to The City of Orem (Orem) and Town of Vineyard (Vineyard) regarding siting of necessary finished water storage for their respective drinking water systems.

Site considerations such as soils, slopes, utilities and drainage as well as opinion of probable construction cost (OPCC) for constructing each option are provided. This information will be utilized by Orem and Vineyard to compare alternatives and make the best decision for their own interests.

The results of this study are limited by the accuracy of the hydraulic model and other data provided by each system or its engineers, and other assumptions used in preparing the study. It is expected that each utility will review and verify adequacy and suitability of selected tank sites as well as tank sizes and appurtenant facilities such as pump stations and transmission lines.

BACKGROUND

Central Utah Water Conservancy District (CUWCD) owns and operates the Don A. Christiansen Regional Water Treatment Plant (DACRWTP) and adjacent finished water storage facilities. The treatment plant and storage are located on the east bench of Orem at approximately 1000 East and 1400 North. CUWCD supplies wholesale potable water locally to Orem, Vineyard, Provo, PacifiCorp, Lehi, Eagle Mountain, Saratoga Springs, and Jordan Valley Water Conservancy District.

The City of Orem is located in the northeast quadrant of Utah County in the State of Utah. Orem produces some of its drinking water from nine underground water wells and from seasonal flows from two natural springs near the system's eastern boundary. It also contracts with CUWCD to provide treated surface water year-round. Orem also delivers water from CUWCD to Vineyard through its pipe network. Orem owns and maintains four of its own finished water storage tanks totaling 12.4 MG. It has also purchased 9.5 MG of storage capacity in the 20 MG CUWCD water storage facility adjacent to DACRWTP.

The Town of Vineyard is located in the northeast quadrant of Utah County in the State of Utah. Vineyard is also adjacent to Utah Lake on its eastern shore. Vineyard recently purchased a small groundwater irrigation well, but produces none of its own drinking water. Much of the drinking water to meet its needs comes from CUWCD and is currently delivered through two connections to CUWCD transmission main (CWP Orem 800 North Aqueduct) and through Orem's drinking water distribution system. Vineyard does not currently own and maintain any finished water storage facilities. It has purchased a small amount of storage space (0.5MG) in the CUWCD 20 MG facility.

CUWCD has informed both Orem and Vineyard that their respective water storage capacities in the facilities adjacent to DACRWTP are presently insufficient to accommodate the peak daily water demands within Orem's and Vineyard's water distribution systems without adversely affecting the operational storage at DACRWTP.

SCOPE

The scope of this project is to study and evaluate options for drinking water system storage for Orem and Vineyard. The main study tasks are as follows:

1. Obtain existing information needed to complete the evaluation and study, including existing water system hydraulic models, relevant water quality data, current and future demand projections, and operational concerns and issues for each water system.
2. Convert existing hydraulic models into extended period simulation models for use in evaluation of the existing water systems and in evaluating potential storage locations.
3. Evaluate existing CUWCD, Orem and Vineyard water system interactions.
4. Review and summarize current and future storage needs of the Orem and Vineyard water systems.
5. Identify optimal general storage tank locations that will meet the needs of each water system.
6. Assist all parties in identifying preferred alternatives for storage tank locations for more detailed analyses.
7. Evaluate each preferred alternative site including:
    - Hydraulic analysis to determine required facilities at each site and to determine system performance
    - Constructability Review
    - Construction Cost Estimates
    - Economic Analysis
    - Comparison of Alternatives

Central Utah Water Conservancy District, Orem and the Town of Vineyard selected Hansen, Allen, & Luce, Inc. (HAL) in December 2015 to complete a study of the drinking water storage needs and potential storage locations for Orem and Vineyard. Work began on the study in February 2016.

CHAPTER 2 - EXISTING WATER SYSTEMS

OREM WATER SYSTEM

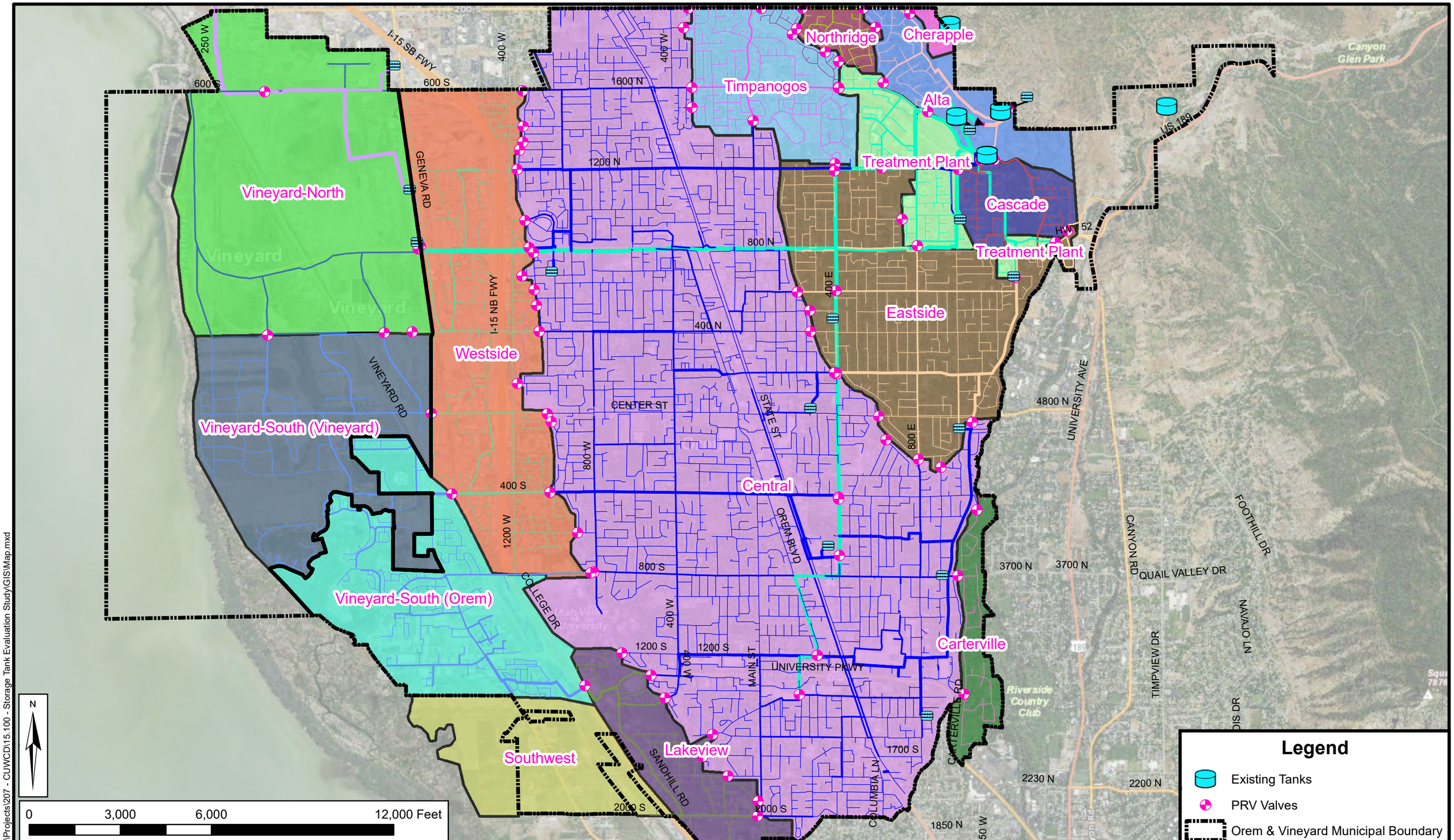
The Orem drinking water distribution system currently serves drinking water to approximately 92,000 people and numerous commercial and industrial customers. Key system information includes:

- 9 drinking water wells
- 2 water springs
- 4 booster stations
- 5 storage tanks (12.4 MG)
- 9.5 MG storage in the 20 MG CUWCD facility
- 12 pressure zones
- 24 mgd average daily production
- 60 mgd peak day production

While Orem maintains multiple pressure zones (i.e. twelve pressure zones) within its water system, four general storage areas have been identified that make sense when evaluating required reservoir storage for the Orem and Vineyard water systems. The four storage areas are referred to herein as the Upper Area, the Central Area, the West Area, and the Lake Area. The pressure zones included in each area are listed in Table 2-1. The locations of the existing water system pressure zones are illustrated on Figure 2-1. The locations of the general storage areas are illustrated on Figure 2-2.

Table 2-1: General Storage Areas versus Existing Pressure Zones

GENERAL STORAGE AREAS	EXISTING WATER SYSTEM PRESSURE ZONES
Upper (Orem)	Cherapple
	Alta
	Northridge
	Timpanogos
	Treatment Plant
	Cascade
	Eastside
Central (Orem)	Central
	Carterville
West (Orem)	Lakeview
	Westside
Lake	Southwest (Orem)
	Vineyard South (Orem)
	Vineyard South (Vineyard)
	Vineyard North (Vineyard)



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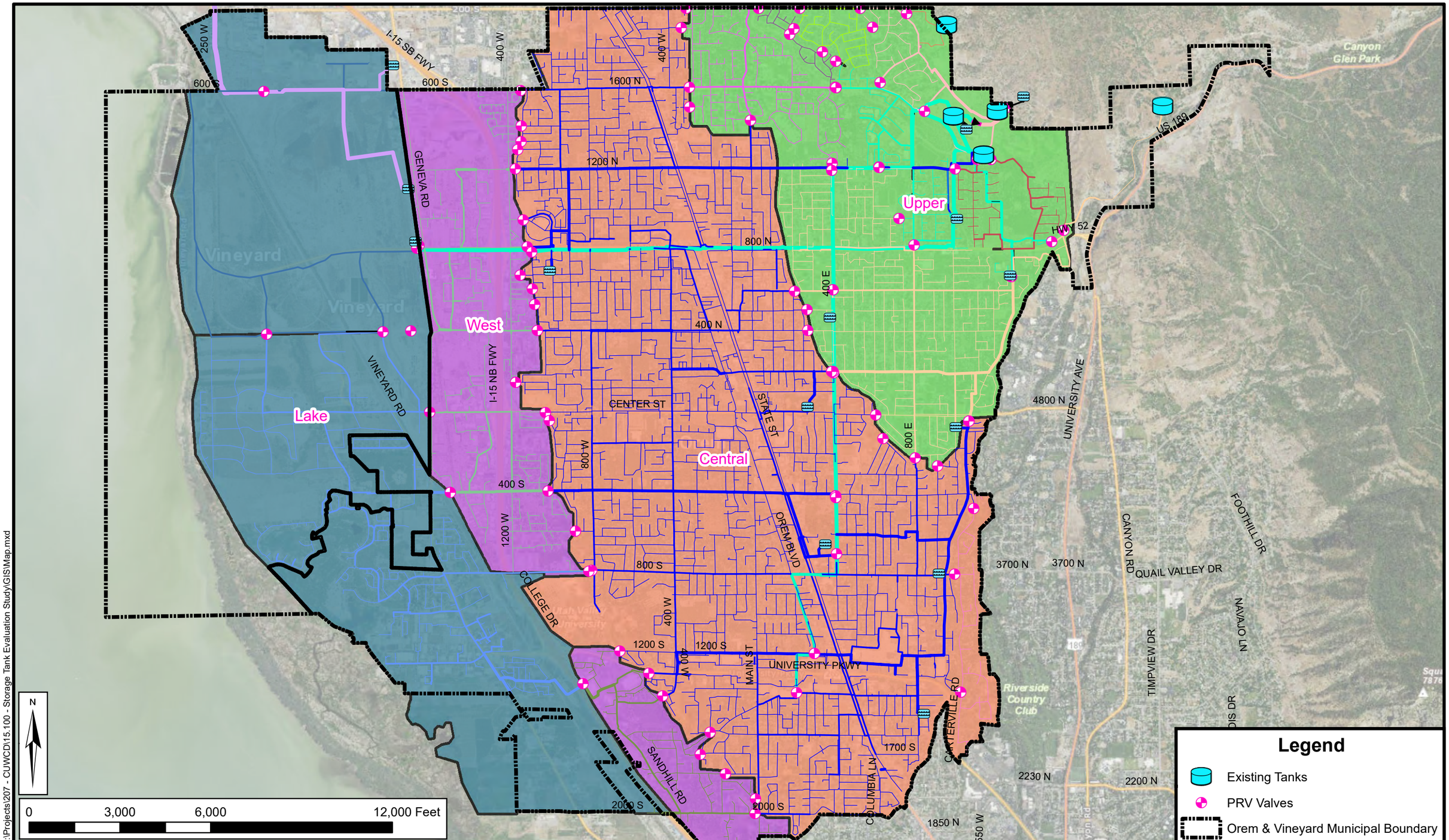
CUWCD - Orem & Vineyard Storage Location Study

Orem & Vineyard Pressure Zones

FIGURE 2-1



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CUWCD - Orem & Vineyard Storage Location Study

Orem & Vineyard General Storage Areas

FIGURE 2-2

Orem currently has 12.9 MG of reservoir storage capacity at an elevation that can serve the Upper Area by gravity and 8 MG of reservoir storage capacity at an elevation that can serve the Central Area by gravity.

One of the necessary components of a water system to make storage functional is the ability to deliver water from the storage location to the area which it serves through transmission mains without excessive head loss or velocity. Peak instantaneous demand for the Orem Central, West and Lake Areas is approximately 54,000 gpm. Records show that wells which pump into the Central Area only account for an average flow of 5,300 gpm and thus the remaining demand at peak instantaneous (48,700 gpm) must be supplied by the Lower Tanks (8 MG) and the CUWCD Tanks. There is currently a 36 inch main from CUWCD tanks to the Central Zone and a 20 inch main from the Lower tanks to the Central Zone. These transmission lines have a capacity of about 20,000 gpm.

Currently, Orem takes advantage of the higher pressure provided by CUWCD from the CUWCD Tanks to overcome the transmission deficiencies. Velocities in the main transmission lines reach 10 fps. This is twice as fast as most transmission lines are designed for because of significant pressure loss. The CUWCD source and storage are favored because the system relies on the pressure provided by CUWCD. This limits the use of the wells and the 8 MG of storage in the Central Zone and forces a majority of the equalization storage to occur in the CUWCD storage.

VINEYARD WATER SYSTEM

The Vineyard drinking water distribution system currently serves drinking water to approximately 500 people (last reported population is approximately 500 people in 2013) and some commercial and industrial customers. Key system information includes:

- 0.5 MG storage in 20 MG CUWCD facility
- 2 pressure zones, defined by source of supply, i.e. one directly from CUWCD (Vineyard North Zone) and one via the Orem distribution system (Vineyard South Zone)
- 2 connections to CUWCD transmission line
- 2 Existing connections to Orem distribution system and one future connection
- 11 mgd peak day production

The two pressure zones identified for Vineyard lie within the general storage area identified as the Lake Area in Table 2-1. See Figure 2-1 for locations.

CUWCD WHOLESALE WATER SYSTEM

The CUWCD treatment and transmission system in Orem consists of the DACRWTP treatment plant, 2 MG clear well, 25 MG treated water storage near DACRWTP and 10 MG storage at North Shore Terminal Reservoir (NSTR) in Saratoga Springs, and a large transmission pipeline. Currently, two deep wells near Vineyard (with a third well already constructed and its well house under construction) and a connection to the DACRWTP supply the CWP system demands (note that water supplied to the CWP system from the DACRWTP does not utilize the existing storage facilities at the treatment plant, but is delivered directly to the CWP system). . A nearly 21 mile transmission line connects DACRWTP to the deep wells in Vineyard and the NSTR storage facility and customers west of Vineyard.

CHAPTER 3 – STORAGE REQUIREMENTS

CURRENT AND BUILDOUT STORAGE REQUIREMENTS

Data for current and future storage needs were extracted from master plan reports from both Orem and Vineyard. These figures appear to be based on drinking water standards for the State of Utah.

Storage requirements are summarized in Table 3-1 by general storage areas as previously defined and were only separated by individual pressure zone for the areas near Utah Lake (Lake Area) of which the entire Vineyard system is a part. As can be seen in Table 3-1, current storage facilities in both Orem and Vineyard are inadequate and would require another 12.0 MG to comply with state standards for the existing system. Of this deficit, 2.2 MG applies to Vineyard and 9.8 MG applies to Orem. Vineyard has a temporary contract with CUWCD to provide 4.0 MG of storage until 2021. There is currently a 30.1 MG storage deficit to meet buildout conditions for both Vineyard and Orem. Of this deficit, 7.7 MG applies to Vineyard and the balance of 22.4 MG applies to Orem. It is also apparent from Table 3-1 that all current and future storage needs are located west of the Upper General Storage Area.

Table 3-1: Storage Analysis by Area

GENERAL STORAGE AREA	PRESSURE ZONE	Existing Storage Capacity (MG)	Existing Required Storage (MG)	Existing Storage Deficit (MG)	Buildout Required Storage (MG)	Buildout Storage Deficit (MG)
Upper (Orem)	Cherapple	13.9	13.9	0	13.9	0
	Alta					
	Northridge					
	Timpanogos					
	Treatment Plant					
	Cascade					
	Eastside					
Central (Orem)	Central	8	13.8	(5.8)	19.1	(11.1)
	Carterville					
West (Orem)	Lakeview	0	2.3	(2.3)	4.8	(4.8)
	Westside					
Lake	Southwest (Orem)	0	0	0.0	2.4	(2.4)
	Vineyard South (Orem)	0	1.7	(1.7)	4.1	(4.1)
	Vineyard South (Vineyard)	0.5	2.5	(2.0)	5.8	(5.3)
	Vineyard North (Vineyard)	0	0.2	(0.2)	2.4	(2.4)
	Orem	**21.9**	**31.7**	**(9.8)**	**44.3**	**(22.4)**
	Vineyard	**0.5**	**2.7**	**(2.2)**	**8.2**	**(7.7)**
TOTAL		**22.4**	**34.4**	**(12.0)**	**52.5**	**(30.1)**

CHAPTER 4 – STORAGE LOCATIONS

POTENTIAL STORAGE LOCATIONS

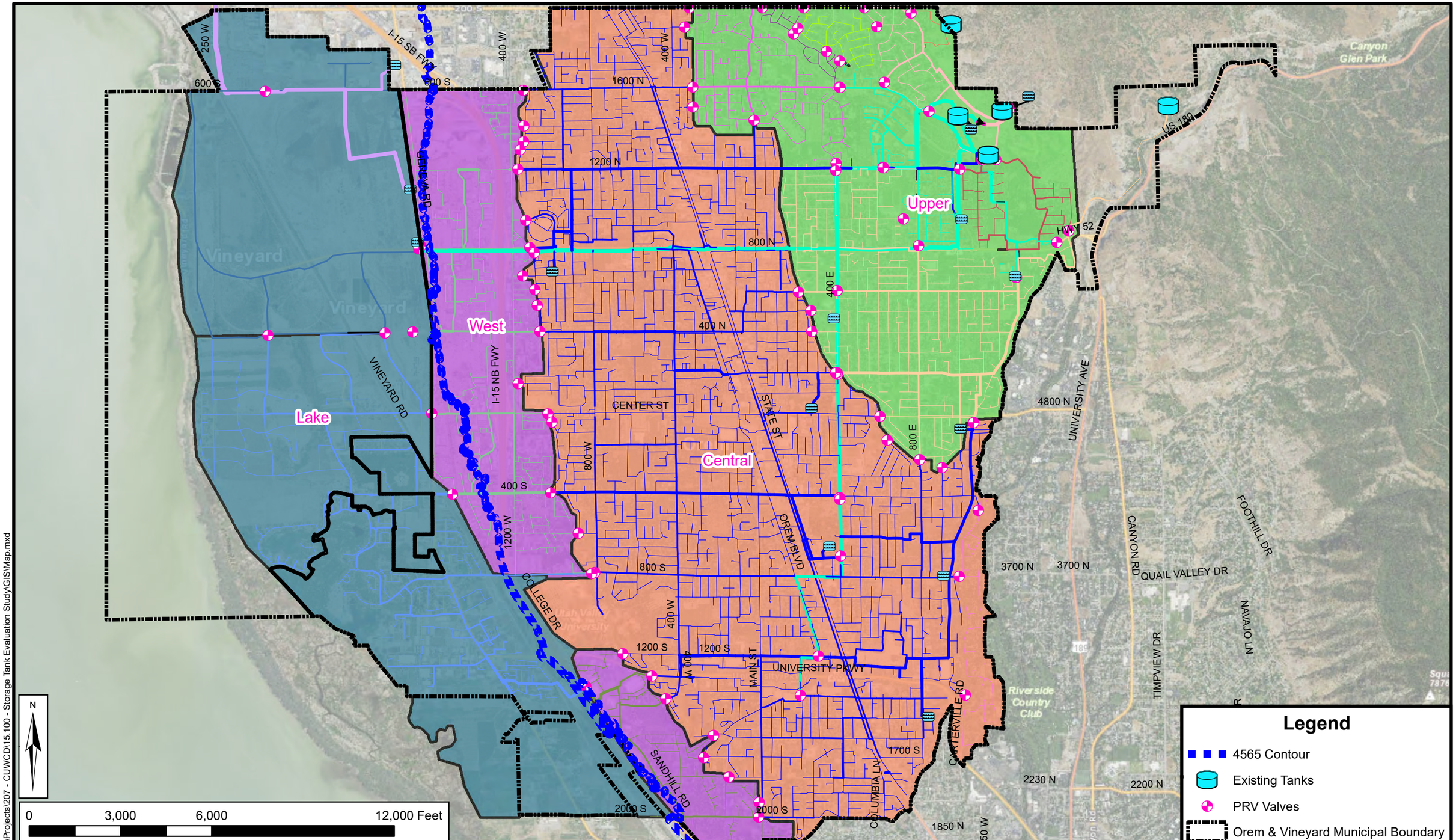
Potential storage tank locations were determined for each general storage area that requires additional storage by identifying elevation bands in which a tank could be located that could serve the general storage area by gravity. These elevation bands were superimposed onto mapping provided by Orem and Vineyard which identified potential or available lands on which a tank could be located. The elevation bands were established and minimum and maximum pressures that the each elevation band could provide to the upper end of each general storage area by gravity were estimated.

There were two potential options discussed in a meeting with CUWCD, Orem and Vineyard regarding whether to include the narrow band associated with the West General Storage Area within the Central General Storage Area or the Lake General Storage Area when considering potential storage locations. It was determined that the West Area would be included with the Central Area and that the contour boundary between the Lake Area versus the Central/West Area would be established at elevation 4565 feet. This will allow storage to be placed at a lower elevation for the Lake Area where more potential locations for storage tanks are available, and storage will be closer to the zone served with shorter transmission and therefore less head loss. Thus, potential tank locations were evaluated for the combined Central/West Area and the Lake Area. As indicated in the prior chapter, there is already sufficient existing storage in the Upper General Storage Area to meet build-out conditions. Potential tank sites have therefore been explored for the Central/West area and for the Lake Area. Figure 4-1 identifies the four General Storage Areas and the location of the 4565-foot contour line that separates the Central/West Area from the Lake Area.

Figures 4-2 through 4-5 illustrate the elevation band in which potential tanks for the Central/West Area can be located within Orem. Figure 4-6 illustrates a potential location for a tank within Lindon City property (approximately 50 N. 1100 E) for the Central/West Area and Figure 4-7 illustrates a potential location within County Property (located across the Provo River just outside of Provo City at approximately 5500 N) for a Central/West Area. As can be seen from the figures, there are very few locations where vacant land exists in which to build a Central/West Area tank(s).

Figures 4-8 and 4-9 illustrate the elevation band in which potential tanks for the Lake Area can be located. Also illustrated on these figures are potential tank properties which include parks, school grounds, undeveloped properties or other larger open-space areas.

The figures referenced above represent elevations required to serve the pressure zones via gravity. Orem has indicated that they are willing to also consider the option of locating a tank(s) for the Central/West Area at an elevation lower than that which would be required to serve the area by gravity, which will require a booster pump station to pump from the tank into the system. Storage that requires pumping will increase operational complexity and significant long term energy costs. However, capital costs may be less when compared to transmission piping costs required to convey gravity storage to areas of use. Due to the immediate need to provide additional storage for the Central/West Area and the potential high cost for required transmission piping within this area if additional storage is provided at a location that allows a gravity feed to serve the area, HAL has looked at locating tanks within the Central/West Area where the elevation would be conducive for gravity feed at a future date for the Lake Area as



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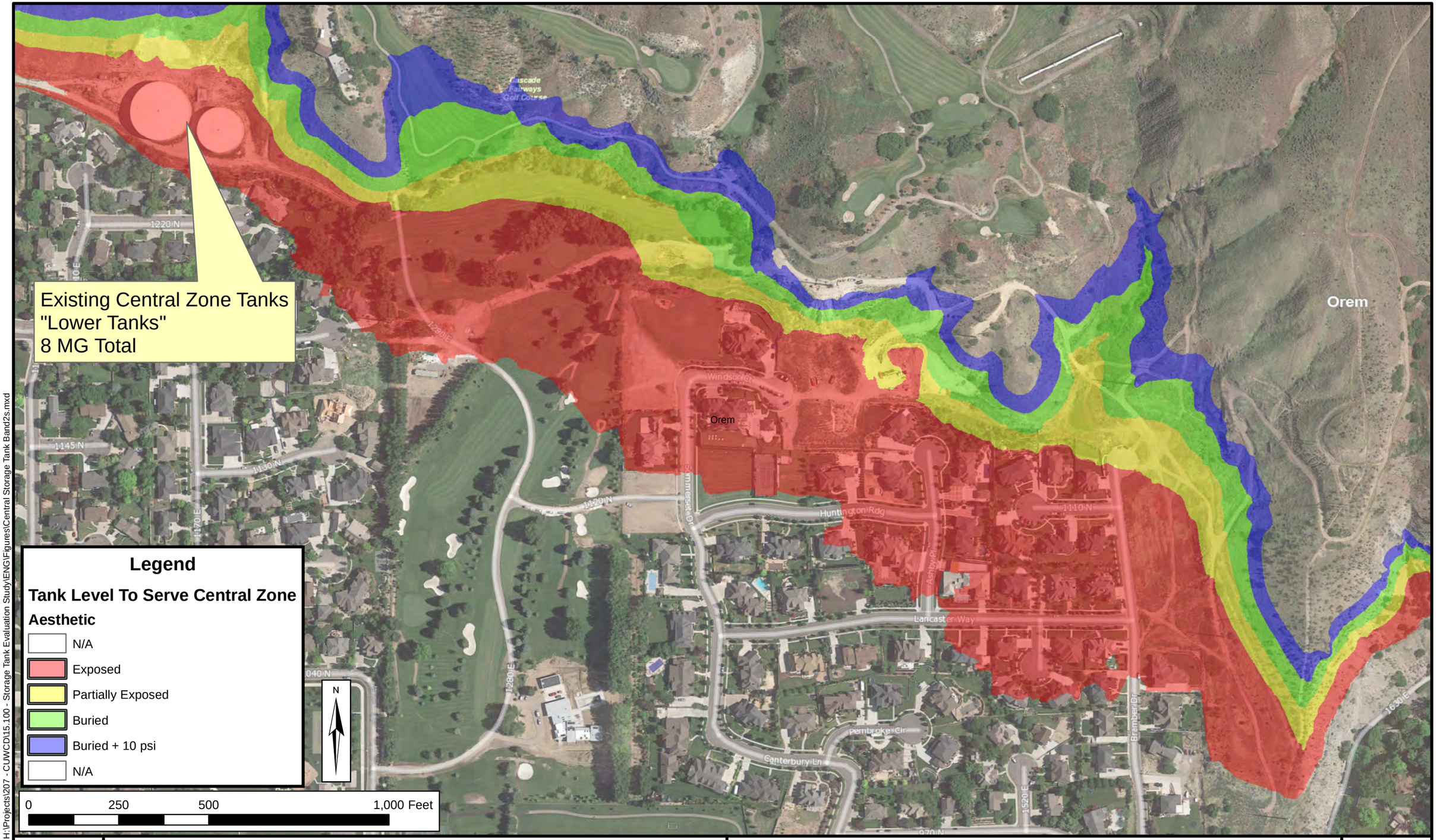
CUWCD - Orem & Vineyard Storage Location Study

Central/West Areas & Lake Area Boundary

FIGURE 4-1



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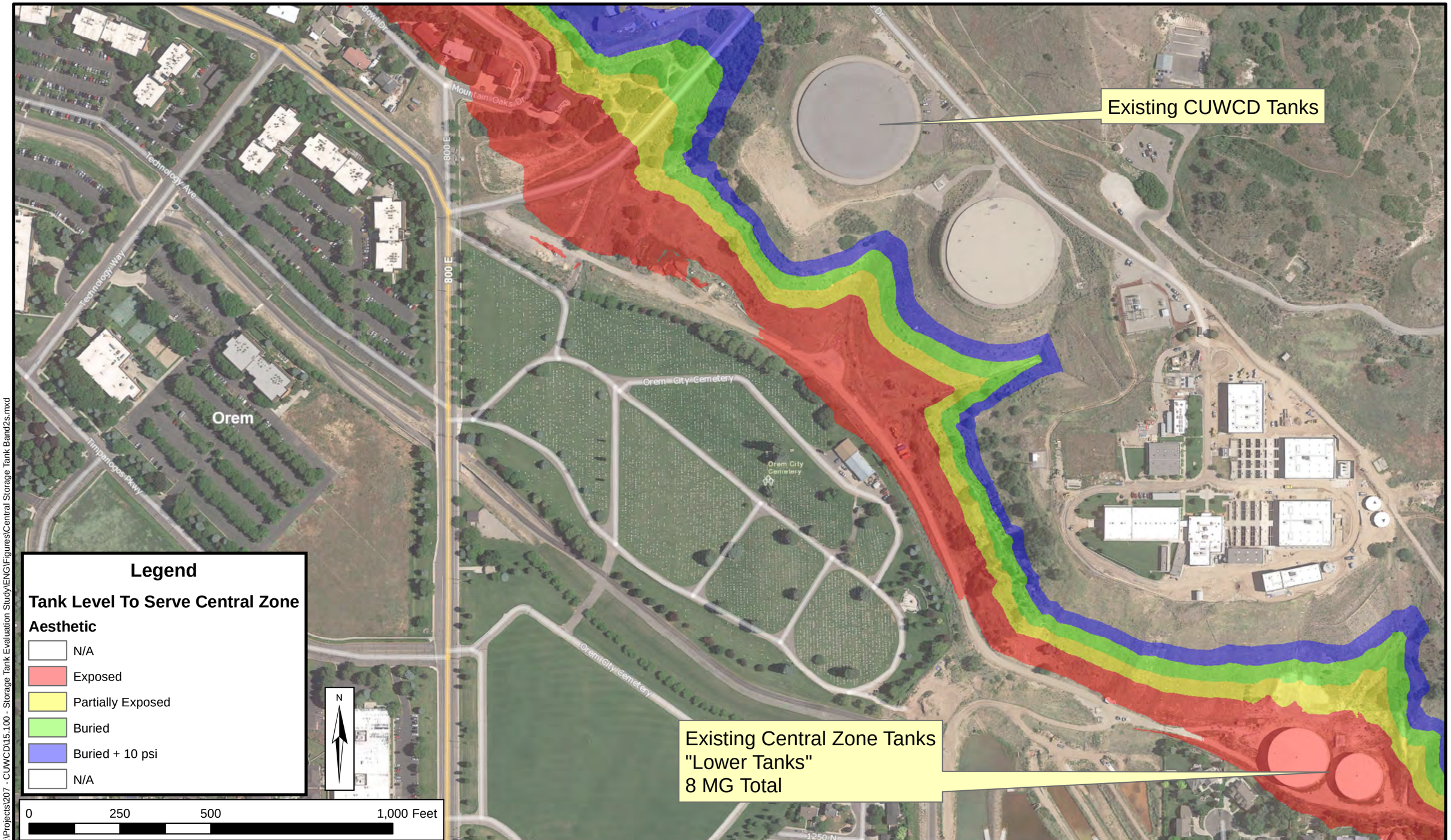
CUWCD - Orem & Vineyard Storage Location Study

Potential Central Zone Storage Locations

FIGURE 4-2



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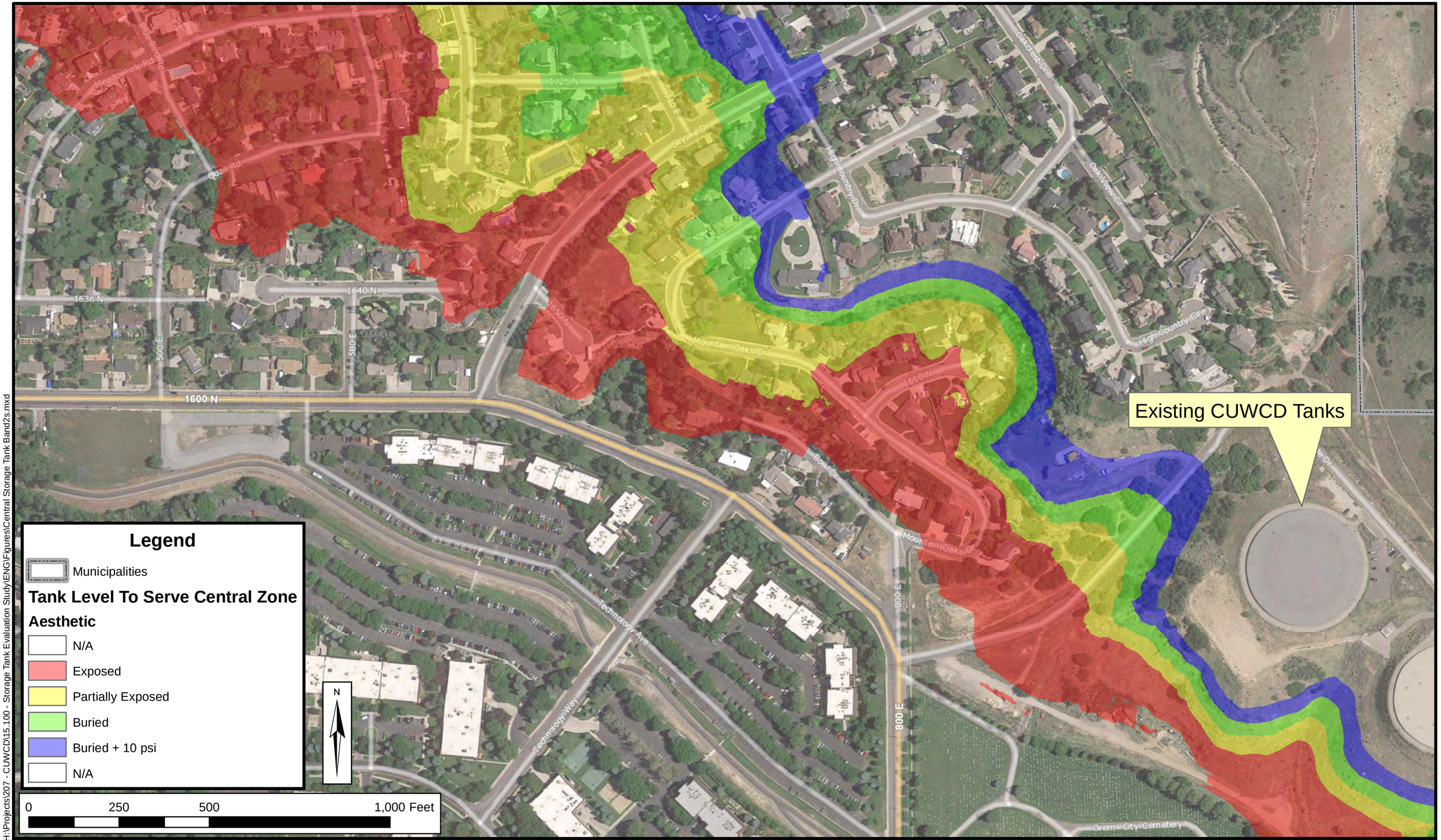
CUWCD - Orem & Vineyard Storage Location Study

Potential Central Zone Storage Locations

FIGURE
4-3



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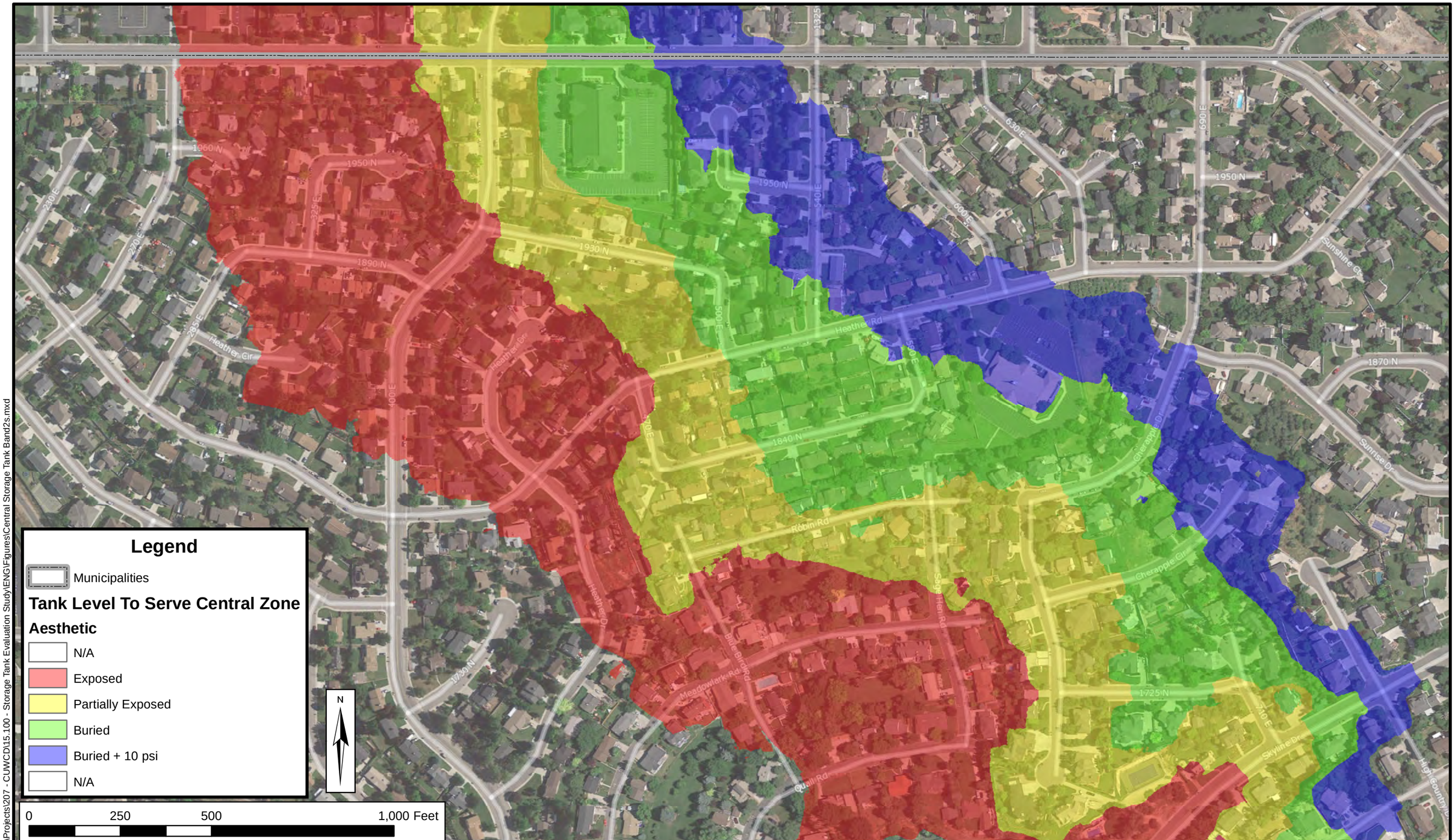
CUWCD - Orem & Vineyard Storage Location Study

Potential Central Zone Storage Locations

FIGURE 4-4



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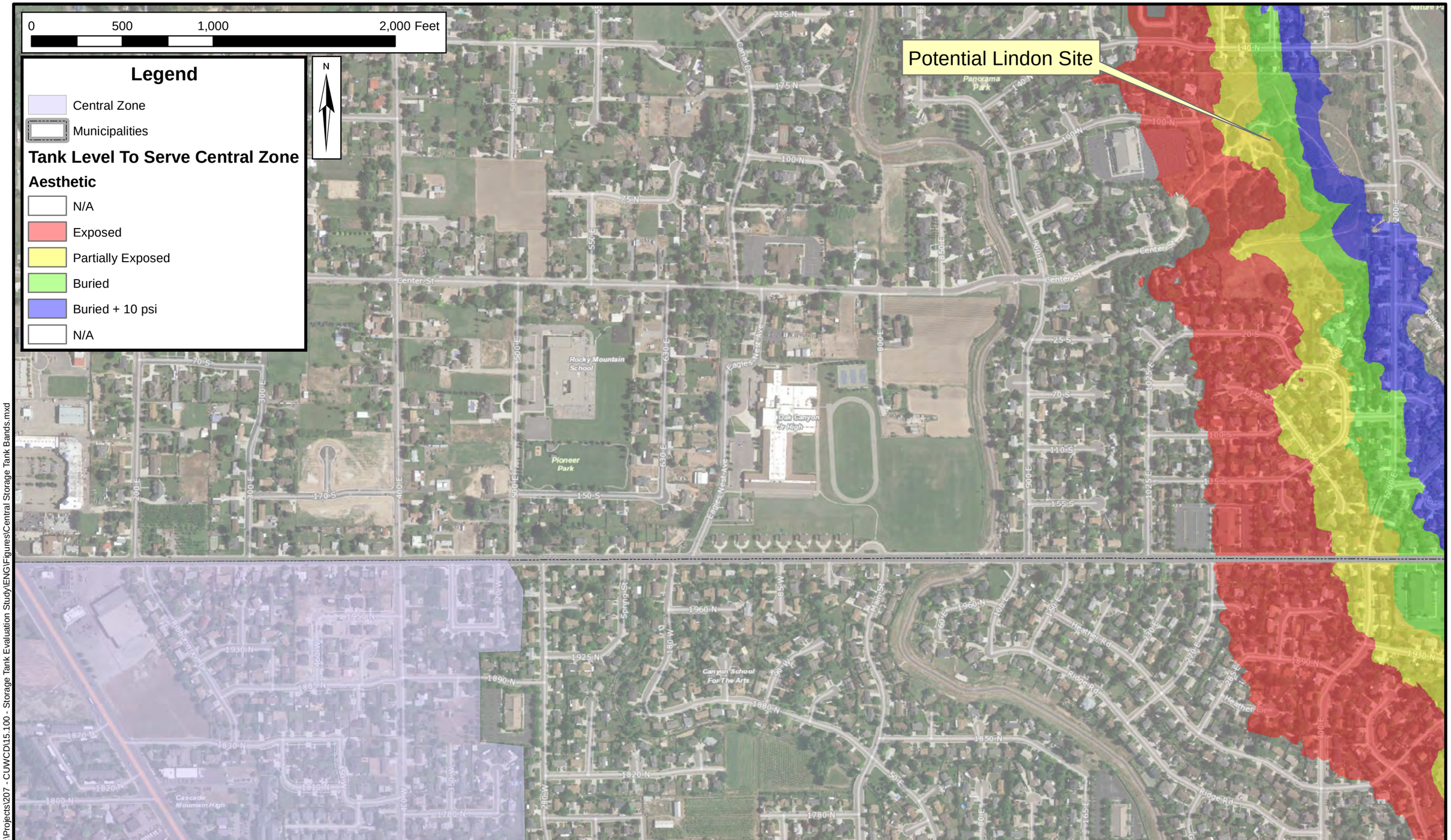
CUWCD - Orem & Vineyard Storage Location Study

Potential Central Zone Storage Locations

FIGURE 4-5



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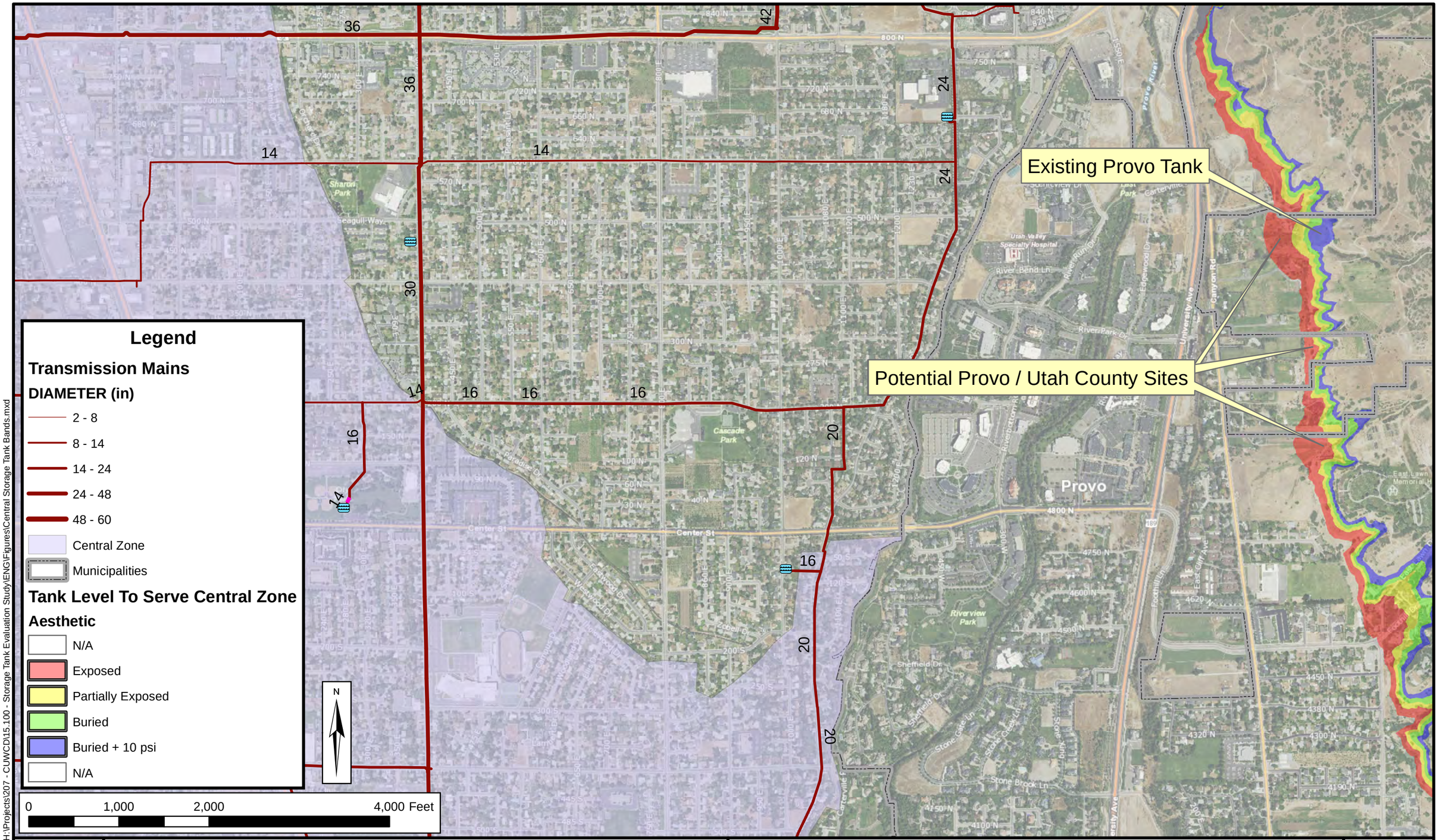
CUWCD - Orem & Vineyard Storage Location Study

Potential Central Zone Storage Locations

FIGURE 4-6



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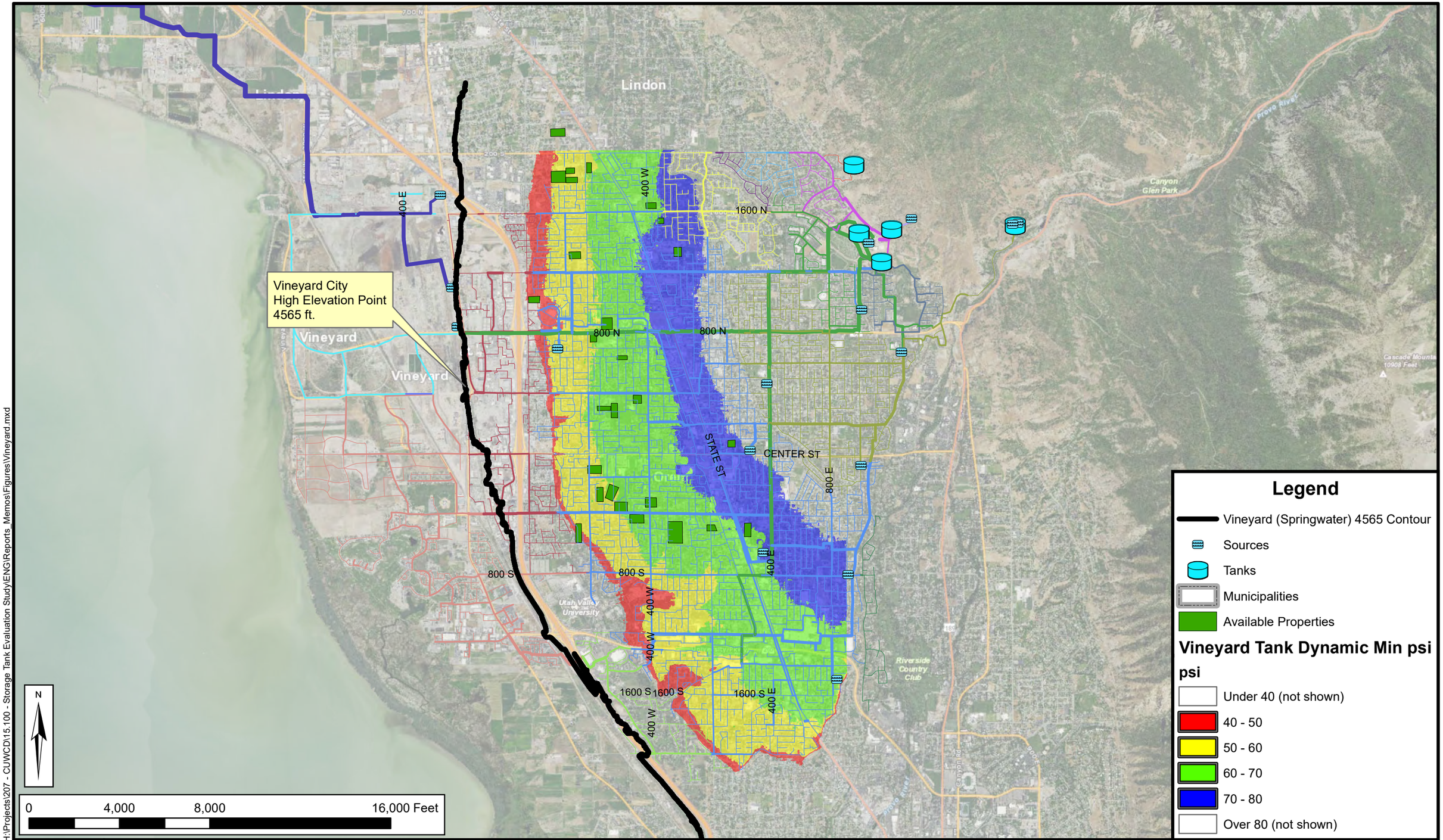
CUWCD - Orem & Vineyard Storage Location Study

Potential Central Zone Storage Locations

FIGURE 4-7



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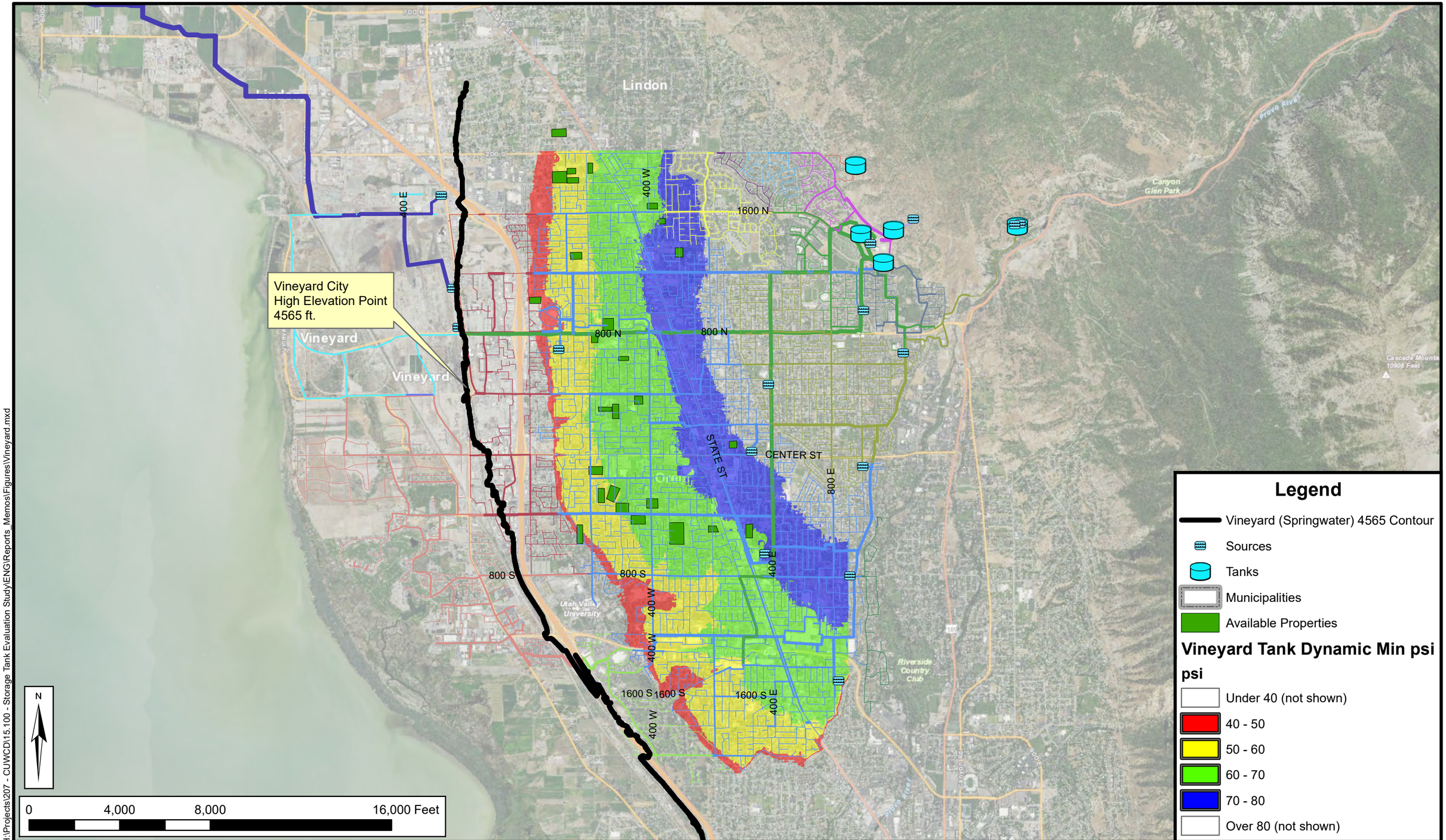
CUWCD - Orem & Vineyard Storage Location Study

Lake Area Storage Location vs. Min. Expected Pressure

FIGURE 4-8



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CUWCD - Orem & Vineyard Storage Location Study

Lake Area Storage Location vs. Max. Pressure

FIGURE 4-9

the Lake Area develops. Initially a booster pumping station would be required to utilize these storage locations within the Central/West Area, but as the tank is converted for use in the Lake Area then the booster pumping station could be used as a backup supply for the Central/West Area. This would require that additional storage be constructed in the future for the Central/West Area to replace the storage that is converted to supply the Lake Area. Orem could also consider constructing storage large enough at these locations to meet storage requirements for the Lake Area as well as for the Central/West Area. Under this scenario, Orem would be committing to long term booster pumping costs into the Central/West Area in exchange for a reduction in capital costs associated with transmission piping in the Central/West Area.

All of the storage required by Vineyard could be effectively located at the CUWCD NSTR site according to the model. This would alleviate some transmission capacity issues in the Orem system. However, as previously discussed, locating all of Vineyard's storage needs at the NSTR would require major contract and operational modifications with both Orem and CUWCD and will not be considered further as a viable option. As will be discussed herein, at least the portion of the required storage for the Vineyard North area could be located at the NSTR, provided suitable contract and operational modifications could be achieved. The remainder of the required storage for the Vineyard South area could be located within the green band on Figure 4-8, either shared with Orem or not; or it could be located within the Town of Vineyard which would require a booster pumping station to boost the pressure at the tank site within Vineyard to the required system pressure (i.e. all locations within Vineyard are at an elevation too low to serve the Vineyard drinking water system via gravity).

OPTIMAL STORAGE LOCATION CONSIDERATIONS

There are many factors that must be considered in evaluation of the optimal locations for storage facilities for Orem and Vineyard. A number of these factors are discussed below.

Land Ownership

Ideal locations for any new water infrastructure will usually be on land already owned by the utility or another government entity that is willing to cooperate with the utility in obtaining the land required. Many of the proposed storage locations are already owned by Orem or CUWCD and are currently vacant or are being used as public parks or school playgrounds.

Site Considerations

Geotechnical, geologic and accompanying structural issues must be taken into consideration in evaluation of each site. Applied Geotechnical Engineering Consultants (AGEC) and Dean L. Webb & Associates (DLW) provided reconnaissance level geotechnical, geological and structural reviews, respectively. The geotechnical investigation consisted mainly of a site visit and review of previous projects performed by AGEC and/or others near the proposed tank sites. Structural reviews looked at recommendations from the geotechnical investigations and proposed tank construction for each site.

Constructability

A constructability review was completed for each of the proposed sites to determine if there are any issues which may affect construction of a tank at the site. The review consisted of evaluating maximum tank footprints based on cut slope limitations, identifying existing utilities and/or structures within the site, identifying drainage availability, and access for construction and maintenance.

Cost

A planning level opinion of probable construction costs (OPCC) was prepared for each of the potential tank sites. The OPCC was initially based on the largest tank that could be constructed or that was required for each site. Optimized alternatives were then developed to identify required storage at each site, and the OPCC was then determined for the optimized tank size. It is not recommended that linear interpolation of the cost to a smaller tank be assumed due to some costs that will not necessarily vary based on tank size. Unit and lump sum costs were prepared using data from RSMeans, from recently completed projects, and from typical construction estimating assumptions, i.e. mobilization typically ranges from 5% to 10% of overall construction cost.

Hydraulic Performance

Part of properly using large water storage facilities is the ability of the transmission system to convey water to the facility and then supply the needed flow rate back into the system at the right time. Measures of performance for this study include maximum pipeline velocity, minimum pressure at customer connections and effect on CUWCD finished water storage levels. Pipeline velocities were maintained at acceptable levels for proper system performance. Typically, velocities were maintained at five feet per second or less for distribution system piping in order to avoid excessive pressure variation for customers within the system and at seven feet per second or less for major transmission piping. Customer connection pressure was maintained at current levels or improved, and option configuration was designed to minimize overuse of storage in the CUWCD finished water storage tanks.

Energy Efficiency

It is expensive to pump water from one location to another or to a higher elevation. Energy and replacement costs must be included in life cycle costs of alternatives evaluations to determine if it is more cost effective to locate tanks at elevations that require pumping into the system pressure or to locate tanks at elevations that can feed the system via gravity. Some of the alternatives evaluated in this study include locating tanks within the pressure zone that will require the use of booster pumping stations to pressure water from the tank into the system. Several of the potential tank sites evaluated could be put into service without the need for booster pumps, although a larger volume of the storage capacity at some sites could be accessed by implementing booster stations. Using lower energy water first and reserving the higher energy potential water for the higher elevation areas is most energy efficient. Currently, Orem allows the higher energy potential water out of the 20 MG CUWCD storage facility to overpower the water produced from wells in the Central Zone. This limits the use of the wells and the existing 8 MG storage in the Central Zone.

Water Quality

Water quality in a water system can be hindered or helped by the addition of a new water storage facility. Water quality has been simulated using the extended period hydraulic model. The hydraulic model generally shows good water quality in the existing system because of high velocities and quick turn over in the water tanks. As long as the water in the new tank alternative locations is recirculated with seven days, water quality should not be affected. In the winter the water levels in the tanks may need to be lowered to ensure proper recirculation.

SELECTED SITES

Potential storage tank locations were addressed previously in this chapter. These potential storage tank locations were discussed with Orem and the Town of Vineyard in a project progress meeting held on April 5, 2016. From information discussed in this meeting, site visits, and additional discussion, six sites were originally selected by Orem and the Town of Vineyard for further analysis. Based on subsequent input from Orem and Vineyard, an additional tank site was added within the Town of Vineyard for required Vineyard storage, and a second alternative to the Site 5 Tank (Site 5a) was added which includes demolition of the existing 8 MG of storage that serves the Orem Central Storage Area and replacement of that storage with a larger tank. Figure 4-10 shows the locations of the seven evaluation sites (note that Site 5 and Site 6 include two alternatives each (the total number of tank sites evaluated is nine).

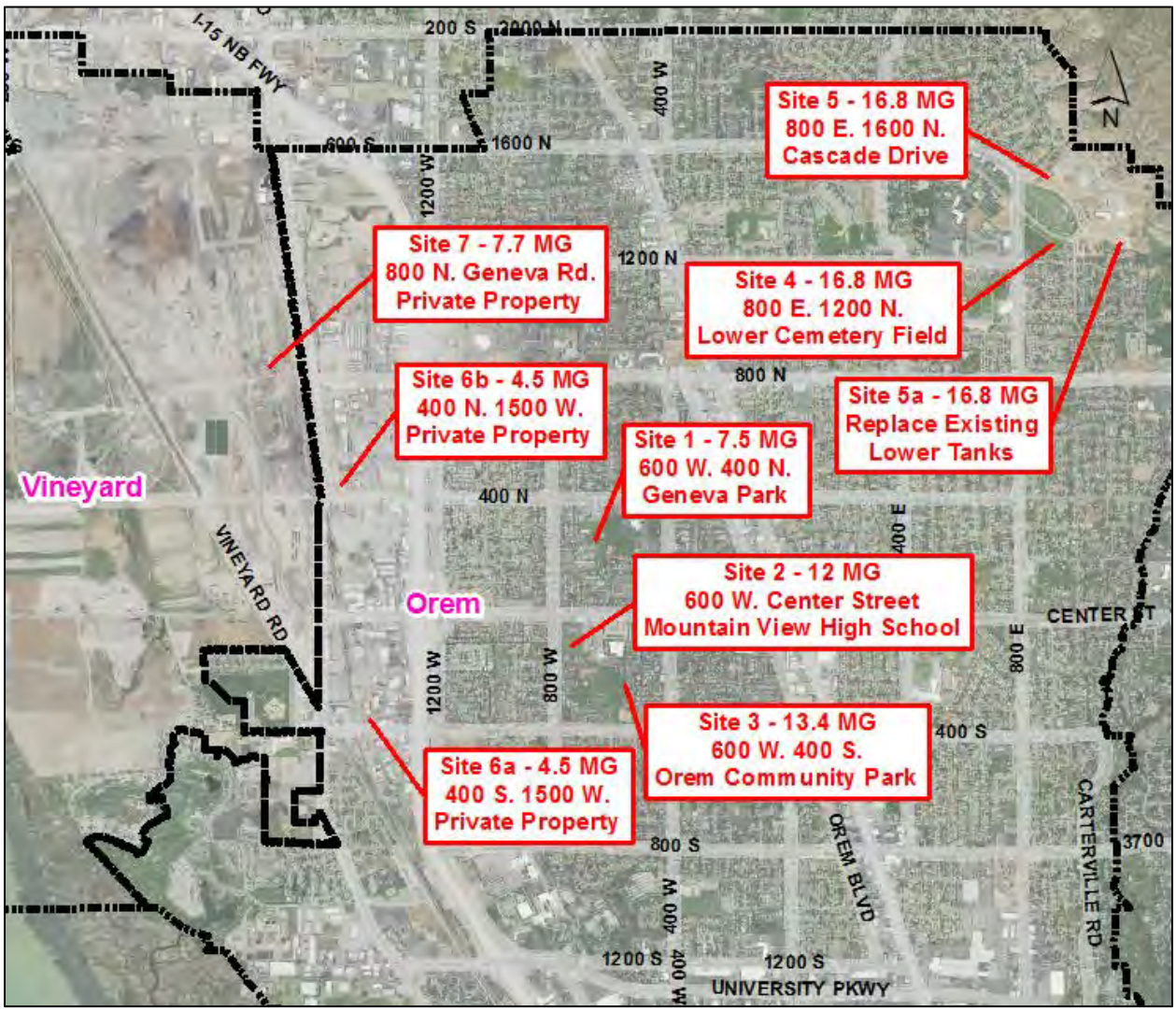


Figure 4-10: Evaluation Sites

GEOTECHNICAL/GEOLOGIC INVESTIGATIONS

A reconnaissance level geotechnical review was completed by AGEC, Inc. for each of the proposed initial six (6) potential tank sites. Site 5a and Site 7 were added after an initial review

of this report and therefor a geotechnical review was not completed for these sites. It is assumed that the geotechnical considerations for Site 5a will be similar to Site 5 and that Site 7 will be similar to Sites 6a and 6b. A letter report was prepared for each of the original six sites and is included in Appendix A. The following is a brief summary of the findings by AGEC for each potential tank site.

SITE 1 – 600 West 400 North (Geneva Park)

It is anticipated that the subsurface soil predominantly consists of sand and gravel. The proposed tanks may be supported on spread footings bearing on undisturbed natural soil or compacted structural fill extending down to undisturbed natural soil. Temporary unretained excavation slopes may be constructed at 1 ½ horizontal to 1 vertical or flatter. It is anticipated that select excavated material from the site may be used for backfill around and above the tanks. There are no mapped active faults extending through the site and the area is mapped as having a "very low" potential for liquefaction.

SITE 2 – 600 West Center Street (Mountain View High School)

It is anticipated that the subsurface soil predominantly consists of sand and gravel. The proposed tanks may be supported on spread footings bearing on undisturbed natural soil or compacted structural fill extending down to undisturbed natural soil. Temporary unretained excavation slopes may be constructed at 1 ½ horizontal to 1 vertical or flatter. It is anticipated that select excavated material from the site may be used for backfill around and above the tanks. There are no mapped active faults extending through the site and the area is mapped as having a "very low" potential for liquefaction.

SITE 3 – 600 West 400 South (Orem Community Park)

It is anticipated that the subsurface soil predominantly consists of sand and gravel. The proposed tanks may be supported on spread footings bearing on undisturbed natural soil or compacted structural fill extending down to undisturbed natural soil. Temporary unretained excavation slopes may be constructed at 1 ½ horizontal to 1 vertical or flatter. It is anticipated that select excavated material from the site may be used for backfill around and above the tanks. There are no mapped active faults extending through the site and the area is mapped as having a "very low" potential for liquefaction.

SITE 4 – Lower Cemetery Field

It is anticipated that the subsurface soil predominantly consists of sand and gravel. The proposed tanks may be supported on spread footings bearing on undisturbed natural soil or compacted structural fill extending down to undisturbed natural soil. Temporary unretained excavation slopes may be constructed at 1 ½ horizontal to 1 vertical or flatter. It is anticipated that select excavated material from the site may be used for backfill around and above the tanks. There are no mapped active faults extending through the site and the area is mapped as having a "very low" potential for liquefaction.

SITE 5 – Cascade Drive

It is anticipated that the subsurface soil predominantly consists of sand. The proposed tanks may be supported on spread footings bearing on undisturbed natural soil or compacted structural fill extending down to undisturbed natural soil. Temporary un-retained excavation slopes may be constructed at 1 ½ horizontal to 1 vertical or flatter. Due to steep slopes and adjacent facilities, it is anticipated that excavation shoring and permanent retaining systems will

be required to facilitate construction at this site. It is anticipated that select excavated material from the site may be used for backfill around and above the tanks. There are no mapped active faults extending through the site and the area is mapped as having a “very low” potential for liquefaction.

Slope stability is of concern for this site. A geotechnical study should be performed to evaluate the stability of existing and proposed slope configurations and appropriate slope stabilization measures to be implemented.

SITE 6 – 4565 Contour

It is anticipated that the subsurface soil predominantly will consists of interlayered clay, silt, and sand. The area is generally mapped as having a “high” to “moderate” potential for liquefaction which may cause settlement under seismic conditions. There are no mapped active faults extending through the site.

The proposed tanks may be supported on spread footings bearing on undisturbed natural soil or compacted structural fill extending down to undisturbed natural soil after implementation of ground improvement to maintain settlement and/or mitigate the liquefaction hazard. Ground improvement methods that may be recommended following a geotechnical analysis include preloading, stone columns, deep soil mixing, grouting, or other soil improvement methods. An alternative to ground improvement may be to support the tanks on deep foundations. Temporary unretained excavation slopes may be constructed at 1 ½ horizontal to 1 vertical or flatter. It is anticipated that select excavated material from the site may be used for backfill around and above the tanks.

STRUCTURAL INVESTIGATIONS

A brief structural review of each potential tank site and the proposed tank options was completed by Dean L Webb & Associates. They also reviewed the geotechnical reconnaissance level reports for each site. With exception of the following two items, they did not identify anything at the proposed sites and potential layout of a tank on each site that would cause any structural concerns.

Item one was a concern at proposed Site 6 near the 4565 Contour. The structural engineer does not recommend sites in this area due to the high groundwater potential, low soil bearing pressure, and the high to moderate potential for liquefaction. If a tank site is constructed in this area, there would be increased costs for soil modification/improvement and increased cost for larger footings to support a tank on the lower soil bearing pressure ground. This site condition would generally be found for all sites located within the Town of Vineyard, including Site 7.

Item two is a general recommendation for all tanks greater than 24 feet in height. Conventionally reinforced concrete tanks are most economical for tanks in the 20-foot to 24-foot wall height range. For taller tanks, pre-stressed tanks (i.e. Tendon-Pre-stressed Concrete Water Tanks – AWWA D115, or Wire- and Strand-Wound Circular, Pre-stressed Concrete Water Tanks – AWWA D110) are typically cheaper to construct.

CONSTRUCTABILITY REVIEW

The following is an evaluation of the seven general storage sites selected for further investigation. The evaluations include a constructability review for each site. The evaluations indicate the maximum potential tank size that could be constructed at the site without extensive

shoring or other provisions for deep construction. This information is used below in Chapter 5 to determine the size of tank required for each alternative.

SITE 1 – 600 West 400 North (Geneva Park)

This site is located at approximately 750 West 255 North, which is a park (Geneva Park), owned by the City of Orem (See Figure 4-11). Additional potential locations are the playground area of Geneva Elementary School to the north and open space to the west owned by Intermountain Health Care (IHC). The Geneva Park area appears to be the best location because it would not require any land acquisition for the tank. Construction costs would be similar on the adjacent two sites, but with the added costs for acquiring the land.

Figure 4-11: Site 1 – 600 West 400 North (Geneva Park)

The entire area is relatively flat with a very gentle slope from east to the west. The area is mostly grass with some trees. The park has a walking path, sport courts, pavilions, sand box, and restrooms. To reduce construction costs, it was assumed that the tank would be constructed east of the restroom and large pavilion area. The tank would be buried construction so the area above could be restored for continued use as a park.

Assuming a maximum cut slope of 2:1 (horizontal to vertical), the available footprint for the tank would be about 325 feet long by 175 feet wide. A rectangular tank 320 feet by 160 feet with a 20 foot water depth would have a storage capacity of about 7.5 million gallons (MG). Two

circular tanks with 160 foot diameter and 24 foot water depth could be constructed on the site with a capacity of about 3.5 MG each. The rectangular tank could be constructed with two cells of varying size for separate storage for Vineyard and Orem. The two circular tanks could also be separate storage reservoirs for each city and be different sizes as required. Separate tanks or cells with associated piping would allow each city control of the water level to maintain required equalization and fire storage.

Construction on the site would be fairly typical for these types of facilities. Special shoring would not be anticipated for construction of the tank. Due to limited space on the site for storage of excavated material, construction would require an agreement with either the school district or the hospital for temporarily stockpiling material. If an agreement could not be reached, temporary storage would need to be off-site which could increase construction costs.

The outlet piping would be very deep and would require trench boxes or slide rail shoring system. The deeper trench excavation would be about 2,400 feet long before the outlet pipe could be at a normal 5-foot depth of cover in 400 North Street. It appears that there is existing storm drain piping in 255 North Street that would be utilized for draining and emergency overflow from the tank. An evaluation of the existing storm drain piping would be required to verify capacity with the potential emergency overflow and draining rates. Draining the tanks would require pumps to lift the water to the storm drain and provide the required air gap.

There are a few existing utilities on the site, however none that would appear to interfere with construction of the tank. There is an overhead powerline along the west boundary line of the park. There is also a sectionalizer cabinet on the southeast corner of the park, but it is unclear where the buried power lines are located which serve this box. An above ground fiber optic box is located near the parking area on the south boundary line of the park. Pull boxes located at the park entrance indicate that buried fiber optic cables appear to be on the west and south sides of the park.

To serve the Orem Central/West Area, a booster pump station would be required. The booster pump station was assumed to have a flow rate of 2,900 gpm at a total dynamic head (TDH) of 204 feet. The booster pump station would require a separate discharge pipe. Power transmission lines on the west side of the park would need to be evaluated to determine if the existing power lines have sufficient capacity for the booster pump station.

It was assumed that outlet pipes would be constructed in 255 North and 725 West. However, the outlet pipes could also be constructed on the west side of with the Geneva Elementary School property or the west side of the IHC property. Constructing the outlet pipes in either of these alternate locations would not require the more expensive asphalt restoration and would be less disruptive to the residents in the area. However, moving the outlet pipes to either of these locations would require easements.

Construction would most likely require closing the park completely, but the sand box with playground equipment may remain open. However, the parking area would need to be closed to the public and used for construction worker parking, storage, and potentially site office trailers. There are 5 homes and two schools adjacent to the site, but not immediately next to the proposed tank location. After the initial demolition and excavation activities, noise should be reduced with the construction occurring below the surrounding grade. Truck traffic entering and exiting the site would be the main concern for noise at this site. If the pipeline route(s) selected are in the existing streets, the streets would need to have sections temporarily closed and/or reduced to single lanes during the daytime construction activities. Traffic interruptions could be reduced if the pipeline(s) are routed along the property lines of the school or hospital grounds.

Depending on soil conditions at the site, ground vibration monitoring may be beneficial during excavation and compacting activities.

SITE 2 – 600 West Center Street (Mountain View High School)

Site 2 is located at approximately 100 South 800 West, and is a sports field for Mountain View High School (See Figure 4-12). This site has limited access which would most likely come from the access road on the west side of the high school. This site is currently owned by Alpine School District and is used as a sports practice field.

Figure 4-12: Site 2 – 600 W. Center St. (Mountain View High School)

This site is also relatively flat with a very gentle slope from east to the west. The area is mostly grass with a scoreboard on the west side. The tank would be buried construction so the area above could be restored for continued use as a sports field.

Assuming a maximum cut slope of 2:1 (horizontal to vertical), the available footprint for the tank would be about 420 feet long by 300 feet wide. A rectangular tank 400 feet by 200 feet with a 20 foot water depth would have a storage capacity of just under 12 MG. Two circular tanks with 180 foot diameter and 25 foot water depth could be constructed on the site with a capacity of about 4.5 MG each. The rectangular tank could be constructed with two cells of varying size for separate storage for Vineyard and Orem. The two circular tanks could also be separate storage reservoirs for each city and be different sizes as required. Separate tanks or cells with

associated piping would allow each city control of the water level to maintain required equalization and fire storage.

Construction on the site would be fairly typical for these types of facilities. Special shoring, i.e. soil nail wall or sheet piles, would be required in the northwest corner to construct the largest size tank possible. The excavated slope on the west side could encroach into the parking area if needed. Due to limited space on the site for storage of excavated material, all excavated material would need to be hauled off-site. Backfill material would then be required to be hauled back to the site.

The outlet piping would be very deep and would require trench boxes or slide rail shoring system. The deeper trench excavation would be about 1,500 feet long before the outlet pipe could be at a normal 5-foot depth of cover in Center Street. It appears that there is existing storm drain piping in 800 West, that would be utilized for draining and emergency overflow from the tank. An evaluation of the existing storm drain piping would be required to verify capacity with the potential emergency overflow and draining rates. Draining the tanks would require pumps to lift the water to the storm drain and provide the required air gap.

There are a few existing utilities on the site and would require some special shoring for construction of the tank. There is an overhead powerline about 20 feet east of the west boundary line of the field. An above ground fiber optic box is located near the northwest corner of the field. Pull boxes located in that corner and on 800 West seem to indicate that buried fiber optic cables appear to be along the east side of 800 West and run in the west exit from the LDS Church parking lot.

To serve the Orem Central/West Area, a booster pump station would be required. The booster pump station was assumed to have a flow rate of 7,400 gpm at a total dynamic head (TDH) of 204 feet. The booster pump station would require a separate discharge pipe. Power transmission lines on the west side of the field would need to be evaluated to determine if the existing power lines have sufficient capacity for the booster pump station.

It was assumed that outlet pipes would be constructed in 800 West. However, the outlet pipes could also be constructed through the school parking lot on the east. Constructing the outlet pipes in this alternate location would be less disruptive to the residents in the area. However, moving the outlet pipes to this location would add about 500 feet of additional pipe.

Construction would require closing the soccer/football field completely. In addition, a portion of the school parking area adjacent to the site would be required for construction worker parking, storage, and site office trailers. There are 14 homes adjacent to the site, one school, and one church. The homes and church are mostly bordering the tank location and noise and/or vibrations could be a concern at this site. Vibration monitoring would be beneficial during excavation and compaction activities. Truck traffic could be routed through the Mountain View Alley to reduce the impact on the neighborhood. If the pipeline route(s) selected are in 800 West, the street would need to have sections temporarily closed and/or reduced to single lanes during the daytime construction activities. Traffic interruptions could be reduced if the pipeline(s) are routed through the school grounds or Mountain View Alley.

SITE 3 – 600 West 400 South (Orem Community Park)

Site 3 is located at approximately 600 West 400 South, which is the Orem Community Park owned by Orem (See Figure 4-13). The site is partially used by the high school as their baseball field. A similar sized area is the ball fields just west of Orem Elementary School which is owned by the school district. The costs to construct a tank at either location would be about

the same; however reconstruction of the four ball fields on top of the tank would add cost because of the more significant site improvements that would have to be replaced and some complexity to the design. This complexity would include determining locations for access hatches, air vents, and a potential booster pump station that would not interfere with the ball fields. The Orem Community Park site was selected because a tank can be located such that hatches, air vents, etc. can be located just outside of the existing outfield baseball fence, and outside the soccer field, without encumbering either use, and because site improvements that would require replacement include primarily lawn areas and a fence.

Figure 4-13: Site 3 – 600 West 400 South (Orem Community Park)

This site is also relatively flat with a very gentle slope from east to the west. The area is mostly grass with the baseball outfield fence that would need to be replaced. The tank would be buried construction so the area above could be restored for continued use as a park and baseball field. Tank construction could be limited to the area north of the baseball infield to reduce the cost of replacing the field, dugout, and bleachers. However, elevations would need to match the existing elevations of the outfield.

Assuming a maximum cut slope of 2:1 (horizontal to vertical), the available footprint for the tank would be about 360 feet long by 360 feet wide. A square tank 320 feet by 320 feet with an 18 foot water depth would have a storage capacity of 13.4 MG. A single circular tank with 320 foot diameter and 24 foot water depth could be constructed on the site with a capacity of about 13.4 MG. The rectangular tank could be constructed with two cells of varying size for separate

storage for Vineyard and Orem. The circular tank could also be divided into separate storage reservoirs for each city, but would be a little more complicated than the rectangular tank. Separate tanks or cells with associated piping would allow each city control of the water level to maintain required equalization and fire storage.

Construction on the site would be fairly typical for these types of facilities. Special shoring is not anticipated to be required for construction of a tank at this site. Due to limited space on the site for storage of excavated material, most of the material would need to be hauled off-site. Some of the backfill material would then be required to be hauled back to the site.

The outlet piping would be very deep and would require trench boxes or slide rail shoring system. The deeper trench excavation would be about 2,800 feet long before the outlet pipe could be at a normal 5-foot depth of cover in 400 South. It appears that there is existing storm drain piping in 600 West that runs through the park that would be utilized for draining and emergency overflow from the tank. An evaluation of the existing storm drain piping would be required to verify capacity with the potential emergency overflow and draining rates. Draining the tanks would require pumps to lift the water to the storm drain and provide the required air gap.

Only two utilities are visible on the site. A power transformer and sectionalizer cabinet are located directly west of the site on the west side of 600 West. In addition, a telephone or communication building is located about 300 feet north of the site, which would not be near any construction activities. However, the location of buried lines through the area is unknown.

To serve the Orem Central /West Area, a booster pump station would be required. The booster pump station was assumed to have a flow rate of 11,500 gpm at a total dynamic head (TDH) of 204 feet. The booster pump station would require separate discharge pipe. Power transmission line locations and capacity would need to be evaluated to determine if the existing power lines have sufficient capacity for the booster pump station and where the potential connection point would be located.

Construction would require completely closing the baseball field, soccer field and potentially the pavilion and parking area. The park and tennis courts west of 600 West could remain open during construction. Construction worker parking, storage, and office trailers could potentially be placed in the northwest corner or the southwest corner of the site, if it is determined that the existing parking lot needs to remain open. There are 12 homes adjacent to the site, but there would be some buffer zone between the homes and the tank site. If the pipelines could be placed off the east side of 600 West, then the roads could all remain open during construction. This site probably has more buffer between homes, schools, and other facilities than Site 1 and Site 2 and would probably have the least impact due to noise during construction.

SITE 4 – Lower Cemetery Field

Site 4 is located at the corner of 800 East and 1200 North, which is the Lower Cemetery Field owned by Orem (See Figure 4-14). The site is currently used for soccer fields. This site is also relatively flat with a very gentle slope from the northeast to the southwest. The area is mostly grass with an asphalt access road around the perimeter. The tank could be a partially buried tank in the northeast corner or a completely above grade tank in the northeast corner, west of the access road. A single circular tank with 304 foot diameter and 31 foot water depth could be constructed on the site with a capacity of about 16.8 MG.

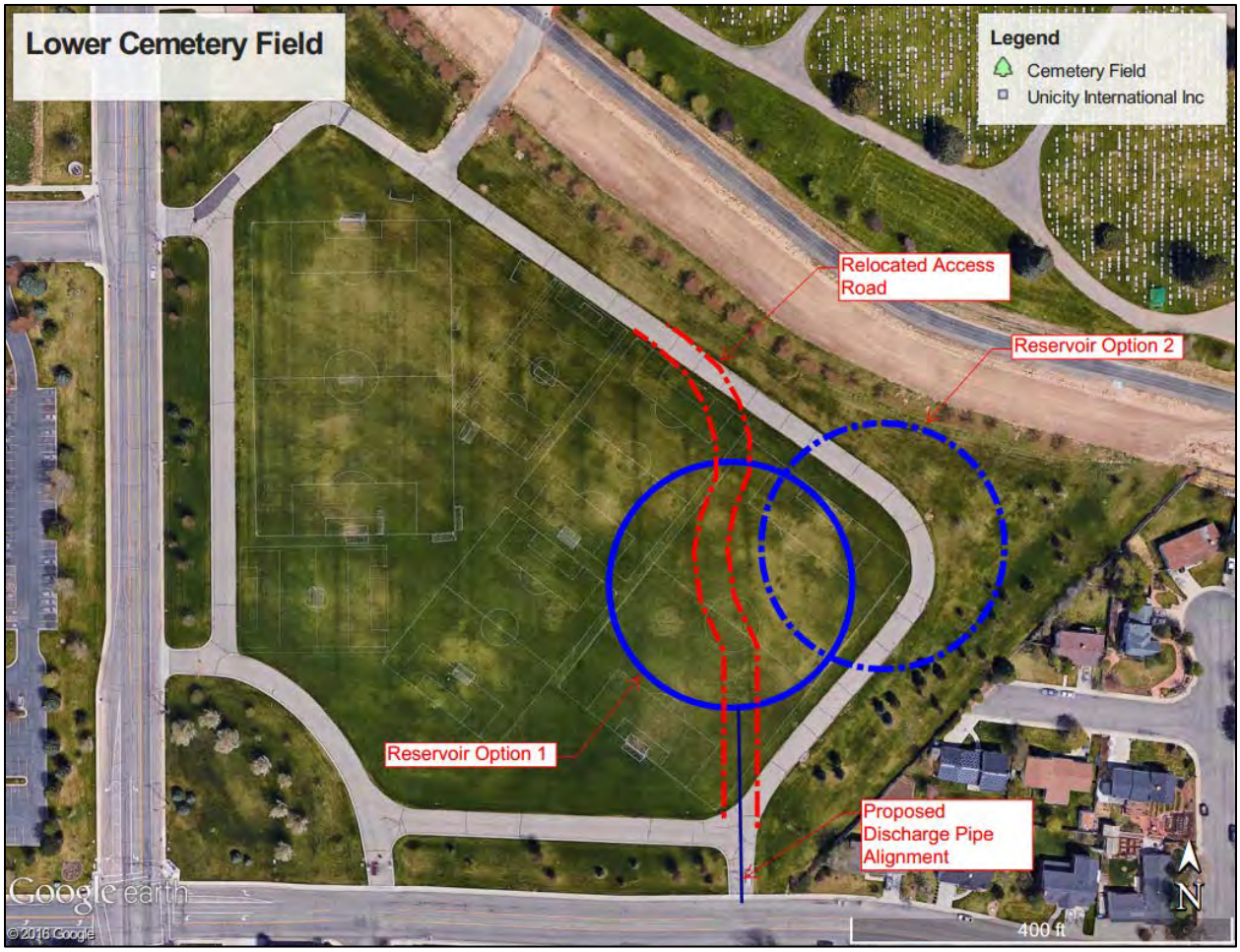


Figure 4-14: Site 4 – 800 East 1200 North (Lower Cemetery Field)

Construction on the site would be fairly typical for these types of facilities. Because the tank would be mostly above grade, special shoring is not required for construction of a tank at this site. Storage of excavated material could be stockpiled at the existing site.

The outlet piping could be constructed with typical conventional methods. It appears that there is existing storm drain piping in 1200 North and on the site that would be utilized for draining and emergency overflow from the tank. An evaluation of the existing storm drain piping would be required to verify capacity with the potential overflow and draining rates. Draining the tank may require pumps to lift the water to the storm drain and provide the required air gap.

Existing utilities include overhead power on the west side of the site and cable TV and/or telephone on the south and east side of the site.

To serve the Orem Central/West Area, a booster pump station would be required. The booster pump station was assumed to have a flow rate of 5,200 gpm at a total dynamic head (TDH) of 70 feet. The booster pump station would require separate discharge pipe. Power transmission lines locations and capacity would need to be evaluated to determine if the existing power lines have sufficient capacity for the booster pump station and where the potential connection point would be located.

Construction would require closing most of the park, depending on the final location selected for the tank. Construction parking, storage, and office trailers would probably be placed along the south side of the park. There are 5 homes adjacent to the site and several more across the street. However, there would be a buffer zone between the tank site and most of the homes which would help reduce noise and vibration impacts. It is not anticipated that 1200 North would need to be completely closed during construction. This street is wide enough to allow single lane traffic during daily construction activities, with only temporary daily closures as needed. Truck traffic would only be on major roads and would not be required to travel through smaller neighborhood streets. Vibration monitoring would probably be beneficial during excavation and compaction activities.

SITE 5 – Cascade Drive

Site 5 is located near the intersection of 800 East and 1600 North on Cascade Drive. Cascade Drive is the access road to the Utah Valley Water Treatment Plant and Bonneville Trail Access parking lot (See Figure 4-15). The area north of Cascade Drive and a small portion south of the road is owned by Orem. The remaining area south of the road is owned by CUWCD. Both of these properties were reviewed as a potential tank site on Cascade Drive. It was determined that the largest tank that could be fit on the Orem property would be a rectangular tank 160 feet long by 140 feet wide and a 31 foot water depth, with a capacity of about 5 MG. Therefore, the Orem property is too small to provide the required 15.9 MG and was eliminated from further consideration. After an initial review of this report, it was determined that another option be included in the study. This additional option would be to replace the existing Orem Lower tanks below the DACRWTP with a new larger 24 MG tank. This would replace the existing 8 MG at the site and add the additional required 15.9 MG needed for buildout.

<u>Option 1 – 15.9 MG Tank on CUWCD Property</u>

The Cascade site is dissected by a high voltage power line and the Orem Reach 2 Aqueduct. The power line could be relocated to the south and east. The Orem Reach 2 Aqueduct is a federal facility and it would be very unlikely that these facilities could be relocated and concerns exist pertaining to relocating roads on the aqueduct and associated valves. Because of this, a tank would have to be constructed either north or south of the pipeline.

This site is very steep sloping from the east to the west. The area is open space with native vegetation. The tank would be a partially buried tank with elevations matching the existing Orem Lower Tanks. This option would be a single circular tank with 295 foot diameter and 31 foot water depth with a capacity of about 15.9 MG, constructed all on CUWCD property.

Construction on the site would be more complicated than typical construction due to the steep slopes, extremely deep outlet piping/transmission pipes, and proximity to existing water tanks located to the east. It is most likely that special shoring, such as a soil nail wall, would be required for excavation for the tank. Due to the needed tank height, the tank would probably be a pre-stressed wire wrapped or tendon tank. Also, because the tank would be partially buried on one side, a keyway wall or geofoam block backfill would most likely be required to prevent sliding.

The outlet piping could be constructed with typical conventional methods. It appears that there is existing storm drain piping in 800 East that could be utilized for draining and emergency overflow from the tank. An evaluation of the existing storm drain piping would be required to verify capacity with the potential emergency overflow and draining rates. Draining the tank would probably not require pumps to lift the water to the storm drain and provide the required air gap.

Figure 4-15: Site 5 – 800 East 1600 North (Cascade Drive)

The existing utilities would not interfere with construction of the tank. The waterline may interfere with construction of the drainage pipeline depending on the depth of cover. The waterline may also need to have special shoring to protect it during excavation and construction of the tank.

No closures would be required during the construction of a tank at this site. Parking, storage, and office trailers could be placed on the existing site. Truck traffic would enter and exit directly onto 1600 North/800 East and would not impact any local neighborhoods. Pipeline route(s) would be on 1600 N/800 E, which should be wide enough to maintain two-way traffic or may require single lane traffic during daily construction activities, depending on the location of the pipelines within the road right-of-way. Due to the location below the existing CUWCD tanks, vibration and settlement monitoring would be required during construction of the soil nail wall, excavation, and during compaction activities.

<u>Option 2 – Site 5a – 24 MG Tank on Orem Property (Replacing Existing 8 MG Lower Tanks)</u>

This option includes replacing the existing Orem Lower tanks (capacity 8 MG) below the DACRWTP with a new larger 24 MG tank. This site is shown in Figure 4-16 below.

Construction on this site would be less complicated that Options 1 above. The only complication would be the temporary loss of storage during construction. The existing steel tanks and pump station would need to be demolished. A new 24 MG concrete above grade tank would be constructed on the site. Because the tank would have an odd shape and be 31 feet tall, it is recommended that a post-tensioned tank be used. A decorated finish (slip liner) could be used on the exterior tank walls so the tank would blend in with the area and be more visibly appealing to the neighbors.

The site would require a soil-nail wall to allow for construction and could probably be a permanent wall and remain after construction. Significant grading at the site would be required, but would be less than Option 1.

Figure 4-16: Site 5a – Orem Existing Lower Tank Site

No closures would be required during construction of the replacement tank at this site and no public roads would be closed during construction. There are 6 homes adjacent to this site. Construction noise would be a potential concern, especially during demolition of the existing tanks. Due to the proximity to the DACRWTP and other buildings to the east, vibration and settlement monitoring would be highly recommended during construction at the site.

The total cost estimate to construct a tank at Site 5a (Option 2) is approximately $25.1 million. The total cost estimate to construction a tank at Site 5 (Option 1) is approximately $21.1 million. Therefore, Site 5 (Option 1) was selected as the option for inclusion in the alternatives analyses in Chapter 5.

SITE 6 – 4565 Contour

No specific site was recommended for the storage tank construction for this area; just somewhere near the 4565 Contour between 400 South and 400 North. A tank in this area would most likely be an above grade steel tank with a booster pump station to pressurize the system. Because a tank in this area would require pumping, the location can be selected that would be least cost to purchase and be as high in elevation as possible. The cost to construct a tank would be similar on most sites either east or west of the railroad tracks or near Geneva Road on the former Geneva Steel site.

Figure 4-17 and Figure 4-18 show two sites that are near the 4565 Contour on 400 South and 400 North, respectively. Both sites are relatively flat with gentle slopes from east to west. Both sites are privately owned and would be required to be purchased for the tank.

Figure 4-17: Site 6a – 400 South 1500 West

A single circular tank with 160 foot diameter and 30 foot water depth could be constructed on the site with a capacity of about 4.5 MG.

Construction on the site would be fairly typical for these types of facilities. Because the tank would be mostly above grade, special shoring is not required for construction of a tank at this site. Any excavated material would be hauled off-site. However, based on recommendations from the geotechnical review, ground improvement will probably be required at these sites, such

as installing the reservoir on auger cast piles or driven steel piles as an alternative to ground improvement.

The outlet piping could be constructed with typical conventional methods. It appears that there is existing storm drain piping at both sites that would be utilized for draining and overflow from the tank. An evaluation of the existing storm drain piping would be required to verify capacity with the potential emergency overflow and draining rates. Draining the tank may require pumps to lift the water to the storm drain and provide the required air gap.

Existing utilities include overhead and buried power, gas, and communication lines typical for an industrial/commercial area. None of the existing utilities would interfere with construction of the tank.

To serve the Vineyard and Orem Lake areas, a booster pump station would be required. Power transmission lines locations and capacity would need to be evaluated to determine if the existing power lines have sufficient capacity for the booster pump station and where the potential connection point would be located.

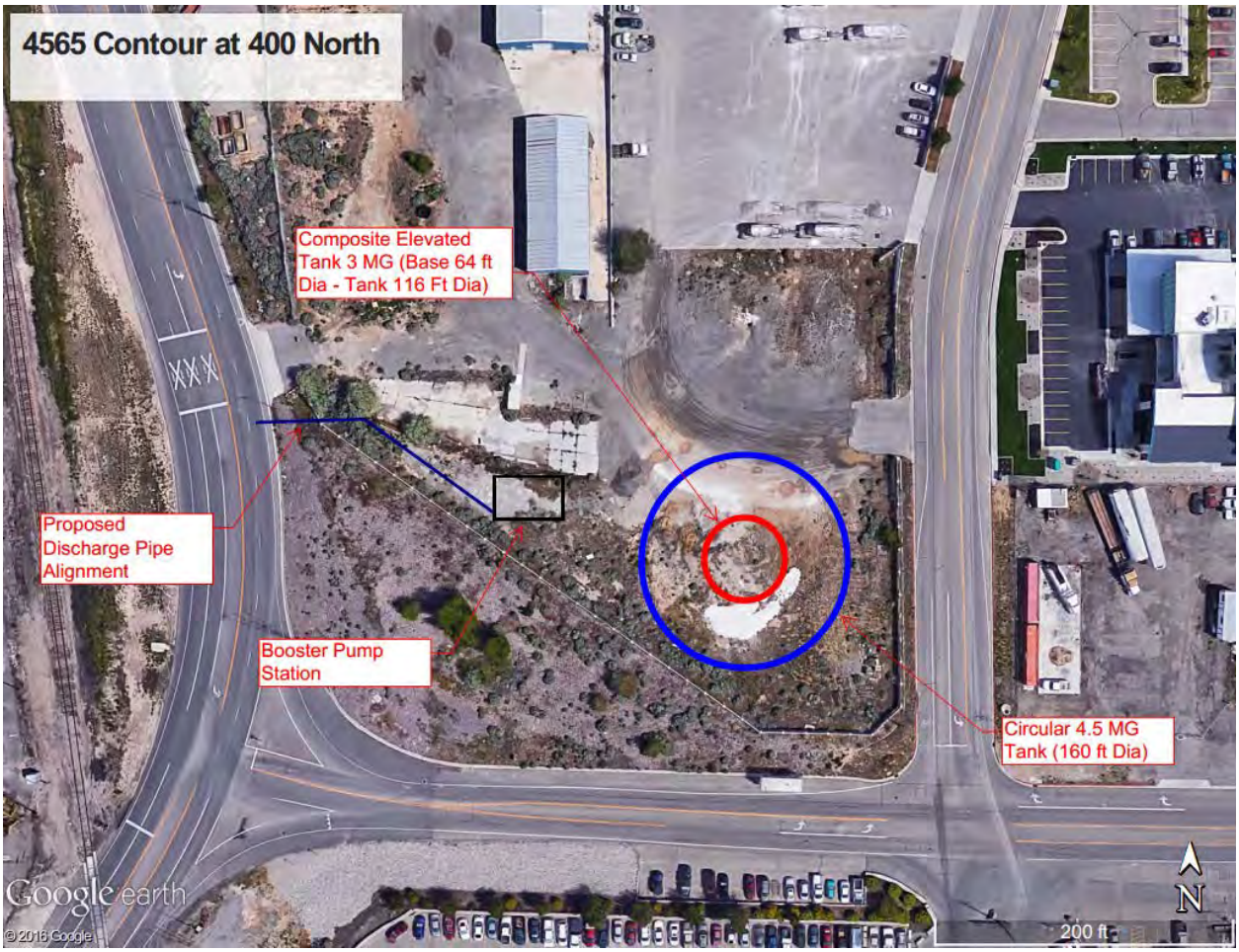


Figure 18: Site 6b – 400 North 1500 West

No site closures would be required for construction at Site 6a and Site 6b. Parking, storage, and office trailers would be provided on site. Truck traffic would enter and exit directly to main arterial streets and would have little impact to surrounding businesses. Streets closures would

be temporary or limited during construction of pipelines to the site. Depending on the selected method of ground stabilization, noise and vibration impacts would vary. If auger cast piles are used there would be minimal noise or vibrations. If driven piles are used there would be significant noise and vibration impacts.

SITE 7 – 800 North, West of Geneva Road, Vineyard

After the initial review of this report, it was requested that a tank site be evaluated within the Town of Vineyard. A location near 800 North, west of Geneva Road, is a potential site due to its proximity to the CUWCD North Shore Aqueduct at this location which could provide the supply to the tank. Figure 4-19 shows the location and proposed layout of this site. Note that since Vineyard is in the process of developing, there are currently many locations within Vineyard that could be selected for the tank. Another potential site would include placing the tank further to the west at an optimal location where the source of supply could be the future CUWCD transmission pipeline that will be constructed along the Union Pacific Railroad for ten additional wells the District plans to construct. Vineyard is in the process of developing a water system master plan which should address optimal locations for a tank or tanks within the proposed distribution system of the Town.

Figure 4-19: Site 7 – 800 North, West of Geneva Road, Vineyard

A tank in this area would most likely be an above grade steel tank with a booster pump station to pressurize the system. Although an exposed above grade concrete tank could also be an option for this site. The area is generally flat and so excavation would be minimal.

A single circular tank with 240 foot diameter and 24 foot water depth could be constructed on the site with a capacity of about 7.7 MG.

Construction on the site would be fairly typical for these types of facilities. Because the tank would be mostly above grade, special shoring is not required for construction of a tank at this site. Any excavated material would be hauled off-site. However, based on recommendations from the geotechnical review for sites 6a and 6b, ground improvement will probably be required at this site, such as preloading the site or installing the tank on auger cast piles or driven steel piles as an alternative to ground improvement.

Street closures would need to be determined, pending the final site selection, although it is anticipated that closures would not be required. Pipeline construction would also likely require temporary street closures or single lane traffic during daily construction activities. Noise impacts would also need to be evaluated after final site selection. However, due to the current construction activity in the area, it is anticipated that noise during construction of the tank would be similar to current levels.

CHAPTER 5 - MODELING AND ALTERNATIVES DEVELOPMENT

BACKGROUND

Hydraulic modeling of the three water systems constituted a major portion of this project. Each individual system represents an important and interesting part of the overall system.

- CUWCD – CUWCD is a major supplier of wholesale water to Orem and Vineyard and has finished water storage co-located with Orem and Vineyard at its DCRWTP facility in the northeast corner of Orem. It also has a very large transmission main located through Orem.
- Orem – Orem's water system represents the largest end consumer demand of the combined systems. It constitutes a large part of the transmission network that moves water from sources in the east portion of Orem (including CUWCD) to service not only the Orem area to the west, but also the Vineyard South area.
- Vineyard – The Vineyard system represents a quickly expanding distribution system which relies on CUWCD and Orem for all of its water supply. CUWCD supplies source water directly to the Vineyard North area. Water is provided to the Vineyard South area from Orem via the Orem water distribution network.

Each water system provided a mostly up-to-date hydraulic model available in an EPANET compatible format. Although each model varied slightly in model settings, conventions and coordinate system, these challenges were overcome and the three models were merged into a combined EPANET hydraulic model.

The "Existing Peak Day" and "Buildout Peak Day" scenarios were selected from each of the individual hydraulic models. It should be noted that in the Vineyard model, a demand condition labeled as "near future" was used for the Existing Peak Day scenario. When combined existing peak day model results were compared to a limited quantity of SCADA data obtained from Orem for summer of 2015, it was observed in the model that this combined model peak day demand may be slightly conservative.

Each individual model was a "steady state" model when received. HAL added model controls based on conversations with Orem system operators and controls identified in the Orem, Vineyard and CUWCD models. As was previously mentioned, the match to summer 2015 SCADA data was reasonable although slightly conservative. No other anomalies were found in the individual models, or in the combined model, that required corrective action.

MODELING OF EXISTING CONDITIONS

One of the necessary components of a water system to make storage functional is the ability to deliver water from the storage location to the area which it serves through transmission mains without excessive head loss or velocity. A limiting condition was observed in the modeling associated with the Orem water system that has impact on the recommendations for the storage tank locations alternatives. Peak instantaneous demand for the Orem Central/West Area and the Lake Area is approximately 54,000 gpm. Records show that wells which pump into the Central Zone only account for an average flow of 5,300 gpm and thus the remaining peak instantaneous demand of 48,700 gpm must be supplied by the Orem's Lower Tanks (8 MG) and the CUWCD Tanks. There is currently a 36-inch diameter transmission pipeline that conveys water from the CUWCD tanks to the Central Zone and a 20-inch diameter pipeline that conveys

water from Lower tanks to the Central Zone. These transmission lines have a capacity of about 20,000 gpm.

Currently, Orem takes advantage of the higher pressure provided by CUWCD from the CUWCD Tanks to overcome the head loss associated transmission deficiencies. Velocities in the main transmission lines reach 10 fps. This velocity is higher than typically allowed in most transmission lines due to excessive pressure loss. To overcome this excessive pressure loss, the CUWCD source and storage are favored because the system relies on the pressure provided by CUWCD. This limits the use of the wells and the existing 8 MG storage (Lower Tanks) in the Central Zone and forces a majority of the equalization storage to occur in the CUWCD storage tank.

ALTERNATIVES

Taking into consideration the information presented in the previous chapters (i.e. required water storage requirements, the seven selected potential water storage tank sites, geotechnical and structural considerations of the potential tank sites, and constructability issues), four alternatives have been developed for further evaluation to identify optimal storage tank locations and sizes. These alternatives include:

Alternative 1 focuses on locating tanks where they can serve the general storage areas identified previously via gravity (i.e. pumping is not required to pressurize the water from the tank into the system). Under Alternative 1, filling the tanks is assumed to be controlled via flow control valves at a constant peak day flow rate.

Alternative 2 locates all additional required storage at the sites located within the Orem Central zone that can serve the Lake Area by gravity, but would have to be pumped into the Central/West Area to serve that storage area. Under Alternative 2, tanks would have to fill during non-peak demand hours and then required storage for the Central/West Areas would be pumped out of the tanks into this area during peak demand hours.

Alternative 3 is a hybrid of Alternative 1 and Alternative 2. Initially, there is an immediate need to provide additional storage for the Central/West Area. Similar to Alternative 2, storage tanks would be located within the Central./West Area at an elevation and constructed to a size that will be conducive for gravity feed at a future date for the Lake Area as the Lake Area develops. Initially, however these tanks or tank can be used to provide storage for the Central/West Area by constructing a booster pumping station at the site(s) capable of pumping into the pressure of the Central/West Area. Under Alternative 3, the booster pumping station(s) would be temporary and would not be required once the additional storage and large diameter transmission piping, identified under Alternative 1, is constructed. Alternative 3 is identical to Alternative 1, but in the near term it provides ground level storage at Site 3 to serve the current deficiencies in the Central zone with pumping.

Alternative 4 is similar to Alternative 1 for Orem, but assumes that all of the Vineyard storage is located within the Town of Vineyard. Storage located inside of Vineyard cannot serve the Town by gravity, but will require pumping out of the tanks into the Vineyard system. Under this alternative, it has been assumed that all of the water supplied to the Vineyard system will be directly from the CUWCD system, and not through Orem. If the tanks are located inside of the Town of Vineyard, Vineyard can take advantage of the transmission capacity already in the CUWCD system and would not need to participate in creating additional transmission capacity in the Orem system. Thus, transmission pipelines pertaining to Orem can be smaller than proposed in Alternative 1.

In identifying which tanks should be built and the volumes of the tanks that should be built at the identified sites in each alternative, several factors have been considered in the evaluation. These include the following:

1. There are some minor differences in elevation between Sites 1 – 600 West 400 North, Site 2 – 600 West Center Street, and Site 3 – 600 West 400 South. While they are close in elevation, due to the existing surface features at these sites it will be difficult to construct tanks at the same elevation that could work in parallel to serve the Lake Area via gravity. For example, Site 1 is at elevation 4745 to 4746 feet, Site 2 at 4740 to 4741 feet, and Site 3 is at elevation 4738 to 4739 feet, existing ground surface elevation.
2. A storage tank can be constructed large enough at Site 3 to serve all of the storage needs for the Vineyard South and Orem Southwest areas of the Lake Area via gravity. This site is also located at the best location to serve this area.
3. Since a storage tank can be constructed at Site 3 large enough to meet build-out needs for the Lake Area (minus Vineyard North), a storage tank can be constructed at Site 2 at a different elevation than the tank at Site 3. This storage tank at Site 2 would be used for the Central/West Area under Alternative 2 along with a booster pumping station.
4. Site 1 is at an elevation that can be used exclusively for the Vineyard North area of the Lake Storage Area. A larger segmented tank can also be constructed at this site where a portion of the tank can be used to meet Orem Central/West Area needs under Alternative 2 with a booster pumping station.
5. Site 4 - Lower Cemetery Field, is located at an elevation lower than the existing 8 MG Lower Tank that serves the Central/West Area. A tank located at this site would therefore require a booster pumping station to match the elevation provided by the Lower Tanks. However, the tank would be located very close to the existing Lower Tanks, and it will be very difficult, due to this proximity, to make these two tanks function efficiently in parallel. Therefore, the Lower Cemetery Field site has been excluded from further consideration in the analysis.
6. Due to the construction related issues with siting a tank at Site 6 – 4565 Contour, the fact that this site is too low in elevation to serve the Lake General Storage Area via gravity (i.e. pumping would be required), and the inclusion of Alternative 4 that assumes Vineyard storage would be located lower in elevation within Vineyard, Site 6 has been excluded from further consideration in the analysis. As indicted previously, the structural engineer does not recommend sites in this area due to the high groundwater potential, low soil bearing pressure, and the high to moderate potential for liquefaction.
7. While the site conditions referenced for Site 6 would apply to most if not all of the sites located within the Town of Vineyard, costs associated with addressing these concerns have been included in evaluation of Site 7, including energy costs associated with pumping from the tanks into the Vineyard water system.

Alternative 1

Alternative 1 was evaluated with the buildout model since the buildout condition would be the most critical condition to test for proper performance. It is proposed that a 15.9 MG tank at Site 5 – Cascade Drive (or replacing the existing Orem Lower Tanks at Site 5a with a 24 MG tank) would be built immediately to satisfy current storage deficiencies and near-term needs. To properly utilize operational storage from this tank, properly sized transmission pipes would need to be constructed to deliver water to service areas in the west. Figure 5-1 shows the tank sites proposed for Alternative 1 along with recommended transmission pipeline improvements. Note that the site shown for Site 5, could be either the Cascade Drive site or Site 5a.

A 2.4 MG storage tank would be built at Site 1 – 600 West 400 North. This tank would be dedicated to serving the Vineyard North zone and would be built before the current temporary

agreement between CUWCD and Vineyard expires in 2021. This tank would be filled from the Vineyard North zone and would float on that zone. An 18-inch diameter pipe would need to be constructed from the Vineyard North zone to Site 1 to connect the tank to the zone. Two current connections to the large CUWCD supply line that borders the zone would remain as the main supply to this zone. This tank and transmission line would serve only the Vineyard North Zone, which is not served by Orem.

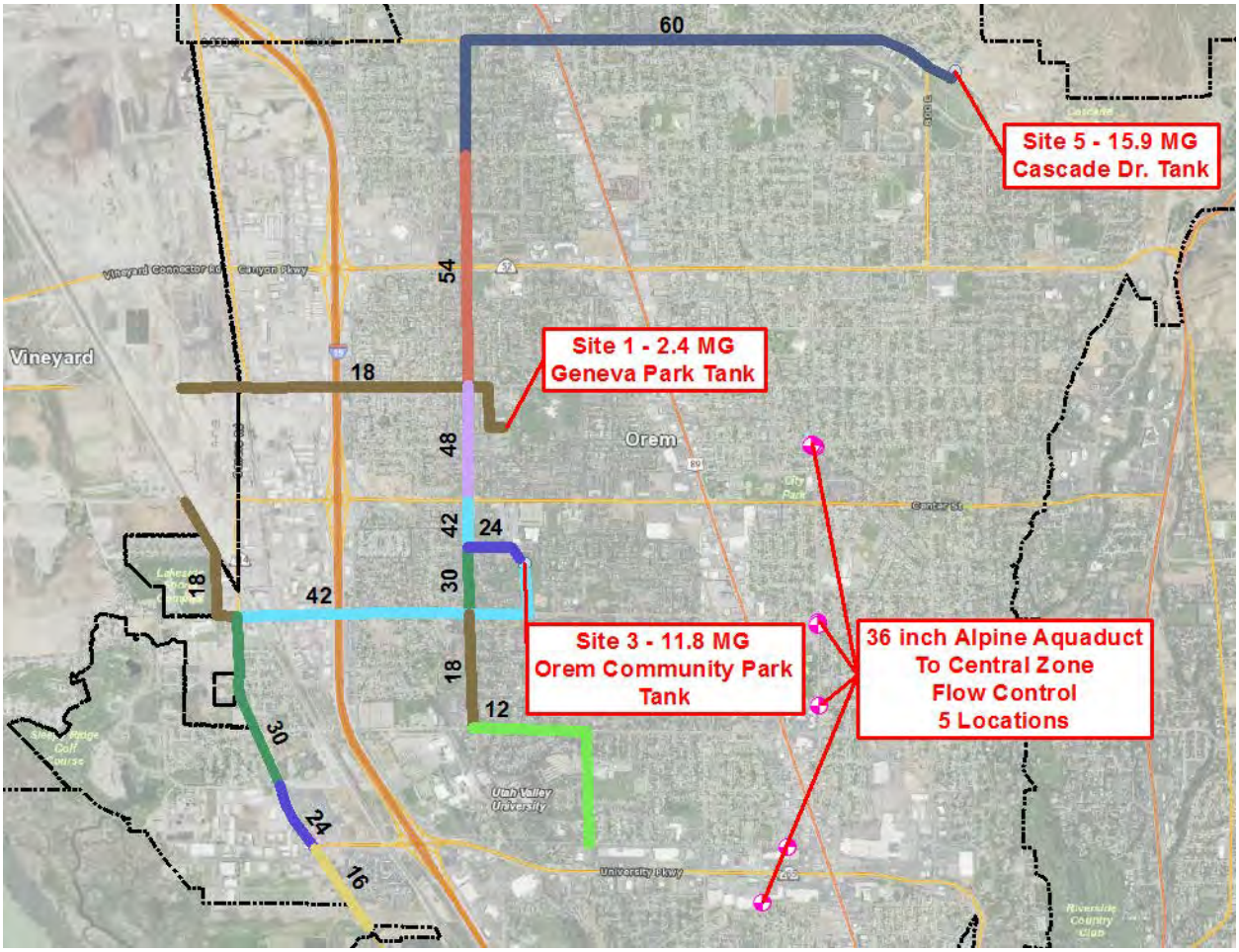


Figure 5-1: Alternative 1 Facilities

Lastly, by approximately 2024 (depending on growth), an 11.8 MG tank would be constructed at Site 3 – 600 West 400 South. This tank would be filled from the same transmission main that delivers water to the Orem Central zone from the Site 5 tank. Although combining water delivery from Site 5 and transmission main from the WTP to the Site 3 tank would increase the size of the stated transmission main, it eliminates the need to build two separate transmission pipes.

Transmission mains were sized to maintain downstream pressure swings within the distribution systems below 20 psi and to prevent excessive utilization of the CUWCD WTP tank. In order to keep existing storage for upper areas from serving lower areas, flow in the existing 'Alpine Aqueduct' between the aqueduct and Orem Central zone was limited through use of flow control valves.

It should also be noted that currently there are east-west transmission deficiencies within the Orem distribution system. The proposed transmission line is also sized to rectify these deficiencies and reduce existing transmission line velocities and associated pressure loss.

Alternative 1 performs well, has good utilization of all proposed tanks at buildout, and reduces water level fluctuation at the CUWCD storage facility. Figure 5-2 shows tank utilization performance for Alternative 1. Figure 5-9 (addressed in a subsequent section) shows WTP tank fluctuation for all four alternatives versus a no-action or existing condition.

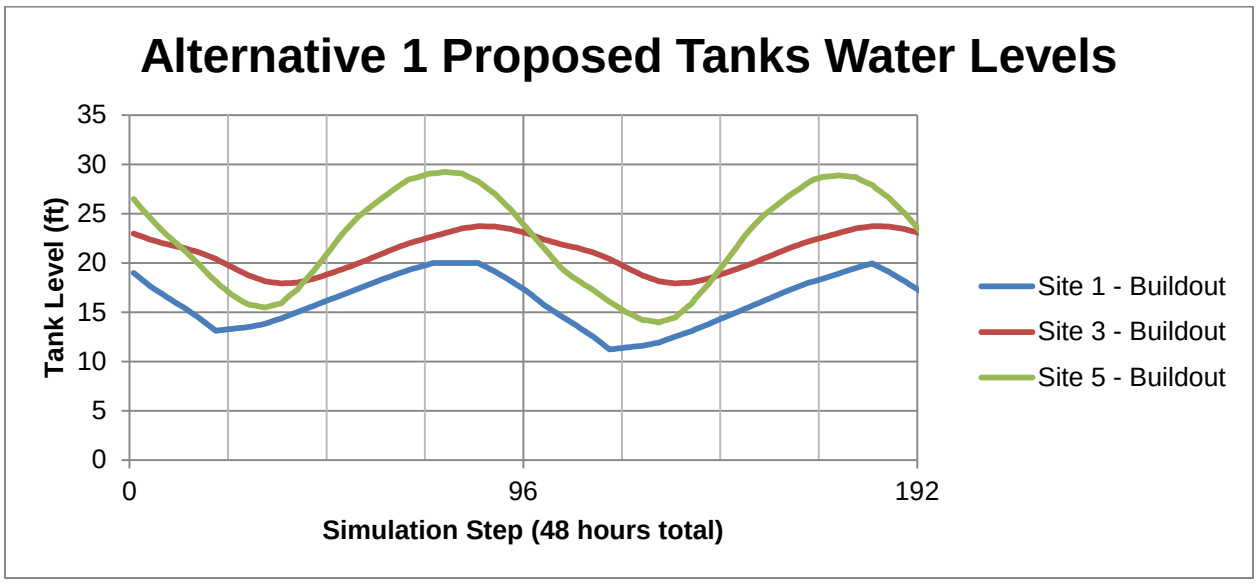


Figure 5-2: Alternative 1 Tanks Utilization Performance

Alternative 2

Alternative 2 focuses on providing all proposed storage tanks within the boundary of the Orem Central/West Storage Area. This alternative also requires three separate tanks to meet the buildout condition. All three proposed tanks would be filled from the surrounding Central zone during off-peak demand periods of the day and would then boost that water back into the Central/West Storage Area during peak demand periods of the day. Figure 5-3 shows the tank sites proposed for Alternative 2 along with recommended transmission pipeline improvements.

The obvious disadvantage to this alternative for Orem would be the need to build and operate booster stations that consume energy in order to operate. Booster stations would be required at both Site 1 and Site 2 to serve the Orem Central zone. Tank storage for Vineyard at Site 1 can serve the Vineyard North zone via gravity. Tank storage for both Orem and Vineyard at Site 3 can serve the Southwest Orem zone, the Vineyard South (Orem) zone and the Vineyard South (Vineyard) zone via gravity. Despite the disadvantage related to pumping into the Orem Central zone, most of the pumping would be required during the summer irrigation season and operational practices could reduce energy demand during winter months.

The tank at Site 2 (10.8 MG) would be built immediately. Current transmission capacity from the main source at CUWCD to the Central/West and Lake Areas at peak hours is deficient and causes large pressure swings. In the short term, building a tank at Site 2 and utilizing pumping from the tank during peak hours and filling the tank during off-peak hours will reduce pressure swings in the eastern Central zone by approximately 40% and reduce water level drop at the WTP tank. Since this tank would be filled during off-peak hours when consumer demands are

less, the current transmission/distribution network, although taxed, could adequately fill the tank. To conserve energy and keep system pressure swings downstream of the booster pump within acceptable levels, some transmission mains would need to be built near the facility.

Site 1 tank would be built by 2021. This tank was assumed to be a rectangular tank with a partition wall to separate the storage for Vineyard North and the rest of the system. This tank would be a 7-MG tank, 2.4 MG would be dedicated to Vineyard North and the balance of 4.6 MG to Orem for the Central/West Area. Even though Site 1 tank holds storage for more than the Vineyard North zone, this tank would be needed around the time that the Vineyard-CUWCD agreement ends. Site 1 tank (Orem side) would be supplied by the new transmission line previously mentioned. The Vineyard North section of the tank would 'float' on the zone it serves and thus would have a dedicated transmission line from this portion of the tank to the zone. Transmission of water from the Orem side of the tank to West Area zones would be through the existing network and PRVs.

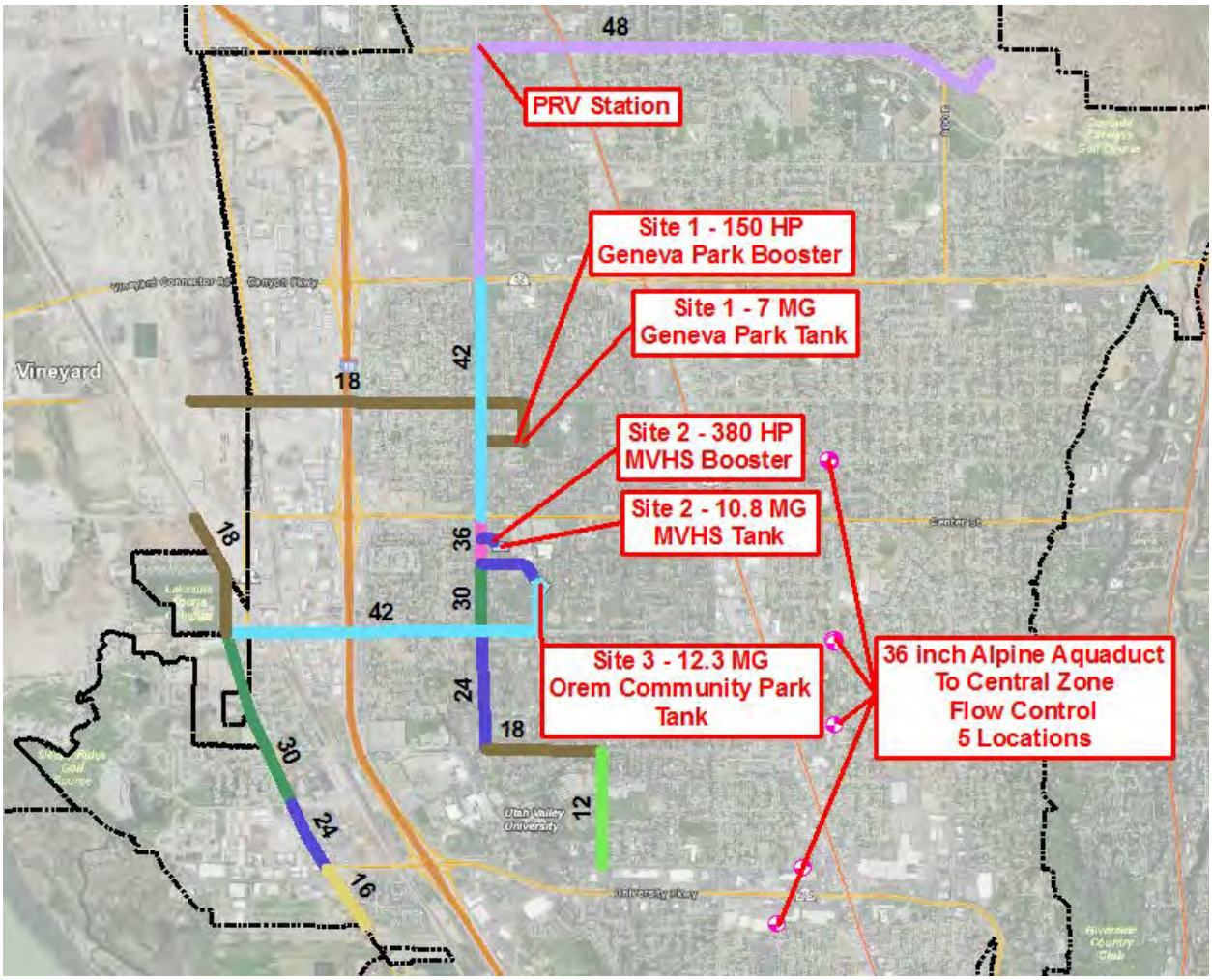


Figure 5-3: Alternative 2 Facilities

By approximately 2024 (depending on growth), a 12.3 MG tank would be constructed at Site 3 – 600 West 400 South. This tank would be filled from the Central Zone piping and the transmission pipeline improvements. A booster pumping station is not required for this tank since it will be used to serve the western areas by gravity. Additional transmission capacity

would also be needed from the tank and within the West and Lake Areas to supply growing demands in the West and Lake Areas.

Performance of this alternative is similar to that of Alternative 1 since the same performance criteria were used in designing improvements. Tank utilization is good and WTP tank fluctuation is lowered as can be seen in Figure 5-4, which shows tank utilization performance for Alternative 2, and Figure 5-9 which shows WTP tank fluctuation for all three alternatives versus a no-action or existing condition.

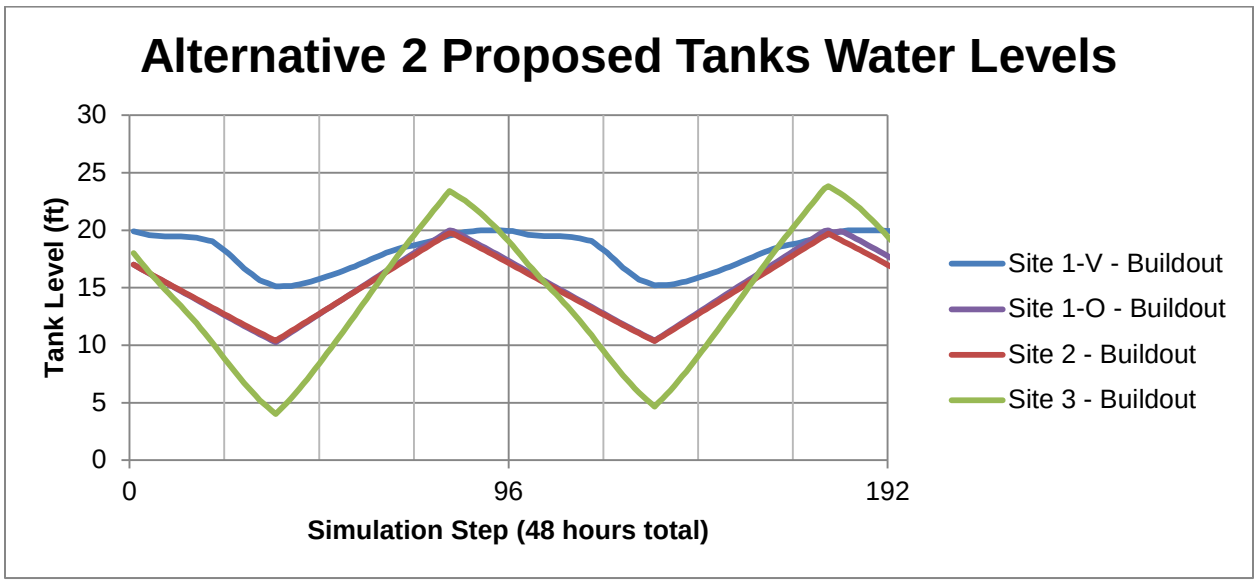


Figure 5-4: Alternative 2 Tanks Utilization Performance

Alternative 3

Alternative 3 is very similar to Alternative 1 with the exception that Site 3 tank (11.8 MG) is constructed first and is used with a booster station to meet near-term deficiencies in the Central/West Area. However at buildout, it is anticipated that all of the required transmission pipelines for full gravity operation would be installed and the booster station would no longer be needed. The booster station could then become a backup system for the Central/West Area. The Site 3 tank would be built immediately and enough transmission enhancements would be made around Site 3 to adequately fill the tank as well as reduce velocities and energy loss when pumping. Figure 5-5 shows the tank sites proposed for Alternative 3 along with recommended transmission pipelines.

Site 1 tank (2.4 MG) would be needed by 2021 and would be constructed as outlined in Alternative 1, being dedicated to Vineyard North zone. As previously stated, this tank is only for Vineyard. Site 5 tank (15.9 MG) or Site 5a (24 MG) would be needed by 2024 (depending on growth) and would also be constructed as outlined in Alternative 1. For optimal water distribution performance and utilization of storage, construction of the large diameter transmission pipeline from Site 5 would need to coincide with the construction of the Site 5 Tank.

Performance of Alternative 3 was checked with hydraulic modeling using the existing peak day model with only Site 3 tank and its associated booster pump installed. Buildout condition performance will be the same as Alternative 1. Figure 5-6 shows tank utilization performance for Alternative 3.

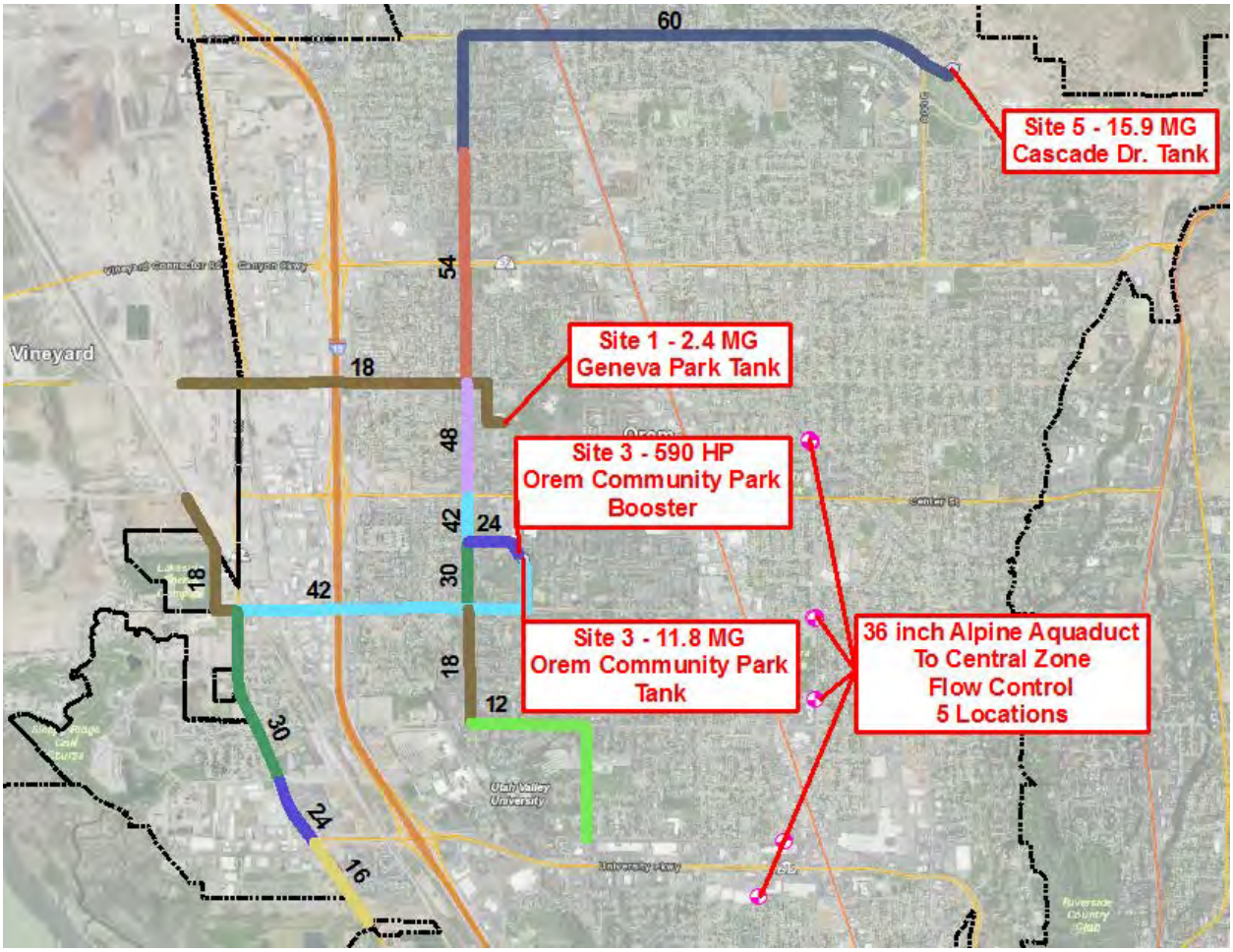


Figure 5-5: Alternative 3 Facilities

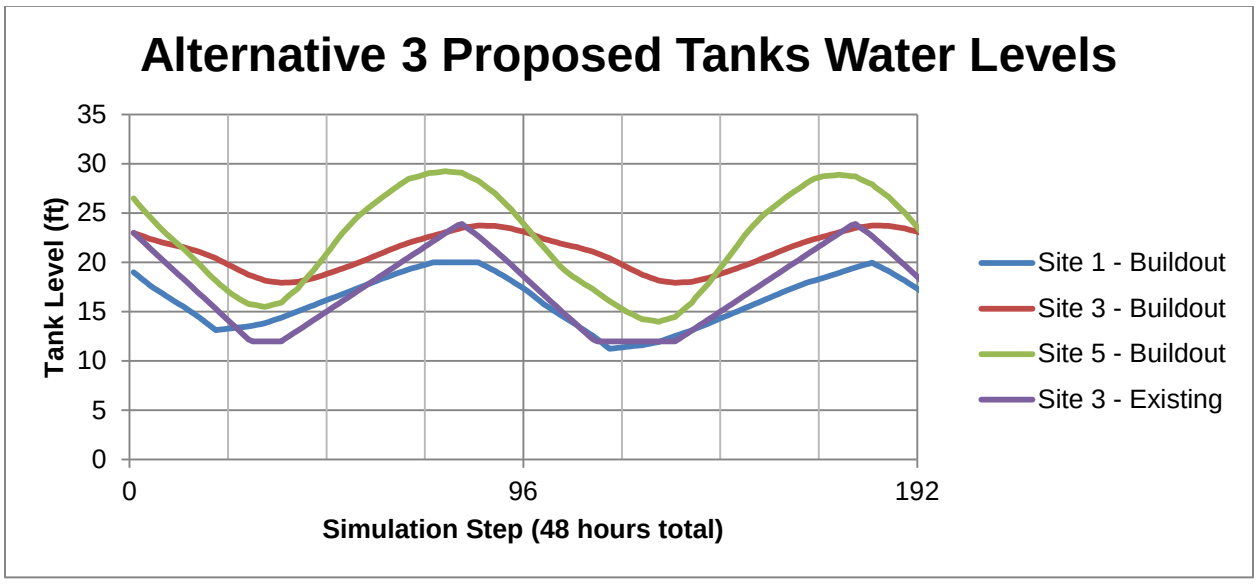


Figure 5-6: Alternative 3 Tanks Utilization Performance

Alternative 4

Alternative 4 is very similar to Alternative 1 for Orem. However, Alternative 4 assumes that Vineyard storage is located within the Town of Vineyard instead of within the Orem limits. It is proposed that a 15.9 MG tank at Site 5 – Cascade Drive (or replacing the existing Orem Lower Tanks at Site 5a with a 24 MG tank) would be built immediately to satisfy current storage deficiencies and near-term needs for Orem. To properly utilize operational storage from this tank, properly sized transmission pipes would need to be constructed to deliver water to service areas in the west. Figure 5-7 shows the tank sites proposed for Alternative 4, along with recommended transmission pipeline improvements. Note that the site shown for Site 5 could be either the Cascade Drive site or Site 5a.

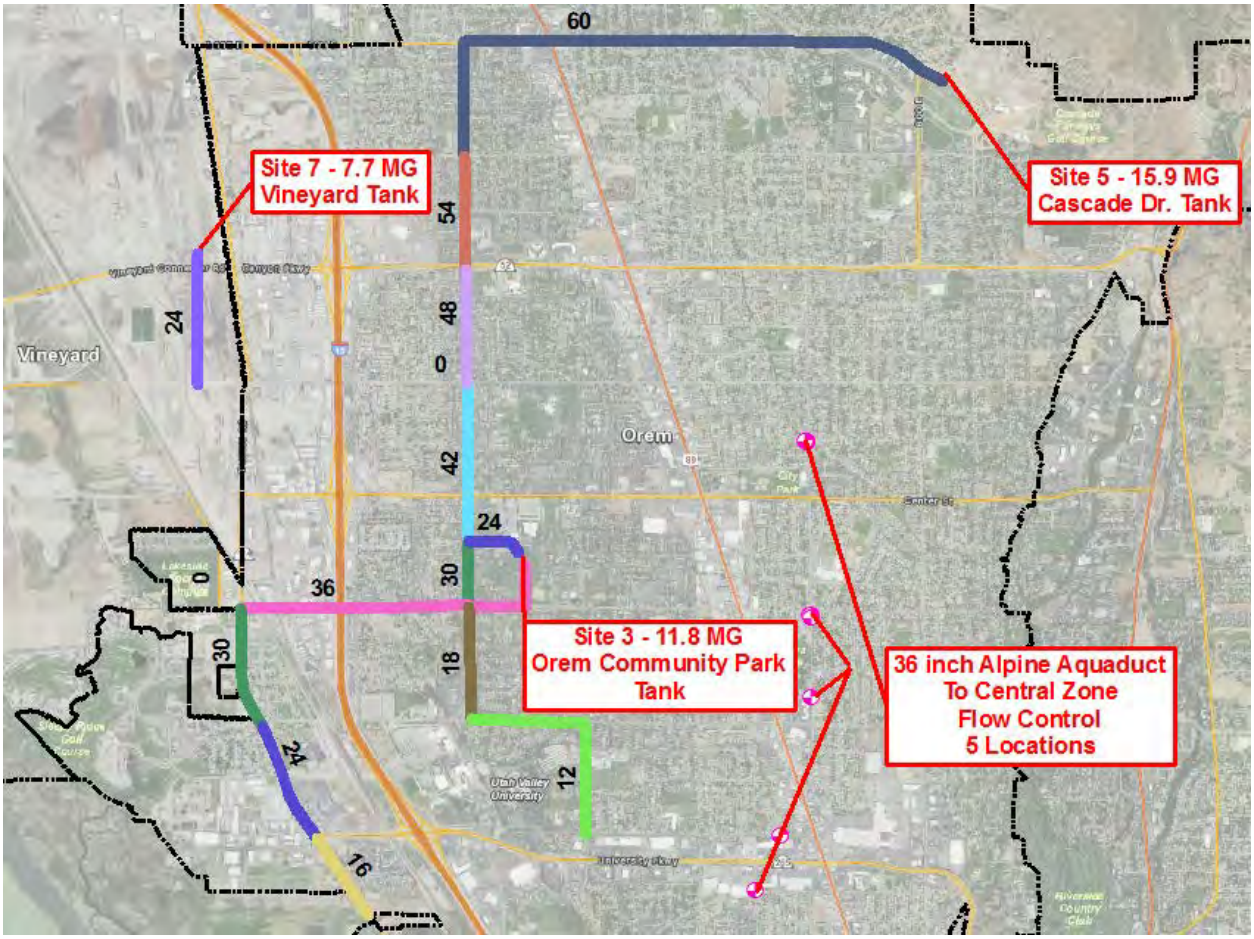


Figure 5-7: Alternative 4 Facilities

A 7.7 MG storage tank would be built at Site 7 – 800 North, Immediately West of Geneva Road in Vineyard. A single large tank could be built at this site, or at some other strategic location in Vineyard, or two smaller tanks could be located at other sites within Vineyard. Currently, there is significant undeveloped land within Vineyard that could be considered for a tank(s) location. This tank would be dedicated to serving all of the Town of Vineyard, and should be built before the current temporary storage agreement between CUWCD and Vineyard expires in 2021. This tank would be filled from connections with the CUWCD North Shore Aqueduct that borders Vineyard from 800 North northward and along the northern side of Vineyard. CUWCD also plans on installing a pipeline along the Union Pacific Railroad, further to the west, to connect a number of future wells the District is constructing. Connections could potentially be made into

this future western pipeline, as well. Due to the elevation of the ground within Vineyard, a booster pumping station will be required to boost the water from the tank to the required water system pressure.

Lastly, by approximately 2024 (depending on growth), a 6.5 MG tank would be constructed at Site 3 – 600 West 400 South to serve the Lake General Storage Area of only Orem. This tank would be filled from the same transmission main that delivers water to the Orem Central zone from the Site 5 tank.

Transmission mains were sized to maintain downstream pressure swings within the distribution systems below 20 psi and to prevent excessive utilization of the CUWCD WTP tank. In order to keep existing storage for upper areas from serving lower areas, flow in the existing 'Alpine Aqueduct' between the aqueduct and Orem Central zone was limited through use of flow control valves.

It should also be noted that currently there are east-west transmission deficiencies within the Orem distribution system. The proposed transmission line is also sized to rectify these deficiencies and reduce existing transmission line velocities and associated pressure loss.

Alternative 4 performs well, has good utilization of all proposed tanks at buildout, and reduces water level fluctuation at the CUWCD storage facility. Figure 5-8 shows tank utilization performance for Alternative 4. Figure 5-9 (addressed in a subsequent section) shows WTP tank fluctuation for all four alternatives versus a no-action or existing condition.

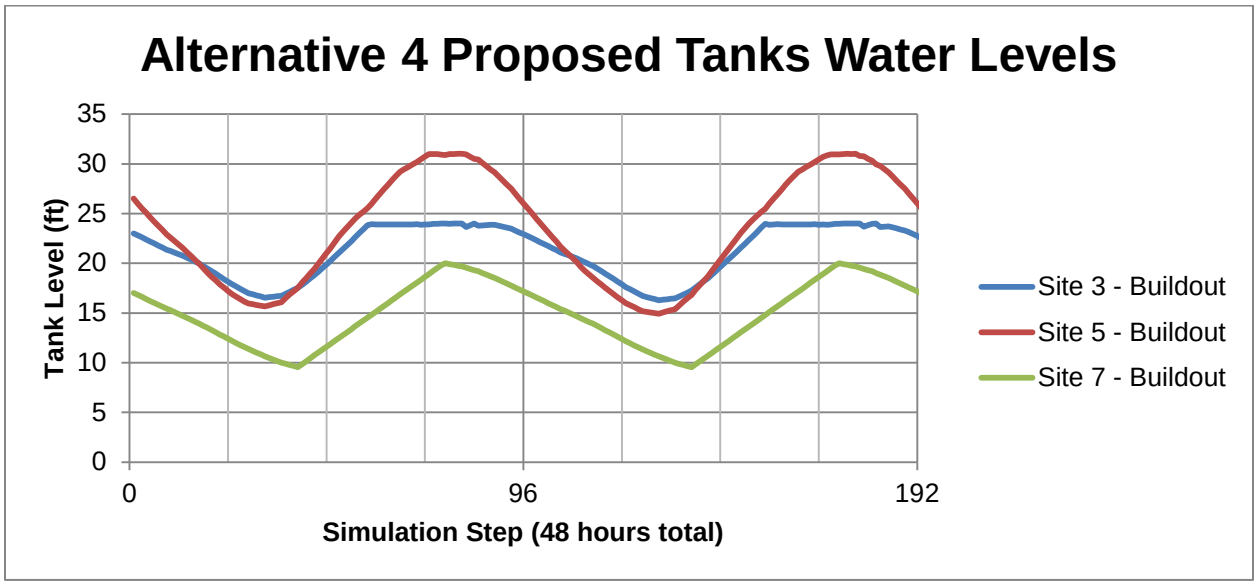


Figure 5-8: Alternative 4 Tanks Utilization Performance

EFFECT OF ALTERNATIVES ON EXISTING TANKS

One of the main outcomes of this study will be a solution that reduces fluctuations in the WTP tanks to acceptable levels. From an optimization perspective, making better use of existing storage will help system performance in the near- and long-term.

As can be seen in the Figure 5-9, all four alternatives significantly improve the situation at the WTP tanks. Minimum tank levels are increased and stay further away from critical levels. It

should be noted that the goal is not to eliminate fluctuation in the WTP tank since Orem maintains emergency and operational storage at this facility. It should also be noted that one of the main differences between Alternatives 1 and 2 is that Alternative 2 fills lower tanks off-peak while Alternative 1 attempts to keep flow rates in transmission lines to the west constant by using flow control valves at outlets from the transmission lines into the system.

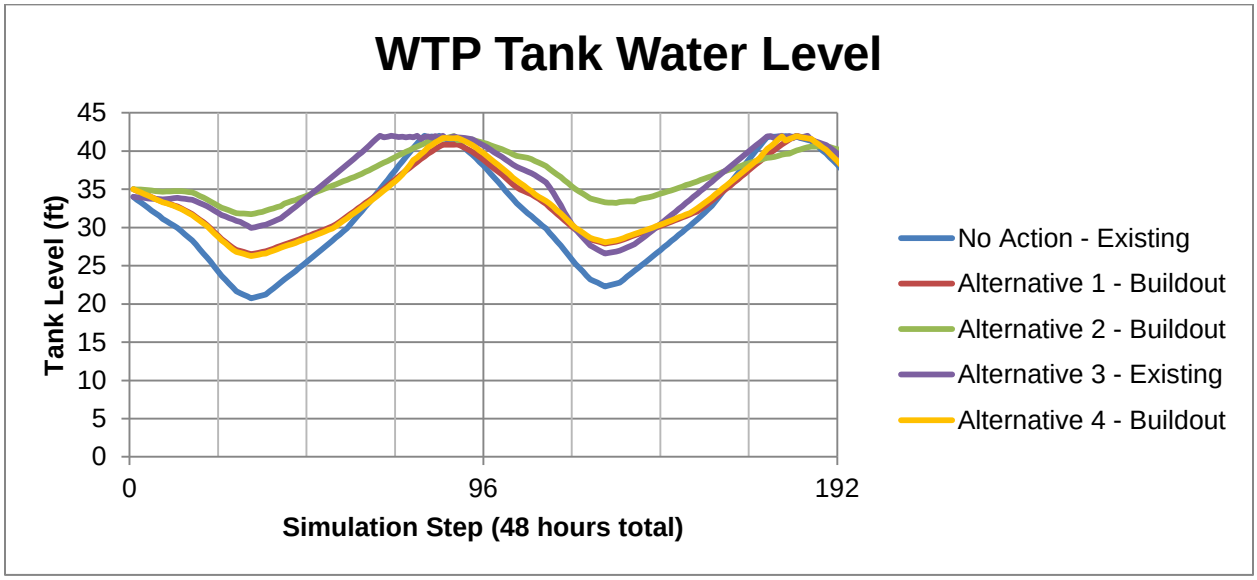


Figure 5-9: Alternatives Effect On WTP Tank Performance

Currently, storage in Orem's existing Lower Tanks is not being fully utilized (i.e. tank levels don't fluctuate within the full range of its operational storage). This effect is due to the lack of adequate transmission capacity to convey the operational storage from the tanks to the Central zone which it serves. With the addition of 2200 feet of new transmission piping to connect the Lower Tanks to the proposed new east-west transmission pipeline, the Lower Tanks are more functional as can be seen in Figure 5-10.

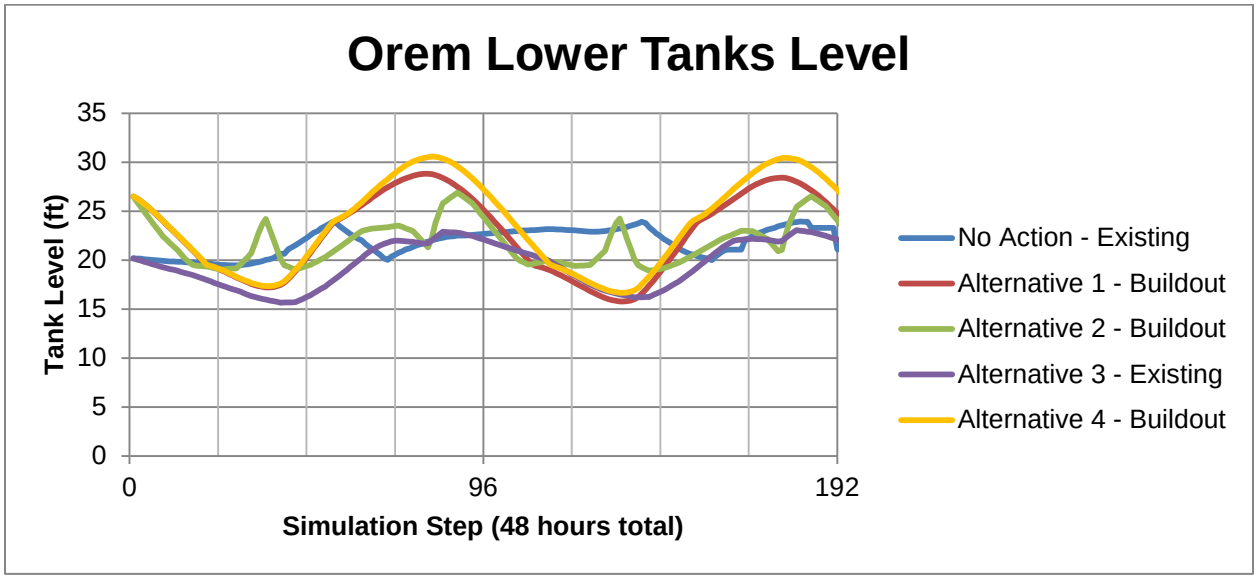


Figure 5-10: Alternatives Effect On Orem Lower Tanks Performance

CHAPTER 6 ALTERNATIVES EVALUATION

ECONOMIC ANALYSIS

The economic analysis of alternatives is based solely on a comparison of costs, including land acquisition (where either Orem or Vineyard do not already own the land), capital construction costs and annual operation and maintenance costs. Since all of the alternatives provide the same level of service, there is no evaluation of benefits. Construction costs and operation and maintenance costs are based on current (2016) price levels. For future project phases, costs were escalated using an assumed annual inflation rate of three percent. All costs are then compared on a future value (FV) and present value (PV) basis. Present values of future costs are based on a discount rate of three percent per year.

Construction Costs

A planning level opinion of probable construction costs (OPCC) was prepared for each of the four alternatives described in Chapter 5. These OPCCs include estimates for tanks and transmission pipelines associated with each alternative. Each site was evaluated for special conditions that could affect the construction cost. For example, costs at Sites 2 and 5 include the construction of soil nail walls to allow near vertical excavation slopes. Costs at all of the sites include the cost of hauling away excess excavated material. For alternatives that include booster pump stations, the construction cost of the pump station along with emergency backup generators was included in the tank estimate. OPCCs for buried tanks located in existing parks or ballfields include the cost of restoring the site to its pre-project condition. Costs for acquiring land not already owned by Orem or the Town of Vineyard are included. Unit and lump sum costs were prepared using data from RS Means, from recently completed projects, and from typical construction estimating assumptions, i.e. mobilization typically ranges from 5% to 10% of overall construction cost.

Tables 6-1, 6-2, 6-3, and 6-4 provide a summary of these OPCCs. Each table has columns for total cost, costs attributed to Orem, and costs assigned to Vineyard. Each tank has a set of transmission pipelines that would be required to integrate the tank into the water system. Costs for construction of these pipelines are included in the OPCCs. Itemized OPCCs for each tank are provided in Appendix B.

Costs of acquiring land not currently owned by Orem or the Town of Vineyard have been included in this analysis, with the exception of Site 2 which is owned by the Alpine School District. It is unlikely that the School District would sell the land for Site 2 to Orem. The City would have to acquire a right-of-way or easement on this land that would allow the District to continue its current use the land. This right-of-way or easement cost is not known at this time, but should be included in the future when discussions can be held with the District to determine the amount.

Construction Phasing

A construction phasing plan was developed for each alternative. Under the phasing plans, the timing of tank and transmission pipeline construction is based on future requirements for additional storage as determined by population projections. Table 6-5 summarizes the phasing plan for each alternative.

Table 6-1: Alternative 1 Opinion of Probable Construction Costs Summary

Description	Unit	Quantity	Unit Cost	Total Cost	Orem Cost	Vineyard Cost
Site 1 - Geneva Park Tank	gallons	2,400,000	lump sum	$ 2,930,581.39	$ -	$ 2,930,581.39
			Contingency @ 30%	$ 879,174.42	$ -	$ 879,174.42
			Sub-Total	$ 3,809,755.81	$ -	$ 3,809,755.81
			Engineering, Admin, & Legal Fees @18%	$ 685,756.05	$ -	$ 685,756.05
			Total Site 1 Tank Construction	**$ 4,495,511.85**	**$ -**	**$ 4,495,511.85**
Transmission Pipelines Constructed by 2021						
18-inch Transmission Pipe	LF	6,000	$ 165.00	$ 990,000.00	$ -	$ 990,000.00
			Contingency @ 25%	$ 247,500.00	$ -	$ 247,500.00
			Sub-Total	$ 1,237,500.00	$ -	$ 1,237,500.00
			Engineering, Admin, & Legal Fees @18%	$ 222,750.00	$ -	$ 222,750.00
			Total Site 1 Transmission Pipeline Construction	**$ 1,460,250.00**	**$ -**	**$ 1,460,250.00**
			TOTAL SITE 1 CONSTRUCTION	**$ 5,955,761.85**	**$ -**	**$ 5,955,761.85**
Site 3 - Orem Community Park Tank	gallons	11,800,000	lump sum	$ 9,869,012.91	$ 5,436,320.67	$ 4,432,692.24
			Contingency @ 30%	$ 2,960,703.87	$ 1,630,896.20	$ 1,329,807.67
			Sub-Total	$ 12,829,716.78	$ 7,067,216.87	$ 5,762,499.91
			Engineering, Admin, & Legal Fees @18%	$ 2,309,349.02	$ 1,272,099.04	$ 1,037,249.98
			Total Site 3 Tank Construction	**$ 15,139,065.80**	**$ 8,339,315.91**	**$ 6,799,749.90**
Transmission Pipelines Constructed by 2024						
16-inch Transmission Pipe	LF	2,200	$ 140.00	$ 308,000.00	$ 308,000.00	$ -
18-inch Transmission Pipe	LF	3,320	$ 165.00	$ 547,800.00	$ -	$ 547,800.00
24-inch Transmission Pipe	LF	3,000	$ 180.00	$ 540,000.00	$ 774,000.00	$ (234,000.00)
30-inch Transmission Pipe	LF	4,200	$ 300.00	$ 1,260,000.00	$ 870,000.00	$ 390,000.00
42-inch Transmission Pipe	LF	5,000	$ 504.00	$ 2,520,000.00	$ 2,520,000.00	$ -
Sub-Total				$ 5,175,800.00	$ 4,472,000.00	$ 703,800.00
			Contingency @ 25%	$ 1,293,950.00	$ 1,118,000.00	$ 175,950.00
			Sub-Total	$ 6,469,750.00	$ 5,590,000.00	$ 879,750.00
			Engineering, Admin, & Legal Fees @18%	$ 1,164,555.00	$ 1,006,200.00	$ 158,355.00
			Total Site 3 Transmission Pipeline Construction	**$ 7,634,305.00**	**$ 6,596,200.00**	**$ 1,038,105.00**
			TOTAL SITE 3 CONSTRUCTION	**$ 22,773,370.80**	**$ 14,935,515.91**	**$ 7,837,854.90**
Site 5 - Cascade Drive Tank	gallons	15,900,000	lump sum	$ 13,748,175.32	$ 13,748,175.32	$ -
			Contingency @ 30%	$ 4,124,452.60	$ 4,124,452.60	$ -
			Sub-Total	$ 17,872,627.92	$ 17,872,627.92	$ -
			Engineering, Admin, & Legal Fees @18%	$ 3,217,073.02	$ 3,217,073.02	$ -
			Total Site 5 Tank Construction	**$ 21,089,700.94**	**$ 21,089,700.94**	**$ -**
Site 5 - Property Acquisition	acre	10	$ 285,000.00	$ 2,850,000.00	$ 2,850,000.00	**$ -**
			Total Site 5 Property Acquisition	**$ 2,850,000.00**	**$ 2,850,000.00**	**$ -**
Transmission Pipelines Constructed by 2017						
12-inch Transmission Pipe	LF	5,300	$ 125.00	$ 662,500.00	$ 662,500.00	$ -
18-inch Transmission Pipe	LF	2,700	$ 165.00	$ 445,500.00	$ 445,500.00	$ -
30-inch Transmission Pipe	LF	1,600	$ 300.00	$ 480,000.00	$ 480,000.00	$ -
42-inch Transmission Pipe	LF	1,100	$ 504.00	$ 554,400.00	$ 1,915,200.00	$ (1,360,800.00)
48-inch Transmission Pipe	LF	2,700	$ 576.00	$ 1,555,200.00	$ 1,555,200.00	$ -
54-inch Transmission Pipe	LF	5,400	$ 648.00	$ 3,499,200.00	$ 1,749,600.00	$ 1,749,600.00
60-inch Transmission Pipe	LF	13,500	$ 720.00	$ 9,720,000.00	$ 9,720,000.00	$ -
Sub-Total				$ 16,916,800.00	$ 16,528,000.00	$ 388,800.00
			Contingency @ 25%	$ 4,229,200.00	$ 4,132,000.00	$ 97,200.00
			Sub-Total	$ 21,146,000.00	$ 20,660,000.00	$ 486,000.00
			Engineering, Admin, & Legal Fees @18%	$ 3,806,280.00	$ 3,718,800.00	$ 87,480.00
			Total Site 5 Transmission Pipeline Construction	**$ 24,952,280.00**	**$ 24,378,800.00**	**$ 573,480.00**
			TOTAL SITE 5 CONSTRUCTION	**$ 48,891,980.94**	**$ 48,318,500.94**	**$ 573,480.00**
			ALTERNATIVE 1 TOTAL CONSTRUCTION	**$ 77,621,113.60**	**$ 63,254,016.85**	**$ 14,367,096.75**

Table 6-2: Alternative 2 Opinion of Probable Construction Costs Summary

Description	Unit	Quantity	Unit Cost	Total Cost	Orem Cost	Vineyard Cost
Site 1 - Geneva Park Tank	gallons	7,000,000	lump sum	$ 7,118,887.62	$ 4,346,297.58	$ 2,772,590.04
			Contingency @ 30%	$ 2,135,666.29	$ 1,303,889.27	$ 831,777.01
			Sub-Total	$ 9,254,553.91	$ 5,650,186.85	$ 3,604,367.05
			Engineering, Admin, & Legal Fees @18%	$ 1,665,819.70	$ 1,017,033.63	$ 648,786.07
			Total Site 1 Tank Construction	**$ 10,920,373.61**	**$ 6,667,220.49**	**$ 4,253,153.12**
Transmission Pipelines Constructed by 2021						
18-inch Transmission Pipe	LF	7,000	$ 165.00	$ 1,155,000.00	$ 148,500.00	$ 1,006,500.00
			Subtotal	$ 1,155,000.00	$ 148,500.00	$ 1,006,500.00
			Contingency @ 25%	$ 288,750.00	$ 37,125.00	$ 251,625.00
			Sub-Total	$ 1,443,750.00	$ 185,625.00	$ 1,258,125.00
			Engineering, Admin, & Legal Fees @18%	$ 259,875.00	$ 33,412.50	$ 226,462.50
			Total Site 1 Transmission Pipeline Construction	**$ 1,703,625.00**	**$ 219,037.50**	**$ 1,484,587.50**
			TOTAL SITE 1 CONSTRUCTION	**$ 12,623,998.61**	**$ 6,886,257.99**	**$ 5,737,740.62**
Site 2 - MVHS Tank	gallons	10,800,000	lump sum	$ 10,054,958.59	$ 10,054,958.59	$ -
			Contingency @ 30%	$ 3,016,487.58	$ 3,016,487.58	$ -
			Sub-Total	$ 13,071,446.17	$ 13,071,446.17	$ -
			Engineering, Admin, & Legal Fees @18%	$ 2,352,860.31	$ 2,352,860.31	$ -
			Total Site 2 Tank Construction	**$ 15,424,306.48**	**$ 15,424,306.48**	**$ -**
Transmission Pipelines Constructed by 2017						
24-inch Transmission Pipe	LF	3,100	$ 180.00	$ 558,000.00	$ 558,000.00	$ -
30-inch Transmission Pipe	LF	1,600	$ 300.00	$ 480,000.00	$ 630,000.00	$ (150,000.00)
36-inch Transmission Pipe	LF	1,100	$ 340.00	$ 374,000.00	$ 748,000.00	$ (374,000.00)
42-inch Transmission Pipe	LF	5,400	$ 504.00	$ 2,721,600.00	$ -	$ 2,721,600.00
			Sub-Total	$ 4,133,600.00	$ 1,936,000.00	$ 2,197,600.00
			Contingency @ 25%	$ 1,033,400.00	$ 484,000.00	$ 549,400.00
			Sub-Total	$ 5,167,000.00	$ 2,420,000.00	$ 2,747,000.00
			Engineering, Admin, & Legal Fees @18%	$ 930,060.00	$ 435,600.00	$ 494,460.00
			Total Site 2 Transmission Pipeline Construction	**$ 6,097,060.00**	**$ 2,855,600.00**	**$ 3,241,460.00**
			TOTAL SITE 2 CONSTRUCTION	**$ 21,521,366.48**	**$ 18,279,906.48**	**$ 3,241,460.00**
Site 3 - Orem Community Park Tank	gallons	12,300,000	lump sum	$ 10,169,012.91	$ 5,787,243.12	$ 4,381,769.79
			Contingency @ 30%	$ 3,050,703.87	$ 1,736,172.94	$ 1,314,530.94
			Sub-Total	$ 13,219,716.78	$ 7,523,416.06	$ 5,696,300.73
			Engineering, Admin, & Legal Fees @18%	$ 2,379,549.02	$ 1,354,214.89	$ 1,025,334.13
			Total Site 3 Tank Construction	**$ 15,599,265.80**	**$ 8,877,630.95**	**$ 6,721,634.86**
Transmission Pipelines Constructed by 2024						
12-inch Transmission Pipe	LF	2,600	$ 125.00	$ 325,000.00	$ 325,000.00	$ -
16-inch Transmission Pipe	LF	1,600	$ 140.00	$ 224,000.00	$ 224,000.00	$ -
18-inch Transmission Pipe	LF	5,500	$ 165.00	$ 907,500.00	$ 445,500.00	$ 462,000.00
24-inch Transmission Pipe	LF	3,000	$ 180.00	$ 540,000.00	$ 306,000.00	$ 234,000.00
30-inch Transmission Pipe	LF	4,200	$ 300.00	$ 1,260,000.00	$ 1,650,000.00	$ (390,000.00)
42-inch Transmission Pipe	LF	5,400	$ 504.00	$ 2,721,600.00	$ 2,721,600.00	$ -
48-inch Transmission Pipe	LF	17,700	$ 576.00	$ 10,195,200.00	$ 7,084,800.00	$ 3,110,400.00
			Sub-Total	$ 16,173,300.00	$ 12,756,900.00	$ 3,416,400.00
			Contingency @ 25%	$ 4,043,325.00	$ 3,189,225.00	$ 854,100.00
			Sub-Total	$ 20,216,625.00	$ 15,946,125.00	$ 4,270,500.00
			Engineering, Admin, & Legal Fees @18%	$ 3,638,992.50	$ 2,870,302.50	$ 768,690.00
			Total Site 3 Transmission Pipeline Construction	**$ 23,855,617.50**	**$ 18,816,427.50**	**$ 5,039,190.00**
			TOTAL SITE 5 CONSTRUCTION	**$ 39,454,883.30**	**$ 27,694,058.45**	**$ 11,760,824.86**
			ALTERNATIVE 2 TOTAL CONSTRUCTION	**$ 73,600,248.39**	**$ 52,860,222.91**	**$ 20,740,025.48**

Table 6-3: Alternative 3 Opinion of Probable Construction Costs Summary

Description	Unit	Quantity	Unit Cost	Total Cost	Orem Cost	Vineyard Cost
Site 1 - Geneva Park Tank	gallons	2,400,000	lump sum	$ 2,930,581.39	$ -	$ 2,930,581.39
			Contingency @ 30%	$ 879,174.42	$ -	$ 879,174.42
			Sub-Total	$ 3,809,755.81	$ -	$ 3,809,755.81
			Engineering, Admin, & Legal Fees @18%	$ 685,756.05	$ -	$ 685,756.05
			Total Site 1 Tank Construction	**$ 4,495,511.85**	**$ -**	**$ 4,495,511.85**
Transmission Pipelines Constructed by 2021						
18-inch Transmission Pipe	LF	6,000	$ 165.00	$ 990,000.00	$ -	$ 990,000.00
			Contingency @ 25%	$ 247,500.00	$ -	$ 247,500.00
			Sub-Total	$ 1,237,500.00	$ -	$ 1,237,500.00
			Engineering, Admin, & Legal Fees @18%	$ 222,750.00	$ -	$ 222,750.00
			Total Site 1 Transmission Pipeline Construction	**$ 1,460,250.00**	**$ -**	**$ 1,460,250.00**
			TOTAL SITE 1 CONSTRUCTION	**$ 5,955,761.85**	**$ -**	**$ 5,955,761.85**
Site 3 - Orem Community Park Tank	gallons	11,800,000	lump sum	$ 11,279,012.91	$ 6,832,846.10	$ 4,446,166.81
			Contingency @ 30%	$ 3,383,703.87	$ 2,049,853.83	$ 1,333,850.04
			Sub-Total	$ 14,662,716.78	$ 8,882,699.93	$ 5,780,016.85
			Engineering, Admin, & Legal Fees @18%	$ 2,639,289.02	$ 1,598,885.99	$ 1,040,403.03
			Total Site 3 Tank Construction	**$ 17,302,005.80**	**$ 10,481,585.92**	**$ 6,820,419.89**
Transmission Pipelines Constructed by 2017						
16-inch Transmission Pipe	LF	2,200	$ 140.00	$ 308,000.00	$ 308,000.00	$ -
18-inch Transmission Pipe	LF	3,320	$ 165.00	$ 547,800.00	$ -	$ 547,800.00
24-inch Transmission Pipe	LF	3,000	$ 180.00	$ 540,000.00	$ 774,000.00	$ (234,000.00)
30-inch Transmission Pipe	LF	4,200	$ 300.00	$ 1,260,000.00	$ 870,000.00	$ 390,000.00
42-inch Transmission Pipe	LF	5,000	$ 504.00	$ 2,520,000.00	$ 2,520,000.00	$ -
Sub-Total				$ 5,175,800.00	$ 4,472,000.00	$ 703,800.00
			Contingency @ 25%	$ 1,293,950.00	$ 1,118,000.00	$ 175,950.00
			Sub-Total	$ 6,469,750.00	$ 5,590,000.00	$ 879,750.00
			Engineering, Admin, & Legal Fees @18%	$ 1,164,555.00	$ 1,006,200.00	$ 158,355.00
			Total Site 3 Transmission Pipeline Construction	**$ 7,634,305.00**	**$ 6,596,200.00**	**$ 1,038,105.00**
			TOTAL SITE 3 CONSTRUCTION	**$ 24,936,310.80**	**$ 17,077,785.92**	**$ 7,858,524.89**
Site 5 - Cascade Drive Tank	gallons	15,900,000	lump sum	$ 13,748,175.32	$ 13,748,175.32	$ -
			Contingency @ 30%	$ 4,124,452.60	$ 4,124,452.60	$ -
			Sub-Total	$ 17,872,627.92	$ 17,872,627.92	$ -
			Engineering, Admin, & Legal Fees @18%	$ 3,217,073.02	$ 3,217,073.02	$ -
			Total Site 5 Tank Construction	**$ 21,089,700.94**	**$ 21,089,700.94**	**$ -**
Site 5 - Property Acquisition	acre	10	$ 285,000.00	$ 2,850,000.00	$ 2,850,000.00	$ -
			Total Site 5 Property Acquisition	**$ 2,850,000.00**	**$ 2,850,000.00**	**$ -**
Transmission Pipelines Constructed by 2024						
12-inch Transmission Pipe	LF	5,300	$ 125.00	$ 662,500.00	$ 662,500.00	$ -
18-inch Transmission Pipe	LF	2,700	$ 165.00	$ 445,500.00	$ 445,500.00	$ -
30-inch Transmission Pipe	LF	1,600	$ 300.00	$ 480,000.00	$ 480,000.00	$ -
42-inch Transmission Pipe	LF	1,100	$ 504.00	$ 554,400.00	$ 1,915,200.00	$ (1,360,800.00)
48-inch Transmission Pipe	LF	2,700	$ 576.00	$ 1,555,200.00	$ 1,555,200.00	$ -
54-inch Transmission Pipe	LF	5,400	$ 648.00	$ 3,499,200.00	$ 1,749,600.00	$ 1,749,600.00
60-inch Transmission Pipe	LF	13,500	$ 720.00	$ 9,720,000.00	$ 9,720,000.00	$ -
Sub-Total				$ 16,916,800.00	$ 16,528,000.00	$ 388,800.00
			Contingency @ 25%	$ 4,229,200.00	$ 4,132,000.00	$ 97,200.00
			Sub-Total	$ 21,146,000.00	$ 20,660,000.00	$ 486,000.00
			Engineering, Admin, & Legal Fees @18%	$ 3,806,280.00	$ 3,718,800.00	$ 87,480.00
			Total Site 5 Transmission Pipeline Construction	**$ 24,952,280.00**	**$ 24,378,800.00**	**$ 573,480.00**
			TOTAL SITE 5 CONSTRUCTION	**$ 48,891,980.94**	**$ 48,318,500.94**	**$ 573,480.00**
			ALTERNATIVE 3 TOTAL CONSTRUCTION	**$ 79,784,053.60**	**$ 65,396,286.86**	**$ 14,387,766.74**

Table 6-4: Alternative 4 Opinion of Probable Construction Costs Summary

Description	Unit	Quantity	Unit Cost	Total Cost	Orem Cost	Vineyard Cost
Site 7 - Vineyard Area Tank	gallons	7,700,000	lump sum	$ 6,883,339.83	$ -	$ 6,883,339.83
			Contingency @ 30%	$ 2,065,001.95	$ -	$ 2,065,001.95
			Sub-Total	$ 8,948,341.78	$ -	$ 8,948,341.78
			Engineering, Admin, & Legal Fees @18%	$ 1,610,701.52	$ -	$ 1,610,701.52
			Total Site 7 Tank Construction	**$ 10,559,043.30**	**$ -**	**$ 10,559,043.30**
Transmission Pipelines Constructed by 2021						
24-inch Transmission Pipe	LF	3,000	$ 180.00	$ 540,000.00	$ -	$ 540,000.00
Sub-Total				$ 540,000.00	$ -	$ 540,000.00
			Contingency @ 25%	$ 135,000.00	$ -	$ 135,000.00
			Sub-Total	$ 675,000.00	$ -	$ 675,000.00
			Engineering, Admin, & Legal Fees @18%	$ 121,500.00	$ -	$ 121,500.00
			Total Site 3 Transmission Pipeline Construction	**$ 796,500.00**	**$ -**	**$ 796,500.00**
Site 7 - Property Acquisition	acre	5	$ 65,000.00	$ 325,000.00	**$ -**	**$ 325,000.00**
			Total Site 7 Property Acquisition	**$ 325,000.00**	**$ -**	**$ 325,000.00**
			TOTAL SITE 7 CONSTRUCTION	**$ 11,680,543.30**	**$ -**	**$ 11,680,543.30**
Site 3 - Orem Community Park Tank	gallons	6,500,000	lump sum	$ 6,369,897.40	$ 6,369,897.40	$ -
			Contingency @ 30%	$ 1,910,969.22	$ 1,910,969.22	$ -
			Sub-Total	$ 8,280,866.62	$ 8,280,866.62	$ -
			Engineering, Admin, & Legal Fees @18%	$ 1,490,555.99	$ 1,490,555.99	$ -
			Total Site 3 Tank Construction	**$ 9,771,422.61**	**$ 9,771,422.61**	**$ -**
Transmission Pipelines Constructed by 2024						
16-inch Transmission Pipe	LF	2,200	$ 140.00	$ 308,000.00	$ 308,000.00	$ -
18-inch Transmission Pipe	LF	-	$ 165.00	$ -	$ -	$ -
24-inch Transmission Pipe	LF	4,300	$ 180.00	$ 774,000.00	$ 774,000.00	$ -
30-inch Transmission Pipe	LF	2,900	$ 300.00	$ 870,000.00	$ 870,000.00	$ -
42-inch Transmission Pipe	LF	5,000	$ 504.00	$ 2,520,000.00	$ 2,520,000.00	$ -
Sub-Total				$ 4,472,000.00	$ 4,472,000.00	$ -
			Contingency @ 25%	$ 1,118,000.00	$ 1,118,000.00	$ -
			Sub-Total	$ 5,590,000.00	$ 5,590,000.00	$ -
			Engineering, Admin, & Legal Fees @18%	$ 1,006,200.00	$ 1,006,200.00	$ -
			Total Site 3 Transmission Pipeline Construction	**$ 6,596,200.00**	**$ 6,596,200.00**	**$ -**
			TOTAL SITE 3 CONSTRUCTION	**$ 16,367,622.61**	**$ 16,367,622.61**	**$ -**
Site 5 - Cascade Drive Tank	gallons	15,900,000	lump sum	$ 13,748,175.32	$ 13,748,175.32	$ -
			Contingency @ 30%	$ 4,124,452.60	$ 4,124,452.60	$ -
			Sub-Total	$ 17,872,627.92	$ 17,872,627.92	$ -
			Engineering, Admin, & Legal Fees @18%	$ 3,217,073.02	$ 3,217,073.02	$ -
			Total Site 5 Tank Construction	**$ 21,089,700.94**	**$ 21,089,700.94**	**$ -**
Site 5 - Property Acquisition	acre	10	$ 285,000.00	$ 2,850,000.00	$ 2,850,000.00	**$ -**
			Total Site 5 Property Acquisition	**$ 2,850,000.00**	**$ 2,850,000.00**	**$ -**
Transmission Pipelines Constructed by 2017						
12-inch Transmission Pipe	LF	5,300	$ 125.00	$ 662,500.00	$ 662,500.00	$ -
18-inch Transmission Pipe	LF	2,700	$ 165.00	$ 445,500.00	$ 445,500.00	$ -
30-inch Transmission Pipe	LF	1,600	$ 300.00	$ 480,000.00	$ 480,000.00	$ -
42-inch Transmission Pipe	LF	3,800	$ 504.00	$ 1,915,200.00	$ 1,915,200.00	$ -
48-inch Transmission Pipe	LF	2,700	$ 576.00	$ 1,555,200.00	$ 1,555,200.00	$ -
54-inch Transmission Pipe	LF	2,700	$ 648.00	$ 1,749,600.00	$ 1,749,600.00	$ -
60-inch Transmission Pipe	LF	13,500	$ 720.00	$ 9,720,000.00	$ 9,720,000.00	$ -
Sub-Total				$ 16,528,000.00	$ 16,528,000.00	$ -
			Contingency @ 25%	$ 4,132,000.00	$ 4,132,000.00	$ -
			Sub-Total	$ 20,660,000.00	$ 20,660,000.00	$ -
			Engineering, Admin, & Legal Fees @18%	$ 3,718,800.00	$ 3,718,800.00	$ -
			Total Site 5 Transmission Pipeline Construction	**$ 24,378,800.00**	**$ 24,378,800.00**	**$ -**
			TOTAL SITE 5 CONSTRUCTION	**$ 48,318,500.94**	**$ 48,318,500.94**	**$ -**
			ALTERNATIVE 4 TOTAL CONSTRUCTION	**$ 76,366,666.85**	**$ 64,686,123.55**	**$ 11,680,543.30**

Table 6-5: Construction Phasing Plan for Alternatives

	Year		
	2017	2021	2024
Alternative 1	Site 5: Orem 15.9 MG Vineyard 0.0 MG Total - 15.9 MG	Site 1: Orem 0.0 MG Vineyard 2.4 MG Total 2.4 MG	Site 3: Orem 6.5 MG Vineyard 5.3 MG Total 11.8 MG
Alternative 2	Site 2: Orem 10.8 MG Vineyard 0.0 MG Total 10.8 MG	Site 1: Orem 4.6 MG Vineyard 2.4 MG Total 7.0 MG	Site 3: Orem 7.0 MG Vineyard 5.3 MG Total 12.3 MG
Alternative 3	Site 3: Orem 6.5 MG Vineyard 5.3 MG Total 11.8 MG	Site 1: Orem 0.0 MG Vineyard 2.4 MG Total 2.4 MG	Site 5: Orem 15.9 MG Vineyard 0.0 MG Total - 15.9 MG
Alternative 4	Site 5: Orem 15.9 MG Vineyard 0.0 MG Total - 15.9 MG	Site 7: Orem 0.0 MG Vineyard 7.7 MG Total 7.7 MG	Site 3: Orem 6.5 MG Vineyard 0.0 MG Total 6.5 MG

Operation and Maintenance Costs

Costs for routine operation, maintenance, and replacement of tanks and pipelines are assumed to be essentially equal for all of the alternatives. These regular costs include items such as tank inspection and cleaning, maintenance of automated valves and electrical equipment, and repair of pipeline leaks. However, the cost of pumping energy varies considerably among the alternatives. Therefore, annual pumping energy was estimated for each alternative. Energy requirements over a 50-year period were estimated. Alternative 1 is an all gravity system and no pumping energy is required. Under Alternative 2, energy requirements vary each year according to the phasing of construction and projected future demand growth. Under Alternative 3 pumping is required until 2024 when the tank at Site 5 is scheduled to come on line. At that time the system would convert to gravity pressure operation. Buildout conditions for Orem are assumed to be reached in the year 2060. Alternative 4 has no pumping for Orem, but Vineyard would need to pump with annual pumping energy increasing each year based on population growth until 2040 when buildout for Vineyard is reached. The present cost of pumping energy is assumed to be $0.10 per kilowatt-hour. This cost is a blended cost that includes energy costs and demand charges. Table 6-6 shows average annual pumping energy requirements over a 50-year period for each alternative.

Table 6-6: Average Annual Pumping Energy for Alternatives

	Average Annual Pumping Energy (kW-hr)	
	Orem	**Vineyard**
Alternative 1	0	0
Alternative 2	732,101	0
Alternative 3	122,024	0
Alternative 4	0	85,599

Economic Comparison of Alternatives

Table 6-7 provides a summary economic comparison of alternatives based on construction costs and annual energy costs. Supporting data for Table 6-7 are provided in Appendix C by year. As shown in the table, Alternative 2 has the lowest total capital cost for Orem, but the highest for Vineyard. Alternative 4 has the lowest total capital cost for Vineyard. Alternatives 2 and 3 have the lowest initial capital outlay (2017) for Orem, whereas Alternatives 1 and 4 have the lowest for Vineyard. Alternative 4 is the lowest present value and future value cost for the Town of Vineyard, but not for Orem. The lowest present value cost for Orem is Alternative 2, followed by Alternative 1. When power costs are factored into future costs for Alternative 2, Alternative 1 is the lowest future-cost alternative for Orem.

Table 6-7: Economic Comparison of Alternatives

	Tank Capital Cost	Transmission Pipeline Capital Cost	Total Capital Cost	Initial Capital Outlay (2017)	PV of Energy Cost	PV of Total Cost	FV of Total Cost
Alternative 1							
Orem[1]	$32,279,000	$30,975,000	$63,254,000	$48,319,000	$0	$63,255,000	$67,239,000
Vineyard	$11,295,000	$3,072,000	$14,367,000	$573,000	$0	$14,367,000	$17,406,000
Total	**$43,574,000**	**$34,047,000**	**$77,621,000**	**$48,892,000**	**$0**	**$77,622,000**	**$84,645,000**
Alternative 2							
Orem[2]	$30,969,000	$21,891,000	$52,860,000	$18,280,000	$3,656,000	$56,516,000	$70,615,000
Vineyard	$10,975,000	$9,765,000	$20,740,000	$3,241,000	$0	$20,740,000	$24,791,000
Total	**$42,634,000**	**$31,656,000**	**$73,600,000**	**$21,521,000**	**$3,656,000**	**$77,256,000**	**$95,406,000**
Alternative 3							
Orem	$34,421,000	$30,975,000	$65,396,000	$17,078,000	$609,000	$66,006,000	$78,970,000
Vineyard	$11,316,000	$3,072,000	$14,388,000	$7,859,000	$0	$14,388,000	$15,489,000
Total	**$46,428,000**	**$32,838,000**	**$79,784,000**	**$24,937,000**	**$609,000**	**$80,394,000**	**$94,459,000**
Alternative 4							
Orem	$33,711,000	$30,975,000	$64,686,000	$48,319,000	$0	$64,687,000	$69,053,000
Vineyard	$10,884,000	$797,000	$11,681,000	$0	$432,000	$12,113,000	$14,704,000
Total	**$44,595,000**	**$31,772,000**	**$76,367,000**	**$48,319,000**	**$432,000**	**$76,800,000**	**$83,757,000**

[1] If Vineyard does not select Alternative 1, then Orem's Alternative 1 costs are the same as Alternative 4.

[2] If Vineyard does not select Alternative 2, then Orem's Alternative 2 costs increase as follows: Tank Capital Cost = $32,401,000, Total Capital Cost = $54,292,000, PV of Total Cost = $57,948,000, and FV of Total Cost = $72,429,000.

Both present value and future value Alternative 2 costs for Vineyard are significantly higher than the other alternatives because under Alternative 2 all of Orem's new tanks are located within the Central Zone area, thereby reducing Orem's required transmission pipeline size from the existing Lower Tanks to the proposed sites in the Central Zone area. Thus, Vineyard's required flow becomes a larger portion or percentage of the transmission pipeline, thereby increasing Vineyard's percentage share of the total pipeline cost.

Alternative 3 has the lowest initial capital outlay for Orem, but in the end the highest total future cost. This is due to the cost escalation of delayed construction of the more expensive tank (site 5), the cost of constructing a booster pump station at Site 3, and pumping energy costs associated with Site 3.

Alternative 1 and Alternative 4 are the same for Orem, with the exception of Vineyard's participation in a tank at Site 3. Under Alternative 4, only Orem builds a tank at Site 3. Without Vineyard's participation at this site, all of the costs for site restoration, etc. are attributable to Orem and not shared. Thus, the cost to build a tank at this site is greater for Orem under Alternative 4. If Alternative 1 is not selected by Vineyard as their best option, then Alternative 4 costs are applicable for Orem and not Alternative 1. The same situation applies to Alternative 2. If Vineyard chooses a different alternative than Alternative 2, then Orem's costs for the tank at Site 3 are higher. See the footnote to Table 6-7 for Orem's costs in this scenario.

OTHER COMPARISON OF ALTERNATIVES CONSIDERATIONS

In addition to economic considerations, other factors should be examined when evaluating alternatives. These other factors include aesthetics, construction and constructability, right-of-way, impacts of existing infrastructure, operations/reliability, traffic/streets, and provision of separate storage for Vineyard. Table 6-8 summarizes how alternatives compare against each other for these criteria.

VARIATIONS IN ALTERNATIVES

Potential exists for variations of each of the alternatives. For example, a booster pump station could be added to the Site 3 tank under Alternative 1 as a backup means of providing water to the Central Area of Orem if the main transmission pipeline needs to be taken out of service for maintenance. However, these variations are not evaluated in this report.

Under Alternatives 1, 2, and 3 it would be economical for Vineyard if it could acquire storage in CUWCD's North Shore Terminal Reservoir (NSTR) for the Vineyard North Area in lieu of constructing storage at Site 1. About 6,000 lineal feet of 18-inch-diameter transmission pipeline could also be eliminated under Alternatives 1, 2, and 3 since water could be delivered to Vineyard through the North Shore Aqueduct. Preliminary estimates for the cost of NSTR storage range from $1.00 to $1.25 per gallon. This would likely provide a more economical solution than constructing storage at Site 1. For example, the cost of purchasing storage in the NSTR future expansion for 2.4 MG at a cost of $1.25 per gallon would be $3,000,000. Whereas the estimated cost of the 2.4 MG constructed at Site 1 with the 18-inch transmission piping is $5,735,000. However, locating Vineyard storage at the NSTR would require significant contract, infrastructure, and operating modifications with CUWCD and it cannot be guaranteed that these modifications could be achieved.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

All four alternatives provide similar levels of service and are viable solutions for Orem's and Vineyard's current and future water system operations. Initial site reviews have identified no insurmountable constructability issues for tanks at any of the sites selected for the alternatives.

The least cost solution for the Town of Vineyard is Alternative 4, constructing their tanks within the Town's boundaries and using booster pumps to pump the water from the tanks to their distribution system. This is the least cost solution when considering total capital cost, initial capital outlay, present value of total cost, and future value of total cost.

Table 6-7. Alternatives Comparison Matrix

	Aesthetics	Construction/ Constructability	Right-of-Way	Impacts on Existing Infrastructure	Operations/Reliability	Traffic/Streets	Separate Storage for Vineyard	Economics
Alternative 1	Tanks at Sites 1 and 3 are completely buried. Sloped backfill for Site 5 tank would be visible from 800 East and surrounding neighborhood.	Site 1 tank has 2,400 feet of deep outlet piping. Site 3 tank has 2,800 feet of deep outlet piping. Site 5 tank has potential slope stability issues. Soil nail wall required to retain excavated slope. Excess excavated soil must be hauled off at all sites.	Sites 1 and 3 owned by City of Orem. Site 5 owned by UCWCD.	Existing parks at Sites 1 and 3 would be taken out of service during construction. Parks would be restored after construction.	All gravity pressure. No pumping required.	62,500 lineal feet of transmission pipes constructed in streets.	Site 1 tank provides 2.4 MG of separate storage for north Vineyard area.	PV of total cost $77.6M. FV of total cost $84.6M. Initial capital outlay $48.9M.
Alternative 2	All tanks buried.	Site 1 tank has 2,400 feet of deep outlet piping. Site 2 tank has 1,500 feet of deep outlet piping. Soil nail wall required to retain excavated slopes. Site 3 tank has 2,800 feet of deep outlet piping. Excess excavated soil must be hauled off at all sites.	Sites 1 and 3 owned by City of Orem. Site 2 owned by Alpine School District.	Existing parks at Sites 1 and 3 and ball field at Site 2 would be taken out of service during construction. Parks and ball field would be restored after construction.	All water deliveries to central area must be pumped.	63,500 lineal feet of transmission pipes constructed in streets.	Two cell tank at Site 1 provides 2.4 MG of separate storage for north Vineyard area.	PV of total cost $77.3M. FV of total cost $95.4M. Initial capital outlay $21.5M.
Alternative 3	Tanks at Sites 1 and 3 are completely buried. Sloped backfill for Site 5 tank would be visible from 800 East and surrounding neighborhood.	Site 1 tank has 2,400 feet of deep outlet piping. Site 3 tank has 2,800 feet of deep outlet piping. Site 5 tank has potential slope stability issues. Soil nail wall required to retain excavated slope. Excess excavated soil must be hauled off at all sites.	Sites 1, 3, and 5 owned by City of Orem.	Existing parks at Sites 1 and 3 would be taken out of service during construction. Parks would be restored after construction.	Initially water delivered to central area must be pumped. After site 5 tank construction becomes an all gravity system. Booster pump at Site 3 tank can provide backup service when transmission line from CUWCD tanks is off line.	62,600 lineal feet of transmission pipes constructed in streets.	Site 1 tank provides 2.4 MG of separate storage for north Vineyard area.	PV of total cost $80.4M. FV of total cost $94.5M. Initial capital outlay $24.9M.
Alternative 4	Tank at Site 3 is completely buried. Sloped backfill for Site 5 tank would be visible from 800 East and surrounding neighborhood. Tank at Site 7 is above ground and would be visible from roads and surrounding neighborhoods.	Site 1 tank has 2,400 feet of deep outlet piping. Site 3 tank has 2,800 feet of deep outlet piping. Site 5 tank has potential slope stability issues. Soil nail wall required to retain excavated slope. Excess excavated soil must be hauled off at all sites. Site 7 tank has foundation issues and will require auger cast piles.	Sites 3 and 5 owned by City of Orem. Vineyard may need to purchase land for Site 7 tank.	Existing park at Site3 would be taken out of service during construction. Park would be restored after construction.	Water delivered from Site 7 tank must be pumped to boost pressure. Vineyard would have all of its storage in one tank.	46,700 lineal feet of transmission pipes constructed in streets.	Site 7 tank provides 7.7 MG of separate storage for Vineyard	PV of total cost $76.8M. FV of total cost $83.8M. Initial capital outlay $48.3M.

Orem's least cost solution is either Alternative 2 or Alternative 1. Alternative 2 is least cost in total capital cost, within $1.2 million of the least cost for initial capital outlay, and least cost for present value of total cost. Alternative 1 is the least cost for future value of total cost. However, if Vineyard selects Alternative 4, then the total future cost difference between Alternative 1 and Alternative 2 is only approximately $3.4 out of approximately $70 million.

Regardless of which alternative is selected, a critical issue in the Orem water system is transmission capacity from the principal water sources of supply from the northeastern part of the City to the central and western areas of the City. Addressing this transmission capacity deficit has been included in all four alternatives addressed herein. The system is currently relying on the head of the CUWCD tank, which in effect forces the equalization storage to occur there.

Recommendations

Our recommendations are as follows:

1. Alternative 4 is the least cost alternative for the Town of Vineyard. Even though Vineyard will have to pump long term from the tank(s) located in Vineyard, it is recommended that Vineyard pursue Alternative 4 (see the additional recommendation for Vineyard in Recommendation 4 below).
2. It is recommended that Orem select Alternative 2. Alternative 1 has the lowest future value of total cost (assuming Vineyard does not select Alternative 1), which is almost $3.4 million less than Alternative 2. However, Alternative 2 has a much lower initial capital outlay, only marginally higher than Alternative 3, which will probably be more politically favorable than the more significant capital outlay required for Alternative 1.
3. Due to existing deficiencies in transmission capacity in the Orem water system, it is recommended that the Orem address the transmission system upgrades identified in the four alternatives along with tank construction.
4. It is recommended that the Town of Vineyard enter into discussions with CUWCD to investigate the feasibility of purchasing storage in the CUWCD North Shore Terminal Reservoir for the Vineyard North Area. As discussed previously, this appears to be significantly more cost effective for Vineyard than constructing a tank at Site 1 to supply the Vineyard North Area. This would also allow Vineyard to reduce the total tank size in Alternative 4 from 7.7 MG to 5.3 MG and would provide a two tank option instead of a single tank.

REFERENCES

Heavy Construction Cost Data, RSMeans, 2016

APPENDIX A

Geotechnical/Geologic Investigation Reports

AGEC
Applied GeoTech

June 10, 2016

Hansen Allen & Luce, Inc.
1045 South 500 East, Suite 110
American Fork, UT 84003

Attention: Michael Chambers
EMAIL: mchambers@hansenallenluce.com

Subject: Reconnaissance Level Geotechnical Review
Proposed Water Tanks - Site No. 1
Approximately 600 West 400 North
Orem, Utah
Project No. 1160431

Gentlemen:

Applied Geotechnical Engineering Consultants, Inc. was requested to provide a reconnaissance level geotechnical review for the possible construction of water tanks at a site located at approximately 600 West 400 North in Orem, Utah. The site location is shown on Figure 1.

SCOPE

The scope of this study included a site visit and review of previous projects performed by AGEC in the area to provide a discussion of anticipated geotechnical conditions. Site access for exploration and testing was not available at the time of this review. Subsurface exploration, laboratory testing and engineering analysis are beyond the scope of this review but should be performed prior to design or construction of the proposed facilities.

SITE CONDITIONS

At the time of our site visit on June 8, 2016, the site consisted of a city park. The site is generally covered with grass and there are areas with concrete sidewalks, tennis courts and occasional trees.

The site is relatively flat with a gentle slope down to the west.

The park extends beyond the area of the proposed tanks in all directions. There are buildings in the distance to the northwest. There is a school in the distance to the south. There is a pavilion to the west.

PROPOSED CONSTRUCTION

It is anticipated that the water tanks would be buried and the area above restored for continued use as a park.

We understand that a rectangular tank approximately 320 feet long by 160 feet wide with a 20-foot water depth or two circular tanks with 160-foot diameter and 24-foot water depth, are being considered.

PRELIMINARY GEOTECHNICAL INFORMATION

Based on our understanding of the proposed construction and our experience in the area, the following preliminary geotechnical information is given:

1. It is anticipated that the natural subsurface soil consists predominantly of sand and gravel. Groundwater is not anticipated at depths that would impact the proposed construction.

2. We anticipate that the proposed water tanks may be supported on spread footings bearing on the undisturbed natural soil or on compacted structural fill extending down to the undisturbed natural soil. For granular soil, the allowable bearing capacity will be a function of the footing width and depth of embedment. We anticipate allowable net bearing pressures on the order of 2,000 to 4,000 pounds per square foot for this site.

3. We anticipate that excavation at the site can be accomplished with conventional excavation equipment. Temporary unretained excavation slopes may be constructed at 1½ horizontal to 1 vertical or flatter.

4. It is anticipated that the material excavated from the site exclusive of topsoil, organics, oversized particles and other deleterious materials could be used for backfill around and above the tanks.

5. The following design parameters are given for IBC 2012:

a.	Site Class	D
b.	Short Period Spectral Response Acceleration, S_S	1.22g
c.	One Second Period Spectral Response Acceleration, S_1	0.43g

6. There are no mapped active faults extending through the site. The closest mapped fault considered to be active is the Wasatch fault located approximately 2.7 miles to the northeast (Black, and others, 2003).

7. The site is located within an area mapped as having a "very low" potential for liquefaction (Anderson and others, 1994). Based on the liquefaction hazard map and our understanding of the geologic conditions of the area, liquefaction is not considered to be a hazard at this site.

LIMITATIONS

This letter has been prepared in accordance with generally accepted geotechnical engineering practices in the area for use of the client for preliminary planning purposes. The preliminary geotechnical information presented above is based on a site visit, review of literature as referenced in the letter and our experience in the area. Geotechnical exploration and laboratory testing should be performed to provide information for design and construction at the site.

If you have any questions or if we can be of further service, please call.

Sincerely,

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

Jay R. McQuivey, P.E.

Reviewed by DRH, P.E., P.G.
JRM/bw

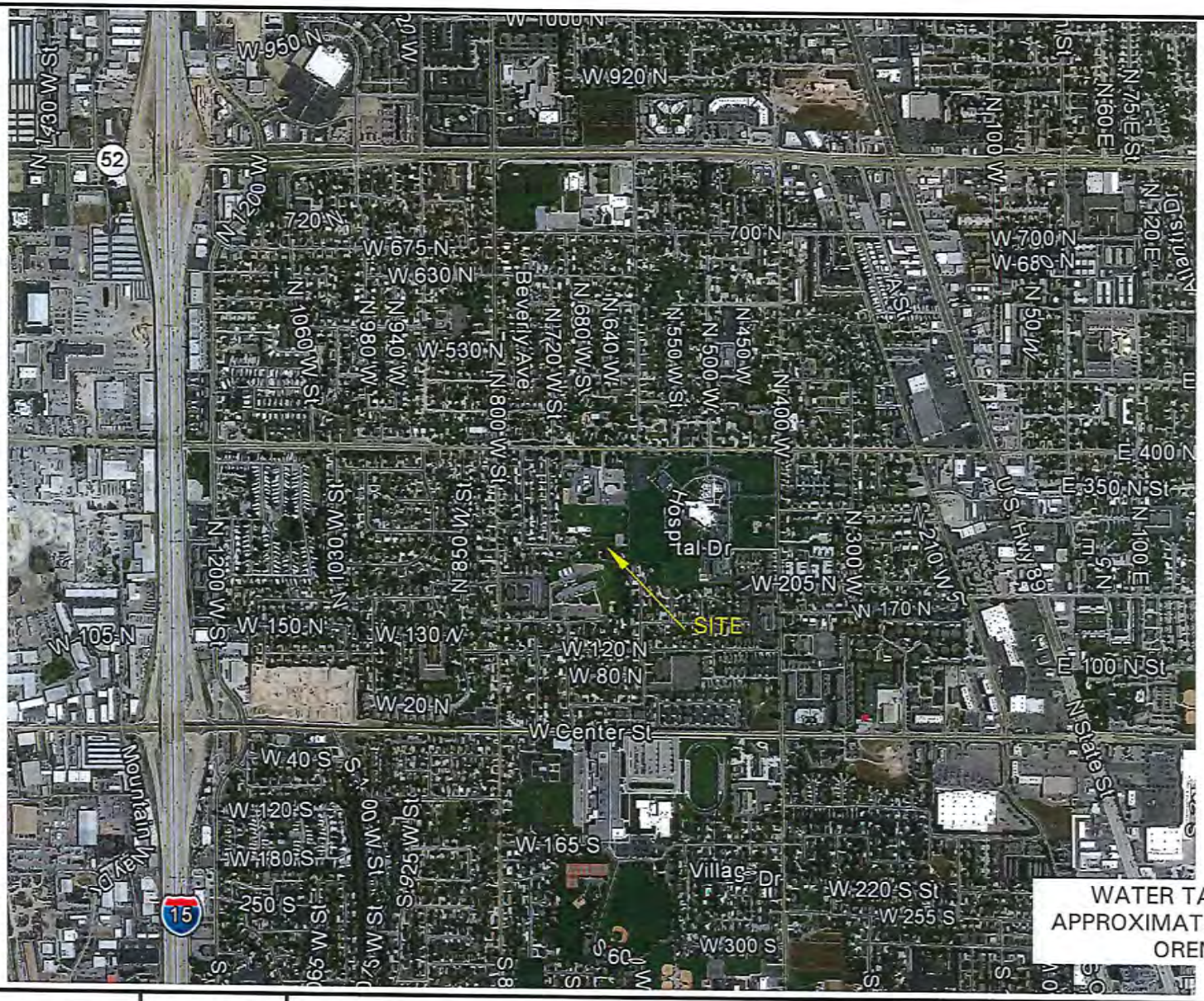
Enclosure

REFERENCES:

Anderson, L.R., Keaton, J.R. and Bischoff, J.E., 1994; "Liquefaction Potential Map for Utah County, Utah Geological Survey Contract Report 94-8

Black, B.D., Hecker, S., Hylland, M.D., Christenson, G.E., and McDonald, G.N., 2003; Quaternary fault and fold database and map of Utah; Utah Geological Survey Map 193DM.

International Building Code, 2012; International Code Council, Inc., Falls Church, Virginia.



WATER TANK SITE NO.1
APPROXIMATELY 600 W 400 N
OREM, UTAH

1160431	AGEC	Site No. 1 Location	Figure 1

AGEC
Applied GeoTech

June 10, 2016

Hansen Allen & Luce, Inc.
1045 South 500 East, Suite 110
American Fork, UT 84003

Attention: Michael Chambers
EMAIL: mchambers@hansenallenluce.com

Subject: Reconnaissance Level Geotechnical Review
Proposed Water Tanks - Site No. 2
Approximately 600 West Center Street
Orem, Utah
Project No. 1160431

Gentlemen:

Applied Geotechnical Engineering Consultants, Inc. was requested to provide a reconnaissance level geotechnical review for the possible construction of water tanks at a site located at approximately 600 West Center Street in Orem, Utah. The site location is shown on Figure 1.

SCOPE

The scope of this study included a site visit and review of previous projects performed by AGEC in the area to provide a discussion of anticipated geotechnical conditions. Site access for exploration and testing was not available at the time of this review. Subsurface exploration, laboratory testing and engineering analysis are beyond the scope of this review but should be performed prior to design or construction of the proposed facilities.

SITE CONDITIONS

At the sime of our site visit on June 8, 2016, the site consisted of a city park. The site is covered with grass.

The site is relatively flat with a gentle slope down to the west.

The park extends beyond the area of the proposed tanks in all directions. There is a church to the north, residences to the south and west and a parking lot to the east.

PROPOSED CONSTRUCTION

It is anticipated that the water tanks would be buried and the area above restored for continued use as a park.

We understand that a rectangular tank approximately 400 feet long by 200 feet wide with a 20-foot water depth or two circular tanks with 180-foot diameter and 25-foot water depth, are being considered.

PRELIMINARY GEOTECHNICAL INFORMATION

Based on our understanding of the proposed construction and our experience in the area, the following preliminary geotechnical information is given:

1. It is anticipated that the natural subsurface soil consists predominantly of sand and gravel. Groundwater is not anticipated at depths that would impact the proposed construction.

2. We anticipate that the proposed water tanks may be supported on spread footings bearing on the undisturbed natural soil or on compacted structural fill extending down to the undisturbed natural soil. For granular soil, the allowable bearing capacity will be a function of the footing width and depth of embedment. We anticipate allowable net bearing pressures on the order of 2,000 to 4,000 pounds per square foot for this site.

3. We anticipate that excavation at the site can be accomplished with conventional excavation equipment. Temporary unretained excavation slopes may be constructed at 1½ horizontal to 1 vertical or flatter.

4. It is anticipated that the material excavated from the site exclusive of topsoil, organics, oversized particles and other deleterious materials could be used for backfill around and above the tanks.

5. The following design parameters are given for IBC 2012:

a.	Site Class	D
b.	Short Period Spectral Response Acceleration, S_S	1.22g
c.	One Second Period Spectral Response Acceleration, S_1	0.42g

6. There are no mapped active faults extending through the site. The closest mapped fault considered to be active is the Wasatch fault located approximately 3 miles to the northeast (Black, and others, 2003).

7. The site is located within an area mapped as having a "very low" potential for liquefaction (Anderson and others, 1994). Based on the liquefaction hazard map and our understanding of the geologic conditions of the area, liquefaction is not considered to be a hazard at this site.

LIMITATIONS

This letter has been prepared in accordance with generally accepted geotechnical engineering practices in the area for use of the client for preliminary planning purposes. The preliminary geotechnical information presented above is based on a site visit, review of literature as referenced in the letter and our experience in the area. Geotechnical exploration and laboratory testing should be performed to provide information for design and construction at the site.

If you have any questions or if we can be of further service, please call.

Sincerely,

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

Jay R. McQuivey, P.E.

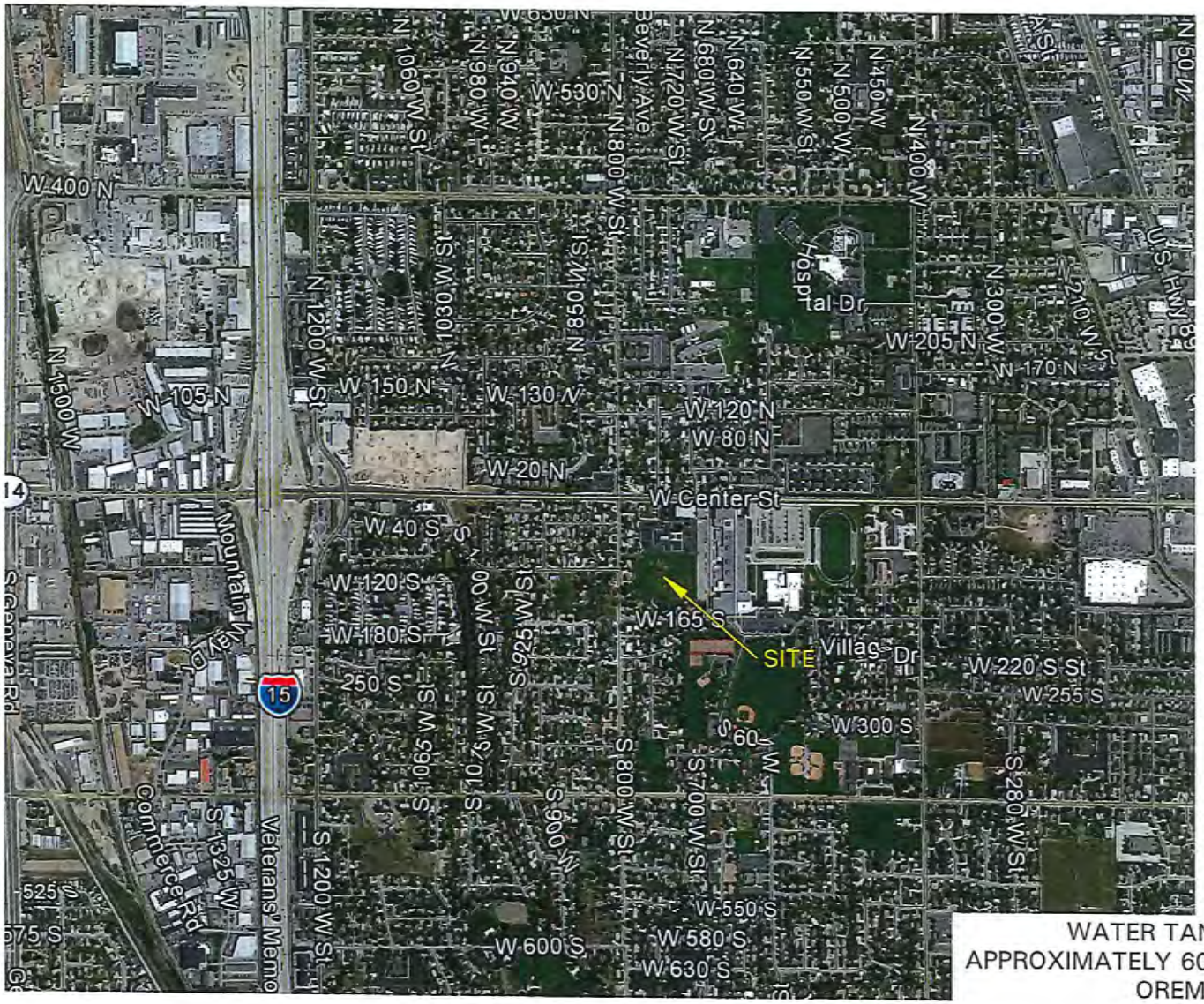
Reviewed by DRH, P.E., P.G.
JRM/bw

REFERENCES:

Anderson, L.R., Keaton, J.R. and Bischoff, J.E., 1994; "Liquefaction Potential Map for Utah County, Utah Geological Survey Contract Report 94-8

Black, B.D., Hecker, S., Hylland, M.D., Christenson, G.E., and McDonald, G.N., 2003; Quaternary fault and fold database and map of Utah; Utah Geological Survey Map 193DM.

International Building Code, 2012; International Code Council, Inc., Falls Church, Virginia.



WATER TANK SITE NO.2
APPROXIMATELY 600 W CENTER STREET
OREM, UTAH

1160431	AGEC	Site No. 2 Location	Figure 1

AGEC
Applied GeoTech

June 10, 2016

Hansen Allen & Luce, Inc.
1045 South 500 East, Suite 110
American Fork, UT 84003

Attention: Michael Chambers
EMAIL: mchambers@hansenallenluce.com

Subject: Reconnaissance Level Geotechnical Review
Proposed Water Tank - Site No. 3
Approximately 600 West 400 South
Orem, Utah
Project No. 1160431

Gentlemen:

Applied Geotechnical Engineering Consultants, Inc. was requested to provide a reconnaissance level geotechnical review for the possible construction of a water tank at a site located at approximately 600 West 400 South in Orem, Utah. The site location is shown on Figure 1.

SCOPE

The scope of this study included a site visit and review of previous projects performed by AGEC in the area to provide a discussion of anticipated geotechnical conditions. Site access for exploration and testing was not available at the time of this review. Subsurface exploration, laboratory testing and engineering analysis are beyond the scope of this review but should be performed prior to design or construction of the proposed facilities.

SITE CONDITIONS

At the sime of our site visit on June 8, 2016, the site consisted of a city park. The site is covered with grass. The site is used for a soccer field and baseball outfield.

The site is relatively flat with a gentle slope down to the west.

The park extends beyond the area of the proposed tank in all directions. There are pavilions in the distance to the north and west and a road in the distance to the west. The baseball infield and facilities are in the distance to the south. There are residences in the distance to the east.

PROPOSED CONSTRUCTION

It is anticipated that the water tank would be buried and the area above restored for continued use as a park.

We understand that a square tank approximately 320 feet by 320 feet with an 18-foot water depth or a circular tank with 320-foot diameter and 24-foot water depth, are being considered.

PRELIMINARY GEOTECHNICAL INFORMATION

Based on our understanding of the proposed construction and our experience in the area, the following preliminary geotechnical information is given:

1. It is anticipated that the natural subsurface soil consists predominantly of sand and gravel. Groundwater is not anticipated at depths that would impact the proposed construction.

2. We anticipate that the proposed water tank may be supported on spread footings bearing on the undisturbed natural soil or on compacted structural fill extending down to the undisturbed natural soil. For granular soil, the allowable bearing capacity will be a function of the footing width and depth of embedment. We anticipate allowable net bearing pressures on the order of 2,000 to 4,000 pounds per square foot for this site.

3. We anticipate that excavation at the site can be accomplished with conventional excavation equipment. Temporary unrestrained excavation slopes may be constructed at 1½ horizontal to 1 vertical or flatter.

4. It is anticipated that the material excavated from the site exclusive of topsoil, organics, oversized particles and other deleterious materials could be used for backfill around and above the tanks.

5. The following design parameters are given for IBC 2012:

a.	Site Class	D
b.	Short Period Spectral Response Acceleration, S_S	1.23g
c.	One Second Period Spectral Response Acceleration, S_1	0.43g

6. There are no mapped active faults extending through the site. The closest mapped fault considered to be active is the Wasatch fault located approximately 2.9 miles to the northeast (Black, and others, 2003).

7. The site is located within an area mapped as having a "very low" potential for liquefaction (Anderson and others, 1994). Based on the liquefaction hazard map and our understanding of the geologic conditions of the area, liquefaction is not considered to be a hazard at this site.

LIMITATIONS

This letter has been prepared in accordance with generally accepted geotechnical engineering practices in the area for use of the client for preliminary planning purposes. The preliminary geotechnical information presented above is based on a site visit, review of literature as referenced in the letter and our experience in the area. Geotechnical exploration and laboratory testing should be performed to provide information for design and construction at the site.

If you have any questions or if we can be of further service, please call.

Sincerely,

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

Jay R. McQuivey, P.E.

Reviewed by DRH, P.E., P.G.
JRM/bw

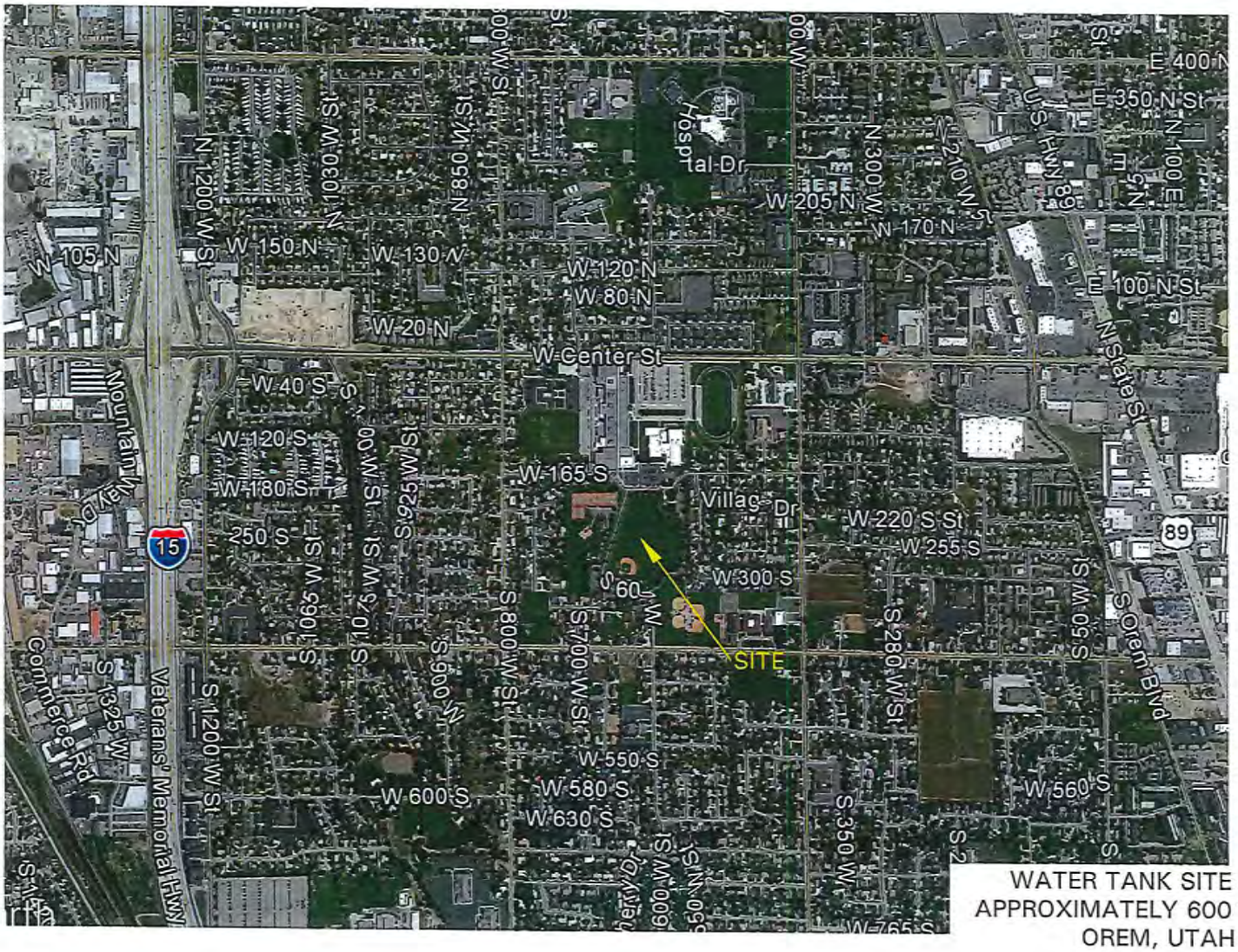
Enclosures

REFERENCES:

Anderson, L.R., Keaton, J.R. and Bischoff, J.E., 1994; "Liquefaction Potential Map for Utah County, Utah Geological Survey Contract Report 94-8

Black, B.D., Hecker, S., Hylland, M.D., Christenson, G.E., and McDonald, G.N., 2003; Quaternary fault and fold database and map of Utah; Utah Geological Survey Map 193DM.

International Building Code, 2012; International Code Council, Inc., Falls Church, Virginia.



WATER TANK SITE NO. 3
APPROXIMATELY 600 W 400 S
OREM, UTAH

1160431	AGEC	Site No. 3 Location	Figure 1

AGEC
Applied GeoTech

June 10, 2016

Hansen Allen & Luce, Inc.
1045 South 500 East, Suite 110
American Fork, UT 84003

Attention: Michael Chambers
EMAIL: mchambers@hansenallenluce.com

Subject: Reconnaissance Level Geotechnical Review
Proposed Water Tank - Site No. 4
Lower Cemetery Field
Approximately 800 East and 1200 North
Orem, Utah
Project No. 1160431

Gentlemen:

Applied Geotechnical Engineering Consultants, Inc. was requested to provide a reconnaissance level geotechnical review for the possible construction of a water tank at a site located at approximately 800 East and 1200 North in Orem, Utah. The site location is shown on Figure 1.

SCOPE

The scope of this study included a site visit and review of previous projects performed by AGEC in the area to provide a discussion of anticipated geotechnical conditions. Site access for exploration and testing was not available at the time of this review. Subsurface exploration, laboratory testing and engineering analysis are beyond the scope of this review but should be performed prior to design or construction of the proposed facilities.

SITE CONDITIONS

At the sime of our site visit on June 8, 2016, the site consisted of a city park that is used for soccer fields. The site is generally covered with grass and there are some trees in the north and east portions of the area. There is a paved trail extending through the area.

The site has a gentle slope down to the southwest.

The park extends beyond the area of the proposed tank to the south and west. There are residences to the southeast. The Murdock canal trail is to the north.

PROPOSED CONSTRUCTION

It is anticipated that the water tank would be partially buried at the east end of the park or completely above grade if it is located west of the loop trail in the eastern portion of the park.

We understand that a circular tank with a 304-foot diameter and 31-foot water depth is being considered.

PRELIMINARY GEOTECHNICAL INFORMATION

Based on our understanding of the proposed construction and our experience in the area, the following preliminary geotechnical information is given:

1. It is anticipated that the natural subsurface soil consists predominantly of sand and gravel. Groundwater is not anticipated at depths that would impact the proposed construction.

2. We anticipate that the proposed water tanks may be supported on spread footings bearing on the undisturbed natural soil or on compacted structural fill extending down to the undisturbed natural soil. For granular soil, the allowable bearing capacity will be a function of the footing width and depth of embedment. We anticipate allowable net bearing pressures on the order of 2,000 to 4,000 pounds per square foot for this site.

3. We anticipate that excavation at the site can be accomplished with conventional excavation equipment. Temporary unretained excavation slopes may be constructed at 1½ horizontal to 1 vertical or flatter.

4. It is anticipated that the material excavated from the site exclusive of topsoil, organics, oversized particles and other deleterious materials could be used for backfill around the tank.

5. The following design parameters are given for IBC 2012:

a.	Site Class	D
b.	Short Period Spectral Response Acceleration, S_S	1.15g
c.	One Second Period Spectral Response Acceleration, S_1	0.42g

6. There are no mapped active faults extending through the site. The closest mapped fault considered to be active is the Wasatch fault located approximately 0.4 miles to the east (Black, and others, 2003).

7. The site is located within an area mapped as having a "very low" potential for liquefaction (Anderson and others, 1994). Based on the liquefaction hazard map and our understanding of the geologic conditions of the area, liquefaction is not considered to be a hazard at this site.

LIMITATIONS

This letter has been prepared in accordance with generally accepted geotechnical engineering practices in the area for use of the client for preliminary planning purposes. The preliminary geotechnical information presented above is based on a site visit, review of literature as referenced in the letter and our experience in the area. Geotechnical exploration and laboratory testing should be performed to provide information for design and construction at the site.

If you have any questions or if we can be of further service, please call.

Sincerely,

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

Jay R. McQuivey, P.E.

Reviewed by DRH, P.E., P.G.
JRM/bw

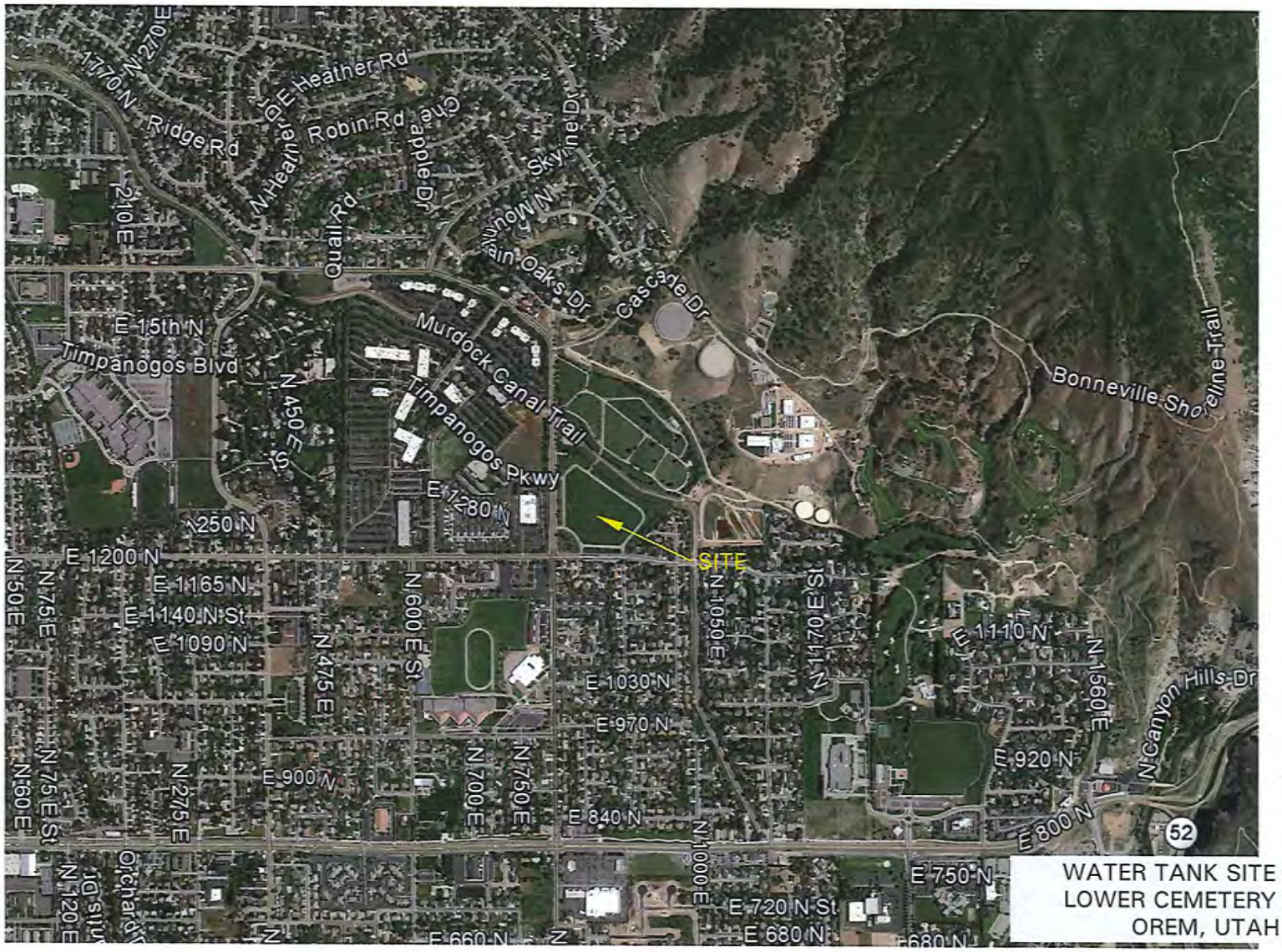
Enclosure

REFERENCES:

Anderson, L.R., Keaton, J.R. and Bischoff, J.E., 1994; "Liquefaction Potential Map for Utah County, Utah Geological Survey Contract Report 94-8

Black, B.D., Hecker, S., Hylland, M.D., Christenson, G.E., and McDonald, G.N., 2003; Quaternary fault and fold database and map of Utah; Utah Geological Survey Map 193DM.

International Building Code, 2012; International Code Council, Inc., Falls Church, Virginia.



WATER TANK SITE NO. 4
LOWER CEMETERY FIELD
OREM, UTAH

1160431	AGEC	Site No. 4 Location	Figure 1

AGEC
Applied GeoTech

June 10, 2016

Hansen Allen & Luce, Inc.
1045 South 500 East, Suite 110
American Fork, UT 84003

Attention: Michael Chambers
EMAIL: mchambers@hansenallenluce.com

Subject: Reconnaissance Level Geotechnical Review
Proposed Water Tank - Site No. 5
Approximately 800 East and Cascade Drive
Orem, Utah
Project No. 1160431

Gentlemen:

Applied Geotechnical Engineering Consultants, Inc. was requested to provide a reconnaissance level geotechnical review for the possible construction of a water tank at a site located at approximately 800 East and Cascade Drive in Orem, Utah. The site location is shown on Figure 1.

SCOPE

The scope of this study included a site visit and review of previous projects performed by AGEC in the area to provide a discussion of anticipated geotechnical conditions. A copy of a geotechnical report, dated April 2004, prepared by RB&G Engineering Inc. for an existing water tank located east of the site, was provided for our review. Site access for exploration and testing was not available at the time of this review. Subsurface exploration, laboratory testing and engineering analysis are beyond the scope of this review but should be performed prior to design or construction of the proposed facilities.

SITE CONDITIONS

At the time of our site visit on June 8, 2016, the site consisted of a hillside area with Cascade Drive extending through the site. Cascade Drive is a two-lane asphalt-paved road. There are overhead power lines, water aqueducts and other buried utilities in the area.

The site has moderate to steep slopes down to the southwest.

The area north of Cascade Drive has a retention pond in the western portion of the area and it appears that the west end of this area has been filled to create the pond embankment. The area north of Cascade Drive has sparse vegetation consisting of grass and weeds. Hillside areas extend to the east and south of this area with a residence to the north and 800 East Street to the west.

The area south and east of Cascade Drive is undeveloped hillside. Vegetation consists of grass and native vegetation with areas of brush. There is an access road along the south end of this area with some construction equipment and materials stored along the road. It appears that there may have been some previous excavation activities that have steepened the slopes in the southern portion of the area. There is a large circular buried reservoir to the northeast, up-slope from the site. There is a drainage to the east. The Orem City Cemetery is to the south.

PROPOSED CONSTRUCTION

We understand that two options are being considered for this site. Option No. 1 is a circular tank with a 304-foot diameter and 31-foot water depth. This tank would be located south of Cascade Drive and partially buried. Option No. 2 would be a rectangular tank 160 feet long by 140 feet wide constructed north of Cascade Drive and partially buried.

PRELIMINARY GEOTECHNICAL INFORMATION

Based on our understanding of the proposed construction and our experience in the area, the following preliminary geotechnical information is given:

1. It is anticipated that the natural subsurface soil consists predominantly of sand. Groundwater is not anticipated at depths that would impact the proposed construction.

2. We anticipate that the proposed water tanks may be supported on spread footings bearing on the undisturbed natural soil or on compacted structural fill extending down to the undisturbed natural soil. For granular soil, the allowable bearing capacity will be a function of the footing width and depth of embedment. We anticipate allowable net bearing pressures on the order of 2,000 to 4,000 pounds per square foot for this site.

3. We anticipate that excavation at the site can be accomplished with conventional excavation equipment. Temporary unretained excavation slopes may be constructed at 1½ horizontal to 1 vertical or flatter. Due to the steep slopes and adjacent facilities, it is anticipated that excavation shoring and permanent retaining systems will be required to facilitate construction at this site.

4. Slope stability is of concern for this site. Geotechnical study should be preformed to evaluate the stability of existing and proposed slope configurations and appropriate slope stabilization measures implemented.

5. It is anticipated that the material excavated from the site exclusive of topsoil, organics, oversized particles and other deleterious materials could be used for backfill around the tank.

6. The following design parameters are given for IBC 2012:

a.	Site Class	D
b.	Short Period Spectral Response Acceleration, S_S	1.14g
c.	One Second Period Spectral Response Acceleration, S_1	0.42g

7. There are no mapped active faults extending through the site. The closest mapped fault considered to be active is the Wasatch fault located approximately 0.3 miles to the east (Black, and others, 2003).

8. The site is located within an area mapped as having a "very low" potential for liquefaction (Anderson and others, 1994). Based on the liquefaction hazard map and our understanding of the geologic conditions of the area, liquefaction is not considered to be a hazard at this site.

LIMITATIONS

This letter has been prepared in accordance with generally accepted geotechnical engineering practices in the area for use of the client for preliminary planning purposes. The preliminary geotechnical information presented above is based on a site visit, review of literature as referenced in the letter and our experience in the area. Geotechnical exploration and laboratory testing should be performed to provide information for design and construction at the site.

If you have any questions or if we can be of further service, please call.

Sincerely,

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

Jay R. McQuivey, P.E.

Reviewed by DRH, P.E., P.G.
JRM/bw

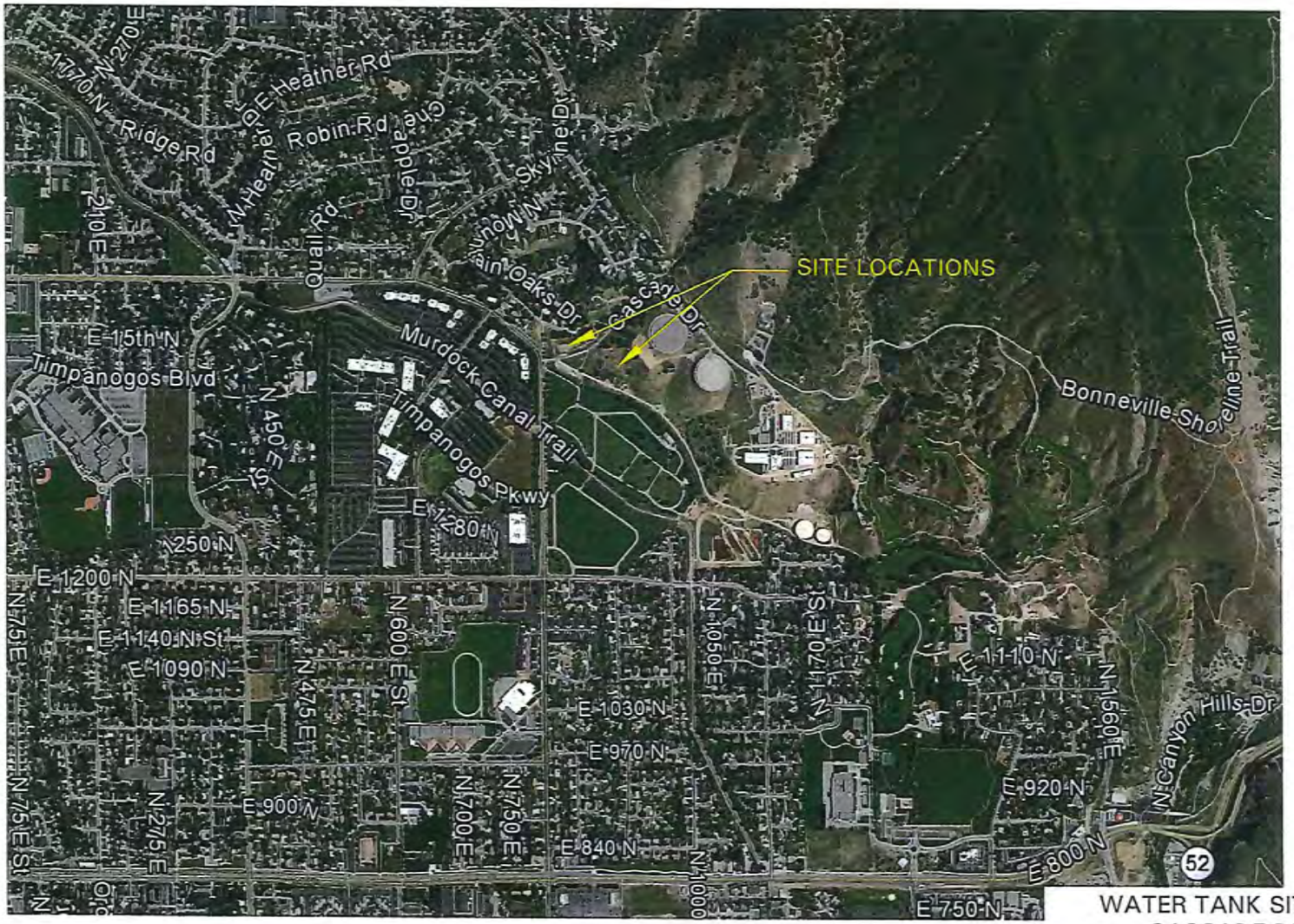
Enclosure

REFERENCES:

Anderson, L.R., Keaton, J.R. and Bischoff, J.E., 1994; "Liquefaction Potential Map for Utah County, Utah Geological Survey Contract Report 94-8

Black, B.D., Hecker, S., Hylland, M.D., Christenson, G.E., and McDonald, G.N., 2003; Quaternary fault and fold database and map of Utah; Utah Geological Survey Map 193DM.

International Building Code, 2012; International Code Council, Inc., Falls Church, Virginia.



WATER TANK SITE NO. 5
CASCADE DRIVE
OREM, UTAH

1160431	AGEC	Site No. 5 Locations	Figure 1

AGEC
Applied GeoTech

June 10, 2016

Hansen Allen & Luce, Inc.
1045 South 500 East, Suite 110
American Fork, UT 84003

Attention: Michael Chambers
EMAIL: mchambers@hansenallenluce.com

Subject: Reconnaissance Level Geotechnical Review
Proposed Water Tank - Site No. 6
Approximately 400 North to 400 South and Geneva Road
Orem, Utah
Project No. 1160431

Gentlemen:

Applied Geotechnical Engineering Consultants, Inc. was requested to provide a reconnaissance level geotechnical review for the possible construction of a water tank in the area between approximately 400 North and 400 South and near Geneva Road in Orem, Utah. Two potential site locations within this area are shown on Figures 1 and 2.

SCOPE

The scope of this study included a site visit to the sites shown on Figures 1 and 2 and review of previous projects performed by AGEC in the area to provide a discussion of anticipated geotechnical conditions. Site access for exploration and testing was not available at the time of this review. Subsurface exploration, laboratory testing and engineering analysis are beyond the scope of this review but should be performed prior to design or construction of the proposed facilities.

SITE CONDITIONS

Approximately 400 South and Geneva Road

The site consisted of a vacant lot at the time of our site visit on June 8, 2016. There are significant fill piles on the site. With the exception of the fill piles, the site is relatively flat with a gentle slope down to the west.

Vegetation at the site consists of sparse grass and weeds.

The surrounding area includes commercial and industrial buildings in all directions. The site is bordered on the south by 400 South Street and on the east by Mountain View Drive.

Approximately 400 North and Geneva Road

The site consisted of a vacant lot at the time of our site visit on June 8, 2016. It appears that there is fill over the surface of the property.

The site has a gentle slope down to the west.

There are vacant lots to the north and west. The site is bordered to the east by 1500 West Street and to the south by 400 North Street.

PROPOSED CONSTRUCTION

We understand that the proposed construction may consist of a circular tank with a diameter of 160 feet, 30-foot water depth and constructed above grade. A booster pump station may be constructed in conjunction with the water tank. Another alternative may be a composite elevated tank with a base diameter of 64 feet and tank diameter of 116 feet.

PRELIMINARY GEOTECHNICAL INFORMATION

Based on our understanding of the proposed construction and our experience in the area, the following preliminary geotechnical information is given:

1. It is anticipated that the natural subsurface soil will consist if interlayered clay, silt and sand. Groundwater in this area may be at a relatively shallow depth.

2. The area is generally mapped as having a "high" to "moderate" potential for liquefaction (Anderson and others, 1994). Based on published literature and our experience in the area, settlement may occur under seismic conditions due to liquefaction of soil layers susceptible to liquefaction.

3. We anticipate that the proposed water tank may be supported on spread footings or a mat foundation bearing on the undisturbed natural soil or on compacted structural fill extending down to the undisturbed natural soil following implementation of any ground improvement that may be necessary to maintain settlement within tolerable limits and/or to mitigate the liquefaction hazard. An alternative to ground improvement may be to support the tanks on deep foundations. For spread footings or mat foundations supported on the undisturbed natural soil or on compacted structural fill following ground improvement, we anticipate allowable net bearing pressures on the order of 1,000 to 2,000 pounds per square foot.

4. Ground improvement may be required to maintain settlement within tolerable limits and/or to mitigate the liquefaction hazard. Some ground improvement methods that may be recommended following a geotechnical analysis of the site include preloading, stone columns, deep soil mixing, grouting or other soil improvement methods.

5. Excavation to significant depths is not anticipated since the tanks are planned to be constructed above grade. We anticipate that relatively shallow excavation at the site can be accomplished with conventional excavation equipment. Excavations should be properly dewatered. Properly dewatered excavation slopes may be constructed at 1½ horizontal to 1 vertical or flatter.

6. The following design parameters are given for IBC 2012:

a.	Site Class	D, E or F
b.	Short Period Spectral Response Acceleration, S_S	1.21g
c.	One Second Period Spectral Response Acceleration, S_1	0.41g

7. There are no mapped active faults extending through the area. The closest mapped faults considered to be active are the Utah Lake faults located approximately 3 to 3½ miles to the west and the Wasatch fault located approximately 3½ to 4 miles to the northeast (Black, and others, 2003).

LIMITATIONS

This letter has been prepared in accordance with generally accepted geotechnical engineering practices in the area for use of the client for preliminary planning purposes. The preliminary geotechnical information presented above is based on a site visit, review of literature as referenced in the letter and our experience in the area. Geotechnical exploration and laboratory testing should be performed to provide information for design and construction at the site.

If you have any questions or if we can be of further service, please call.

Sincerely,

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

PROFESSIONAL ENGINEER
6/10/16
JAY R. MCQUIVEY
No. 177892-2202
STATE OF UTAH

Jay R. McQuivey, P.E.

Reviewed by DRH, P.E., P.G.
JRM/bw

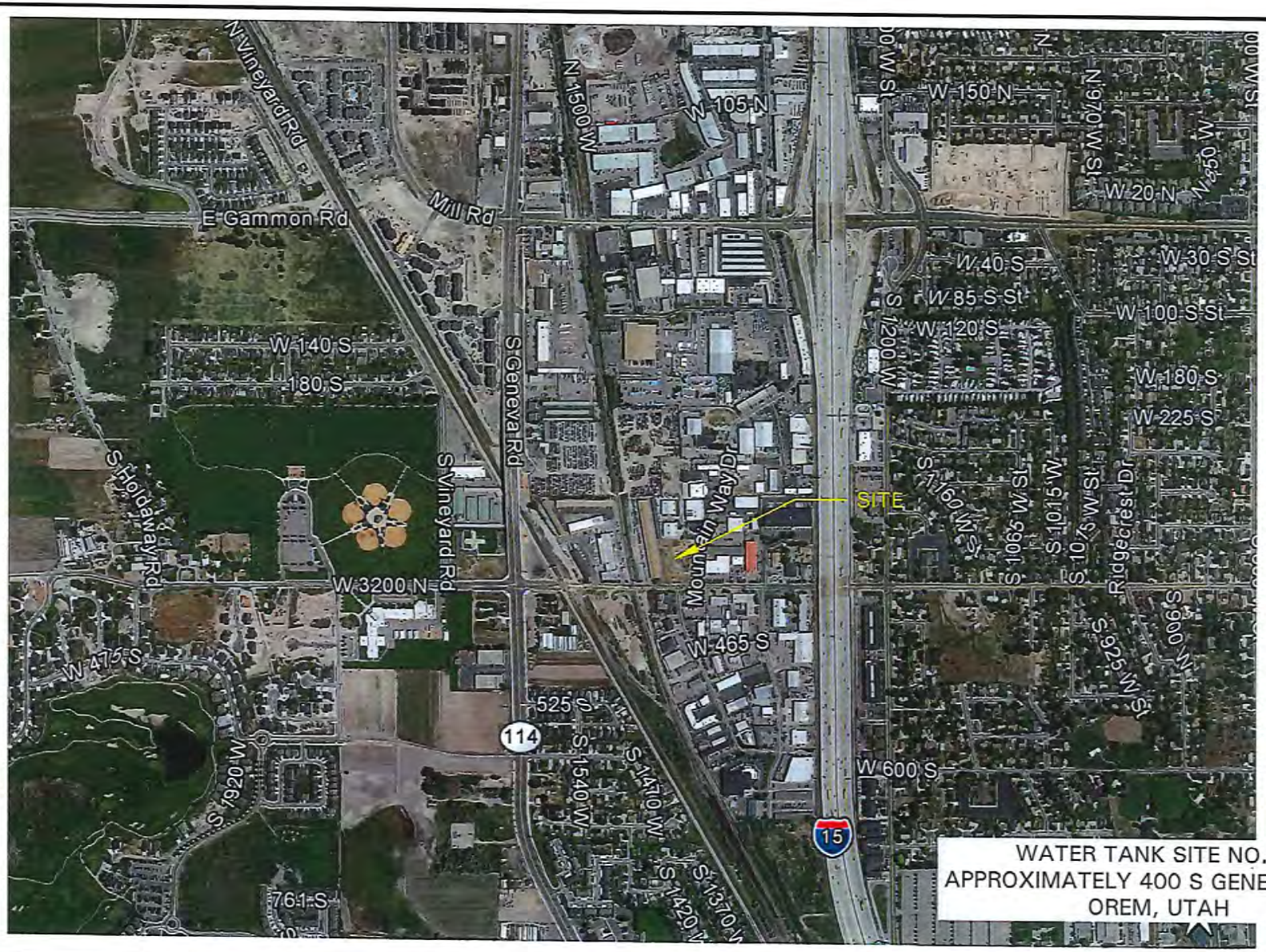
Enclosures

REFERENCED:

Anderson, L.R., Keaton, J.R. and Bischoff, J.E., 1994; "Liquefaction Potential Map for Utah County, Utah Geological Survey Contract Report 94-8

Black, B.D., Hecker, S., Hylland, M.D., Christenson, G.E., and McDonald, G.N., 2003; Quaternary fault and fold database and map of Utah; Utah Geological Survey Map 193DM.

International Building Code, 2012; International Code Council, Inc., Falls Church, Virginia.



1160431	AGEC	Site No. 6a Location	Figure 1

WATER TANK SITE NO. 6b
APPROXIMATELY 400 N GENEVA ROAD
OREM, UTAH

1160431	AGEC	Site No. 6b Location	Figure 2

APPENDIX B

Detailed Tank Cost Estimates

CUWCD, Orem & Vineyard
Storage Siting Study
Opinion of Probable Construction Costs

Alternative #1 Transmission Pipeline Costs

Description	Unit	Quantity		Unit Cost		Total Cost
Site 1 - Geneva Park Tank (2021)						
18-inch Transmission Pipe	LF	6,000	$	165.00	$	990,000.00
Site 3 - Community Park Tank (2029)						
16-inch Transmission Pipe	LF	2,200	$	140.00	$	308,000.00
18-inch Transmission Pipe	LF	3,320	$	165.00	$	547,800.00
24-inch Transmission Pipe	LF	3,000	$	180.00	$	540,000.00
30-inch Transmission Pipe	LF	4,200	$	300.00	$	1,260,000.00
42-inch Transmission Pipe	LF	5,000	$	504.00	$	2,520,000.00
Sub-Total		17,720			$	5,175,800.00
Site 5 - Cascade Dr Tank (2017)						
12-inch Transmission Pipe	LF	5,300	$	125.00	$	662,500.00
18-inch Transmission Pipe	LF	2,700	$	165.00	$	445,500.00
30-inch Transmission Pipe	LF	1,600	$	300.00	$	480,000.00
42-inch Transmission Pipe	LF	1,100	$	504.00	$	554,400.00
48-inch Transmission Pipe	LF	2,700	$	576.00	$	1,555,200.00
54-inch Transmission Pipe	LF	5,400	$	648.00	$	3,499,200.00
60-inch Transmission Pipe	LF	13,500	$	720.00	$	9,720,000.00
Sub-Total		32,300			$	16,916,800.00
Sub-Total Construction					$	23,082,600.00
Contingency @ 25%					$	5,770,650.00
Total Construction					**$**	**28,853,250.00**
Engineering, Admin, & Legal Fees @ 18%					$	5,193,585.00
Total Alternative #1					**$**	**34,046,835.00**

CUWCD, Orem & Vineyard
Storage Siting Study
Opinion of Probable Construction Costs

Alternative #1 Orem Only Transmission Pipeline Costs

Description	Unit	Quantity		Unit Cost		Total Cost
Site 1 - Geneva Park Tank (2021)						
18-inch Transmission Pipe	LF	-	$	165.00	$	-
Site 3 - Community Park Tank (2029)						
16-inch Transmission Pipe	LF	2,200	$	140.00	$	308,000.00
18-inch Transmission Pipe	LF	-	$	165.00	$	-
24-inch Transmission Pipe	LF	4,300	$	180.00	$	774,000.00
30-inch Transmission Pipe	LF	2,900	$	300.00	$	870,000.00
42-inch Transmission Pipe	LF	5,000	$	504.00	$	2,520,000.00
Sub-Total		14,400			$	4,472,000.00
Site 5 - Cascade Dr Tank (2017)						
12-inch Transmission Pipe	LF	5,300	$	125.00	$	662,500.00
18-inch Transmission Pipe	LF	2,700	$	165.00	$	445,500.00
30-inch Transmission Pipe	LF	1,600	$	300.00	$	480,000.00
42-inch Transmission Pipe	LF	3,800	$	504.00	$	1,915,200.00
48-inch Transmission Pipe	LF	2,700	$	576.00	$	1,555,200.00
54-inch Transmission Pipe	LF	2,700	$	648.00	$	1,749,600.00
60-inch Transmission Pipe	LF	13,500	$	720.00	$	9,720,000.00
Sub-Total		32,300			$	16,528,000.00
Sub-Total Construction					$	21,000,000.00
Contingency @ 25%					$	5,250,000.00
Total Construction					**$**	**26,250,000.00**
Engineering, Admin, & Legal Fees @ 18%					$	4,725,000.00
Total Alternative #1					**$**	**30,975,000.00**

CUWCD, Orem & Vineyard
Storage Siting Study
Opinion of Probable Construction Costs

Alternative #1 Vineyard Transmission Pipeline Costs

Description	Unit	Quantity		Unit Cost		Total Cost
Site 1 - Geneva Park Tank (2021)						
18-inch Transmission Pipe	LF	6,000	$	165.00	$	990,000.00
Site 3 - Community Park Tank (2029)						
16-inch Transmission Pipe	LF	-	$	140.00	$	-
18-inch Transmission Pipe	LF	3,320	$	165.00	$	547,800.00
24-inch Transmission Pipe	LF	(1,300)	$	180.00	$	(234,000.00)
30-inch Transmission Pipe	LF	1,300	$	300.00	$	390,000.00
42-inch Transmission Pipe	LF	-	$	340.00	$	-
Sub-Total		3,320			$	703,800.00
Site 5 - Cascade Dr Tank (2017)						
12-inch Transmission Pipe	LF	-	$	125.00	$	-
18-inch Transmission Pipe	LF	-	$	165.00	$	-
30-inch Transmission Pipe	LF	-	$	300.00	$	-
42-inch Transmission Pipe	LF	(2,700)	$	504.00	$	(1,360,800.00)
48-inch Transmission Pipe	LF	-	$	576.00	$	-
54-inch Transmission Pipe	LF	2,700	$	648.00	$	1,749,600.00
60-inch Transmission Pipe	LF	-	$	720.00	$	-
Sub-Total		-			$	388,800.00
Sub-Total Construction					$	2,082,600.00
Contingency @ 25%					$	520,650.00
Total Construction					**$**	**2,603,250.00**
Engineering, Admin, & Legal Fees @ 18%					$	468,585.00
Total Alternative #1					**$**	**3,071,835.00**

CUWCD, Orem & Vineyard
Storage Siting Study
Opinion of Probable Construction Costs

Site 1 - 600 West 400 North Site (Geneva Park)
2.4 MG Buried Concrete Tank

Description	Unit	Quantity	Unit Cost	Total Cost
Temp Construction Fence Rental (12 month)	LF	1,100	$ 6.30	$ 6,930.00
Concrete Sidewalk Demolition	SY	422	$ 12.05	$ 5,087.78
Basketball Court Asphalt Demolition	SY	331	$ 5.85	$ 1,938.30
Demolition Dump Fees	Ton	169	$ 71.44	$ 12,100.88
Miscellaneous Structures Demolition	LS	1	$ 1,500.00	$ 1,500.00
Tree Removal	EA	14	$ 735.00	$ 10,290.00
Clear and Grub Site	AC	0.92	$ 4,300.00	$ 3,956.00
Strip and Stockpile Topsoil	CY	1,481	$ 0.59	$ 874.07
Dewatering	DAY	180	$ 886.67	$ 159,600.00
Excavation	CY	24,000	$ 1.58	$ 37,920.00
Hauling Off-Site	CY	15,000	$ 7.40	$ 111,000.00
Hauling On-Site	CY	15,000	$ 2.38	$ 35,700.00
Buried Concrete Tank Construction	GAL	2,400,000	$ 0.50	$ 1,200,000.00
Valve Vault Construction	LS	1	$ 200,000.00	$ 200,000.00
SCADA and Controls	LS	1	$ 15,000.00	$ 15,000.00
Backfill	CY	15,000	$ 2.17	$ 32,550.00
Compaction	CY	15,000	$ 0.36	$ 5,400.00
Concrete Sidewalk	SF	4,750	$ 6.60	$ 31,350.00
Lightposts	EA	3	$ 2,365.00	$ 7,095.00
Electrical Conduit	LF	600	$ 18.40	$ 11,040.00
Electrical Wire Cable	LF	600	$ 1.55	$ 930.00
Basketball Court (concrete)	SF	3,000	$ 6.60	$ 19,800.00
Basketball Court Standard	EA	2	$ 3,075.00	$ 6,150.00
Trees	EA	14	$ 161.00	$ 2,254.00
Topsoil	SY	4,444	$ 6.30	$ 28,000.00
Grass Hydro-Seeding	SF	40,000	$ 0.06	$ 2,300.00
Sprinkler System	SF	40,000	$ 0.30	$ 12,000.00
Horseshoe Pits	EA	2	$ 500.00	$ 1,000.00
Restoration of Stockpile Area	SF	20,000	$ 1.25	$ 25,000.00
Access Driveway Asphalt Pavement	SY	469	$ 24.31	$ 11,398.69
Parking Area Asphalt Overlay	SY	778	4.98	$ 3,873.33
24-inch RCP Drain Pipe	LF	210	125	$ 26,250.00
18-inch Outlet Pipe	LF	2,400	247.5	$ 594,000.00
Asphalt Restoration	SY	2,667	$ 29.36	$ 78,293.33
Traffic Control	LS	1	$ 50,000.00	$ 50,000.00
SWPPP	LS	1	$ 10,000.00	$ 10,000.00
Surveying	LS	1	$ 10,000.00	$ 10,000.00
Materials Testing	LS	1	$ 10,000.00	$ 10,000.00
Mobilization	LS	1	$ 150,000.00	$ 150,000.00

Sub-Total Construction	$	2,930,581.39
Contingency @ 30%	$	879,174.42
Total Construction	**$**	**3,809,755.80**
Engineering, Admin, & Legal Fees @ 18%	$	685,756.04
TOTAL PROJECT COSTS	**$**	**4,495,511.85**
Range (-10%)	$	4,045,000
Range (+50%)	$	6,744,000

CUWCD, Orem & Vineyard
Storage Siting Study
Opinion of Probable Construction Costs

Site 3 - 600 West 400 South Site (Orem Community Park)
11.8 MG Buried Concrete Tank
Combined Orem and Vineyard Costs

Description	Unit	Quantity	Unit Cost	Total Cost
Temp Construction Fence Rental (12 month)	LF	1,810	$ 6.30	$ 11,403.00
Clear and Grub Site	AC	3.0	$ 4,300.00	$ 12,900.00
Strip and Stockpile Topsoil	CY	7,499	$ 0.59	$ 4,424.34
Dewatering	DAY	180	$ 1,330.00	$ 239,400.00
Excavation	CY	108,782	$ 1.58	$ 171,875.91
Hauling Off-Site	CY	67,989	$ 7.40	$ 503,117.78
Hauling On-Site	CY	67,989	$ 2.38	$ 161,813.56
Buried Concrete Tank Construction	GAL	11,800,000	$ 0.50	$ 5,900,000.00
Valve Vault Construction	LS	1	$ 300,000.00	$ 300,000.00
SCADA and Controls	LS	1	$ 20,000.00	$ 20,000.00
Backfill	CY	67,989	$ 2.17	$ 147,535.89
Compaction	CY	67,989	$ 0.36	$ 24,476.00
Topsoil	SY	22,497	$ 6.30	$ 141,729.00
Grass Hydro-Seeding	SF	130,680	$ 0.06	$ 7,514.10
Sprinkler System	SF	130,680	$ 0.25	$ 32,670.00
24-inch RCP Drain Pipe	LF	500	125	$ 62,500.00
36-inch Outlet Pipe	LF	2,800	510	$ 1,428,000.00
Asphalt Restoration	SY	3,667	$ 29.36	$ 107,653.33
Traffic Control	LS	1	$ 50,000.00	$ 50,000.00
SWPPP	LS	1	$ 10,000.00	$ 10,000.00
Surveying	LS	1	$ 12,000.00	$ 12,000.00
Materials Testing	LS	1	$ 20,000.00	$ 20,000.00
Mobilization	LS	1	$ 500,000.00	$ 500,000.00

Sub-Total Construction	$ 9,869,012.91
Contingency @ 30%	$ 2,960,703.87
Total Construction	**$ 12,829,716.78**
Engineering, Admin, & Legal Fees @ 18%	$ 2,309,349.02
TOTAL PROJECT COSTS	**$ 15,139,065.81**
Range (-10%)	$ 13,625,000
Range (+50%)	$ 22,709,000

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CUWCD, Orem & Vineyard
Storage Siting Study
Opinion of Probable Construction Costs

Site 3 - 600 West 400 South Site (Orem Community Park)
11.8 MG Buried Concrete Tank
Orem's Portion of Costs (6.5 MG)

Description	Unit	Quantity	Unit Cost	Total Cost
Temp Construction Fence Rental (12 month)	LF	1,810	$ 6.30	$ 6,281.31
Clear and Grub Site	AC	3.0	$ 4,300.00	$ 7,105.93
Strip and Stockpile Topsoil	CY	7,499	$ 0.59	$ 2,437.14
Dewatering	DAY	180	$ 1,330.00	$ 131,872.88
Excavation	CY	108,782	$ 1.58	$ 94,677.41
Hauling Off-Site	CY	67,989	$ 7.40	$ 277,141.15
Hauling On-Site	CY	67,989	$ 2.38	$ 89,134.59
Buried Concrete Tank Construction	GAL	11,800,000	$ 0.50	$ 3,250,000.00
Valve Vault Construction	LS	1	$ 300,000.00	$ 165,254.24
SCADA and Controls	LS	1	$ 20,000.00	$ 11,016.95
Backfill	CY	67,989	$ 2.17	$ 81,269.77
Compaction	CY	67,989	$ 0.36	$ 13,482.54
Topsoil	SY	22,497	$ 6.30	$ 78,071.06
Grass Hydro-Seeding	SF	130,680	$ 0.06	$ 4,139.12
Sprinkler System	SF	130,680	$ 0.25	$ 17,996.19
24-inch RCP Drain Pipe	LF	500	125	$ 34,427.97
36-inch Outlet Pipe	LF	2,800	510	$ 786,610.17
Asphalt Restoration	SY	3,667	$ 29.36	$ 59,300.56
Traffic Control	LS	1	$ 50,000.00	$ 27,542.37
SWPPP	LS	1	$ 10,000.00	$ 5,508.47
Surveying	LS	1	$ 12,000.00	$ 6,610.17
Materials Testing	LS	1	$ 20,000.00	$ 11,016.95
Mobilization	LS	1	$ 500,000.00	$ 275,423.73

Sub-Total Construction	$ 5,436,320.67
Contingency @ 30%	$ 1,630,896.20
Total Construction	**$ 7,067,216.87**
Engineering, Admin, & Legal Fees @ 18%	$ 1,272,099.04
TOTAL PROJECT COSTS	**$ 8,339,315.91**
Range (-10%)	$ 7,505,000
Range (+50%)	$ 12,509,000

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CUWCD, Orem & Vineyard
Storage Siting Study
Opinion of Probable Construction Costs

Site 3 - 600 West 400 South Site (Orem Community Park)
11.8 MG Buried Concrete Tank
Vineyard's Portion of Costs (5.3 MG)

Description	Unit	Quantity		Unit Cost		Total Cost
Temp Construction Fence Rental (12 month)	LF	1,810	$	6.30	$	5,121.69
Clear and Grub Site	AC	3.0	$	4,300.00	$	5,794.07
Strip and Stockpile Topsoil	CY	7,499	$	0.59	$	1,987.21
Dewatering	DAY	180	$	1,330.00	$	107,527.12
Excavation	CY	108,782	$	1.58	$	77,198.50
Hauling Off-Site	CY	67,989	$	7.40	$	225,976.63
Hauling On-Site	CY	67,989	$	2.38	$	72,678.97
Buried Concrete Tank Construction	GAL	11,800,000	$	0.50	$	2,650,000.00
Valve Vault Construction	LS	1	$	300,000.00	$	134,745.76
SCADA and Controls	LS	1	$	20,000.00	$	8,983.05
Backfill	CY	67,989	$	2.17	$	66,266.12
Compaction	CY	67,989	$	0.36	$	10,993.46
Topsoil	SY	22,497	$	6.30	$	63,657.94
Grass Hydro-Seeding	SF	130,680	$	0.06	$	3,374.98
Sprinkler System	SF	130,680	$	0.25	$	14,673.81
24-inch RCP Drain Pipe	LF	500		125	$	28,072.03
36-inch Outlet Pipe	LF	2,800		510	$	641,389.83
Asphalt Restoration	SY	3,667	$	29.36	$	48,352.77
Traffic Control	LS	1	$	50,000.00	$	22,457.63
SWPPP	LS	1	$	10,000.00	$	4,491.53
Surveying	LS	1	$	12,000.00	$	5,389.83
Materials Testing	LS	1	$	20,000.00	$	8,983.05
Mobilization	LS	1	$	500,000.00	$	224,576.27

Sub-Total Construction	$	4,432,692.24
Contingency @ 30%	$	1,329,807.67
Total Construction	**$**	**5,762,499.91**
Engineering, Admin, & Legal Fees @ 18%	$	1,037,249.98
TOTAL PROJECT COSTS	**$**	**6,799,749.90**
Range (-10%)	$	6,119,000
Range (+50%)	$	10,200,000

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CUWCD, Orem & Vineyard
Storage Siting Study
Opinion of Probable Construction Costs

Site 5 - Cascade Drive 15.9 MG Partially Buried Concrete Tank
(All on CUWCD Property)

Description	Unit	Quantity	Unit Cost	Total Cost
Temp Construction Fence Rental (12 month)	LF	2,500	$ 6.30	$ 15,750.00
Clear and Grub Site	AC	9.2	$ 4,300.00	$ 39,560.00
Strip and Stockpile Topsoil	CY	14,852	$ 0.59	$ 8,762.68
Dewatering	DAY	180	$ 1,093.00	$ 196,740.00
Excavation	CY	161,181	$ 1.58	$ 254,665.98
Hauling Off-Site	CY	151,107	$ 7.40	$ 1,118,193.19
Hauling On-Site	CY	50,369	$ 2.38	$ 119,878.37
Soil Nail Wall	SF	37,352	$ 40.00	$ 1,494,080.00
Buried Concrete Tank Construction	GAL	15,900,000	$ 0.50	$ 7,950,000.00
Valve Vault Construction	LS	1	$ 400,000.00	$ 400,000.00
Backfill	CY	50,369	$ 2.17	$ 109,300.87
Compaction	CY	50,369	$ 0.36	$ 18,132.86
Topsoil	SY	36,491	$ 6.30	$ 229,894.00
Native Grasses Hydro-Seeding	SF	328,420	$ 0.06	$ 20,362.04
Chain Link Fencing	LF	932	$ 28.50	$ 26,562.00
Restoration of Stockpile Area	SF	40,000	$ 1.25	$ 50,000.00
24-inch RCP Drain Pipe	LF	1,600	125	$ 200,000.00
60-inch Outlet Pipe	LF	800	720	$ 576,000.00
Trench Asphalt Pavement Restoration	SY	2,667	$ 29.36	$ 78,293.33
Traffic Control	LS	1	$ 50,000.00	$ 50,000.00
SWPPP	LS	1	$ 10,000.00	$ 10,000.00
Surveying	LS	1	$ 12,000.00	$ 12,000.00
Materials Testing	LS	1	$ 20,000.00	$ 20,000.00
Mobilization	LS	1	$ 750,000.00	$ 750,000.00

Sub-Total Construction	$ 13,748,175.32
Contingency @ 30%	$ 4,124,452.60
Total Construction	**$ 17,872,627.91**
Engineering, Admin, & Legal Fees @ 18%	$ 3,217,073.02
TOTAL PROJECT COSTS	**$ 21,089,700.94**
Range (-10%)	$ 18,980,000
Range (+50%)	$ 31,635,000

CUWCD, Orem & Vineyard
Storage Siting Study
Opinion of Probable Construction Costs

Alternative #2 Transmission Pipeline Costs
Total Costs

Description	Unit	Quantity		Unit Cost		Total Cost
Site 1 - Geneva Park Tank (2021)						
18-inch Transmission Pipe	LF	7,000	$	165.00	$	1,155,000.00
Sub-Total					$	1,155,000.00
Site 2 - MVHS Tank (2017)						
24-inch Transmission Pipe	LF	3,100	$	180.00	$	558,000.00
30-inch Transmission Pipe	LF	1,600	$	300.00	$	480,000.00
36-inch Transmission Pipe	LF	1,100	$	340.00	$	374,000.00
42-inch Transmission Pipe	LF	5,400	$	504.00	$	2,721,600.00
Sub-Total		11,200			$	4,133,600.00
Site 3 - Community Park Tank (2024)						
12-inch Transmission Pipe	LF	2,600	$	125.00	$	325,000.00
16-inch Transmission Pipe	LF	1,600	$	140.00	$	224,000.00
18-inch Transmission Pipe	LF	5,500	$	165.00	$	907,500.00
24-inch Transmission Pipe	LF	3,000	$	180.00	$	540,000.00
30-inch Transmission Pipe	LF	4,200	$	300.00	$	1,260,000.00
42-inch Transmission Pipe	LF	5,400	$	504.00	$	2,721,600.00
48-inch Transmission Pipe	LF	17,700	$	576.00	$	10,195,200.00
Sub-Total		40,000			$	16,173,300.00
Sub-Total Construction					$	21,461,900.00
Contingency @ 25%					$	5,365,475.00
Total Construction					**$**	**26,827,375.00**
Engineering, Admin, & Legal Fees @ 18%					$	4,828,927.50
Total Alternative #2					**$**	**31,656,302.50**

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Alternative #2 Orem Only Transmission Pipeline Costs

Description	Unit	Quantity		Unit Cost		Total Cost
Site 1 - Geneva Park Tank (2021)						
18-inch Transmission Pipe	LF	900	$	165.00	$	148,500.00
Sub-Total					$	148,500.00
Site 2 - MVHS Tank (2017)						
24-inch Transmission Pipe	LF	3,100	$	180.00	$	558,000.00
30-inch Transmission Pipe	LF	2,100	$	300.00	$	630,000.00
36-inch Transmission Pipe	LF	2,200	$	340.00	$	748,000.00
42-inch Transmission Pipe	LF	-	$	504.00	$	-
Sub-Total		7,400			$	1,936,000.00
Site 3 - Community Park Tank (2024)						
12-inch Transmission Pipe	LF	2,600	$	125.00	$	325,000.00
16-inch Transmission Pipe	LF	1,600	$	140.00	$	224,000.00
18-inch Transmission Pipe	LF	2,700	$	165.00	$	445,500.00
24-inch Transmission Pipe	LF	1,700	$	180.00	$	306,000.00
30-inch Transmission Pipe	LF	5,500	$	300.00	$	1,650,000.00
42-inch Transmission Pipe	LF	5,400	$	504.00	$	2,721,600.00
48-inch Transmission Pipe	LF	12,300	$	576.00	$	7,084,800.00
Sub-Total		31,800			$	12,756,900.00
Sub-Total Construction					$	14,841,400.00
Contingency @ 25%					$	3,710,350.00
Total Construction					**$**	**18,551,750.00**
Engineering, Admin, & Legal Fees @ 18%					$	3,339,315.00
Total Alternative #2					**$**	**21,891,065.00**

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Alternative #2 Vineyard Transmission Pipeline Costs

Description	Unit	Quantity		Unit Cost		Total Cost
Site 1 - Geneva Park Tank (2021)						
18-inch Transmission Pipe	LF	6,100	$	165.00	$	1,006,500.00
Sub-Total					$	1,006,500.00
Site 2 - MVHS Tank (2017)						
24-inch Transmission Pipe	LF	-	$	180.00	$	-
30-inch Transmission Pipe	LF	(500)	$	300.00	$	(150,000.00)
36-inch Transmission Pipe	LF	(1,100)	$	340.00	$	(374,000.00)
42-inch Transmission Pipe	LF	5,400	$	504.00	$	2,721,600.00
Sub-Total		3,800			$	2,197,600.00
Site 3 - Community Park Tank (2024)						
12-inch Transmission Pipe	LF	-	$	125.00	$	-
16-inch Transmission Pipe	LF	-	$	140.00	$	-
18-inch Transmission Pipe	LF	2,800	$	165.00	$	462,000.00
24-inch Transmission Pipe	LF	1,300	$	180.00	$	234,000.00
30-inch Transmission Pipe	LF	(1,300)	$	300.00	$	(390,000.00)
42-inch Transmission Pipe	LF	-	$	504.00	$	-
48-inch Transmission Pipe	LF	5,400	$	576.00	$	3,110,400.00
Sub-Total		8,200			$	3,416,400.00
Sub-Total Construction					$	6,620,500.00
Contingency @ 25%					$	1,655,125.00
Total Construction					**$**	**8,275,625.00**
Engineering, Admin, & Legal Fees @ 18%					$	1,489,612.50
Total Alternative #2					**$**	**9,765,237.50**

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Storage Siting Study
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Site 1 - 600 West 400 North Site (Geneva Park)
7 MG Buried Concrete Tank
(With Dividing Wall and Vineyard Gravity Pipe)

Description	Unit	Quantity	Unit Cost	Total Cost
Temp Construction Fence Rental (12 month)	LF	1,800	$ 6.30	$ 11,340.00
Tennis Court Concrete Demolition	SY	1,375	$ 13.75	$ 18,900.14
Concrete Sidewalk Demolition	SY	544	$ 12.05	$ 6,560.56
Miscellaneous Concrete Demolition	SY	179	$ 12.05	$ 2,152.93
Basketball Court Asphalt Demolition	SY	331	$ 5.85	$ 1,938.30
Demolition Dump Fees	Ton	546	$ 71.44	$ 39,005.79
Miscellaneous Structures Demolition	LS	1	$ 1,500.00	$ 1,500.00
Tree Removal	EA	20	$ 735.00	$ 14,700.00
Clear and Grub Site	AC	2.1	$ 4,300.00	$ 9,030.00
Strip and Stockpile Topsoil	CY	3,348	$ 0.59	$ 1,975.04
Dewatering	DAY	180	$ 1,330.00	$ 239,400.00
Excavation	CY	77,000	$ 1.58	$ 121,660.00
Hauling Off-Site	CY	48,125	$ 7.40	$ 356,125.00
Hauling On-Site	CY	48,125	$ 2.38	$ 114,537.50
Buried Concrete Tank Construction	GAL	7,000,000	$ 0.50	$ 3,500,000.00
Dividing Wall (2.4 MG/4.6 MG)	CY	240	$ 650.00	$ 156,000.00
Vineyard Valve Vault	LS	1	$ 200,000.00	$ 200,000.00
Orem Valve Vault	LS	1	$ 200,000.00	$ 200,000.00
Central Zone Booster Pump Station	HP	150	$ 2,000.00	$ 300,000.00
120 kW Generator	kW	120	$ 450.00	$ 54,000.00
SCADA and Controls	LS	1	$ 50,000.00	$ 50,000.00
Backfill	CY	48,125	$ 2.17	$ 104,431.25
Compaction	CY	48,125	$ 0.36	$ 17,325.00
Concrete Sidewalk	SF	6,150	$ 6.60	$ 40,590.00
Lightposts	EA	6	$ 2,365.00	$ 14,190.00
Electrical Conduit	LF	1,250	$ 18.40	$ 23,000.00
Electrical Wire Cable	LF	1,250	$ 1.55	$ 1,937.50
Tennis Court (concrete)	SF	12,400	$ 6.60	$ 81,840.00
Tennis Court 10 feet High Fencing	LF	450	$ 40.00	$ 18,000.00
Tennis Court 4 foot Gate	EA	1	$ 560.00	$ 560.00
Basketball Court (concrete)	SF	3,000	$ 6.60	$ 19,800.00
Basketball Court Standard	EA	2	$ 3,075.00	$ 6,150.00
Trees	EA	20	$ 161.00	$ 3,220.00
Topsoil	SY	7,615	$ 6.30	$ 47,972.40
Grass Hydro-Seeding	SF	68,532	$ 0.06	$ 3,940.59
Sprinkler System	SF	68,532	$ 0.30	$ 20,559.60
Horseshoe Pits	EA	2	$ 500.00	$ 1,000.00
Pavillion 12 ft x 12 ft	SF	144	$ 20.00	$ 2,880.00
Restoration of Stockpile Area	SF	80,000	$ 1.25	$ 100,000.00
Access Driveway Asphalt Pavement	SY	469	$ 24.31	$ 11,398.69
Parking Area Asphalt Overlay	SY	778	4.98	$ 3,873.33
24-inch RCP Drain Pipe	LF	210	125	$ 26,250.00
18-inch Outlet Pipe	LF	2,400	247.5	$ 594,000.00
Asphalt Restoration	SY	2,900	$ 29.36	$ 85,144.00
Traffic Control	LS	1	$ 50,000.00	$ 50,000.00
SWPPP	LS	1	$ 10,000.00	$ 10,000.00
Surveying	LS	1	$ 12,000.00	$ 12,000.00
Materials Testing	LS	1	$ 20,000.00	$ 20,000.00
Mobilization	LS	1	$ 400,000.00	$ 400,000.00

Sub-Total Construction	$ 7,118,887.62
Contingency @ 30%	$ 2,135,666.29
Total Construction	**$ 9,254,553.91**
Engineering, Admin, & Legal Fees @ 18%	$ 1,665,819.70
TOTAL PROJECT COSTS	**$ 10,920,373.61**
Range (-10%)	$ 9,828,000
Range (+50%)	$ 16,381,000

CUWCD, Orem & Vineyard
Storage Siting Study
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Site 1 - 600 West 400 North Site (Geneva Park)
7 MG Buried Concrete Tank
(With Dividing Wall and Vineyard Gravity Pipe)
Orem's Portion of Costs (4.6 MG)

Description	Unit	Quantity	Unit Cost	Total Cost
Temp Construction Fence Rental (12 month)	LF	1,800	$ 6.30	$ 7,452.00
Tennis Court Concrete Demolition	SY	1,375	$ 13.75	$ 12,420.09
Concrete Sidewalk Demolition	SY	544	$ 12.05	$ 4,311.22
Miscellaneous Concrete Demolition	SY	179	$ 12.05	$ 1,414.78
Basketball Court Asphalt Demolition	SY	331	$ 5.85	$ 1,273.74
Demolition Dump Fees	Ton	546	$ 71.44	$ 25,632.38
Miscellaneous Structures Demolition	LS	1	$ 1,500.00	$ 985.71
Tree Removal	EA	20	$ 735.00	$ 9,660.00
Clear and Grub Site	AC	2.1	$ 4,300.00	$ 5,934.00
Strip and Stockpile Topsoil	CY	3,348	$ 0.59	$ 1,297.88
Dewatering	DAY	180	$ 1,330.00	$ 157,320.00
Excavation	CY	77,000	$ 1.58	$ 79,948.00
Hauling Off-Site	CY	48,125	$ 7.40	$ 234,025.00
Hauling On-Site	CY	48,125	$ 2.38	$ 75,267.50
Buried Concrete Tank Construction	GAL	7,000,000	$ 0.50	$ 2,300,000.00
Dividing Wall (2.4 MG/4.6 MG)	CY	240	$ 650.00	$ 102,514.29
Vineyard Valve Vault				
Orem Valve Vault	LS	1	$ 200,000.00	$ 200,000.00
Central Zone Booster Pump Station	HP	150	$ 2,000.00	$ 300,000.00
120 kW Generator	kW	120	$ 450.00	$ 54,000.00
SCADA and Controls	LS	1	$ 50,000.00	$ 32,857.14
Backfill	CY	48,125	$ 2.17	$ 68,626.25
Compaction	CY	48,125	$ 0.36	$ 11,385.00
Concrete Sidewalk	SF	6,150	$ 6.60	$ 26,673.43
Lightposts	EA	6	$ 2,365.00	$ 9,324.86
Electrical Conduit	LF	1,250	$ 18.40	$ 15,114.29
Electrical Wire Cable	LF	1,250	$ 1.55	$ 1,273.21
Tennis Court (concrete)	SF	12,400	$ 6.60	$ 53,780.57
Tennis Court 10 feet High Fencing	LF	450	$ 40.00	$ 11,828.57
Tennis Court 4 foot Gate	EA	1	$ 560.00	$ 368.00
Basketball Court (concrete)	SF	3,000	$ 6.60	$ 13,011.43
Basketball Court Standard	EA	2	$ 3,075.00	$ 4,041.43
Trees	EA	20	$ 161.00	$ 2,116.00
Topsoil	SY	7,615	$ 6.30	$ 31,524.72
Grass Hydro-Seeding	SF	68,532	$ 0.06	$ 2,589.53
Sprinkler System	SF	68,532	$ 0.30	$ 13,510.59
Horseshoe Pits	EA	2	$ 500.00	$ 657.14
Pavillion 12 ft x 12 ft	SF	144	$ 20.00	$ 1,892.57
Restoration of Stockpile Area	SF	80,000	$ 1.25	$ 65,714.29
Access Driveway Asphalt Pavement	SY	469	$ 24.31	$ 7,490.57
Parking Area Asphalt Overlay	SY	778	4.98	$ 2,545.33
24-inch RCP Drain Pipe	LF	210	125	$ 17,250.00
18-inch Outlet Pipe (All Vineyard)				
Asphalt Restoration	SY	233	$ 29.36	$ 55,951.77
Traffic Control	LS	1	$ 50,000.00	$ 32,857.14
SWPPP	LS	1	$ 10,000.00	$ 6,571.43
Surveying	LS	1	$ 12,000.00	$ 7,885.71
Materials Testing	LS	1	$ 20,000.00	$ 13,142.86
Mobilization	LS	1	$ 400,000.00	$ 262,857.14

Sub-Total Construction	$ 4,346,297.58
Contingency @ 30%	$ 1,303,889.27
Total Construction	**$ 5,650,186.85**
Engineering, Admin, & Legal Fees @ 18%	$ 1,017,033.63
TOTAL PROJECT COSTS	**$ 6,667,220.49**
Range (-10%)	$ 6,000,000
Range (+50%)	$ 10,001,000

CUWCD, Orem & Vineyard
Storage Siting Study
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Site 1 - 600 West 400 North Site (Geneva Park)
7 MG Buried Concrete Tank
(With Dividing Wall and Vineyard Gravity Pipe)
Vineyard's Portion of Costs (2.4 MG)

Description	Unit	Quantity	Unit Cost	Total Cost
Temp Construction Fence Rental (12 month)	LF	1,800	$ 6.30	$ 3,888.00
Tennis Court Concrete Demolition	SY	1,375	$ 13.75	$ 6,480.05
Concrete Sidewalk Demolition	SY	544	$ 12.05	$ 2,249.33
Miscellaneous Concrete Demolition	SY	179	$ 12.05	$ 738.15
Basketball Court Asphalt Demolition	SY	331	$ 5.85	$ 664.56
Demolition Dump Fees	Ton	546	$ 71.44	$ 13,373.42
Miscellaneous Structures Demolition	LS	1	$ 1,500.00	$ 514.29
Tree Removal	EA	20	$ 735.00	$ 5,040.00
Clear and Grub Site	AC	2.1	$ 4,300.00	$ 3,096.00
Strip and Stockpile Topsoil	CY	3,348	$ 0.59	$ 677.16
Dewatering	DAY	180	$ 1,330.00	$ 82,080.00
Excavation	CY	77,000	$ 1.58	$ 41,712.00
Hauling Off-Site	CY	48,125	$ 7.40	$ 122,100.00
Hauling On-Site	CY	48,125	$ 2.38	$ 39,270.00
				$ -
Buried Concrete Tank Construction	GAL	7,000,000	$ 0.50	$ 1,200,000.00
Dividing Wall (2.4 MG/4.6 MG)	CY	240	$ 650.00	$ 53,485.71
Vineyard Valve Vault	LS	1	$ 200,000.00	$ 200,000.00
Orem Valve Vault				
Central Zone Booster Pump Station (All Orem)				
120 kW Generator (All Orem)				
SCADA and Controls	LS	1	$ 50,000.00	$ 17,142.86
Backfill	CY	48,125	$ 2.17	$ 35,805.00
Compaction	CY	48,125	$ 0.36	$ 5,940.00
Concrete Sidewalk	SF	6,150	$ 6.60	$ 13,916.57
Lightposts	EA	6	$ 2,365.00	$ 4,865.14
Electrical Conduit	LF	1,250	$ 18.40	$ 7,885.71
Electrical Wire Cable	LF	1,250	$ 1.55	$ 664.29
Tennis Court (concrete)	SF	12,400	$ 6.60	$ 28,059.43
Tennis Court 10 feet High Fencing	LF	450	$ 40.00	$ 6,171.43
Tennis Court 4 foot Gate	EA	1	$ 560.00	$ 192.00
Basketball Court (concrete)	SF	3,000	$ 6.60	$ 6,788.57
Basketball Court Standard	EA	2	$ 3,075.00	$ 2,108.57
Trees	EA	20	$ 161.00	$ 1,104.00
Topsoil	SY	7,615	$ 6.30	$ 16,447.68
Grass Hydro-Seeding	SF	68,532	$ 0.06	$ 1,351.06
Sprinkler System	SF	68,532	$ 0.30	$ 7,049.01
Horseshoe Pits	EA	2	$ 500.00	$ 342.86
Pavillion 12 ft x 12 ft	SF	144	$ 20.00	$ 987.43
Restoration of Stockpile Area	SF	80,000	$ 1.25	$ 34,285.71
Access Driveway Asphalt Pavement	SY	469	$ 24.31	$ 3,908.12
Parking Area Asphalt Overlay	SY	778	4.98	$ 1,328.00
24-inch RCP Drain Pipe	LF	210	125	$ 9,000.00
18-inch Outlet Pipe (All Vineyard)	LF	2,400	247.5	$ 594,000.00
Asphalt Restoration	SY	2,900	$ 29.36	$ 29,192.23
Traffic Control	LS	1	$ 50,000.00	$ 17,142.86
SWPPP	LS	1	$ 10,000.00	$ 3,428.57
Surveying	LS	1	$ 12,000.00	$ 4,114.29
Materials Testing	LS	1	$ 20,000.00	$ 6,857.14
Mobilization	LS	1	$ 400,000.00	$ 137,142.86

Sub-Total Construction	$ 2,772,590.04
Contingency @ 30%	$ 831,777.01
Total Construction	**$ 3,604,367.05**
Engineering, Admin, & Legal Fees @ 18%	$ 648,786.07
TOTAL PROJECT COSTS	**$ 4,253,153.12**
Range (-10%)	$ 3,827,000
Range (+50%)	$ 6,380,000

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Site 2 - 600 West Center Street Site (MVHS)
10.8 MG Buried Concrete Tank
(All Orem)

Description	Unit	Quantity	Unit Cost	Total Cost
Temp Construction Fence Rental (12 month)	LF	1,710	$ 6.30	$ 10,773.00
Concrete Sidewalk Demolition	SY	22	$ 12.05	$ 267.78
Demolition Dump Fees	Ton	5.00	$ 71.44	$ 356.85
Clear and Grub Site	AC	4.2	$ 4,300.00	$ 18,060.00
Strip and Stockpile Topsoil	CY	6,771	$ 0.59	$ 3,994.78
Dewatering	DAY	180	$ 1,330.00	$ 239,400.00
Excavation	CY	131,416	$ 1.58	$ 207,637.28
Hauling Off-Site	CY	164,270	$ 7.40	$ 1,215,598.00
Soil Nail Wall	SF	6,000	$ 40.00	$ 240,000.00
Buried Concrete Tank Construction	GAL	10,800,000	$ 0.50	$ 5,400,000.00
Valve Vault Construction	LS	1	$ 400,000.00	$ 400,000.00
Central Zone Booster Pump Station	HP	400	$ 2,000.00	$ 800,000.00
300 kW Generator	kW	300	$ 400.00	$ 120,000.00
SCADA and Controls	LS	1	$ 50,000.00	$ 50,000.00
Hauling Backfill from Offsite	CY	82,135	$ 2.38	$ 195,481.30
Backfill	CY	82,135	$ 2.17	$ 178,232.95
Compaction	CY	82,135	$ 0.36	$ 29,568.60
Concrete Sidewalk	SF	250	$ 6.60	$ 1,650.00
Topsoil	SY	20,312	$ 6.30	$ 127,968.40
Grass Hydro-Seeding	SF	182,812	$ 0.06	$ 10,511.69
Sprinkler System	SF	182,812	$ 0.25	$ 45,703.00
Replace Church Chain Link Fence	LF	540	$ 28.50	$ 15,390.00
Parking Area Asphalt Overlay	SY	4,097	4.98	$ 20,401.40
24-inch RCP Drain Pipe	LF	520	125	$ 65,000.00
Asphalt Restoration	SY	578	$ 29.36	$ 16,963.56
Traffic Control	LS	1	$ 50,000.00	$ 50,000.00
SWPPP	LS	1	$ 10,000.00	$ 10,000.00
Surveying	LS	1	$ 12,000.00	$ 12,000.00
Materials Testing	LS	1	$ 20,000.00	$ 20,000.00
Mobilization	LS	1	$ 550,000.00	$ 550,000.00

Sub-Total Construction	$	10,054,958.59
Contingency @ 30%	$	3,016,487.58
Total Construction	**$**	**13,071,446.16**
Engineering, Admin, & Legal Fees @ 18%	$	2,352,860.31
TOTAL PROJECT COSTS	**$**	**15,424,306.47**
Range (-10%)	$	13,881,000
Range (+50%)	$	23,137,000

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Site 3 - 600 West 400 South Site (Orem Community Park)
12.3 MG Buried Concrete Tank
(No Booster Pump Station)

Description	Unit	Quantity	Unit Cost	Total Cost
Temp Construction Fence Rental (12 month)	LF	1,810	$ 6.30	$ 11,403.00
Clear and Grub Site	AC	3.0	$ 4,300.00	$ 12,900.00
Strip and Stockpile Topsoil	CY	7,499	$ 0.59	$ 4,424.34
Dewatering	DAY	180	$ 1,330.00	$ 239,400.00
Excavation	CY	108,782	$ 1.58	$ 171,875.91
Hauling Off-Site	CY	67,989	$ 7.40	$ 503,117.78
Hauling On-Site	CY	67,989	$ 2.38	$ 161,813.56
Buried Concrete Tank Construction	GAL	12,300,000	$ 0.50	$ 6,150,000.00
Valve Vault Construction	LS	1	$ 300,000.00	$ 300,000.00
SCADA and Controls	LS	1	$ 20,000.00	$ 20,000.00
Backfill	CY	67,989	$ 2.17	$ 147,535.89
Compaction	CY	67,989	$ 0.36	$ 24,476.00
Topsoil	SY	22,497	$ 6.30	$ 141,729.00
Grass Hydro-Seeding	SF	130,680	$ 0.06	$ 7,514.10
Sprinkler System	SF	130,680	$ 0.25	$ 32,670.00
24-inch RCP Drain Pipe	LF	500	125	$ 62,500.00
36-inch Outlet Pipe	LF	2,800	510	$ 1,428,000.00
Asphalt Restoration	SY	3,667	$ 29.36	$ 107,653.33
Traffic Control	LS	1	$ 50,000.00	$ 50,000.00
SWPPP	LS	1	$ 10,000.00	$ 10,000.00
Surveying	LS	1	$ 12,000.00	$ 12,000.00
Materials Testing	LS	1	$ 20,000.00	$ 20,000.00
Mobilization	LS	1	$ 550,000.00	$ 550,000.00

Sub-Total Construction	$ 10,169,012.91
Contingency @ 30%	$ 3,050,703.87
Total Construction	**$ 13,219,716.78**
Engineering, Admin, & Legal Fees @ 18%	$ 2,379,549.02
TOTAL PROJECT COSTS	**$ 15,599,265.81**
Range (-10%)	$ 14,039,000
Range (+50%)	$ 23,399,000

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Site 3 - 600 West 400 South Site (Orem Community Park)
12.3 MG Buried Concrete Tank
Orem's Portion of Costs (7.0 MG)

Description	Unit	Quantity	Unit Cost	Total Cost
Temp Construction Fence Rental (12 month)	LF	1,810	$ 6.30	$ 6,489.51
Clear and Grub Site	AC	3.0	$ 4,300.00	$ 7,341.46
Strip and Stockpile Topsoil	CY	7,499	$ 0.59	$ 2,517.92
Dewatering	DAY	180	$ 1,330.00	$ 136,243.90
Excavation	CY	108,782	$ 1.58	$ 97,815.56
Hauling Off-Site	CY	67,989	$ 7.40	$ 286,327.19
Hauling On-Site	CY	67,989	$ 2.38	$ 92,089.02
Buried Concrete Tank Construction	GAL	12,300,000	$ 0.50	$ 3,500,000.00
Valve Vault Construction	LS	1	$ 300,000.00	$ 170,731.71
SCADA and Controls	LS	1	$ 20,000.00	$ 11,382.11
Backfill	CY	67,989	$ 2.17	$ 83,963.51
Compaction	CY	67,989	$ 0.36	$ 13,929.43
Topsoil	SY	22,497	$ 6.30	$ 80,658.78
Grass Hydro-Seeding	SF	130,680	$ 0.06	$ 4,276.32
Sprinkler System	SF	130,680	$ 0.25	$ 18,592.68
24-inch RCP Drain Pipe	LF	500	125	$ 35,569.11
36-inch Outlet Pipe	LF	2,800	510	$ 812,682.93
Asphalt Restoration	SY	3,667	$ 29.36	$ 61,266.12
Traffic Control	LS	1	$ 50,000.00	$ 28,455.28
SWPPP	LS	1	$ 10,000.00	$ 5,691.06
Surveying	LS	1	$ 12,000.00	$ 6,829.27
Materials Testing	LS	1	$ 20,000.00	$ 11,382.11
Mobilization	LS	1	$ 500,000.00	$ 313,008.13

Sub-Total Construction	$ 5,787,243.12
Contingency @ 30%	$ 1,736,172.94
Total Construction	**$ 7,523,416.06**
Engineering, Admin, & Legal Fees @ 18%	$ 1,354,214.89
TOTAL PROJECT COSTS	**$ 8,877,630.95**
Range (-10%)	$ 7,989,000
Range (+50%)	$ 13,317,000

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Site 3 - 600 West 400 South Site (Orem Community Park)
12.3 MG Buried Concrete Tank
Vineyard's Portion of Costs (5.3 MG)

Description	Unit	Quantity	Unit Cost	Total Cost
Temp Construction Fence Rental (12 month)	LF	1,810	$ 6.30	$ 4,913.49
Clear and Grub Site	AC	3.0	$ 4,300.00	$ 5,558.54
Strip and Stockpile Topsoil	CY	7,499	$ 0.59	$ 1,906.42
Dewatering	DAY	180	$ 1,330.00	$ 103,156.10
Excavation	CY	108,782	$ 1.58	$ 74,060.35
Hauling Off-Site	CY	67,989	$ 7.40	$ 216,790.59
Hauling On-Site	CY	67,989	$ 2.38	$ 69,724.54
Buried Concrete Tank Construction	GAL	12,300,000	$ 0.50	$ 2,650,000.00
Valve Vault Construction	LS	1	$ 300,000.00	$ 129,268.29
SCADA and Controls	LS	1	$ 20,000.00	$ 8,617.89
Backfill	CY	67,989	$ 2.17	$ 63,572.37
Compaction	CY	67,989	$ 0.36	$ 10,546.57
Topsoil	SY	22,497	$ 6.30	$ 61,070.22
Grass Hydro-Seeding	SF	130,680	$ 0.06	$ 3,237.78
Sprinkler System	SF	130,680	$ 0.25	$ 14,077.32
24-inch RCP Drain Pipe	LF	500	125	$ 26,930.89
36-inch Outlet Pipe	LF	2,800	510	$ 615,317.07
Asphalt Restoration	SY	3,667	$ 29.36	$ 46,387.21
Traffic Control	LS	1	$ 50,000.00	$ 21,544.72
SWPPP	LS	1	$ 10,000.00	$ 4,308.94
Surveying	LS	1	$ 12,000.00	$ 5,170.73
Materials Testing	LS	1	$ 20,000.00	$ 8,617.89
Mobilization	LS	1	$ 500,000.00	$ 236,991.87

Sub-Total Construction	$ 4,381,769.79
Contingency @ 30%	$ 1,314,530.94
Total Construction	**$ 5,696,300.73**
Engineering, Admin, & Legal Fees @ 18%	$ 1,025,334.13
TOTAL PROJECT COSTS	**$ 6,721,634.86**
Range (-10%)	$ 6,049,000
Range (+50%)	$ 10,083,000

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Alternative #3 Transmission Pipeline Costs

Description	Unit	Quantity		Unit Cost		Total Cost
Site 1 - Geneva Park Tank (2021)						
18-inch Transmission Pipe	LF	6,000	$	165.00	$	990,000.00
Site 3 - Community Park Tank (2017)						
16-inch Transmission Pipe	LF	2,200	$	140.00	$	308,000.00
18-inch Transmission Pipe	LF	3,320	$	165.00	$	547,800.00
24-inch Transmission Pipe	LF	3,000	$	180.00	$	540,000.00
30-inch Transmission Pipe	LF	4,200	$	300.00	$	1,260,000.00
42-inch Transmission Pipe	LF	5,000	$	504.00	$	2,520,000.00
Sub-Total		17,720			$	5,175,800.00
Site 5 - Cascade Dr Tank (2024)						
12-inch Transmission Pipe	LF	5,300	$	125.00	$	662,500.00
18-inch Transmission Pipe	LF	2,700	$	165.00	$	445,500.00
30-inch Transmission Pipe	LF	1,600	$	300.00	$	480,000.00
42-inch Transmission Pipe	LF	1,100	$	504.00	$	554,400.00
48-inch Transmission Pipe	LF	2,700	$	576.00	$	1,555,200.00
54-inch Transmission Pipe	LF	5,400	$	648.00	$	3,499,200.00
60-inch Transmission Pipe	LF	13,500	$	720.00	$	9,720,000.00
Sub-Total		32,300			$	16,916,800.00
Sub-Total Construction					$	23,082,600.00
Contingency @ 25%					$	5,770,650.00
Total Construction					**$**	**28,853,250.00**
Engineering, Admin, & Legal Fees @ 18%					$	5,193,585.00
Total Alternative #3					**$**	**34,046,835.00**

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Alternative #3 Orem Only Transmission Pipeline Costs

Description	Unit	Quantity		Unit Cost		Total Cost
Site 1 - Geneva Park Tank (2021)						
18-inch Transmission Pipe	LF	-	$	165.00	$	-
Site 3 - Community Park Tank (2017)						
16-inch Transmission Pipe	LF	2,200	$	140.00	$	308,000.00
18-inch Transmission Pipe	LF	-	$	165.00	$	-
24-inch Transmission Pipe	LF	4,300	$	180.00	$	774,000.00
30-inch Transmission Pipe	LF	2,900	$	300.00	$	870,000.00
42-inch Transmission Pipe	LF	5,000	$	504.00	$	2,520,000.00
Sub-Total		14,400			$	4,472,000.00
Site 5 - Cascade Dr Tank (2024)						
12-inch Transmission Pipe	LF	5,300	$	125.00	$	662,500.00
18-inch Transmission Pipe	LF	2,700	$	165.00	$	445,500.00
30-inch Transmission Pipe	LF	1,600	$	300.00	$	480,000.00
42-inch Transmission Pipe	LF	3,800	$	504.00	$	1,915,200.00
48-inch Transmission Pipe	LF	2,700	$	576.00	$	1,555,200.00
54-inch Transmission Pipe	LF	2,700	$	648.00	$	1,749,600.00
60-inch Transmission Pipe	LF	13,500	$	720.00	$	9,720,000.00
Sub-Total		32,300			$	16,528,000.00
Sub-Total Construction					$	21,000,000.00
Contingency @ 25%					$	5,250,000.00
Total Construction					**$**	**26,250,000.00**
Engineering, Admin, & Legal Fees @ 18%					$	4,725,000.00
Total Alternative #3					**$**	**30,975,000.00**

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Alternative #3 Vineyard Transmission Pipeline Costs

Description	Unit	Quantity		Unit Cost		Total Cost
Site 1 - Geneva Park Tank (2021)						
18-inch Transmission Pipe	LF	6,000	$	165.00	$	990,000.00
Site 3 - Community Park Tank (2017)						
16-inch Transmission Pipe	LF	-	$	140.00	$	-
18-inch Transmission Pipe	LF	3,320	$	165.00	$	547,800.00
24-inch Transmission Pipe	LF	(1,300)	$	180.00	$	(234,000.00)
30-inch Transmission Pipe	LF	1,300	$	300.00	$	390,000.00
42-inch Transmission Pipe	LF	-	$	504.00	$	-
Sub-Total		3,320			$	703,800.00
Site 5 - Cascade Dr Tank (2024)						
12-inch Transmission Pipe	LF	-	$	125.00	$	-
18-inch Transmission Pipe	LF	-	$	165.00	$	-
30-inch Transmission Pipe	LF	-	$	300.00	$	-
42-inch Transmission Pipe	LF	(2,700)	$	504.00	$	(1,360,800.00)
48-inch Transmission Pipe	LF	-	$	576.00	$	-
54-inch Transmission Pipe	LF	2,700	$	648.00	$	1,749,600.00
60-inch Transmission Pipe	LF	-	$	720.00	$	-
Sub-Total		-			$	388,800.00
Sub-Total Construction					$	2,082,600.00
Contingency @ 25%					$	520,650.00
Total Construction					**$**	**2,603,250.00**
Engineering, Admin, & Legal Fees @ 18%					$	468,585.00
Total Alternative #3					**$**	**3,071,835.00**

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Site 1 - 600 West 400 North Site (Geneva Park)
2.4 MG Buried Concrete Tank

Description	Unit	Quantity	Unit Cost	Total Cost
Temp Construction Fence Rental (12 month)	LF	1,100	$ 6.30	$ 6,930.00
Concrete Sidewalk Demolition	SY	422	$ 12.05	$ 5,087.78
Basketball Court Asphalt Demolition	SY	331	$ 5.85	$ 1,938.30
Demolition Dump Fees	Ton	169	$ 71.44	$ 12,100.88
Miscellaneous Structures Demolition	LS	1	$ 1,500.00	$ 1,500.00
Tree Removal	EA	14	$ 735.00	$ 10,290.00
Clear and Grub Site	AC	0.92	$ 4,300.00	$ 3,956.00
Strip and Stockpile Topsoil	CY	1,481	$ 0.59	$ 874.07
Dewatering	DAY	180	$ 886.67	$ 159,600.00
Excavation	CY	24,000	$ 1.58	$ 37,920.00
Hauling Off-Site	CY	15,000	$ 7.40	$ 111,000.00
Hauling On-Site	CY	15,000	$ 2.38	$ 35,700.00
Buried Concrete Tank Construction	GAL	2,400,000	$ 0.50	$ 1,200,000.00
Valve Vault Construction	LS	1	$ 200,000.00	$ 200,000.00
SCADA and Controls	LS	1	$ 15,000.00	$ 15,000.00
Backfill	CY	15,000	$ 2.17	$ 32,550.00
Compaction	CY	15,000	$ 0.36	$ 5,400.00
Concrete Sidewalk	SF	4,750	$ 6.60	$ 31,350.00
Lightposts	EA	3	$ 2,365.00	$ 7,095.00
Electrical Conduit	LF	600	$ 18.40	$ 11,040.00
Electrical Wire Cable	LF	600	$ 1.55	$ 930.00
Basketball Court (concrete)	SF	3,000	$ 6.60	$ 19,800.00
Basketball Court Standard	EA	2	$ 3,075.00	$ 6,150.00
Trees	EA	14	$ 161.00	$ 2,254.00
Topsoil	SY	4,444	$ 6.30	$ 28,000.00
Grass Hydro-Seeding	SF	40,000	$ 0.06	$ 2,300.00
Sprinkler System	SF	40,000	$ 0.30	$ 12,000.00
Horseshoe Pits	EA	2	$ 500.00	$ 1,000.00
Restoration of Stockpile Area	SF	20,000	$ 1.25	$ 25,000.00
Access Driveway Asphalt Pavement	SY	469	$ 24.31	$ 11,398.69
Parking Area Asphalt Overlay	SY	778	4.98	$ 3,873.33
24-inch RCP Drain Pipe	LF	210	125	$ 26,250.00
18-inch Outlet Pipe	LF	2,400	247.5	$ 594,000.00
Asphalt Restoration	SY	2,667	$ 29.36	$ 78,293.33
Traffic Control	LS	1	$ 50,000.00	$ 50,000.00
SWPPP	LS	1	$ 10,000.00	$ 10,000.00
Surveying	LS	1	$ 10,000.00	$ 10,000.00
Materials Testing	LS	1	$ 10,000.00	$ 10,000.00
Mobilization	LS	1	$ 150,000.00	$ 150,000.00

Sub-Total Construction	$	2,930,581.39
Contingency @ 30%	$	879,174.42
Total Construction	**$**	**3,809,755.80**
Engineering, Admin, & Legal Fees @ 18%	$	685,756.04
TOTAL PROJECT COSTS	**$**	**4,495,511.85**
Range (-10%)	$	4,045,000
Range (+50%)	$	6,744,000

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Site 3 - 600 West 400 South Site (Orem Community Park)
11.8 MG Buried Concrete Tank
(with Booster Pump Station)

Description	Unit	Quantity	Unit Cost	Total Cost
Temp Construction Fence Rental (12 month)	LF	1,810	$ 6.30	$ 11,403.00
Clear and Grub Site	AC	3.0	$ 4,300.00	$ 12,900.00
Strip and Stockpile Topsoil	CY	7,499	$ 0.59	$ 4,424.34
Dewatering	DAY	180	$ 1,330.00	$ 239,400.00
Excavation	CY	108,782	$ 1.58	$ 171,875.91
Hauling Off-Site	CY	67,989	$ 7.40	$ 503,117.78
Hauling On-Site	CY	67,989	$ 2.38	$ 161,813.56
Buried Concrete Tank Construction	GAL	11,800,000	$ 0.50	$ 5,900,000.00
Valve Vault Construction	LS	1	$ 300,000.00	$ 300,000.00
Central Zone Booster Pump Station	HP	600	$ 2,000.00	$ 1,200,000.00
450 kW Generator	kW	450	$ 400.00	$ 180,000.00
SCADA and Controls	LS	1	$ 50,000.00	$ 50,000.00
Backfill	CY	67,989	$ 2.17	$ 147,535.89
Compaction	CY	67,989	$ 0.36	$ 24,476.00
Topsoil	SY	22,497	$ 6.30	$ 141,729.00
Grass Hydro-Seeding	SF	130,680	$ 0.06	$ 7,514.10
Sprinkler System	SF	130,680	$ 0.25	$ 32,670.00
24-inch RCP Drain Pipe	LF	500	125	$ 62,500.00
36-inch Outlet Pipe	LF	2,800	510	$ 1,428,000.00
Asphalt Restoration	SY	3,667	$ 29.36	$ 107,653.33
Traffic Control	LS	1	$ 50,000.00	$ 50,000.00
SWPPP	LS	1	$ 10,000.00	$ 10,000.00
Surveying	LS	1	$ 12,000.00	$ 12,000.00
Materials Testing	LS	1	$ 20,000.00	$ 20,000.00
Mobilization	LS	1	$ 500,000.00	$ 500,000.00

Sub-Total Construction	$ 11,279,012.91
Contingency @ 30%	$ 3,383,703.87
Total Construction	**$ 14,662,716.78**
Engineering, Admin, & Legal Fees @ 18%	$ 2,639,289.02
TOTAL PROJECT COSTS	**$ 17,302,005.81**
Range (-10%)	$ 15,571,000
Range (+50%)	$ 25,954,000

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Site 3 - 600 West 400 South Site (Orem Community Park)
11.8 MG Buried Concrete Tank
Orem's Portion of Costs with Booster Pump Station (6.5 MG)

Description	Unit	Quantity	Unit Cost	Total Cost
Temp Construction Fence Rental (12 month)	LF	1,810	$ 6.30	$ 6,281.31
Clear and Grub Site	AC	3.0	$ 4,300.00	$ 7,105.93
Strip and Stockpile Topsoil	CY	7,499	$ 0.59	$ 2,437.14
Dewatering	DAY	180	$ 1,330.00	$ 131,872.88
Excavation	CY	108,782	$ 1.58	$ 94,677.41
Hauling Off-Site	CY	67,989	$ 7.40	$ 277,141.15
Hauling On-Site	CY	67,989	$ 2.38	$ 89,134.59
Buried Concrete Tank Construction	GAL	11,800,000	$ 0.50	$ 3,250,000.00
Valve Vault Construction	LS	1	$ 300,000.00	$ 165,254.24
Central Zone Booster Pump Station	HP	600	$ 2,000.00	$ 1,200,000.00
450 kW Generator	kW	450	$ 400.00	$ 180,000.00
SCADA and Controls	LS	1	$ 50,000.00	$ 27,542.37
Backfill	CY	67,989	$ 2.17	$ 81,269.77
Compaction	CY	67,989	$ 0.36	$ 13,482.54
Topsoil	SY	22,497	$ 6.30	$ 78,071.06
Grass Hydro-Seeding	SF	130,680	$ 0.06	$ 4,139.12
Sprinkler System	SF	130,680	$ 0.25	$ 17,996.19
24-inch RCP Drain Pipe	LF	500	125	$ 34,427.97
36-inch Outlet Pipe	LF	2,800	510	$ 786,610.17
Asphalt Restoration	SY	3,667	$ 29.36	$ 59,300.56
Traffic Control	LS	1	$ 50,000.00	$ 27,542.37
SWPPP	LS	1	$ 10,000.00	$ 5,508.47
Surveying	LS	1	$ 12,000.00	$ 6,610.17
Materials Testing	LS	1	$ 20,000.00	$ 11,016.95
Mobilization	LS	1	$ 500,000.00	$ 275,423.73

Sub-Total Construction	$ 6,832,846.10
Contingency @ 30%	$ 2,049,853.83
Total Construction	**$ 8,882,699.92**
Engineering, Admin, & Legal Fees @ 18%	$ 1,598,885.99
TOTAL PROJECT COSTS	**$ 10,481,585.91**
Range (-10%)	$ 9,433,000
Range (+50%)	$ 15,723,000

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Site 3 - 600 West 400 South Site (Orem Community Park)
11.8 MG Buried Concrete Tank
Vineyard's Portion of Costs without Booster Pump Station (5.3)

Description	Unit	Quantity	Unit Cost	Total Cost
Temp Construction Fence Rental (12 month)	LF	1,810	$ 6.30	$ 5,121.69
Clear and Grub Site	AC	3.0	$ 4,300.00	$ 5,794.07
Strip and Stockpile Topsoil	CY	7,499	$ 0.59	$ 1,987.21
Dewatering	DAY	180	$ 1,330.00	$ 107,527.12
Excavation	CY	108,782	$ 1.58	$ 77,198.50
Hauling Off-Site	CY	67,989	$ 7.40	$ 225,976.63
Hauling On-Site	CY	67,989	$ 2.38	$ 72,678.97
Buried Concrete Tank Construction	GAL	11,800,000	$ 0.50	$ 2,650,000.00
Valve Vault Construction	LS	1	$ 300,000.00	$ 134,745.76
Central Zone Booster Pump Station				
450 kW Generator				
SCADA and Controls	LS	1	$ 50,000.00	$ 22,457.63
Backfill	CY	67,989	$ 2.17	$ 66,266.12
Compaction	CY	67,989	$ 0.36	$ 10,993.46
Topsoil	SY	22,497	$ 6.30	$ 63,657.94
Grass Hydro-Seeding	SF	130,680	$ 0.06	$ 3,374.98
Sprinkler System	SF	130,680	$ 0.25	$ 14,673.81
24-inch RCP Drain Pipe	LF	500	125	$ 28,072.03
36-inch Outlet Pipe	LF	2,800	510	$ 641,389.83
Asphalt Restoration	SY	3,667	$ 29.36	$ 48,352.77
Traffic Control	LS	1	$ 50,000.00	$ 22,457.63
SWPPP	LS	1	$ 10,000.00	$ 4,491.53
Surveying	LS	1	$ 12,000.00	$ 5,389.83
Materials Testing	LS	1	$ 20,000.00	$ 8,983.05
Mobilization	LS	1	$ 500,000.00	$ 224,576.27

Sub-Total Construction	$ 4,446,166.82
Contingency @ 30%	$ 1,333,850.04
Total Construction	**$ 5,780,016.86**
Engineering, Admin, & Legal Fees @ 18%	$ 1,040,403.03
TOTAL PROJECT COSTS	**$ 6,820,419.90**
Range (-10%)	$ 6,138,000
Range (+50%)	$ 10,231,000

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Site 5 - Cascade Drive 15.9 MG Partially Buried Concrete Tank
(All on CUWCD Property)

Description	Unit	Quantity	Unit Cost	Total Cost
Temp Construction Fence Rental (12 month)	LF	2,500	$ 6.30	$ 15,750.00
Clear and Grub Site	AC	9.2	$ 4,300.00	$ 39,560.00
Strip and Stockpile Topsoil	CY	14,852	$ 0.59	$ 8,762.68
Dewatering	DAY	180	$ 1,093.00	$ 196,740.00
Excavation	CY	161,181	$ 1.58	$ 254,665.98
Hauling Off-Site	CY	151,107	$ 7.40	$ 1,118,193.19
Hauling On-Site	CY	50,369	$ 2.38	$ 119,878.37
Soil Nail Wall	SF	37,352	$ 40.00	$ 1,494,080.00
Buried Concrete Tank Construction	GAL	15,900,000	$ 0.50	$ 7,950,000.00
Valve Vault Construction	LS	1	$ 400,000.00	$ 400,000.00
Backfill	CY	50,369	$ 2.17	$ 109,300.87
Compaction	CY	50,369	$ 0.36	$ 18,132.86
Topsoil	SY	36,491	$ 6.30	$ 229,894.00
Native Grasses Hydro-Seeding	SF	328,420	$ 0.06	$ 20,362.04
Chain Link Fencing	LF	932	$ 28.50	$ 26,562.00
Restoration of Stockpile Area	SF	40,000	$ 1.25	$ 50,000.00
24-inch RCP Drain Pipe	LF	1,600	125	$ 200,000.00
60-inch Outlet Pipe	LF	800	720	$ 576,000.00
Trench Asphalt Pavement Restoration	SY	2,667	$ 29.36	$ 78,293.33
Traffic Control	LS	1	$ 50,000.00	$ 50,000.00
SWPPP	LS	1	$ 10,000.00	$ 10,000.00
Surveying	LS	1	$ 12,000.00	$ 12,000.00
Materials Testing	LS	1	$ 20,000.00	$ 20,000.00
Mobilization	LS	1	$ 750,000.00	$ 750,000.00

Sub-Total Construction	$ 13,748,175.32
Contingency @ 30%	$ 4,124,452.60
Total Construction	**$ 17,872,627.91**
Engineering, Admin, & Legal Fees @ 18%	$ 3,217,073.02
TOTAL PROJECT COSTS	**$ 21,089,700.94**
Range (-10%)	$ 18,980,000
Range (+50%)	$ 31,635,000

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Alternative #4 Transmission Pipeline Costs

Description	Unit	Quantity		Unit Cost		Total Cost
Site 3 - Community Park Tank (2024)						
16-inch Transmission Pipe	LF	2,200	$	140.00	$	308,000.00
18-inch Transmission Pipe	LF	-	$	165.00	$	-
24-inch Transmission Pipe	LF	4,300	$	180.00	$	774,000.00
30-inch Transmission Pipe	LF	2,900	$	300.00	$	870,000.00
42-inch Transmission Pipe	LF	5,000	$	504.00	$	2,520,000.00
Sub-Total		14,400			$	4,472,000.00
Site 5 - Cascade Dr Tank (2017)						
12-inch Transmission Pipe	LF	5,300	$	125.00	$	662,500.00
18-inch Transmission Pipe	LF	2,700	$	165.00	$	445,500.00
30-inch Transmission Pipe	LF	1,600	$	300.00	$	480,000.00
42-inch Transmission Pipe	LF	3,800	$	504.00	$	1,915,200.00
48-inch Transmission Pipe	LF	2,700	$	576.00	$	1,555,200.00
54-inch Transmission Pipe	LF	2,700	$	648.00	$	1,749,600.00
60-inch Transmission Pipe	LF	13,500	$	720.00	$	9,720,000.00
Sub-Total		32,300			$	16,528,000.00
Site 7 - 800 North Vineyard Tank (2021)						
24-inch Transmission Pipe	LF	3,000	$	180.00	$	540,000.00
Sub-Total Construction					$	21,540,000.00
Contingency @ 25%					$	5,385,000.00
Total Construction					**$**	**26,925,000.00**
Engineering, Admin, & Legal Fees @ 18%					$	4,846,500.00
Total Alternative #4					**$**	**31,771,500.00**

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Alternative #4 Orem Only Transmission Pipeline Costs

Description	Unit	Quantity		Unit Cost		Total Cost
Site 3 - Community Park Tank (2024)						
16-inch Transmission Pipe	LF	2,200	$	140.00	$	308,000.00
18-inch Transmission Pipe	LF	-	$	165.00	$	-
24-inch Transmission Pipe	LF	4,300	$	180.00	$	774,000.00
30-inch Transmission Pipe	LF	2,900	$	300.00	$	870,000.00
42-inch Transmission Pipe	LF	5,000	$	504.00	$	2,520,000.00
Sub-Total		14,400			$	4,472,000.00
Site 5 - Cascade Dr Tank (2017)						
12-inch Transmission Pipe	LF	5,300	$	125.00	$	662,500.00
18-inch Transmission Pipe	LF	2,700	$	165.00	$	445,500.00
30-inch Transmission Pipe	LF	1,600	$	300.00	$	480,000.00
42-inch Transmission Pipe	LF	3,800	$	504.00	$	1,915,200.00
48-inch Transmission Pipe	LF	2,700	$	576.00	$	1,555,200.00
54-inch Transmission Pipe	LF	2,700	$	648.00	$	1,749,600.00
60-inch Transmission Pipe	LF	13,500	$	720.00	$	9,720,000.00
Sub-Total		32,300			$	16,528,000.00
Site 7 - 800 North Vineyard Tank (2021)						
24-inch Transmission Pipe	LF	-	$	180.00	$	-
Sub-Total Construction					$	21,000,000.00
Contingency @ 25%					$	5,250,000.00
Total Construction					**$**	**26,250,000.00**
Engineering, Admin, & Legal Fees @ 18%					$	4,725,000.00
Total Alternative #4					**$**	**30,975,000.00**

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Alternative #3 Vineyard Transmission Pipeline Costs

Description	Unit	Quantity		Unit Cost		Total Cost
Site 1 - Geneva Park Tank (2021)						
18-inch Transmission Pipe	LF	6,000	$	165.00	$	990,000.00
Site 3 - Community Park Tank (2017)						
16-inch Transmission Pipe	LF	-	$	140.00	$	-
18-inch Transmission Pipe	LF	-	$	165.00	$	-
24-inch Transmission Pipe	LF	-	$	180.00	$	-
30-inch Transmission Pipe	LF	-	$	300.00	$	-
42-inch Transmission Pipe	LF	-	$	504.00	$	-
Sub-Total		-			$	-
Site 5 - Cascade Dr Tank (2024)						
12-inch Transmission Pipe	LF	-	$	125.00	$	-
18-inch Transmission Pipe	LF	-	$	165.00	$	-
30-inch Transmission Pipe	LF	-	$	300.00	$	-
42-inch Transmission Pipe	LF	-	$	504.00	$	-
48-inch Transmission Pipe	LF	-	$	576.00	$	-
54-inch Transmission Pipe	LF	-	$	648.00	$	-
60-inch Transmission Pipe	LF	-	$	720.00	$	-
Sub-Total		-			$	-
Sub-Total Construction					$	990,000.00
Contingency @ 25%					$	247,500.00
Total Construction					**$**	**1,237,500.00**
Engineering, Admin, & Legal Fees @ 18%					$	222,750.00
Total Alternative #3					**$**	**1,460,250.00**

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Site 3 - 600 West 400 South Site (Orem Community Park)
6.5 MG Buried Concrete Tank
Orem Only Tank

Description	Unit	Quantity		Unit Cost		Total Cost
Temp Construction Fence Rental (12 month)	LF	1,810	$	6.30	$	11,403.00
Clear and Grub Site	AC	2.0	$	4,300.00	$	8,600.00
Strip and Stockpile Topsoil	CY	3,333	$	0.59	$	1,966.67
Dewatering	DAY	180	$	1,330.00	$	239,400.00
Excavation	CY	38,667	$	1.58	$	61,093.33
Hauling Off-Site	CY	24,167	$	7.40	$	178,833.33
Hauling On-Site	CY	24,167	$	2.38	$	57,516.67
Buried Concrete Tank Construction	GAL	6,500,000	$	0.50	$	3,250,000.00
Valve Vault Construction	LS	1	$	300,000.00	$	300,000.00
SCADA and Controls	LS	1	$	20,000.00	$	20,000.00
Backfill	CY	24,167	$	2.17	$	52,441.67
Compaction	CY	24,167	$	0.36	$	8,700.00
Topsoil	SY	10,000	$	6.30	$	63,000.00
Grass Hydro-Seeding	SF	87,120	$	0.06	$	5,009.40
Sprinkler System	SF	87,120	$	0.25	$	21,780.00
24-inch RCP Drain Pipe	LF	500		125	$	62,500.00
36-inch Outlet Pipe	LF	2,800		510	$	1,428,000.00
Asphalt Restoration	SY	3,667	$	29.36	$	107,653.33
Traffic Control	LS	1	$	50,000.00	$	50,000.00
SWPPP	LS	1	$	10,000.00	$	10,000.00
Surveying	LS	1	$	12,000.00	$	12,000.00
Materials Testing	LS	1	$	20,000.00	$	20,000.00
Mobilization	LS	1	$	400,000.00	$	400,000.00

Sub-Total Construction	$	6,369,897.40
Contingency @ 30%	$	1,910,969.22
Total Construction	**$**	**8,280,866.62**
Engineering, Admin, & Legal Fees @ 18%	$	1,490,555.99
TOTAL PROJECT COSTS	**$**	**9,771,422.61**
Range (-10%)	$	8,794,000
Range (+50%)	$	14,658,000

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Site 5 - Cascade Drive 15.9 MG Partially Buried Concrete Tank
(All on CUWCD Property)

Description	Unit	Quantity	Unit Cost	Total Cost
Temp Construction Fence Rental (12 month)	LF	2,500	$ 6.30	$ 15,750.00
Clear and Grub Site	AC	9.2	$ 4,300.00	$ 39,560.00
Strip and Stockpile Topsoil	CY	14,852	$ 0.59	$ 8,762.68
Dewatering	DAY	180	$ 1,093.00	$ 196,740.00
Excavation	CY	161,181	$ 1.58	$ 254,665.98
Hauling Off-Site	CY	151,107	$ 7.40	$ 1,118,193.19
Hauling On-Site	CY	50,369	$ 2.38	$ 119,878.37
Soil Nail Wall	SF	37,352	$ 40.00	$ 1,494,080.00
Buried Concrete Tank Construction	GAL	15,900,000	$ 0.50	$ 7,950,000.00
Valve Vault Construction	LS	1	$ 400,000.00	$ 400,000.00
Backfill	CY	50,369	$ 2.17	$ 109,300.87
Compaction	CY	50,369	$ 0.36	$ 18,132.86
Topsoil	SY	36,491	$ 6.30	$ 229,894.00
Native Grasses Hydro-Seeding	SF	328,420	$ 0.06	$ 20,362.04
Chain Link Fencing	LF	932	$ 28.50	$ 26,562.00
Restoration of Stockpile Area	SF	40,000	$ 1.25	$ 50,000.00
24-inch RCP Drain Pipe	LF	1,600	125	$ 200,000.00
60-inch Outlet Pipe	LF	800	720	$ 576,000.00
Trench Asphalt Pavement Restoration	SY	2,667	$ 29.36	$ 78,293.33
Traffic Control	LS	1	$ 50,000.00	$ 50,000.00
SWPPP	LS	1	$ 10,000.00	$ 10,000.00
Surveying	LS	1	$ 12,000.00	$ 12,000.00
Materials Testing	LS	1	$ 20,000.00	$ 20,000.00
Mobilization	LS	1	$ 750,000.00	$ 750,000.00

Sub-Total Construction	$ 13,748,175.32
Contingency @ 30%	$ 4,124,452.60
Total Construction	**$ 17,872,627.91**
Engineering, Admin, & Legal Fees @ 18%	$ 3,217,073.02
TOTAL PROJECT COSTS	**$ 21,089,700.94**
Range (-10%)	$ 18,980,000
Range (+50%)	$ 31,635,000

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Alternative #4 Vineyard Transmission Pipeline Costs

Description	Unit	Quantity		Unit Cost		Total Cost
Site 3 - Community Park Tank (2029)						
16-inch Transmission Pipe	LF	-	$	140.00	$	-
18-inch Transmission Pipe	LF	-	$	165.00	$	-
24-inch Transmission Pipe	LF	-	$	180.00	$	-
30-inch Transmission Pipe	LF	-	$	300.00	$	-
42-inch Transmission Pipe	LF	-	$	340.00	$	-
Sub-Total		-			$	-
Site 5 - Cascade Dr Tank (2017)						
12-inch Transmission Pipe	LF	-	$	125.00	$	-
18-inch Transmission Pipe	LF	-	$	165.00	$	-
30-inch Transmission Pipe	LF	-	$	300.00	$	-
42-inch Transmission Pipe	LF	-	$	504.00	$	-
48-inch Transmission Pipe	LF	-	$	576.00	$	-
54-inch Transmission Pipe	LF	-	$	648.00	$	-
60-inch Transmission Pipe	LF	-	$	720.00	$	-
Sub-Total		-			$	-
Site 7 - 800 North Vineyard Tank (2021)						
24-inch Transmission Pipe	LF	3,000	$	180.00	$	540,000.00
Sub-Total Construction					$	540,000.00
Contingency @ 25%					$	135,000.00
Total Construction					**$**	**675,000.00**
Engineering, Admin, & Legal Fees @ 18%					$	121,500.00
Total Alternative #4					**$**	**796,500.00**

APPENDIX C

Economic Analysis

Table 1 - Alternative 1 Economic Analysis

Presesnt Value of Capital and Pumping Energy Cost

Cost Escalation Rate = 3.00%

Discount Rate = 3.00%

	Tank Capital Cost		Transmission Capital Cost		Total Capital Cost		FV of Capital Cost[1]		PV of Capital Cost[1]		Annual Pumping Energy Cost[2]		FV of Energy Cost[1]		PV of Energy Cost[1]		FV Total Cost[1]		PV Total Cost[1]	
Year	Orem	Vineyard	Orem	Vineyard	Orem	Vineyard	Orem	Vineyard	Orem	Vineyard	Orem	Vineyard	Orem	Vineyard	Orem	Vineyard	Orem	Vineyard	Orem	Vineyard
2017	$23,939,701		$24,378,800	$573,480	$48,318,501	$573,480	$48,319,000	$573,000	$48,319,000	$573,000	$0	$0	$0	$0	$0	$0	$48,319,000	$573,000	$48,319,000	$573,000
2018					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2019					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2020					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2021		$4,495,512		$1,460,250	$0	$5,955,762	$0	$6,904,000	$0	$5,956,000	$0	$0	$0	$0	$0	$0	$0	$6,904,000	$0	$5,956,000
2022					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2023					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2024	$8,339,316	$6,799,750	$6,596,200	$1,038,105	$14,935,516	$7,837,855	$18,920,000	$9,929,000	$14,936,000	$7,838,000	$0	$0	$0	$0	$0	$0	$18,920,000	$9,929,000	$14,936,000	$7,838,000
2025					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2026					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2027					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2028					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2029					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2030					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2031					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2032					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2033					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2034					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2035					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2036					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2037					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2038					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2039					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2040					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2041					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2042					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2043					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2044					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2045					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2046					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2047					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2048					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2049					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2050					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2051					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2052					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2053					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2054					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2055					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2056					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2057					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2058					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2059					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2060					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2061					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2062					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2063					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2064					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2065					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2066					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
TOTAL	$32,279,017	$11,295,262	$30,975,000	$3,071,835	$63,254,017	$14,367,097	$67,239,000	$17,406,000	$63,255,000	$14,367,000	$0	$0	$0	$0	$0	$0	$67,239,000	$17,406,000	$63,255,000	$14,367,000

[1] Rounded to nearest $1000

[2] Energy cost assumed to be $0.10 per kW-hr

Table 2 - Alternative 2 Economic Analysis

Presesnt Value of Capital and Pumping Energy Cost

Cost Escalation Rate = 3.00%

Discount Rate = 3.00%

	Tank Capital Cost		Transmission Capital Cost		Total Capital Cost		FV of Capital Cost[1]		PV of Capital Cost[1]		Annual Pumping Energy Cost[2]		FV of Energy Cost[1]		PV of Energy Cost[1]		FV Total Cost[1]		PV Total Cost[1]	
Year	Orem	Vineyard	Orem	Vineyard	Orem	Vineyard	Orem	Vineyard	Orem	Vineyard	Orem	Vineyard	Orem	Vineyard	Orem	Vineyard	Orem	Vineyard	Orem	Vineyard
2017	$15,424,306		$2,855,600	$3,241,460	$18,279,906	$3,241,460	$18,280,000	$3,241,000	$18,280,000	$3,241,000	$72,150	$0	$72,000	$0	$72,000	$0	$18,352,000	$3,241,000	$18,352,000	$3,241,000
2018					$0	$0	$0	$0	$0	$0	$72,150	$0	$77,000	$0	$72,000	$0	$77,000	$0	$72,000	$0
2019					$0	$0	$0	$0	$0	$0	$72,150	$0	$79,000	$0	$72,000	$0	$79,000	$0	$72,000	$0
2020					$0	$0	$0	$0	$0	$0	$72,150	$0	$81,000	$0	$72,000	$0	$81,000	$0	$72,000	$0
2021	$6,667,220	$4,253,153	$219,038	$1,484,588	$6,886,258	$5,737,741	$7,983,000	$6,652,000	$6,886,000	$5,738,000	$96,861	$0	$112,000	$0	$97,000	$0	$8,095,000	$6,652,000	$6,983,000	$5,738,000
2022					$0	$0	$0	$0	$0	$0	$99,191	$0	$118,000	$0	$99,000	$0	$118,000	$0	$99,000	$0
2023					$0	$0	$0	$0	$0	$0	$100,425	$0	$124,000	$0	$100,000	$0	$124,000	$0	$100,000	$0
2024	$8,877,631	$6,721,635	$18,816,428	$5,039,190	$27,694,058	$11,760,825	$35,082,000	$14,898,000	$27,694,000	$11,761,000	$28,205	$0	$36,000	$0	$28,000	$0	$35,118,000	$14,898,000	$27,722,000	$11,761,000
2025					$0	$0	$0	$0	$0	$0	$30,535	$0	$40,000	$0	$31,000	$0	$40,000	$0	$31,000	$0
2026					$0	$0	$0	$0	$0	$0	$32,865	$0	$44,000	$0	$33,000	$0	$44,000	$0	$33,000	$0
2027					$0	$0	$0	$0	$0	$0	$35,195	$0	$49,000	$0	$35,000	$0	$49,000	$0	$35,000	$0
2028					$0	$0	$0	$0	$0	$0	$37,524	$0	$54,000	$0	$38,000	$0	$54,000	$0	$38,000	$0
2029					$0	$0	$0	$0	$0	$0	$39,854	$0	$59,000	$0	$40,000	$0	$59,000	$0	$40,000	$0
2030					$0	$0	$0	$0	$0	$0	$42,184	$0	$64,000	$0	$42,000	$0	$64,000	$0	$42,000	$0
2031					$0	$0	$0	$0	$0	$0	$44,514	$0	$69,000	$0	$45,000	$0	$69,000	$0	$45,000	$0
2032					$0	$0	$0	$0	$0	$0	$46,843	$0	$75,000	$0	$47,000	$0	$75,000	$0	$47,000	$0
2033					$0	$0	$0	$0	$0	$0	$49,173	$0	$81,000	$0	$49,000	$0	$81,000	$0	$49,000	$0
2034					$0	$0	$0	$0	$0	$0	$51,503	$0	$88,000	$0	$52,000	$0	$88,000	$0	$52,000	$0
2035					$0	$0	$0	$0	$0	$0	$53,833	$0	$94,000	$0	$54,000	$0	$94,000	$0	$54,000	$0
2036					$0	$0	$0	$0	$0	$0	$56,163	$0	$101,000	$0	$56,000	$0	$101,000	$0	$56,000	$0
2037					$0	$0	$0	$0	$0	$0	$58,492	$0	$109,000	$0	$58,000	$0	$109,000	$0	$58,000	$0
2038					$0	$0	$0	$0	$0	$0	$60,822	$0	$117,000	$0	$61,000	$0	$117,000	$0	$61,000	$0
2039					$0	$0	$0	$0	$0	$0	$63,152	$0	$125,000	$0	$63,000	$0	$125,000	$0	$63,000	$0
2040					$0	$0	$0	$0	$0	$0	$65,482	$0	$133,000	$0	$65,000	$0	$133,000	$0	$65,000	$0
2041					$0	$0	$0	$0	$0	$0	$67,229	$0	$141,000	$0	$67,000	$0	$141,000	$0	$67,000	$0
2042					$0	$0	$0	$0	$0	$0	$68,976	$0	$149,000	$0	$69,000	$0	$149,000	$0	$69,000	$0
2043					$0	$0	$0	$0	$0	$0	$70,723	$0	$157,000	$0	$71,000	$0	$157,000	$0	$71,000	$0
2044					$0	$0	$0	$0	$0	$0	$72,470	$0	$166,000	$0	$72,000	$0	$166,000	$0	$72,000	$0
2045					$0	$0	$0	$0	$0	$0	$74,218	$0	$175,000	$0	$74,000	$0	$175,000	$0	$74,000	$0
2046					$0	$0	$0	$0	$0	$0	$75,965	$0	$184,000	$0	$76,000	$0	$184,000	$0	$76,000	$0
2047					$0	$0	$0	$0	$0	$0	$77,712	$0	$194,000	$0	$78,000	$0	$194,000	$0	$78,000	$0
2048					$0	$0	$0	$0	$0	$0	$79,459	$0	$205,000	$0	$79,000	$0	$205,000	$0	$79,000	$0
2049					$0	$0	$0	$0	$0	$0	$81,206	$0	$215,000	$0	$81,000	$0	$215,000	$0	$81,000	$0
2050					$0	$0	$0	$0	$0	$0	$82,953	$0	$227,000	$0	$83,000	$0	$227,000	$0	$83,000	$0
2051					$0	$0	$0	$0	$0	$0	$84,701	$0	$238,000	$0	$85,000	$0	$238,000	$0	$85,000	$0
2052					$0	$0	$0	$0	$0	$0	$86,448	$0	$251,000	$0	$86,000	$0	$251,000	$0	$86,000	$0
2053					$0	$0	$0	$0	$0	$0	$88,195	$0	$263,000	$0	$88,000	$0	$263,000	$0	$88,000	$0
2054					$0	$0	$0	$0	$0	$0	$89,942	$0	$277,000	$0	$90,000	$0	$277,000	$0	$90,000	$0
2055					$0	$0	$0	$0	$0	$0	$91,689	$0	$290,000	$0	$92,000	$0	$290,000	$0	$92,000	$0
2056					$0	$0	$0	$0	$0	$0	$93,436	$0	$305,000	$0	$93,000	$0	$305,000	$0	$93,000	$0
2057					$0	$0	$0	$0	$0	$0	$95,184	$0	$320,000	$0	$95,000	$0	$320,000	$0	$95,000	$0
2058					$0	$0	$0	$0	$0	$0	$96,931	$0	$335,000	$0	$97,000	$0	$335,000	$0	$97,000	$0
2059					$0	$0	$0	$0	$0	$0	$98,678	$0	$352,000	$0	$99,000	$0	$352,000	$0	$99,000	$0
2060					$0	$0	$0	$0	$0	$0	$100,425	$0	$369,000	$0	$100,000	$0	$369,000	$0	$100,000	$0
2061					$0	$0	$0	$0	$0	$0	$100,425	$0	$380,000	$0	$100,000	$0	$380,000	$0	$100,000	$0
2062					$0	$0	$0	$0	$0	$0	$100,425	$0	$391,000	$0	$100,000	$0	$391,000	$0	$100,000	$0
2063					$0	$0	$0	$0	$0	$0	$100,425	$0	$403,000	$0	$100,000	$0	$403,000	$0	$100,000	$0
2064					$0	$0	$0	$0	$0	$0	$100,425	$0	$415,000	$0	$100,000	$0	$415,000	$0	$100,000	$0
2065					$0	$0	$0	$0	$0	$0	$100,425	$0	$427,000	$0	$100,000	$0	$427,000	$0	$100,000	$0
2066					$0	$0	$0	$0	$0	$0	$100,425	$0	$440,000	$0	$100,000	$0	$440,000	$0	$100,000	$0
TOTAL	$30,969,158	$10,974,788	$21,891,065	$9,765,238	$52,860,223	$20,740,025	$61,345,000	$24,791,000	$52,860,000	$20,740,000	$3,660,506	$0	$9,270,000	$0	$3,656,000	$0	$70,615,000	$24,791,000	$56,516,000	$20,740,000

[1] Rounded to nearest $1000

[2] Energy cost assumed to be $0.10 per kW-hr

Table 3 - Alternative 3 Economic Analysis

Presesnt Value of Capital and Pumping Energy Cost

Cost Escalation Rate = 3.00%

Discount Rate = 3.00%

	Tank Capital Cost		Transmission Capital Cost		Total Capital Cost		FV of Capital Cost[1]		PV of Capital Cost[1]		Annual Pumping Energy Cost[2]		FV of Energy Cost[1]		PV of Energy Cost[1]		FV Total Cost[1]		PV Total Cost[1]	
Year	Orem	Vineyard	Orem	Vineyard	Orem	Vineyard	Orem	Vineyard	Orem	Vineyard	Orem	Vineyard	Orem	Vineyard	Orem	Vineyard	Orem	Vineyard	Orem	Vineyard
2017	$10,481,586	$6,820,420	$6,596,200	$1,038,105	$17,077,786	$7,858,525	$17,078,000	$7,859,000	$17,078,000	$7,859,000	$87,160	$0	$87,000	$0	$87,000	$0	$17,165,000	$7,859,000	$17,165,000	$7,859,000
2018					$0	$0	$0	$0	$0	$0	$87,160	$0	$92,000	$0	$87,000	$0	$92,000	$0	$87,000	$0
2019					$0	$0	$0	$0	$0	$0	$87,160	$0	$95,000	$0	$87,000	$0	$95,000	$0	$87,000	$0
2020					$0	$0	$0	$0	$0	$0	$87,160	$0	$98,000	$0	$87,000	$0	$98,000	$0	$87,000	$0
2021		$4,495,512		$1,460,250	$0	$5,955,762	$0	$6,904,000	$0	$5,956,000	$87,160	$0	$101,000	$0	$87,000	$0	$101,000	$6,904,000	$87,000	$5,956,000
2022					$0	$0	$0	$0	$0	$0	$87,160	$0	$104,000	$0	$87,000	$0	$104,000	$0	$87,000	$0
2023					$0	$0	$0	$0	$0	$0	$87,160	$0	$107,000	$0	$87,000	$0	$107,000	$0	$87,000	$0
2024	$23,939,701		$24,378,800	$573,480	$48,318,501	$573,480	$61,208,000	$726,000	$48,319,000	$573,000	$0	$0	$0	$0	$0	$0	$61,208,000	$726,000	$48,319,000	$573,000
2025					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2026					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2027					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2028					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2029					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2030					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2031					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2032					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2033					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2034					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2035					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2036					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2037					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2038					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2039					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2040					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2041					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2042					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2043					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2044					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2045					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2046					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2047					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2048					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2049					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2050					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2051					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2052					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2053					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2054					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2055					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2056					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2057					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2058					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2059					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2060					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2061					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2062					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2063					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2064					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2065					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2066					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
TOTAL	$34,421,287	$11,315,932	$30,975,000	$3,071,835	$65,396,287	$14,387,767	$78,286,000	$15,489,000	$65,397,000	$14,388,000	$610,120	$0	$684,000	$0	$609,000	$0	$78,970,000	$15,489,000	$66,006,000	$14,388,000

[1] Rounded to nearest $1000

[2] Energy cost assumed to be $0.10 per kW-hr

Table 4 - Alternative 4 Economic Analysis

Presesnt Value of Capital and Pumping Energy Cost

Cost Escalation Rate = 3.00%

Discount Rate = 3.00%

	Tank Capital Cost		Transmission Capital Cost		Total Capital Cost		FV of Capital Cost[1]		PV of Capital Cost[1]		Annual Pumping Energy Cost[2]		FV of Energy Cost[1]		PV of Energy Cost[1]		FV Total Cost[1]		PV Total Cost[1]	
Year	Orem	Vineyard	Orem	Vineyard	Orem	Vineyard	Orem	Vineyard	Orem	Vineyard	Orem	Vineyard	Orem	Vineyard	Orem	Vineyard	Orem	Vineyard	Orem	Vineyard
2017	$23,939,701		$24,378,800		$48,318,501	$0	$48,319,000	$0	$48,319,000	$0	$0	$0	$0	$0	$0	$0	$48,319,000	$0	$48,319,000	$0
2018					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2019					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2020					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2021		$10,884,043		$796,500	$0	$11,680,543	$0	$13,541,000	$0	$11,681,000	$0	$0	$0	$0	$0	$0	$0	$13,541,000	$0	$11,681,000
2022					$0	$0	$0	$0	$0	$0	$0	$626	$0	$1,000	$0	$1,000	$0	$1,000	$0	$1,000
2023					$0	$0	$0	$0	$0	$0	$0	$1,251	$0	$2,000	$0	$1,000	$0	$2,000	$0	$1,000
2024	$9,771,423		$6,596,200		$16,367,623	$0	$20,734,000	$0	$16,368,000	$0	$0	$1,877	$0	$2,000	$0	$2,000	$20,734,000	$2,000	$16,368,000	$2,000
2025					$0	$0	$0	$0	$0	$0	$0	$2,503	$0	$3,000	$0	$3,000	$0	$3,000	$0	$3,000
2026					$0	$0	$0	$0	$0	$0	$0	$3,129	$0	$4,000	$0	$3,000	$0	$4,000	$0	$3,000
2027					$0	$0	$0	$0	$0	$0	$0	$3,754	$0	$5,000	$0	$4,000	$0	$5,000	$0	$4,000
2028					$0	$0	$0	$0	$0	$0	$0	$4,380	$0	$6,000	$0	$4,000	$0	$6,000	$0	$4,000
2029					$0	$0	$0	$0	$0	$0	$0	$5,006	$0	$7,000	$0	$5,000	$0	$7,000	$0	$5,000
2030					$0	$0	$0	$0	$0	$0	$0	$5,632	$0	$9,000	$0	$6,000	$0	$9,000	$0	$6,000
2031					$0	$0	$0	$0	$0	$0	$0	$6,257	$0	$10,000	$0	$6,000	$0	$10,000	$0	$6,000
2032					$0	$0	$0	$0	$0	$0	$0	$6,883	$0	$11,000	$0	$7,000	$0	$11,000	$0	$7,000
2033					$0	$0	$0	$0	$0	$0	$0	$7,509	$0	$12,000	$0	$8,000	$0	$12,000	$0	$8,000
2034					$0	$0	$0	$0	$0	$0	$0	$8,134	$0	$14,000	$0	$8,000	$0	$14,000	$0	$8,000
2035					$0	$0	$0	$0	$0	$0	$0	$8,760	$0	$15,000	$0	$9,000	$0	$15,000	$0	$9,000
2036					$0	$0	$0	$0	$0	$0	$0	$9,386	$0	$17,000	$0	$9,000	$0	$17,000	$0	$9,000
2037					$0	$0	$0	$0	$0	$0	$0	$10,012	$0	$19,000	$0	$10,000	$0	$19,000	$0	$10,000
2038					$0	$0	$0	$0	$0	$0	$0	$10,637	$0	$20,000	$0	$11,000	$0	$20,000	$0	$11,000
2039					$0	$0	$0	$0	$0	$0	$0	$11,263	$0	$22,000	$0	$11,000	$0	$22,000	$0	$11,000
2040					$0	$0	$0	$0	$0	$0	$0	$11,889	$0	$24,000	$0	$12,000	$0	$24,000	$0	$12,000
2041					$0	$0	$0	$0	$0	$0	$0	$11,889	$0	$25,000	$0	$12,000	$0	$25,000	$0	$12,000
2042					$0	$0	$0	$0	$0	$0	$0	$11,889	$0	$26,000	$0	$12,000	$0	$26,000	$0	$12,000
2043					$0	$0	$0	$0	$0	$0	$0	$11,889	$0	$26,000	$0	$12,000	$0	$26,000	$0	$12,000
2044					$0	$0	$0	$0	$0	$0	$0	$11,889	$0	$27,000	$0	$12,000	$0	$27,000	$0	$12,000
2045					$0	$0	$0	$0	$0	$0	$0	$11,889	$0	$28,000	$0	$12,000	$0	$28,000	$0	$12,000
2046					$0	$0	$0	$0	$0	$0	$0	$11,889	$0	$29,000	$0	$12,000	$0	$29,000	$0	$12,000
2047					$0	$0	$0	$0	$0	$0	$0	$11,889	$0	$30,000	$0	$12,000	$0	$30,000	$0	$12,000
2048					$0	$0	$0	$0	$0	$0	$0	$11,889	$0	$31,000	$0	$12,000	$0	$31,000	$0	$12,000
2049					$0	$0	$0	$0	$0	$0	$0	$11,889	$0	$32,000	$0	$12,000	$0	$32,000	$0	$12,000
2050					$0	$0	$0	$0	$0	$0	$0	$11,889	$0	$32,000	$0	$12,000	$0	$32,000	$0	$12,000
2051					$0	$0	$0	$0	$0	$0	$0	$11,889	$0	$33,000	$0	$12,000	$0	$33,000	$0	$12,000
2052					$0	$0	$0	$0	$0	$0	$0	$11,889	$0	$34,000	$0	$12,000	$0	$34,000	$0	$12,000
2053					$0	$0	$0	$0	$0	$0	$0	$11,889	$0	$35,000	$0	$12,000	$0	$35,000	$0	$12,000
2054					$0	$0	$0	$0	$0	$0	$0	$11,889	$0	$37,000	$0	$12,000	$0	$37,000	$0	$12,000
2055					$0	$0	$0	$0	$0	$0	$0	$11,889	$0	$38,000	$0	$12,000	$0	$38,000	$0	$12,000
2056					$0	$0	$0	$0	$0	$0	$0	$11,889	$0	$39,000	$0	$12,000	$0	$39,000	$0	$12,000
2057					$0	$0	$0	$0	$0	$0	$0	$11,889	$0	$40,000	$0	$12,000	$0	$40,000	$0	$12,000
2058					$0	$0	$0	$0	$0	$0	$0	$11,889	$0	$41,000	$0	$12,000	$0	$41,000	$0	$12,000
2059					$0	$0	$0	$0	$0	$0	$0	$11,889	$0	$42,000	$0	$12,000	$0	$42,000	$0	$12,000
2060					$0	$0	$0	$0	$0	$0	$0	$11,889	$0	$44,000	$0	$12,000	$0	$44,000	$0	$12,000
2061					$0	$0	$0	$0	$0	$0	$0	$11,889	$0	$45,000	$0	$12,000	$0	$45,000	$0	$12,000
2062					$0	$0	$0	$0	$0	$0	$0	$11,889	$0	$46,000	$0	$12,000	$0	$46,000	$0	$12,000
2063					$0	$0	$0	$0	$0	$0	$0	$11,889	$0	$48,000	$0	$12,000	$0	$48,000	$0	$12,000
2064					$0	$0	$0	$0	$0	$0	$0	$11,889	$0	$49,000	$0	$12,000	$0	$49,000	$0	$12,000
2065					$0	$0	$0	$0	$0	$0	$0	$11,889	$0	$51,000	$0	$12,000	$0	$51,000	$0	$12,000
2066					$0	$0	$0	$0	$0	$0	$0	$11,889	$0	$52,000	$0	$12,000	$0	$52,000	$0	$12,000
TOTAL	$33,711,124	$10,884,043	$30,975,000	$796,500	$64,686,124	$11,680,543	$69,053,000	$13,541,000	$64,687,000	$11,681,000	$0	$427,997	$0	$1,163,000	$0	$432,000	$69,053,000	$14,704,000	$64,687,000	$12,113,000

[1] Rounded to nearest $1000

[2] Energy cost assumed to be $0.10 per kW-hr