MORONI CITY CULINARY WATER SOURCE FEASIBILITY STUDY
2020

Moroni City
PO Box 870
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PREPARED BY:
Sunrise Engineering

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1.0 EXECUTIVE SUMMARY

Moroni City is found in Sanpete County, Utah. Moroni's culinary water system source are two wells, Well #2 and Well #3. Well #2 has a high level of nitrates. These nitrates are hazardous to young children and to older adults. Currently, Moroni City, blends the water from Well #2 with water from Well #3 to lower the concentration of nitrates in their culinary water system. This works well until Well #3 needs to be shut down for maintenance.

As such, Sunrise Engineering Inc. prepared this source feasibility study as an amendment to the existing Moroni City Water Master Plan prepared by Ensign Engineering. This source feasibility study compares the possibility of creating a new well source to treating Well #2. This study also looks at a projected future demand and compares the ability of a new well and treatment systems at meeting these future demands.

This study has also created a capital improvements plan that identifies areas in the City's culinary water system that could be improved.

2.0 INTRODUCTION

2.1 Background

Moroni is located in Sanpete County, Utah, about 22 miles south-east of Nephi along Highway 132. An area map is provided as Figure 2.1. The City's culinary water is provided by Moroni City Water System (MCWS). This study has been prepared for Moroni City as an amendment to the Moroni City Water Master Plan Report which was created in 2015 by Ensign Engineering. The amendment's purpose is to help the community effectively manage its existing culinary water system, to plan and prepare for future growth and improvements, and to provide recommendations on how to best solve the City's nitrate problem.

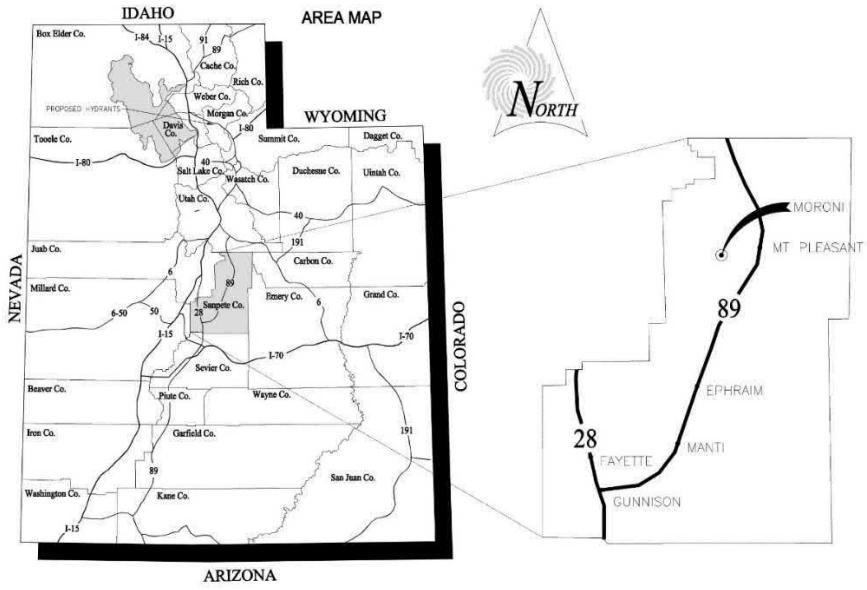

Figure 2.1. Area map of Moroni in Sanpete County, Utah.

Currently Moroni City has three wells: Well #1, Well #2, and Well #3. The water from Well #1 is high in nitrates, and is used for a secondary irrigation system within the City. Well #2 has a nitrate concentration that is higher than allowed by the *State of Utah Rules Governing Public Drinking Water Systems.* These high concentrations can be dangerous to those who drink this water, especially to young children and older adults. Well #3 has nitrate concentrations that are below the maximum contaminate levels. Well #2 has been mixed with Well #3 to provide safe drinking water and allow Well #2 to be used. There are times when maintenance is needed on Well #3. At these times, Moroni is left without a usable source of water because Well #2 cannot be used without blending with Well #3.

One of the primary objectives of this study was to evaluate possible alternatives to solve the nitrate problem that happens when Well #3 is taken out of service for maintenance. In order to best accomplish this objective, this study establishes a growth projection using a five-point analysis which includes evaluation of water right, source capacity, storage capacity, treatment, and distribution in accordance with the *State of Utah Rules Governing Public Drinking Water Systems (Rules)* throughout the next 20 years. Using this growth projection, will evaluate 2 main options to solve the nitrate problems currently experienced:

1. Add a new source of water that meets the MCL for nitrates.
2. Treat the water from Well #2 such that it can be used independently of Well #3.

The study will then compare the data from a hydrogeologic well siting study with the data from two different water treatment methods on how each alternative best meets current and future demand for economic safe drinking water.

Current data has been used where possible, as well as the data provided in the Moroni City Water Master Plan Report.

2.2 Authorization and Purpose of Study

Moroni City, recognizing the need to provide a safe and adequate source of culinary water for their community and to obey the law, Moroni retained Sunrise Engineering to assist them in the study and evaluation of their dilemma to provide an approved culinary water source. The purpose of this study is to address the following issues:

1. Perform a Hydrogeologic Study to determine and identify the feasibility of adding a new well source free of additional nitrates.
2. Perform a preliminary treatment study to determine and identify the cost to treat Well #2. In addition to the capital costs of this alternative, an evaluation of operational and maintenance costs will be performed.

3.0 FIVE POINT ANALYSIS

3.1 SYSTEM USER ANALYSIS

3.1.1 Length of Planning Period

A 20-year planning period was chosen to amend the current Water Master Plan, beginning in 2020 and ending in 2040. The City should review and update the planning projections in this study, every 5 to 10 years or as otherwise dictated by growth.

3.1.2 Growth Rate

A growth analysis was conducted by projecting the growth of the City for the next 20 years. The census estimates and current population are shown in Table 3.1.2.1. After evaluating the census data for the City an estimated growth rate of 2% was chosen to stay consistent with the current Water Master Plan.

Table 3.1.2.1. Moroni City Population is based on the census estimates from the Governor's Office of Budget and Management.

Moroni City Population Estimates		
Year	**Population**	**Average Annual Growth Rate**
2013	1,432	-
2015	1,510	5.45%
2016	1,530	1.32%
2017	1,451	-5.16%
2018	1,458	0.48%
2019	1,468	0.69%
Average Annual Growth Rate		0.56%

Although estimated growth rates may change, it is necessary to project a community's growth over the planning period to estimate the increased demands and loadings on a community's infrastructure. This allows for future required improvements and expansions to be done in a responsible and systematic manner.

Table 3.1.2.2 Moroni City Population Projection is based on a 2% growth rate as estimated in the current Water Master Plan.

Moroni City Population Projection		
Year	**Population**	**Projected Annual Increase**
2020	1,497	2.00%
2030	1,825	2.00%
2040	2,225	2.00%

It should be noted that the rate of growth is not as important as total growth. If the rate of growth changes, and the maximum number of connections is reached earlier or later than expected, then future improvements that are needed to support that growth will need to be conducted earlier or later than expected as well. With a faster growth system, revenue is collected quicker and debt service can be retired earlier, making the additional improvements possible. System fees are set at an amount to allow payment of system debt service under no growth conditions in case of slower growth rates.

3.1.3.1 Existing Culinary Water Connections and ERCs

Public water system's connections are typically categorized by type, for example, residential, commercial, industrial, and institutional. The number of each type of connection was obtained from the Utah Division of Water Rights website.

The system currently has 541 total culinary connections including 503 residential connections, 18 commercial connections, 7 industrial connections, and 13 institutional connections.

One Equivalent Residential Connection (ERC) is defined as the amount of culinary water required by an average residential connection. The Utah Division of Drinking Water (DDW) standards state that on average a residential connection is estimated to use 400 gallons per day for indoor use, or approximately 12,000 gallons per month. Since an ERC is the equivalent number of residential connections per commercial, industrial, and institutional connections, this number can be used to estimate the amount of source, storage, and water rights needed for a system using the DDW standards.

The amount of water used by each type of connection was used to find that type of connections' equivalent of residential connections. For example, there are 18 commercial connections that approximately used a combined total of 1,243,244 gallons of water in one year. On average a commercial connection would use 69,069 gallons per year which is 1.4 times larger than the amount of water used per residential connection. Each commercial connection is 1.4 of a residential connection times the 18 commercial connections, which gives a total of 25 ERCs for the commercial connections. This process gives Moroni City an ERC value of 644. The breakdown of connections can be seen in Table 3.1.3.1.

Table 3.1.3.1 Moroni City has a total ERC value of 644.

Current ERC's			
Category	**Connections**	**ERC/Connection**	**Total ERCs***
Residential	503	1.00	503
Commercial	18	1.40	25
Industrial	7	2.52	18
Institutional	13	7.53	98
		Total	**644**
*Rounded to the nearest ERC			

Moroni City has an existing secondary water system, so the culinary system is not used for outdoor irrigation. For purposes of this study, it is assumed that the only outdoor irrigation with the culinary water system is the six acres the City currently irrigates, and new connections through the next 20 years.

3.1.3.2 Projected Culinary Water Connections and ERCs

In 2040 the City's water system is projected to have 957 ERCs. This number of ERCs was calculated using the compound interest formula and the projected population growth rate, the existing number of culinary water ERCs, and the 20-year planning period for culinary water improvements.

The projected number of ERCs for the 20-year planning period was calculated using the compound interest formula as follows: $F = \text{Current Connections} \times (1+\text{rate})^{20\ \text{years}}$ where F is the projected number of future connections and the growth rate is 2.0% per year.

Total ERCs: $F = 644\ \text{ERCs} \times (1+0.02)^{20} = 957\ \text{ERCs}$

This projection breakdown is shown in Table 3.1.3.2.

Table 3.1.3.2 Moroni is projected to have 957 ERCs in 20 years.

20 Year Projected ERC's			
Category	**Connections**	**ERC/Connection**	**Total ERCs***
Residential	747	1.00	747
Commercial	27	1.40	37
Industrial	10	2.52	26
Institutional	19	7.53	146
		Total	**957**
*Rounded to the nearest ERC			

The recommendations for future expansions and improvements in the following section are based upon what is needed in the projected future. However, this could change based on how quickly the City grows. The total number of ERC's is more important than the number of years. If the City grows faster than 2% per year, then the recommendations will need to be implemented faster than expected.

3.2 SOURCE CAPACITY ANALYSIS

3.2.1 Existing Source Capacity

Moroni City currently has water rights for three wells and one unnamed spring. However, Well #1 is only used for secondary water because the quality of water is not good enough for it to be used in the culinary system. Well #2 has high levels of nitrates and can be harmful if not diluted with other water. Currently Moroni City blends water from Well #3 and Well #2 to lower the concentration of nitrates in the culinary water. This is regarded as a safe system and passes all State Regulations.

However, there have been times in the past where Well #3 cannot operate and therefore cannot dilute the nitrates from Well #2. As part of this study a treatment feasibility study was conducted and is explained in detail in Section 6.0.

Sunrise Engineering measured the flow at each well with a flow meter. According to these measurements, Well #3 can produce 377 gpm, and Well #2 produces 230 gpm. The Division of Drinking water uses what is known as the safe yield for a well as the available source for that well. The safe yield is the amount of groundwater that can be withdrawn from a groundwater basin over a period of time without exceeding the long-term recharge of the basin or unreasonably affect the basin's physical and chemical integrity. The safe yield for Well #2 is 270 gpm and Well #3 is 425 gpm. 3.2.2 Existing Required Source Capacity

Sunrise Engineering has used 377 gpm for Well #3 and 230 gpm for Well #2 as the source capacity for this report because this number has been recently measured and is more conservative. Using these values the total source available for Moroni City is 607 gpm.

A drinking water or indoor source capacity analysis is provided to verify that the culinary system has enough source capacity to comply with State Regulations. The State of Utah Public Drinking Water Standards, Section 5, requires public water supplies to have the water source capacity and the legal right to withdraw from their sources 800 gallons per day per connection for indoor use. Regulations also state that the sources must be capable of meeting irrigation demands required of the system at peak daily demands. The State recommends 3.38 gpm per irrigated acre as a peak outdoor watering demand.

Moroni City has a separate irrigation system that irrigates residential connections. However, City irrigates 6 acres with the culinary water system.

It has been determined that Moroni City needed 544.23 gpm of source to meet the above state requirements. These calculations are shown in Figure 3.2.2. The City has an exisitng source surplus of 63 gpm.

A. Existing Required Source Capacity:

Residential Use:

Indoor

503 ERCs x (800 gpd / ERC) x (1 day / 24 hr) x (1 hr / 60 min.) = 279.44 gpm

Outdoor (Assume 0% of ERCs)

- ERCs x (1 acre / 2 ERCs) x (3.39 gpm / irr. acre) = 0.00 gpm

Commercial Use:

Indoor

25 ERCs x (800 gpd / ERC) x (1 day / 24 hr) x (1 hr / 60 min.) = 13.89 gpm

Outdoor (Assume 0% of ERCs)

- ERCs x (1 acre / 2 ERCs) x (3.39 gpm / irr. acre) = 0.00 gpm

Industrial Use:

Indoor

18 ERCs x (800 gpd / ERC) x (1 day / 24 hr) x (1 hr / 60 min.) = 10.00 gpm

Outdoor (Assume 0% of ERCs)

- ERCs x (1 acre / 2 ERCs) x (3.39 gpm / irr. acre) = 0.00 gpm

Institutional Use:

Indoor

98 ERCs x (800 gpd / ERC) x (1 day / 24 hr) x (1 hr / 60 min) = 54.44 gpm

Outdoor (Assume 100% of ERCs)

98 ERCs x (1 acre / 2 ERCs) x (3.39 gpm / irr. acre) = 166.11 gpm

Parks and Cemetaries

6 irr. Acre (3.39 gpm / irr. Acre) = 20.34 gpm

Total Existing Required Source Capacity = 544.23 gpm

Total Available Source Capacity = 607 gpm

Estimated Existing Source Capacity Surplus = 63 gpm

Figure 3.2.2. According to Utah *Rules,* Moroni has a source surplus of 63 gpm.

3.2.3 Projected Required Source Capacity

A projected source analysis was conducted to ensure that any improvements that are made in the near future will be of benefit in 20 years. Using the same regulations as stated in Section 3.2.1 a required source capacity of 1,210 was found to be needed by the year 2040. This leaves Moroni City with a deficit of 603 gpm without losing any water to a treatment system. These calculations are shown in Figure 3.2.3.1. A timeline of projected source is compared to the current source capacity is shown in Figure 3.2.3.2.

B. Projected Required Source Capacity - 20 Yrs

Residential Use:

Indoor

747 ERCs x (800 gpd / ERC) x (1 day / 24 hr) x (1 hr / 60 min.) = 415.00 gpm

Outdoor (Assume 100% of New ERCs)

244 ERCs x (1 acre / 2 ERCs) x (3.39 gpm / irr. acre) = 413.58 gpm

Commercial Use:

Indoor

37 ERCs x (800 gpd / ERC) x (1 day / 24 hr) x (1 hr / 60 min.) = 20.56 gpm

Outdoor (Assume 0% of ERCs)

- ERCs x (1 acre / 2 ERCs) x (3.39 gpm / irr. acre) = 0.00 gpm

Industrial Use:

Indoor

26 ERCs x (800 gpd / ERC) x (1 day / 24 hr) x (1 hr / 60 min.) = 14.44 gpm

Outdoor (Assume 0% of ERCs)

- ERCs x (1 acre / 2 ERCs) x (3.39 gpm / irr. acre) = 0.00 gpm

Institutional Use:

Indoor

145 ERCs x (800 gpd / ERC) x (1 day / 24 hr) x (1 hr / 60 min) = 80.56 gpm

Outdoor (Assume 100% of ERCs)

145 ERCs x (1 acre / 2 ERCs) x (3.39 gpm / irr. acre) = 245.78 gpm

Parks and Cemeteries

6 irr. Acre (3.39 gpm / irr. Acre) = 20.34 gpm

Total Projected Required Source Capacity = 1,210.25 gpm

Total Available Source Capacity = 607 gpm

Estimated Projected Source Capacity Deficit = (603) gpm

Figure 3.2.3.1 According to Utah *Rules,* Moroni will have a deficit of 603 gpm.

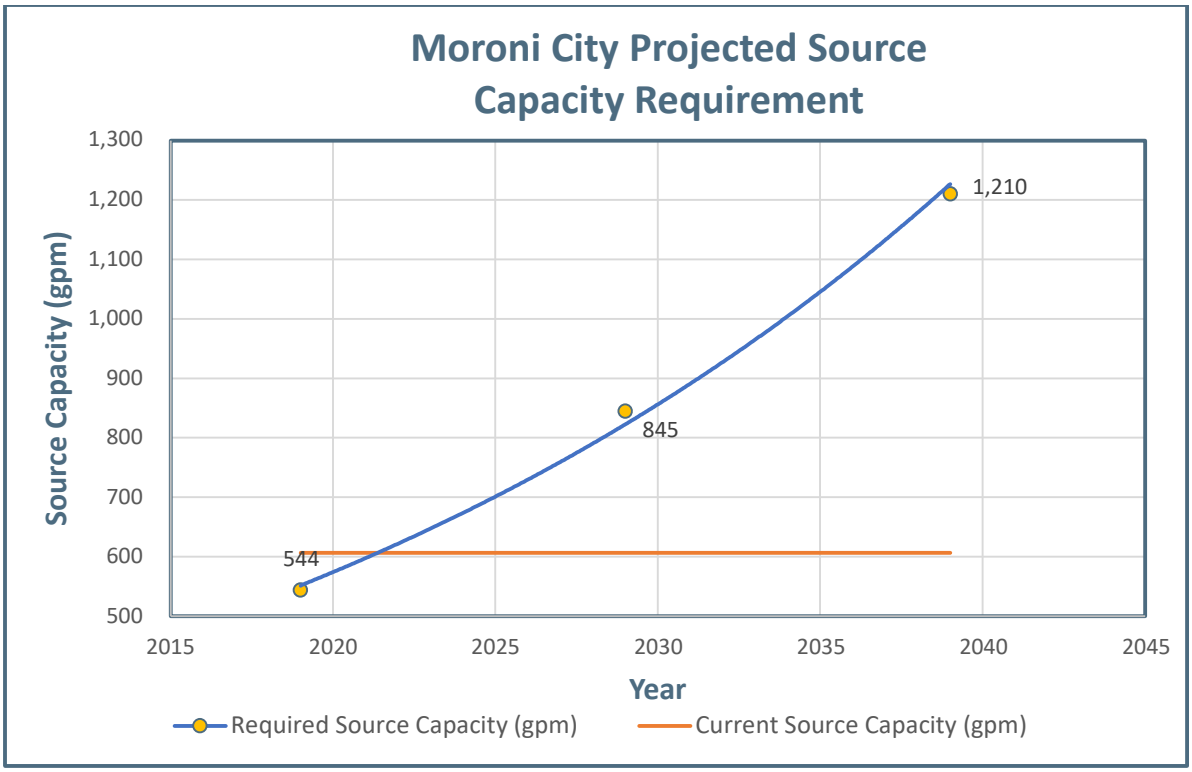

Figure 3.2.3.2. Moroni will need to acquire more source in the near future.

3.2.4 Hydrogeologic Study and Source Treatment Study

A Hydrogeologic Study was conducted to locate the best location for a new culinary well that would not have high levels of nitrates. A more in-depth analysis of this option can be found in Section 4.0. This section merely discusses the effects of the potential new wells to the Source capacity. Three possible locations were found to drill test wells.

A new well will help Moroni City to solve their nitrate problem if the new well has a low level of nitrate in the water. This water could be used to dilute the water from Well #2. If Well #3 or the new well need to be shut down for maintenance, then there will still be water to dilute Well #2's water. According to the Hydrogeologic Study that was conducted a new well could possibly produce up to 400 gpm of water which gives the City a deficit of 203 gpm in 2040. An additional source will be needed within the next 15 years if the City grows at 2% per year. If the City grows faster than more source will need to be added sooner. This could change based on community growth.

400 gpm is the source target for the projected well. However, there are wells that produce less than expected and it is possible that less than 400 gpm could be produced from a new well.

A source treatment study was conducted by comparing a reverse osmosis filter (RO) with an Ion Exchange Unit (IX) to remove excess nitrates. A more in-depth analysis of this study can be found in Section 6.0. This Section discusses the effects of the source treatment to the source capacity.

Reverse Osmosis involves passing the water through a membrane filter. The filter has very small pores that allow water but not nitrate, salts, and other material to pass through. As part of treatment with RO, a portion of the water pumped from Well #2 will be discarded with most of the nitrates from the

pumped water. This leaves less water that can be used by the City, but if Well #3 cannot operate then the water from Well #2 can be used alone safely. If a RO filter is used to treat the water from Well #2 then there will be 203 gpm available for the City from Well #2 when Well #3 is shut off.

Ion exchange (IX) involves letting the water pass over a resin which removes the nitrate from the water through a chemical reaction. This resin will need to be recharged every 33.5 hours by adding salt to the resin. This salt causes the IX to have a high TDS concentration when it discharges. This discharge would be stored in a tank and diluted with well water. The resultant water could be slowly discharged to the San Pitch River at a rate where the tank would be empty by the next regeneration. This allows Well #2 to pump water without blending to Well #3. If the IX is running Well #2 would lose 47 gpm of source to allow for discharging salt, so Well #2 would produce 183 gpm.

3.2.5 Recommended Source Capacity Improvements

Sunrise Engineering recommends drilling a new well in the immediate future. We also recommend that the City track growth and prepare for additional source capacity as growth progresses. At a 2% growth projection, another source will need to be added within the near future.

3.3 WATER RIGHTS

3.3.1 Existing Required Water Rights

Moroni City currently has four individual water rights. Three of the water rights are for underground water wells and one water right is for an unnamed spring. These water rights, their water right number, source type, total divertible water in cubic feet per second (cfs) and acre-feet per year (ac-ft/yr) are shown in Table 3.3.1.1.

Table 3.3.1.1. Moroni City has four water rights for a total of 1,503.4 ac-ft/yr.

Moroni Town Water Rights Summary					
	W.R. #	**Point of Diversion**	**Source Type**	**Total Divertible (cfs)**	**Total Divertible (ac-ft/yr)**
1	65-1704		Underground Water Wells	1	191.2
2	65-2252		Underground Water Wells	0.75	543.0
3	65-273		Underground Water Wells	1	724.0
4	65-3232		Unnamed Spring	0.063	45.3
			Total		1,503.4

According to the *Rules*, Utah has six climate zones (excluding non-arable lands), which correspond with consumptive use and annual precipitation. In the central mountains, outside watering requirements are quite low (Zone 1), compared with the southern part of the state where the climate is usually very warm

and dry (Zone 6). As a result, these zones have different outside watering requirements. Rule R309-510 provides minimum recommended requirements for outside consumptive use for each zone.

Moroni is in Zone 3 which requires 1.66 ac-ft per year per irrigated acre of water rights. The *Rules* state that a municipality must have 400 gallons of water right per connection per day. These requirements reflect the average annual demand on the system. Figure 3.3.1.2 shows the calculations that figure the amount of water rights currently needed by Moroni City.

B. Existing Required Water Right:

Residential Use:

Indoor

503 ERCs x (400 gal / ERC day) x (365 day / 1 year) x (1 ac-ft / 325,851 gal) = 225.37 ac-ft

Outdoor (Assume 100% of ERCs)

503 ERCs x (1 ir. Acre / 2 ERCs) x (1.66 ac-ft/yr / ir.-acre/yr) = 417.49 ac-ft

Commercial Use:

Indoor

25 ERCs x (400 gal / ERC day) x (365 day / 1 year) x (1 ac-ft / 325,851 gal) = 11.20 ac-ft

Outdoor (Assume 100% of ERCs)

25 ERCs x (1 ir. acre / 2 ERCs) x (1.66 ac-ft/yr / ir.-acre/yr) = 20.75 ac-ft

Industrial Use:

Indoor

18 ERCs x (400 gal / ERC day) x (365 day / 1 year) x (1 ac-ft / 325,851 gal) = 8.07 ac-ft

Outdoor (Assume 100% of ERCs)

18 ERCs x (1 ir. acre / 2 ERCs) x (1.66 ac-ft/yr / ir.-acre/yr) = 14.94 ac-ft

Institutional Use:

Indoor

98 ERCs x (400 gal / ERC day) x (365 day / 1 year) x (1 ac-ft / 325,851 gal) = 43.91 ac-ft

Outdoor (Assume 100% of ERCs)

98 ERCs x (1 ir. acre / 2 ERCs) x (1.66 ac-ft/yr / ir.-acre/yr) = 81.34 ac-ft

Parks and Cemeteries

6.00 ir. Acres x (1.66 ac-ft/yr / ir. Acre/yr) = 9.96 ac-ft

Total Existing Required Water Right = 833.03 ac-ft

Total Existing Water Right = 1,503 ac-ft

Estimated Existing Water Right Surplus = 670 ac-ft

Figure 3.3.1.2. Moroni City currently needs 833.03 ac-ft/year of water rights according to the Utah *Rules*.

Moroni City currently has 1,503.4 ac-ft per year of water rights. They need 833.03 ac-ft of water rights to be in compliance with the Utah *Rules*. This gives Moroni a surplus of 670 ac-ft of water rights per year.

3.3.2 Projected Required Water Rights

The calculations shown in Section 3.3.1 were repeated with the 20-year projected amount of ERC's. These calculations are shown in Figure 3.3.2.1. These calculations assume that each new residential connection irrigates their yards with culinary water.

C. Projected Required Water Right - 20 Yrs

Residential Use:

Indoor

747 ERCs x (400 gal / ERC day) x (365 day / 1 year) x (1 ac-ft / 325,851 gal) = 334.70 ac-ft

Outdoor (Assume 100% of New ERCs)

747 ERCs x (1 ir. Acre / 2 ERCs) x (1.66 ac-ft/yr / ir.-acre/yr) = 620.01 ac-ft

Commercial Use:

Indoor

37 ERCs x (400 gal / ERC day) x (365 day / 1 year) x (1 ac-ft / 325,851 gal) = 16.58 ac-ft

Outdoor (Assume 0% of ERCs)

0 ERCs x (1 ir. acre / 2 ERCs) x (1.66 ac-ft/yr / ir.-acre/yr) = 0.00 ac-ft

Industrial Use:

Indoor

26 ERCs x (400 gal / ERC day) x (365 day / 1 year) x (1 ac-ft / 325,851 gal) = 11.65 ac-ft

Outdoor (Assume 0% of ERCs)

0 ERCs x (1 ir. acre / 2 ERCs) x (1.66 ac-ft/yr / ir.-acre/yr) = 0.00 ac-ft

Institutional Use

Indoor

145 ERCs x (400 gal / ERC day) x (365 day / 1 year) x (1 ac-ft / 325,851 gal) = 64.97 ac-ft

Outdoor (Assume 100% of ERCs)

145 ERCs x (1 ir. acre / 2 ERCs) x (1.66 ac-ft/yr / ir.-acre/yr) = 120.35 ac-ft

Parks and Cemeteries

6.00 ir. Acres x (1.87 ac-ft/yr / ir. Acre/yr) = 11.22 ac-ft

Total Projected Required Water Right =	**1,179.47**	**ac-ft**
Total Existing Water Right =	**1,503**	**ac-ft**
Estimated Projected Water Right Surplus =	**324**	**ac-ft**

Figure 3.3.2.1. Moroni City will need 1,179.47 ac-ft per year of water rights by the year 2040.

In 2040, Moroni City will need 1,179.17 ac-ft/yr of water rights which gives Moroni 324 ac-ft per year of surplus water rights.

Utah has a “use it or lose it” statute regarding water rights. If a water right holder does not use their entire water right for seven years, then that holder loses that portion of their water rights. Qualified public water suppliers may have water rights that are extended 50 years. Their water rights are protected through these years if there is enough information to show that the water rights are needed to meet reasonable future requirements of the public water supplier for the next 40 years.

It is recommended that Moroni City conducts a 40-year water right plan. This plan is described in more detail in Section 7.

3.4 STORAGE CAPACITY ANALYSIS

3.4.1 Existing Required Storage Capacity

Water storage capacity requirements are divided into three categories: indoor, outdoor, and fire protection (fire flow). The *Rules* require a minimum storage capacity sufficient to meet a system’s average day demand plus fire flow. An average-day demand is about 400 gallons per day per connection for indoor use.

Moroni City’s residential connections use a separate secondary irrigation system for outdoor water use. So, it was assumed that residential water use is zero acres per connection. The City does use the culinary system to irrigate 6 acres. Utah is split into six different zones each with a different required amount of storage required to meet the needs of outdoor irrigation. These requirements help to identify the amount of water needed for outdoor use. Since Moroni City is in Consumptive Use Zone 3, the State requires 2,528 gallons per irrigated acre of storage.

Fire flow requirements state that a system must have the capacity to maintain fire flow during peak day use. Fire flow is either 1,500 gpm for two hours, or requirements from local fire authorities, whichever is stricter. In Moroni City, the local fire authority is the Sanpete Fire Marshall, whose requirements for fire flow are the same as the State at 1,500 gpm for two hours.

This information was used to calculate the required storage capacity as shown in Figure 3.4.1.

A. Existing Required Storage Capacity:

Residential Use:

Indoor

503 ERCs x 400 gal./ERC = 201,200 gal.

Outdoor (Assume 90% of ERCs)

- ERCs x 1 acre / 2 ERCs x 2528 gal/irr. acre = 0 gal.

Commercial Use:

Indoor

25 ERCs x 400 gal./ERC = 10,000 gal.

Outdoor (Assume 0% of ERCs)

0 ERCs x 1 acre / 2 ERCs x 2528 gal/irr. acre = 0 gal.

Industrial Use:

Indoor

18 ERCs x 400 gal. = 7,200 gal.

Outdoor (Assume 0% of ERCs)

- ERCs x 1 acre / 2 ERCs x 2528 gal/irr. acre = 0 gal.

Institutional Use:

Indoor

98 ERCs x 400 gal/ERC = 39,200 gal.

Outdoor (Assume 100% of ERCs)

98 ERCs x 1 acre / 2 ERCs x 2528 gal/irr. acre = 123,872 gal

Parks and Cemeteries

6 acres 2,848 gal/acre = 17,088 gal

Fire Protection:

1500 gal./min x 2 hr. x 60 min./hr = 180,000 gal.

Total Current Required Storage Capacity = 578,560 gal.

Total Existing Storage Capacity = 780,000 gal.

Estimated Existing Storage Capacity Surplus = 201,440 gal.

Figure 3.4.1 Moroni City has a surplus of 201,440 gallons for their storage according to the Utah *Rules.*

The current required storage for Moroni City is 578,560 gal. Moroni City currently has 780,000 gallons of storage giving them a surplus of 201,440 gallons.

3.4.2 Projected Required Storage Capacity

The required storage capacity was projected to the end of 10 years and the end of 20 years. The City's operator told Sunrise Engineering that the current secondary water system is nearly to its capacity. As such, this projection assumes that all new connections will use culinary water to irrigate. If the City upsizes the current secondary irrigation system, then additional storage will be needed much later than projected. Alternatively, if more residents move into Moroni then were projected, and the City does not have the secondary capacity to serve these residents then additional storage may need to be constructed earlier than projected.

In ten years, Moroni City will be required to have 844,261 gallons of storage. Unless a new tank is constructed, Moroni City will have 780,000 gallons of storage leaving the City with a deficit of 64,261 gallons.

The requirements stated in Section 3.4.1 and the 20-year projected ERCs were used to calculate the storage that will be required in 20 years. This calculation is shown in Figure 3.4.2.1.

B. Projected Required Storage Capacity - 20 Yrs

Residential Use:

Indoor

747 ERCs x 400 gal. / ERC = 298,800 gal.

Outdoor (Assume 100% of New ERCs)

244 ERCs x 1 acre / 2 ERCs x 2528 gal / irr. acre = 308,416 gal.

Commercial Use:

Indoor

37 ERCs x 400 gal. / ERC = 14,800 gal.

Outdoor (Assume 0% of ERCs)

0 ERCs x 1 acre / 2 ERCs x 2528 gal / irr. acre = 0 gal.

Industrial Use:

Indoor

26 ERCs x 400 gal. = 10,400 gal.

Outdoor (Assume 0% of ERCs)

- ERCs x 1 acre / 2 ERCs x 2528 gal / irr. acre = 0 gal.

Institutional Use:

Indoor

145 ERCs x 400 gal / ERC = 58,000 gal.

Outdoor (Assume 100% of ERCs)

145 ERCs x 1 acre / 2 ERCs x 2528 gal / irr. acre = 183,280 gal

Parks and Cemeteries

6 acres 2,848 gal / acre = 17,088 gal

Fire Protection:

1500 gal. / min x 2 hr. x 60 min. / hr = 180,000 gal.

Total Projected Required Storage Capacity =	**1,070,784**	**gal.**
Total Existing Storage Capacity =	**780,000**	**gal.**
Estimated Projected Storage Capacity Deficit =	**(290,784)**	**gal.**

Figure 3.4.2.1. In 20 years, Moroni will have a deficit of 290,784 gallons of storage.

In 20 years, Moroni City will be required to have 1,070,784 gal of storage. If a new tank is not constructed, then Moroni City will have 780,000 gallons of storage with a deficit of 290,784 gallons. Figure 3.4.2.2 shows a chart of the projected required storage compared to the current storage. According to this Moroni City will meet their capacity in eight years.

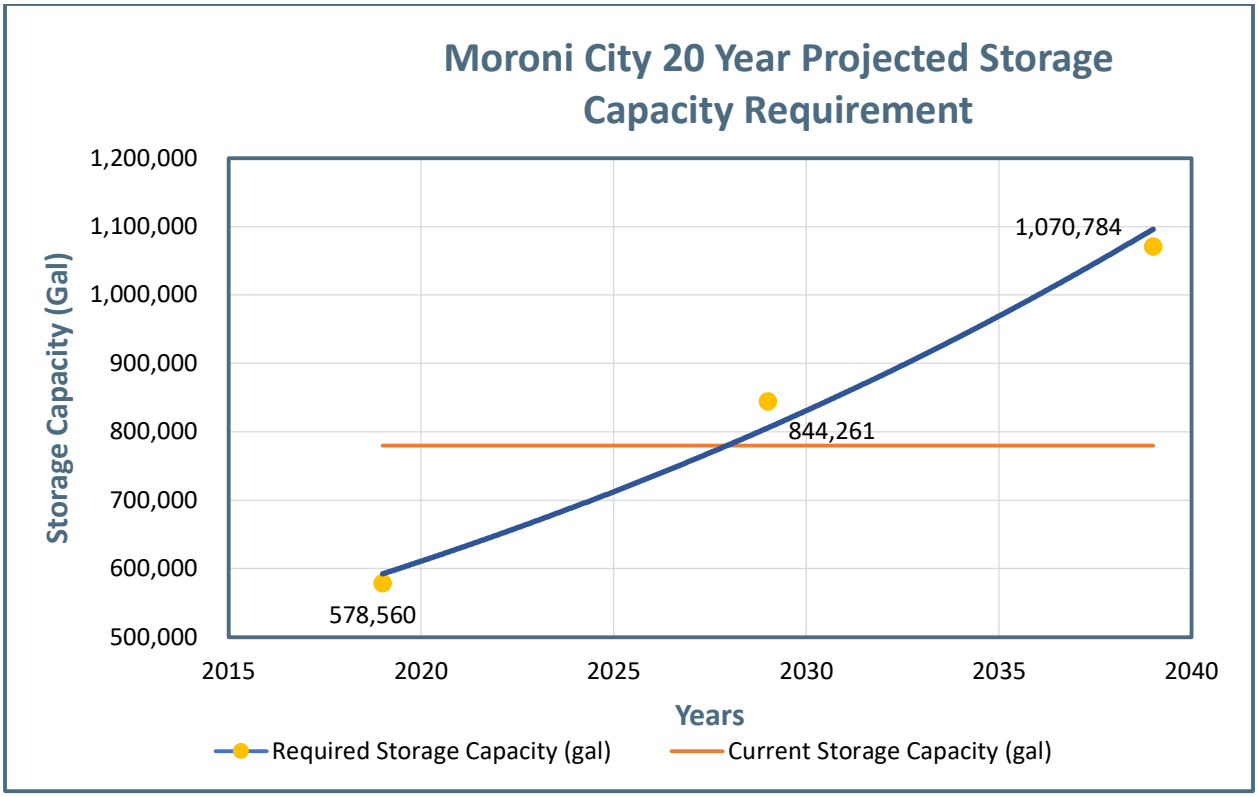

Figure 3.4.2.2. Moroni will be required to have more storage within the next ten years.

3.5 WATER TREATMENT REQUIREMENTS

Nitrate is required to be below 10 mg/L in culinary water. This can be accomplished by blending or by treatment. However, it is encouraged to treat to 5 mg/L so that there is a safety buffer of 5 mg/L if the treatment system was not working perfectly or if something else where to happen to the system. Blending the water is a way to make the water safe to drink but is not currently possible when Well #3 requires maintenance. Water treatment would allow the City to treat Well #2 and produce safe water without a new source and when Well #3 is shut down. Section 6.0 of this report discusses options to treat drinking water with high nitrates.

4.0 DISTRIBUTION SYSTEM ANALYSIS

Moroni City's distribution system was analyzed in accordance with the *State of Utah Rules Governing Public Drinking Water Systems (Rules).* This analysis was conducted based on a review of the existing system's physical attributes and the results of a computer-generated hydraulic model of the system.

4.1 Computer Model of the Distribution System

The existing Moroni City culinary distribution system was modeled using H_2O Net, a water system modeling program. The model was created using the existing system maps. The features from these maps that were put into the model are the tanks, the Pressure Relief Valves (PRV), pipeline size, and pipeline locations. In this model, various demands are spread throughout the system to represent scenarios such as average day conditions, peak instantaneous demand, and peak day demand under fire flow conditions. During the fire-flow analysis, the program calculates the maximum design fire flow that

can be obtained at each of the nodes on the system without causing the residual pressure to drop below 20 psi, which is the minimum allowable pressure according to the *Rules.*

The model output data for the existing system under the current average day conditions is shown in Exhibit E01.

This model was also used to predict the system demand based on the projected growth rate and was used to determine what impacts these future demands may have on the system. The model was used to show the demands from the 20-year projection. As noted previously the Water Study should be updated regularly along with the hydraulic model. If larger growth occurs than was predicted, then this study and model should be updated earlier to help the City comply with the *Rules.*

4.2 System Analysis

4.2.1 Minimum Pressures and Demands

The *Rules* require that distribution systems equipped with fire hydrants be designed so that a minimum of 20 psi exists at all points within the system when fire flows are imposed on the system in addition to peak-day demand flows. For systems constructed after January 2007, the minimum dynamic pressure at peak-day demand is 40 psi and the minimum dynamic pressure at peak-instantaneous demand is 30 psi. The Utah Division of Drinking Water encourages existing systems to meet the new rule requirements whenever possible. It is typically recommended that distribution system pressures are maintained between 40 and 90 psi during normal system operations.

Average-Day Demand

According to the *Rules,* the required storage capacity of a system should represent the quantity of water required by the system during an average day. The average-day demand used in the hydraulic model is calculated by dividing the current required storage capacity (minus the required fire storage) across a 24-hour (1440-minute) period. The resulting average-day demand used in the hydraulic model for the existing system is 277 gpm. The projected average-day demand used in the hydraulic model is 619 gpm.

Peak-Day Demand

Moroni City has fire hydrants as a part of the distribution system, and as such the peak-day demand with an imposed fire flow is used in the computer model. According to the *Rules,* the peak-day demand is the anticipated water demand on the day of highest water consumption. This is also the same value used to estimate the required source capacity for the system. The existing required source capacity for the system was calculated to be 544 gpm. The 20-year projected peak-day demand of 1,210 gpm was used for analyzing the system under future peak-day demand conditions.

Peak-Instantaneous Demand

The peak-instantaneous demand represents the point of maximum usage on the system and typically occurs during the hottest part of the year when indoor and outdoor usages are the highest. The peak-instantaneous demand was estimated by applying a peaking factor of two to the peak-day demand. The current system peak-instantaneous demand used in the model is 1,088 gpm, and the 20-year projected peak-instantaneous demand is 2,421 gpm.

4.2.2 System Pressures

Current Pressures

Moroni City's existing water system consists of two pressure zones. The upper pressure zone is fed by the upper tank. The lower pressure zone is fed by the lower tank and is fed by water that passes through the three pressure relief valves (PRV). The current peak instantaneous pressures in the water system range from 50 psi to 86 psi. The current system can maintain adequate pressures under existing peak-instantaneous demands.

Existing average day pressures in the system are shown in Exhibit E01. Dynamic pressures under current peak instantaneous demand are shown in Exhibit E02.

Projected Future Pressures

The projected use was also modeled to find pressures and fire flows that can be anticipated as the system begins to grow. The system has projected pressures that range between 38 psi to 83 psi for the peak instantaneous demand. The system will be able to maintain adequate pressures under projected peak-instantaneous demands.

The future average day pressures are shown in Exhibit E04, and the dynamic pressures under current peak instantaneous demand are shown in Exhibit E05.

4.2.3 Hydrants & Fire Flow

The *Rules* require that all fire hydrants be supplied by a pipeline 8-inches in diameter or larger unless it can be demonstrated, through the use of computer modeling, that a smaller main line will meet the minimum fire flow requirements with any parts of the model dropping below 20 psi. As discussed previously the target fire flow for Moroni City is 1,500 gpm.

The existing system has the capacity to provide the recommended 1,500 gpm fire flow to nearly all the areas in the system. These flows are shown in Exhibit E03. There are two nodes in the model that have less than 200 gpm, but these nodes are only supply nodes and do not have a fire hydrant. Therefore, these lines do not need to meet the 1,500 gpm recommendation from the *Rules.* There are two nodes between 1,000 gpm and 1,500 gpm, five nodes between 1,500 gpm and 2,000 gpm, and the rest of the nodes are higher than 2,000 gpm. Moroni City has excellent existing fire flows.

4.2.4 Pipes & Loops

Moroni City's distribution system mainly contains 6 & 8 inch pipes, with one line leading to the middle school that is 12 inch. There are also three supply lines that are 2 inch. These lines lead to the elementary school, homes on the 200 W from 200 S to 100 S, and the line to the Bishops Storehouse. The lines that feed both pressures zones from the tanks are 10 & 12 inch. The City is generally well looped.

4.3 Recommended Distribution System Improvements

The majority of the distribution system is 40-years old. This is a long time for certain types of pipe to be installed. If the pipe is ductile iron or PVC, then this pipe could last a lot longer than 40 years. However, cast iron pipe generally needs to be replaced by 40 years. It is understood that most of the cast iron pipes were replaced during the 1999 water project.

There are no indications or history that show that the current distribution system has problems. There are no pipelines that need to be replaced currently. However, the operator should watch these 40-yr old areas in case a problem should arise. If a problem arises then it should be taken care of as soon as possible to mitigate a larger problem.

5.0 HYDROGEOLOGIC STUDY

5.1 Overview

This portion of the Source Feasibility Study summarizes the Hydrogeologic Study that was conducted by Sunrise Engineering in May 2020. The entire Hydrogeologic Study can be found in the appendices of this report. The Hydrogeologic Study investigated the feasibility of constructing a new well that would have nitrate levels low enough to pass State and Federal Regulations, and to produce enough water to meet current and projected future demand.

5.2 Discoveries

Moroni sits in Northern Sanpete Valley. The valley branches into a northeast branch and a northwest branch just north of Moroni similar to a "Y" as shown in Figure 5.2.1. The aquifers in this region flow down these two branches and merge underneath Moroni near the location of Wells #1 and #2. The confluence of the aquifers causes a stagnant groundwater zone near those wells.

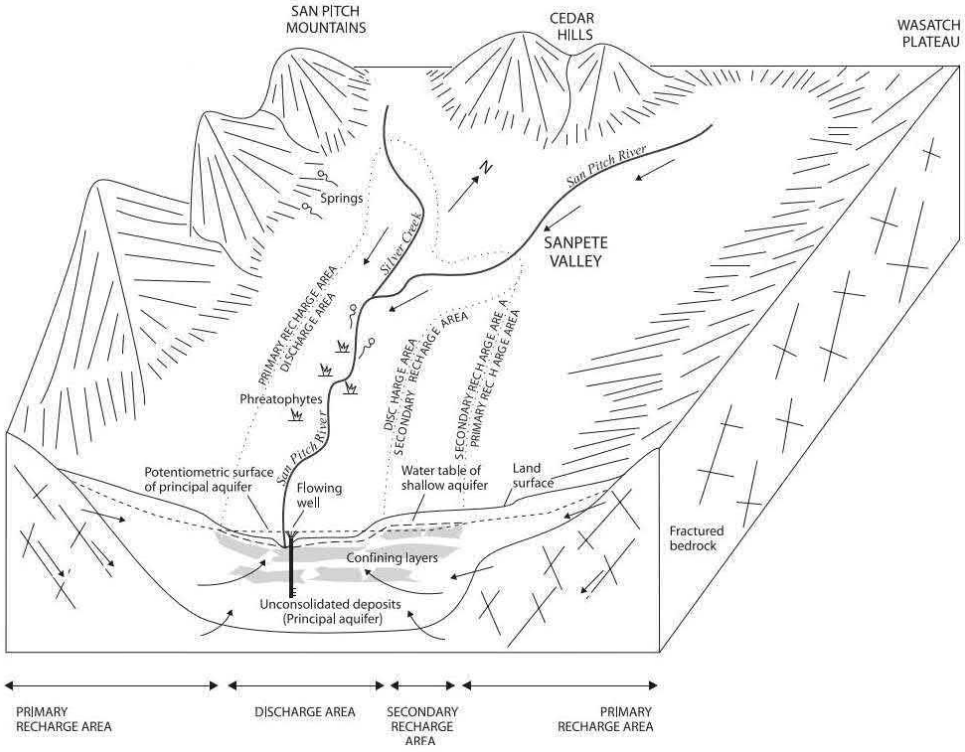

Figure 5.2.1 Schematic block diagram showing recharge areas and direction of groundwater flow in Sanpete Valley, Sanpete County, Utah (from Snyder and Lowe, 1998).

The water from Wells #1 and #2 have levels of nitrate above the maximum contaminant level (MCL) of 10 mg/L. Nitrate mainly caused by dissolved nitrogen in ground water and is considered a non-adsorbed

solute. This means that the nitrate moves with the groundwater with no transformation and little or no retardation. The nitrate is very mobile in groundwater because of this (Freeze and Cherry, 1979). Nitrate occurs naturally in groundwater from nitrate sources on the land surface, in the soil zone, in shallow subsoil zones, or from contact with rock formation such as pitchblende.

The nitrate levels in Wells #1 and #2 indicate that nitrate sources exist near the wells. The stagnant groundwater zone from the "Y" in the aquifer system cause the nitrate to stay near Wells #1 and #2. This causes the water near Wells #1 and #2 to have a higher concentration of nitrates then other areas in the valley. These nitrate levels in the surrounding study areas are shown in Table 5.2.1.

Table 5.2.1. Available Nitrate Concentrations at Wells within the Study Area

Well	Recent Sampling Date	Nitrate Concentration (mg/L)
City Well #1	3/8/1999	11.27
City Well #2	12/17/2019	10.12
City Well #3	12/17/2019	1.24
Turkey Plant Well #1	9/25/2019	2.55
Turkey Plant Well #2	9/25/2019	2.61
Turkey Plant Well #3	9/25/2019	0.80

Note: Red values indicate the concentrations are above the MCL for nitrate (10 mg/L)

5.3 Recommendations

Based on the hydrogeologic data from existing wells in the area three sites have been recommended as test well sites. Test Well A is located on the northwestern corner of a City property. If the well receives water from a protected aquifer, the City can protect the well without the need to acquire land from adjacent property owners. If the City can acquire the adjacent land, then it would be better to place this test well further northwest, near the 100-yr floodplain of Silver Creek, as shown in Appendix B Fig. 4.

Test Well B is located southwest of Test Well A near two roads. This well site may have higher production potential if the land is available to the City.

Test Well C is west of the 100-year floodplain of Silver Creek.

The recommended procedures for developing a new well site can be found in Appendix B Hydrogeologic Study and as follows:

1. Drill a test well at one of the three recommended locations to a depth of approximately 400 feet below grade. Install an 8-inch diameter steel casing. Perforate the casing at water-bearing strata as determined during drilling.
2. Develop the well.
3. Perform a step-drawdown pumping test following well development.
4. Perform a constant-rate pumping test. The constant-rate will be determined from the step-drawdown test.
5. At the end of the pumping test, collect a water sample for laboratory testing of nitrate. If the production of the test well meets the desired quantity, the sample should be analyzed for all chemical compounds as required by the Utah Division of Drinking Water (DDW).

6. Convert the test well to a 12-inch diameter production well if the water quality meets the drinking water standards as set forth by DDW, and after a preliminary evaluation report (PER) and well construction specifications are approved by DDW, and appropriate water rights are transferred.

The price for a new well consists of the cost of drilling the well, the cost of the well pump house, and connecting the well to the existing pipe system. Test Well A would be the least expensive option because the City will not need to purchase any additional property or easements. Test Well A would cost about $1,254,700 to construct. A well typically costs $29,980 a year to operate.

The water from Test Well A could be pumped to the same pipeline that carries water from Well #3 to the storage tanks. The pipe that leads to the storage tank will be above the recommended capacity for an 8" PVC pipe if Well #3, Well #2, and Test Well A are all pumped at the same time.

5.4 General Notes

It is important to realize that the services provided in this section include professional opinions and judgements based on the data collected and analyzed. These services were performed in accordance with current and generally accepted water resource engineering principles and practices. These services are not a guarantee because of incomplete knowledge of geologic history, subsurface conditions, and hydraulic characteristics present. The estimated aquifer parameters were based on geologic information from geologic maps, reports, and have not been verified by subsurface field investigations. This section may be subject to change as additional information becomes available.

6.0 SOURCE TREATMENT STUDY

6.1 INTRODUCTION

Moroni City currently has high nitrates in Well #2, that can cause health problems for young children and babies. The City is blending this water with the water from Well #3 to create a safe drinking water source. However, when Well #3 undergoes maintenance and needs to be closed the City cannot use the water from Well #2 alone. For the City to fix this problem they must either find a low nitrate source, as described in Section 4, or they must treat the water from Well #2.

Two treatment alternatives were researched for this study:

1. Reverse Osmosis
2. Ion Exchange

6.2 REVERSE OSMOSIS

A reverse osmosis system (RO) would consist of running a portion of the raw well water through a series of membranes with microscopic pores that allow water but not contaminants to pass through. Pumps are required to generate enough pressure for the water to pass through the membranes, and a facility must be created to store the pumps and membranes that make up the entire RO system.

The permeate, clean water that passes through the filter, will then be blended with the portion of water that did not pass through the filter. Blending the permeate with raw well water allows the water to have safe nitrate levels while optimizing the amount of water available to use.

The contaminants remain in a small portion of the water and are discharged. This discharge, known as a concentrate, has a high concentration of nitrates, total dissolved solids, and other contaminants. This concentrate must be discharged somewhere. Typically, this is discharged back into waters of the State.

However, to be discharged into waters of the State the concentrate must have contaminant levels lower than the allowed levels for receiving water body. Moroni City would either discharge directly into the San Pitch River. The TDS level for concentrate discharged into the San Pitch River is 1,200 mg/L. The concentrate from the projected RO would have a TDS level of 2,567 mg/L. This concentrate would also need to be diluted with raw well water to meet the required level. Well #2 would be able to produce 203 gpm when Well #3 is shut down.

Sunrise Engineering received advice from WesTech on the type of RO system to use and to acquire a rough price for the RO system. This technical proposal can be found in Appendix C. The following paragraphs provide a summary of this technical proposal.

A RO system would cost around $327,000. This price includes all the materials to build the RO system, the clean-in-place system, and 15 days of on-site technical assistance from WesTech to insure proper installation. A RO system would also need a building to house the RO, piping from the well, piping back to the system, and piping for the concentrate to discharge to the river. The total cost for the RO system would be $2,570,800 with an annual operating and maintenance cost of $63,655. This does not consider the cost to pump water from the well as this cost will be included in all three alternatives.

6.3 ION EXCHANGE

An ion exchange water treatment plant involves passing the water through ion exchange resin where unwanted ions, such as nitrates, are removed. The resin will eventually reach its capacity to hold the unwanted ions and must be regenerated with salt. There are many different types of resins that can be used. Purolite recommends a resin called, A520E, for Moroni City's system.

The WesTech system would use the same resin that Purolite recommends. The ion exchange system would lower the 10.1 mg/L of Nitrate to 3 mg/L. This would be blended with untreated water to create a safe nitrate level of 4.9 mg/L.

An ion exchange system would consist of three vessels. Two would run while the extra vessel would regenerate. The regeneration would need to occur every 33.5 hours. Each regeneration would take 600 lbs. of regenerate. As the vessel regenerates it will produce a heavily concentrated brine that would need to be discharged. This discharge would be stored in a tank and diluted with well water. The resultant water could be slowly discharged to the San Pitch River at a rate where the tank would be empty by the next regeneration. This would lower the amount of source available for the City to use by 47 gpm. The amount of source from Well #2 available for the City to use, while Well #3 is shut off, would be 183 gpm.

The total cost to implement an ion exchange system will be around $2,341,100. This total cost is broken down in Appendix A. The ion exchange would cost $45,647 a year to operate and maintain. This does not consider the cost to pump water from the well as this cost will be included in all three alternatives.

However, the resin manufacturer recommends not using the ion exchange system in Moroni due to the hardness of the Moroni well water. If the hardness in the water is above 120 parts per million (ppm) it will affect the regeneration process by causing the hardness to precipitate in the ion exchange vessels. This plugs up the resin beads and causes the ion exchange to be less efficient and eventually will need to be clean out or replaced. Moroni Cities water hardness is 296 ppm. To lower this hardness below the

120 ppm threshold a water softening system could be added to the system. This would add additional costs to the ion exchange system.

6.4 SUMMARY

In summary, both a reverse osmosis system and an ion exchange system would be able to lower the nitrate levels in Well #2 for the well to be used safely on its own. The reverse osmosis option would cost less and would also remove dissolved solids in addition to the nitrates. Reverse osmosis will not have to be regenerated and the City will not need to purchase additional salt to keep the reverse osmosis running. Reverse osmosis and ion exchange both lose source water during treatment with reverse osmosis losing more water due to the constant waste stream. Ion exchange is not possible without water softening because of the hardness of the water.

Both treatment options would only need to run when Well #3 is shut down.

7.0 CAPITAL IMPROVEMENTS PLAN

7.1 New Well and Pump Line

Section 5.0 and Section 6.0 compared possibilities to resolve the nitrate problem in Moroni City's culinary water system. In these sections it was found that a new well could be drilled in three different locations which may have low nitrate water. Drilling a new well was found to be cheaper than constructing a nitrate treatment system. And a new well would add additional source for Moroni City.

Moroni City currently has 607 gpm of source capacity. Moroni currently has a surplus of 63 gpm of source. Based on the 2% growth projection, within 20 years Moroni City will need to provide an additional 603 gpm of source to their system. For these reasons Sunrise Engineering recommends drilling a test well at test well site A, if this test well has water quality tests that pass the Division of Drinking Water's standards then this site should be converted to a producing culinary well. It is not expected that this one new well will pump the 603 gpm required for the 20-year projections. Moroni City should plan to identify and drill and additional well in 10-15 years depending on the actual growth of the City.

The current well line is an old cast iron pipe, and all the wells rely on this pipe to convey water to the tanks. As part of this well project a new pump line should be constructed to deliver the source water to the storage tanks. It is recommended that all three wells be connected to this new pump line. Rather then abandon the old pump line, this pump line could stay in service through the remainder of its life. Each well could pump through both pump lines. This would provide redundancy. If one line needs to be repaired or maintained, the City could still supply water to the storage tanks. The additional pump line would also help to conserve energy. When it is necessary to pump multiple wells concurrently, separating the flow into the two pipes will help reduce headloss, and ultimately conserve energy and money.

7.2 New Storage Tank

Currently Moroni City has two tanks with a total storage capacity of 780,000 gallons. The current storage required by the *Rules* is 578,560 gallons. This gives Moroni City a current surplus of 201,440 gallons. However, Moroni City is projected to meet that capacity within eight years. The City will need an additional 290,784 gallons within the next 20 years. Therefore, Sunrise Engineering recommends building a new 500,000-gallon tank to handle the projected 20-year storage requirements.

The new tank's overflow could also be utilized, and not wasted. This could be accomplished by piping the overflow to the irrigation storage ponds. These improvements can be seen in Exhibit E07 and Exhibit E08.

7.3 Overflow Improvements

The current tank used to overflow into a nearby ditch which would flow onto private property and near homes. This ditch has overflowed in the past and has caused property damage to several homes. A citizen of the City has come through and filled in the ditch. The tank now just overflows onto the ground, causing a large flooding risk to the homes downhill from the tank. In order to fix this problem, a new overflow pipe could be constructed to carry the overflow from the tank to a safe location. This would also reduce the risk of the public tampering with the overflow and causing damage that was experienced in the past.

One possible safe location is the City's existing irrigation storage pond located east of the lower tank. This pond is also at an elevation that the overflow line could gravity flow to the pond. This would allow the tank to overflow to a safe location while conserving water in an arid area. This would also reduce the demand on the culinary system. It is assumed that during peak irrigation season, if the pond storage were to run low, the culinary system would take on additional demand due to supplementing the secondary irrigation system through the use of culinary water for outdoor use.

The tank overflow line could also be used as an option of supplying water to the irrigation pond. When the culinary system isn't using well #2, the higher nitrate water could be used to supplement the irrigation system. This could be accomplished by using the new tank overflow line. One of the well pump lines could supply water to a junction box connected to the overflow line, then it could gravity flow to the pond. By helping keep the irrigation ponds operating.

If the overflow water is not wasted, then more people would be able to irrigate with the irrigation system. Fewer people would need to use the culinary system to meet their irrigation needs.

An airgap would be constructed to preserve the integrity of the culinary water system. The airgap would be placed between the tank and an overflow junction box. This junction box would be placed at an elevation high enough to allow the water to gravity flow through a new pipeline to the irrigation ponds. Allowing the tank to overflow safely, while also conserving water, and reducing the pressure on the culinary water system.

A full irrigation system study is also recommended to review the capacity of the current irrigation system. This study would be able to see the irrigation systems source and storage needs and be able to see the area that the current system would be able to serve as Moroni City continues to grow.

7.4 Isolation Zones

Moroni City has difficulty isolating areas within their system. The common practice is to isolate each block individually. At this time, the City does not believe that they can afford to replace all of the valves necessary to get to this point. In order to isolate at least portions of the City, Sunrise Engineering has consulted with the Moroni City's water system operator and has divided the City into nine isolation zones. These zones will enable the operator to shut down a portion of the system to do repairs rather than the current practice of shutting down the entire system. While only having nine zones is not ideal,

this will be a significant improvement from the alternative of shutting off the whole pressure zone to make repairs on the system.

There are 21 existing valves and 3 new valves that split the City into these 9 isolation zones. After consulting with the system operator, it was determined that around half of the existing valves do not work and will need to be replaced. It was assumed that 75% could need to be replaced and this cost was used to be more conservative with the estimate. In addition to those valves the existing Pressure Relief Valves need to be replaced. They no longer work properly and cannot manually be shut off.

A fire hydrant coverage map was also created and is shown in Exhibit E10. State code states that the allowable range of each hydrant is 500 ft. There was one location in Moroni that did not have coverage by a fire hydrant.

It is also recommended to exercise all valves and to identify all broken valves during the design of the next water project.

7.5 SCADA

It is recommended that the current SCADA system be upgraded to allow for monitoring of pump flow rates, pump line flow rates, irrigation pond level, and to allow the pumps to operate at varying flow rates.

A Variable-Frequency Drive (VFD) should also be installed on Well #2 and the new Well. Well #3 already have a VFD. The VFD allows the pump to pump at different speeds. Controlling the pump rates and monitoring the flow rates will allow the City to better utilize the blending of the sources.

A flow meter is recommended on the line that leads to the upper tank. This will help to monitor where the water in the system is going and how it is used. The existing flow meters on each well should also be connected to the SCADA system to allow for accurate blending of the low nitrate water to the high nitrate water.

An alarm should be programmed into the SCADA system. This alarm should alert the operator if Well #2 begins pumping without either of the low nitrate sources also pumping.

These would help to automate the City's system and would help the recommended improvements work in an efficient way. The SCADA should be able to monitor the irrigation ponds level and when the ponds lower the SCADA could switch the existing pump line to feed the irrigation pond instead of the tanks. This would also allow the system to switch from pumping into the new line to pumping into the old line and would help to cover the irrigation and culinary storage to fill up efficiently.

7.6 40-Year Water Rights Plan

A 40-year plan is conducted to preserve existing excess water rights help by public water suppliers. The plan consists of gather the water rights and change applications. These water rights are then compared to the needed rights of the public water supplier over the course of next 40 years.

A public water supplier will fall under the State's "use it or lose it" statue without a 40-year plan. These plans need to be updated as needed. The State Engineer recommends that a 40-year plan be conducted under the direction of a licensed engineer.

This plan would cost around $10,000 to conduct.

7.7 Well Production

Sunrise Engineering measured the flow from Well #2 at 230 gpm and Well #3 at 375 gpm. The Division of Drinking water uses what is known as the safe yield for a well as the available source for that well. The safe yield is the amount of groundwater that can be withdrawn from a groundwater basin over a period of time without exceeding the long-term recharge of the basin or unreasonably affect the basin's physical and chemical integrity.

The safe yield for Well #2 is 270 gpm and Well #3 is 425 gpm. Sunrise Engineering recommends when the time comes to replace the pumps at each well, to replace the pumps so that they will increase the capacity to match the safe yield.

7.8 OPC Summary

The combined costs for each of these recommendations is shown in Table 7.8.1.

Table 7.8.1. The total probable costs for all the recommended improvements are $3,500,000.

Moroni City Capital Improvements Opinion of Probable Cost		
Well Drilling	$	495,000.00
Well Building	$	364,000.00
Overflow Line Improvements	$	263,550.00
Culinary Pipeline Improvements	$	537,715.00
New 500,000 Gallon Tank	$	685,000.00
Distribution System Improvements	$	107,900.00
SCADA Improvements	$	87,000.00
Construction Contingency*	$	425,000.00
Incidentals & Professional Services	$	533,700.00
Total Costs	$	3,498,865.00

The total cost for the recommended improvements of the capital facilities plan is $3,500,000. This would allow Moroni City to fix their nitrate problem, add new source to their culinary water system, to create additional storage, fill the irrigation pond without breaking the irrigation system, isolate the culinary system into zones, automate the entire system, and protect the City's future water rights.

8.0 SUMMARY AND RECOMMENDATION

In summary, an additional low-nitrate source and a nitrate treatment plant allow Moroni City to use water from Well #2 safely when Well #3 needs to be shut-down for any reason.

A new low-nitrate source may be available at the three recommended test well sites. This would also allow the City to meet projected water source needs. A new well would cost $1,254,700 to construct with operating costs typically around $29,980 a year.

Reverse osmosis and ion exchange systems could remove the nitrate to safe drinking levels. However, an ion exchange system may not be feasible for Moroni City if the water hardness is above 120 ppm, because this hardness would precipitate from the water and clog the treatment system. Both treatment systems would lower the amount of source available when the treatment systems are in use. These systems would only need to be used when Well #3 is shut-off.

Reverse osmosis would cost around $2,570,800 with an annual operating and maintenance cost of $63,655. Ion exchange would cost around $2,341,100 with an annual operating and maintenance cost of $45,647.

The recommended option is to drill a test well with a goal of finding a low nitrate water source. This option is the least expensive of the three alternatives, and this option could help to meet the City's 20-year water needs. The City will need to find new source within the next 20 years to meet their projected source needs. A new well would be able to solve the City's nitrate problem and may provide enough source to provide for the City's needs in the next 20 years.

Additional recommendations that are covered in the capital improvements plan would help to create additional storage, fill the irrigation pond without breaking the irrigation system, isolate the culinary system into zones, automate the entire system, and protect the City's future water rights.

EXHIBIT E01:

EXISITING AVERAGE DAY DEMAND

EXISTING TANKS

PRV

PRV

PRV

TURKEY PLANT

W 300 N

W 100 N

E 1200 N

N 100 E

S 100 W

S State St

N State St

112

SCALE
0 350' 700'
HORIZ: 1" = 700'

LEGEND

JUNCTION PRESSURES (psi)

< 20	
20 - 40	
40 - 60	
60 - 90	
> 90	

PIPE DIAMETER SIZE (in.)

2"	
6"	
8"	
10"	
12"	

PRESSURE ZONE BOUNDARY

811 Know what's **below.** **Call before you dig.** 1-800-662-4111

REV NO.	COMMENT	DATE

SUNRISE ENGINEERING
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FILLMORE, UTAH 84631
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MORONI CITY

MORONI CITY WATER SOURCE FEASIBILITY STUDY
HYDRAULIC MODEL
EXISTING AVERAGE DAY DEMAND

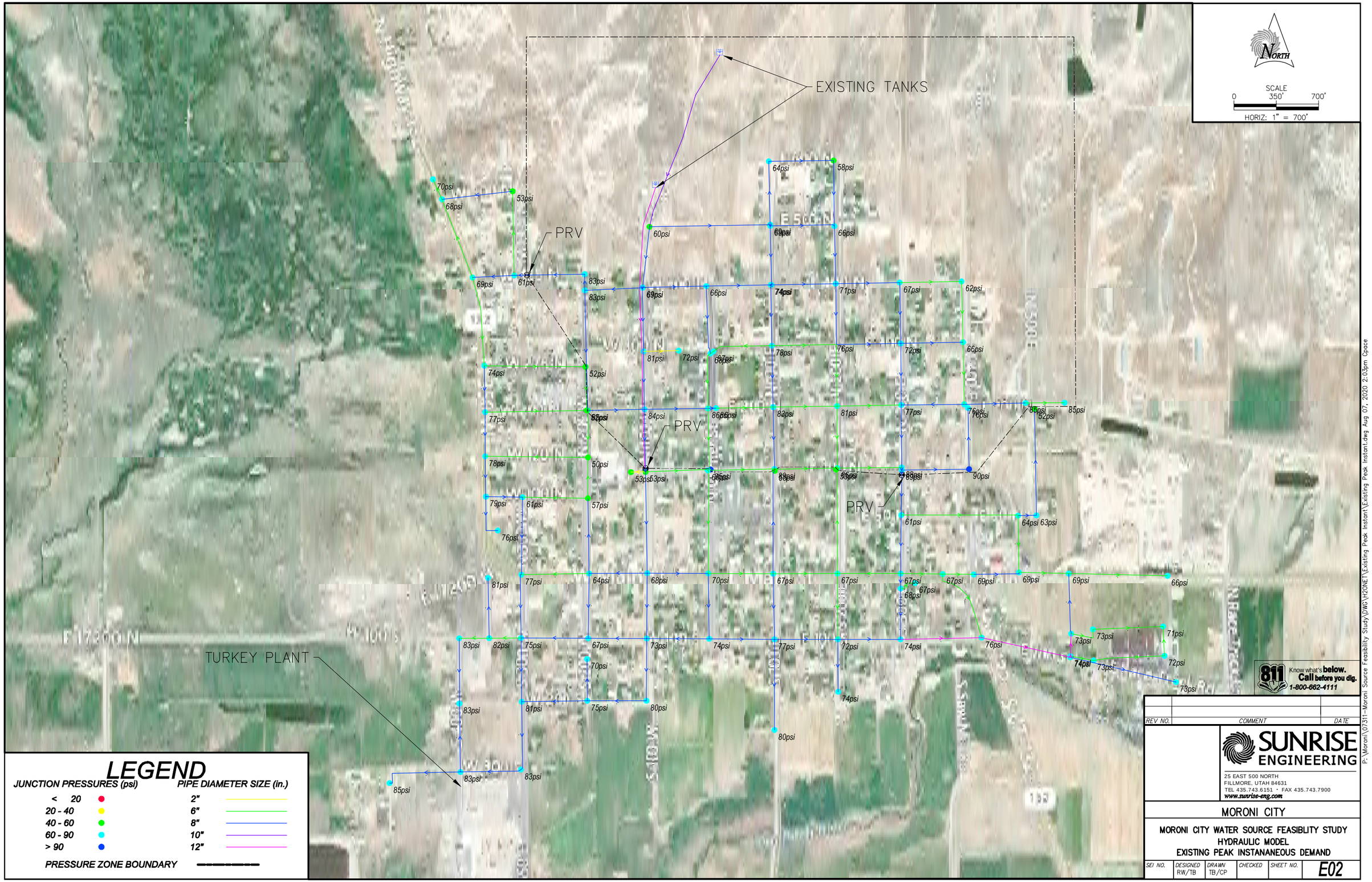
SEI NO.	DESIGNED	DRAWN	CHECKED	SHEET NO.
	RW/TB	TB/CP		E01

P:\Moroni\07311-Moroni Source Feasibility Study\DWG\H2ONET\Existing Average Day Demand\Existing Average Day Demand.dwg Aug 07, 2020 1:53pm Cpace

EXHIBIT E02:

EXISITING PEAK

INSTANTANEOUS DEMAND



LEGEND

JUNCTION PRESSURES (psi)

< 20	
20 - 40	
40 - 60	
60 - 90	
> 90	

PIPE DIAMETER SIZE (in.)

2"	
6"	
8"	
10"	
12"	

PRESSURE ZONE BOUNDARY

NORTH

SCALE
0 350' 700'
HORIZ: 1" = 700'

811 Know what's **below.** **Call** before you dig. 1-800-662-4111

REV NO.	COMMENT	DATE

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MORONI CITY WATER SOURCE FEASIBLITY STUDY
HYDRAULIC MODEL
EXISTING PEAK INSTANANEOUS DEMAND

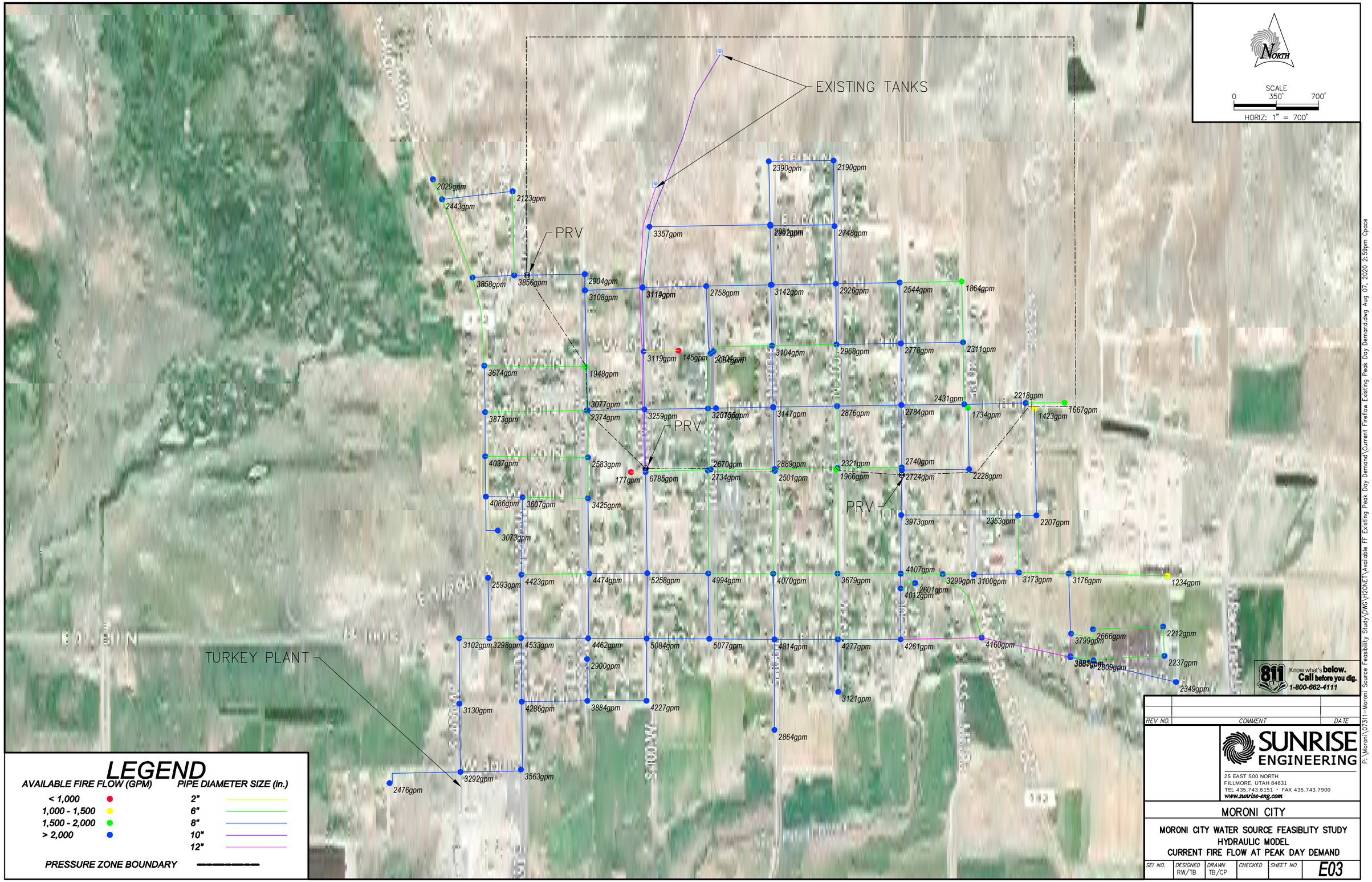
SEI NO.	DESIGNED	DRAWN	CHECKED	SHEET NO.
	RW/TB	TB/CP		E02

P:\Moroni\07311-Moroni Source Feasibility Study\DWG\H2ONET\Existing Peak Instant\Existing Peak Instant.dwg Aug 07, 2020 2:03pm Cpace

EXHIBIT E03:

CURRENT FIRE FLOW

AT PEAK DAY DEMAND



LEGEND

AVAILABLE FIRE FLOW (GPM)	PIPE DIAMETER SIZE (in.)
< 1,000	2"
1,000 - 1,500	6"
1,500 - 2,000	8"
> 2,000	10"
	12"

PRESSURE ZONE BOUNDARY

REV NO.	COMMENT	DATE

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MORONI CITY

MORONI CITY WATER SOURCE FEASIBLITY STUDY
HYDRAULIC MODEL
CURRENT FIRE FLOW AT PEAK DAY DEMAND

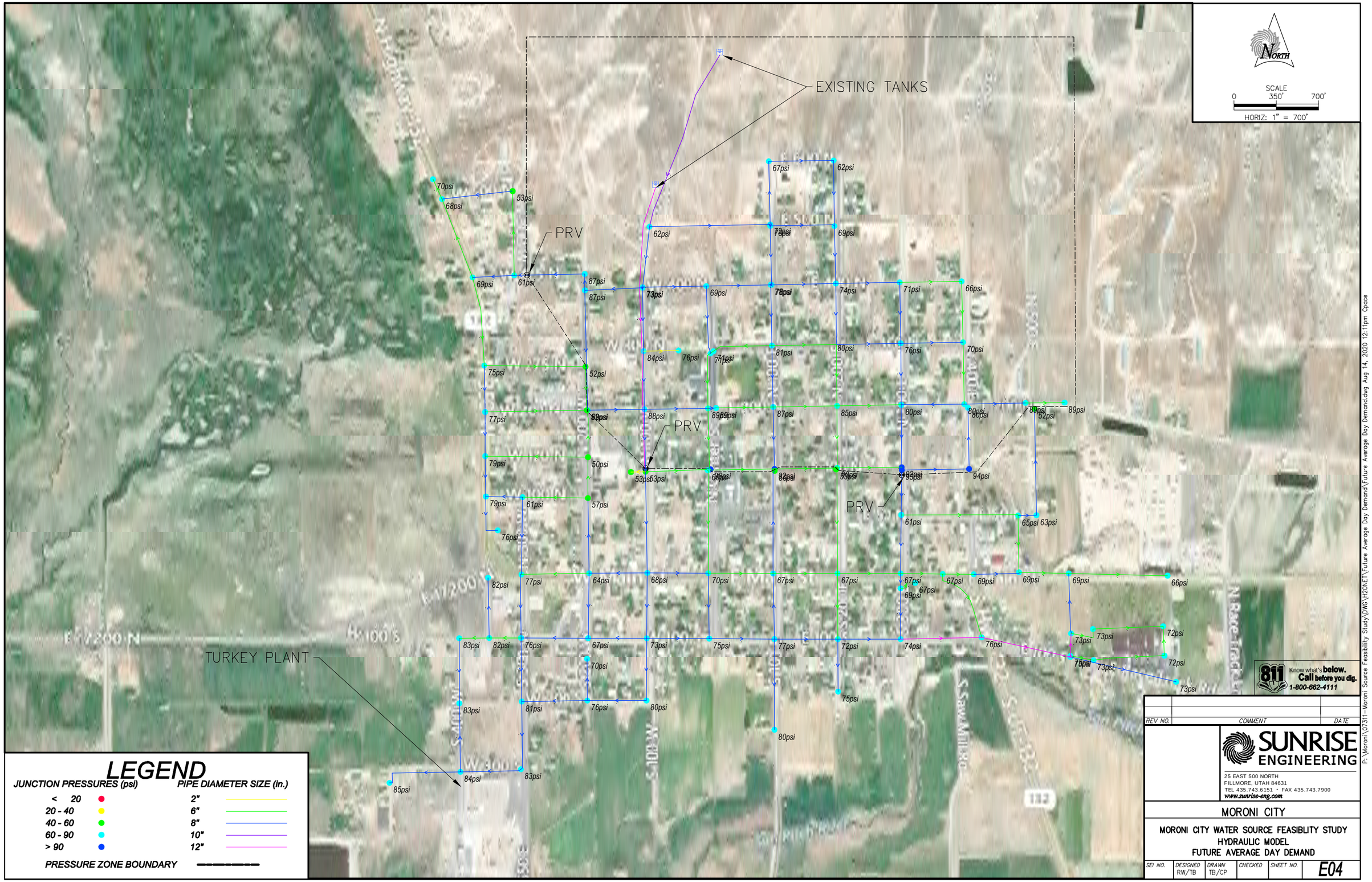
SEI NO.	DESIGNED	DRAWN	CHECKED	SHEET NO.
	RW/TB	TB/CP		E03

P:\Moroni\07311-Moroni Source Feasibility Study\DWG\H2ONET\Available FF Existing Peak Day Demand\Current Fire

Aug 07, 2020 2:59pm Cpace

EXHIBIT E04:

FUTURE AVERAGE DAY DEMAND


EXISTING TANKS
PRV
PRV
PRV
TURKEY PLANT
W 300 S
S 100 W
S Sawmill Rd
N Race Track Rd
112
SCALE
0 350' 700'
HORIZ: 1" = 700'
LEGEND
JUNCTION PRESSURES (psi)
< 20
20 - 40
40 - 60
60 - 90
> 90
PIPE DIAMETER SIZE (in.)
2"
6"
8"
10"
12"
PRESSURE ZONE BOUNDARY
Know what's below. Call before you dig. 1-800-662-4111
REV NO. COMMENT DATE
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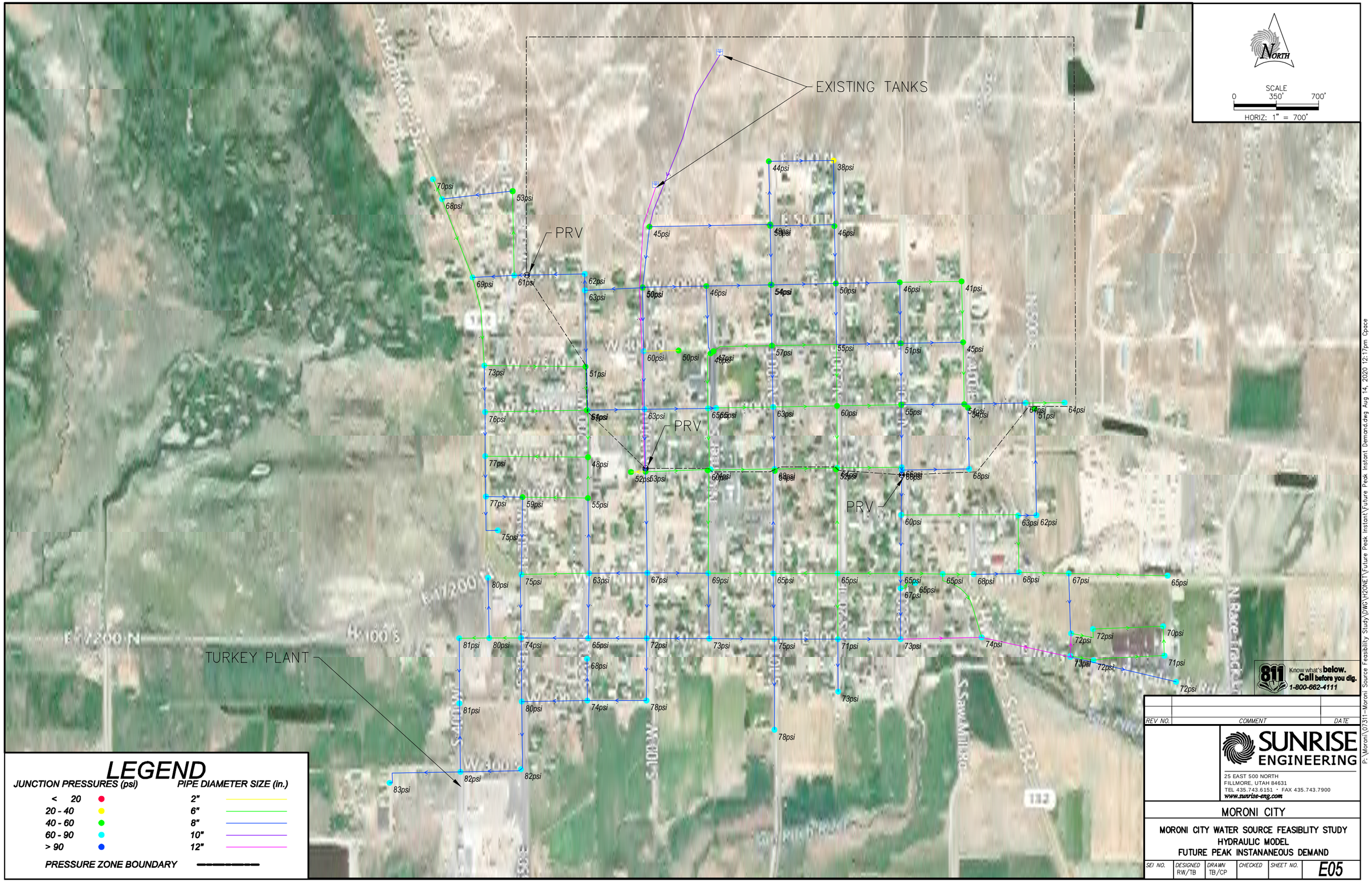
MORONI CITY WATER SOURCE FEASIBILITY STUDY
HYDRAULIC MODEL
FUTURE AVERAGE DAY DEMAND
SEI NO. DESIGNED RW/TB DRAWN TB/CP CHECKED SHEET NO. E04
P:\Moroni\07311-Moroni Source Feasibility Study\DWG\H2ONET\Future Average Day Demand\Future Average Day Demand.dwg Aug 14, 2020 12:11pm Cpace

EXHIBIT E05:

FUTURE PEAK INSTANTANEOUS DEMAND



SCALE
0 350' 700'
HORIZ: 1" = 700'

Know what's below. Call before you dig. 1-800-662-4111

LEGEND

JUNCTION PRESSURES (psi)		PIPE DIAMETER SIZE (in.)	
< 20		2"	
20 - 40		6"	
40 - 60		8"	
60 - 90		10"	
> 90		12"	

PRESSURE ZONE BOUNDARY

REV NO.	COMMENT	DATE

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MORONI CITY WATER SOURCE FEASIBLITY STUDY
HYDRAULIC MODEL
FUTURE PEAK INSTANANEOUS DEMAND

SEI NO.	DESIGNED	DRAWN	CHECKED	SHEET NO.
	RW/TB	TB/CP		E05

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EXHIBIT E06:

FUTURE FIRE FLOW

AT PEAK DAY DEMAND

NORTH

SCALE
0 350' 700'
HORIZ: 1" = 700'

LEGEND

AVAILABLE FIRE FLOW (GPM)	PIPE DIAMETER SIZE (in.)
< 1,000	2"
1,000 - 1,500	6"
1,500 - 2,000	8"
> 2,000	10"
	12"

PRESSURE ZONE BOUNDARY

811 Know what's **below.** **Call** before you dig. 1-800-662-4111

REV NO.	COMMENT	DATE

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MORONI CITY WATER SOURCE FEASIBLITY STUDY
HYDRAULIC MODEL
FUTURE FIRE FLOWS

SEI NO.	DESIGNED	DRAWN	CHECKED	SHEET NO.	
	RW/TB	TB/CP			E06

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EXHIBIT E07:

CAPITAL FACILITES

PLAN OVERVIEW

OVERFLOW LINE TO POND

AIR GAP

OVERFLOW JUNCTION BOX

TANK OVERFLOW DRAINS TO POND

500,000 G TANK

10" LINE FILLS EXISITNG TANK

12" PUMP LINE

8" PUMP LINE CONNECTS TO EXISITNG PUMP LINE

NEW PRV

EXISITNG 8" PUMP LINE

NEW PRV

NEW PRV

NEW 12" PUMP LINE

TEST WELL A

NEW WELL AND WELL HOUSE

NEW 12" PUMP LINE

EXISITNG 8" PUMP LINE

NEW 8" LINE CONNECTS WELL #2 TO NEW PUMP LINE

EXISITNG 8" PUMP LINE

SCALE

0 500' 1000'

HORIZ: 1" = 1000'

NORTH

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REV NO.	COMMENT	DATE

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MORONI CITY

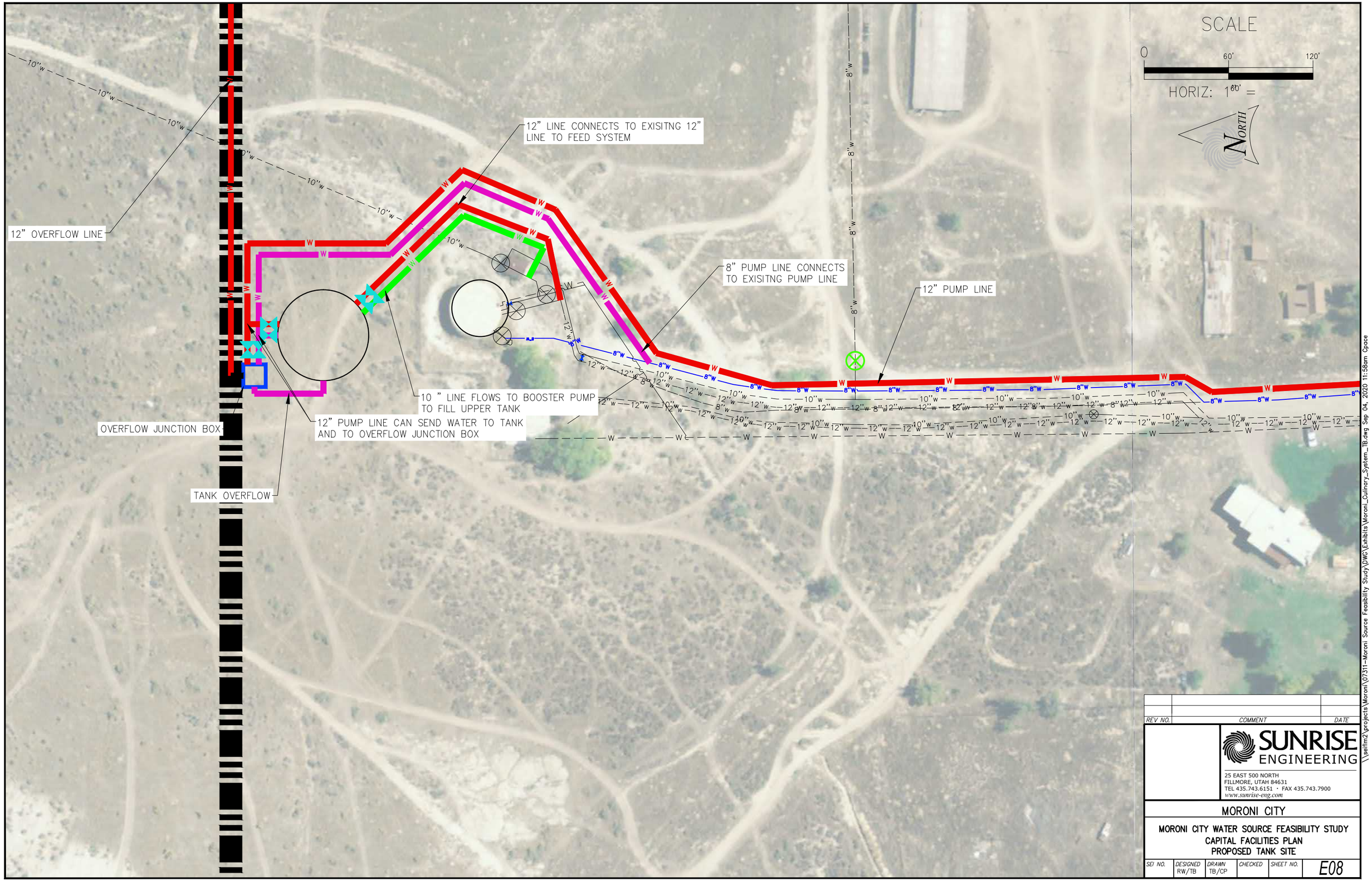
MORONI CITY WATER SOURCE FEASIBLITY STUDY
CAPITAL FACILITIES PLAN
OVERVIEW

SEI NO.	DESIGNED	DRAWN	CHECKED	SHEET NO.
	RW/TB	TB/CP		E07

EXHIBIT E08:

PROPOSED TANK

SITE IMRPOVEMENTS



REV NO.	COMMENT	DATE

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MORONI CITY

MORONI CITY WATER SOURCE FEASIBILITY STUDY
CAPITAL FACILITIES PLAN
PROPOSED TANK SITE

SEI NO.	DESIGNED	DRAWN	CHECKED	SHEET NO.
	RW/TB	TB/CP		E08

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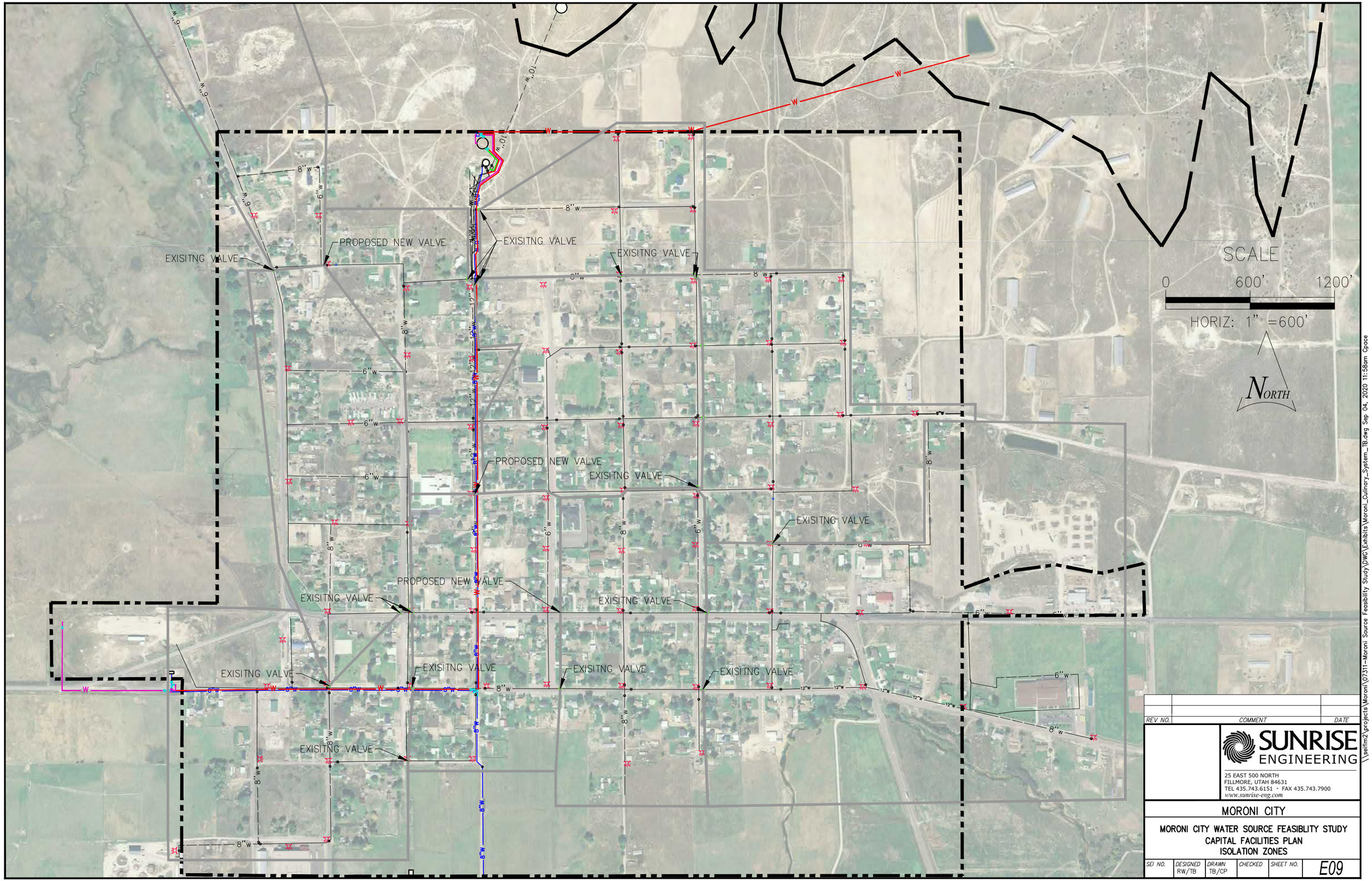
EXHIBIT E09:
ISOLATION ZONES



REV NO.	COMMENT	DATE

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MORONI CITY WATER SOURCE FEASIBLITY STUDY
CAPITAL FACILITIES PLAN
ISOLATION ZONES

SEI NO.	DESIGNED	DRAWN	CHECKED	SHEET NO.
	RW/TB	TB/CP		E09

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EXHIBIT E10:
HYDRANT COVERAGE

PROPOSED HYDRANT

SCALE
0 600' 1200'
HORIZ: 1"=600'
NORTH

REV NO.	COMMENT	DATE

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MORONI CITY WATER SOURCE FEASIBLITY STUDY
CAPITAL FACILITIES PLAN
HYDRANT COVERAGE

SEI NO.	DESIGNED	DRAWN	CHECKED	SHEET NO.
	RW/TB	TB/CP		E10

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APPENDIX A:

ENGINEER'S OPINION OF PROBABLE COSTS

SUNRISE ENGINEERING, INC.
CONSULTING ENGINEERS AND SURVEYORS

Opinion of Probable Costs

Project: Moroni City Culinary Water Improvements

By: CP/TB
Date: Aug-20

New 500,000 Gallon Tank

ITEM NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	Earthwork & Site Prep - 500k Gal Concrete Water Storage Tank	1	L.S.	$ 50,000.00	$ 50,000.00
2	500,000 Gal Water Storage Tank	1	L.S.	$ 500,000.00	$ 500,000.00
3	Site Piping/Interconnect w/System	1	L.S.	$ 65,000.00	$ 65,000.00
4	Chain Link Fence & Gates	1	L.S.	$ 25,000.00	$ 25,000.00
5	Electrical & Instrumentation	1	L.S.	$ 20,000.00	$ 20,000.00
6	Purchase Land for Tank	1	L.S.	$ 25,000.00	$ 25,000.00
	Construction Subtotal				**$ 685,000**

Culinary Pumpline Improvements

ITEM NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	TOTAL
7	Mobilization	1	L.S.	$ 45,000.00	$ 45,000.00
8	8" Pipeline from new well to Well #3	1,500	L.F.	$ 30.00	$ 45,000.00
9	12" Pipeline from new Well #3 to tank	6,300	L.F.	$ 42.00	$ 264,600.00
10	Pipe Bedding	7,800	L.F.	$ 2.00	$ 15,600.00
11	8" Gate Valve	8	EA	$ 2,600.00	$ 20,800.00
12	8" Check Valve	3	EA	$ 7,000.00	$ 21,000.00
13	12" Gate Valve	2	EA	$ 3,500.00	$ 7,000.00
14	12" Check Valve	1	EA	$ 10,000.00	$ 10,000.00
15	Connect to Existing Pipeline	3	EA	$ 1,500.00	$ 4,500.00
16	Culinary Tank Modifications (For new pump line connection)	0	EA	$ 10,000.00	$ -
17	Excavation and Subgrade Preparation	0	L.S.	$ 30,000.00	$ -
18	Highway Boring 8 Inch	60	L.F.	$ 200.00	$ 12,000.00
19	Highway Boring 12 Inch	110	L.F.	$ 260.00	$ 28,600.00
20	Asphalt Repair 3" Thick	321	S.Y.	$ 40.00	$ 12,840.00
21	Untreated Base Course 6" thick	3,500	S.Y.	$ 1.25	$ 4,375.00
22	Pavement Cutting	6,000	L.F.	$ 1.75	$ 10,500.00
23	3" Air Relief Valve	2	EA	$ 6,700.00	$ 13,400.00
24	Solid Rock Excavation	1,500	L.F.	$ 15.00	$ 22,500.00
					-
	Construction Subtotal				**$ 537,715**

Overflow Line Improvements

ITEM NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	TOTAL
25	Mobilization	1	L.S.	$ 70,000.00	$ 70,000.00
26	12" Pipe and Fittings from Lower Tank to Pond	3,650	L.F.	$ 35.00	$ 127,750.00
27	Pipe Bedding	3,650	L.F.	$ 2.00	$ 7,300.00
28	12" Gate Valve	3	EA	$ 3,500.00	$ 10,500.00
29	Concrete Overflow Vault	1	EA	$ 11,500.00	$ 11,500.00
30	12" Ultrasonic Flowmeter	1	EA	$ 6,500.00	$ 6,500.00
31	Solid Rock Excavation	2,000	L.F.	$ 15.00	$ 30,000.00
					-
	Construction Subtotal				**$ 263,550**

Well Drilling at Site 'A'

ITEM NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	TOTAL
32	Well Driller Mobilization	1	LS	$ 20,000.00	$ 20,000
33	Construct Test Well	1	LS	$ 100,000.00	$ 100,000
34	Construct Well (12" Diameter, 400' Deep)	1	LS	$ 375,000.00	$ 375,000
	Subtotal Well Drilling				**$ 495,000**

Well Building

ITEM NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	TOTAL
35	Mobilization	1	LS	$ 24,000.00	$ 24,000
36	Concrete Well House	1	LS	$ 80,000.00	$ 80,000
37	Earth Work for Well House	1	LS	$ 10,000.00	$ 10,000
38	Well House Electrical & HVAC	1	LS	$ 45,000.00	$ 45,000
39	Well House Piping	1	LS	$ 40,000.00	$ 40,000
40	Well House Instrumentation & Control	1	LS	$ 20,000.00	$ 20,000
41	Standby Generator & ATS	1	LS	$ 60,000.00	$ 60,000
42	Equip Well	1	LS	$ 35,000.00	$ 35,000
43	Property Acquisition, Rights of Way/Easement Purchase	1	LS	$ -	$ -
44	New Power Service to Well (Estimated)	1	Est	$ 50,000.00	$ 50,000
	Subtotal Well Building				**$ 364,000**

SCADA System Improvements					
ITEM NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	TOTAL
45	Instrumentation & Control	6	Each	$ 12,000.00	$ 72,000.00
46	Flow Meters on Pump Lines	3	Each	$ 5,000.00	$ 15,000.00
					-
	SCADA Subtotal				**$ 87,000**
Distribution System Improvements					
ITEM NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	TOTAL
47	12" Valve	0	Each	$ 3,500	$ -
48	10" Valve	0	Each	$ 3,000	$ -
49	8" Valve	10	Each	$ 2,600	$ 26,000
50	6" Valve	4	Each	$ 2,200	$ 8,800
51	8" PRV	3	Each	$ 7,000	$ 21,000
52	Fire Hydrant Assembly	1	Each	$ 4,500	$ 4,500
	Distribution System Improvements Subtotal				**$ 107,900**
	Construction Subtotal				**$ 2,540,165**
	Contingency	17%	17%		$ 425,000
	Total Construction				**$ 2,965,165**
	INCIDENTALS & PROFESSIONAL SERVICES				
53	Incidentals & Professional Services		18%	(of Construction)	$ 533,700
	Incidentals & Professional Services Total				**$ 533,700**
	TOTAL PROJECT COST				**$ 3,498,865**

SUNRISE ENGINEERING, INC.
CONSULTING ENGINEERS AND SURVEYORS

Opinion of Probable Costs

Project: Moroni City Culinary Water Improvements
Typical New Well Development

By:
Date: Jun-20

Well O&M

	Item Description		Annual Cost
1	Electrical Costs *The cost of running the electrical equipment inside to treatment plant including the cost for normal operation and periodic clean-up. (Based on $0.10 per kW-hr.)*	$	24,000.00
2	HVAC Costs *The cost to maintain a feasible climate in the pump house.*	$	2,400.00
3	Additional Labor Cost *The cost to have the maintenance department perform typical maintenance on the system. This analysis assumed 2 man hours per week at $20 per hour.*	$	2,080.00
4	Miscellaneous Maintenance Costs *Cost of materials to perform routine maintenance on the pump house.*	$	1,500.00
	Total Increase in Annual Costs	**$**	**29,980.00**

SUNRISE ENGINEERING, INC.
CONSULTING ENGINEERS AND SURVEYORS

Opinion of Probable Costs

Project: Moroni City Culinary Water Improvements
Reverse Osmosis Treatment System

By: CP/TB
Date: Jun-20

Reverse Osmosis Treatment System

ITEM NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	Mobilization	1	L.S.	70,000.00	70,000.00
2	Reverse Osmosis System	1	L.S.	620,000.00	620,000.00
3	Site Work	1	L.S.	25,000.00	25,000.00
4	CMU Building (36'x50')	1	L.S.	450,000.00	450,000.00
5	Building Mechanical	1	L.S.	15,000.00	15,000.00
6	Misc. Piping and Connections	1	L.S.	150,000.00	150,000.00
7	Install RO System	1	L.S.	125,000.00	125,000.00
8	Gratings and Handrailing	1	L.S.	25,000.00	25,000.00
9	Feed Tank	1	Each	20,000.00	20,000.00
10	Transfer Pumps	1	L.S.	25,000.00	25,000.00
11	Permeate Tank	1	Each	20,000.00	20,000.00
12	VFD's	1	L.S.	25,000.00	25,000.00
13	Compressor System	1	Each	25,000.00	25,000.00
14	Distribution Pump System	1	Each	75,000.00	75,000.00
15	4" Discharge pipe to river	1,300	L.F.	25.00	32,500.00
16	6' Chainlink Fence	500	L.F.	35.00	17,500.00
17	UBC	200	Ton	20.00	4,000.00
18	Electrical and Controls	1	L.S.	75,000.00	75,000.00
19	Property Acquisition, Rights of Way/Easement Purchase	1	L.S.	$ 30,000.00	$ 30,000
	Construction Subtotal				**$ 1,829,000**
	Contingency		20%		$ 366,000
	Total Construction				**$ 2,195,000**
	INCIDENTALS & PROFESSIONAL SERVICES				
20	Incidentals & Professional Services		20%	(of Construction)	$ 365,800
21	Discharge Permitting	1	L.S.	$ 10,000.00	$ 10,000
	Incidentals & Professional Services Total				**$ 375,800**
	TOTAL PROJECT COST				**$ 2,570,800**

In providing opinions of probable construction cost, the Client understands that the Engineer has no control over costs or the price of labor, equipment or materials., or over the Contractor's method of pricing, and that the opinion of probable construction cost provided herein is made on the basis of the Engineer's qualifications and experience. The Engineer makes no warranty, expressed or implied, as to the accuracy of such opinions compared to bid or actual costs.

SUNRISE ENGINEERING, INC.
CONSULTING ENGINEERS AND SURVEYORS

Opinion of Probable Costs

Project: Moroni City Culinary Water Improvements
Reverse Osmosis Treatment System

By: CP/TB
Date: Jun-20

Reverse Osmosis O&M

	Item Description		Annual Cost
1	Membrane Replacement Fund *A fund to be set aside to replace the membranes. This analysis assumed that the membranes will be replaced every 3 years.*	$	12,000.00
2	Electrical Costs *The cost of running the electrical equipment inside to treatment plant including the cost for normal operation and periodic clean-up. (Based on $0.10 per kW-hr.)*	$	26,140.00
3	Chemical Costs *The cost of the chemicals required to clean the membranes. Based on one Clean in Place cycle every month. This also accounts for coagulation chemicals.*	$	7,615.00
4	HVAC Costs *The cost to maintain a feasible climate in the treatment building*	$	4,500.00
5	Additional Labor Cost *The cost to have the maintenance department perform typical maintenance on the system. This analysis assumed 10 man hours per week at $20 per hour.*	$	10,400.00
6	Miscellaneous Maintenance Costs *Cost of materials to perform routine maintenance on the treatment plant.*	$	3,000.00
	Total Increase in Annual Costs	**$**	**63,655.00**

SUNRISE ENGINEERING, INC.
CONSULTING ENGINEERS AND SURVEYORS

Opinion of Probable Costs

Project: Moroni City Culinary Water Improvements
Ion Exchange Treatment System

By: CP/TB
Date: Jun-20

Ion Exchange Treatment System

ITEM NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	Mobilization	1	L.S.	75,000.00	75,000.00
2	Ion Exchange System	1	L.S.	585,000.00	585,000.00
3	Site Work	1	L.S.	25,000.00	25,000.00
4	CMU Building (36'x48')	1	L.S.	430,000.00	430,000.00
5	Building Mechanical	1	L.S.	15,000.00	15,000.00
6	Misc. Piping & Connections	1	L.S.	75,000.00	75,000.00
7	Ancillary Equipment	1	L.S.	150,000.00	150,000.00
8	Distribution Pump System	1	Each	75,000.00	75,000.00
9	3" Discharge pipe to river	1,300	L.F.	22.00	28,600.00
10	6' Chainlink Fence	500	L.F.	$ 35.00	$ 17,500
11	UBC	200	Ton	$ 20.00	$ 4,000
12	Electrical and Controls	1	L.S.	$ 80,000.00	$ 80,000
13	Brine Holding Tank & Mixing System for Discharge	1	L.S.	$ 75,000.00	$ 75,000
14	Property Acquisition, Rights of Way/Easement Purchase	1	LS	$ 30,000.00	$ 30,000
	Construction Subtotal				**$ 1,665,100**
	Contingency		20%		$ 333,000
	Total Construction				**$ 1,998,100**
	INCIDENTALS & PROFESSIONAL SERVICES				
15	Incidentals & Professional Services		20%	(of Construction)	$ 333,000
16	Discharge Permitting	1	L.S.	$ 10,000.00	$ 10,000
	Incidentals & Professional Services Total				**$ 343,000**
	TOTAL PROJECT COST				**$ 2,341,100**

In providing opinions of probable construction cost, the Client understands that the Engineer has no control over costs or the price of labor, equipment or materials., or over the Contractor's method of pricing, and that the opinion of probable construction cost provided herein is made on the basis of the Engineer's qualifications and experience. The Engineer makes no warranty, expressed or implied, as to the accuracy of such opinions compared to bid or actual costs.

SUNRISE ENGINEERING, INC.
CONSULTING ENGINEERS AND SURVEYORS

Opinion of Probable Costs

Project: Moroni City Culinary Water Improvements
Ion Exchange Treatment System

By: CP/TB
Date: Jun-20

Ion Exchange O&M

	Item Description		Annual Cost
1	Salt *The annual cost of regenerating the resin.*	$	2,775.00
2	Water *The annual cost to operate the ion exchange treatment system.*	$	17,472.00
3	HVAC Costs *The cost to maintain a feasible climate in the treatment building*	$	4,500.00
4	Additional Labor Cost *The cost to have the maintenance department perform typical maintenance on the system.* *This analysis assumed 10 man hours per week at $20 per hour.*	$	10,400.00
5	Miscellaneous Maintenance Costs *Cost of materials to perform routine maintenance on the treatment plant.*	$	1,500.00
6	Resin Replacement *The cost of resin spread over 5 years.*	$	9,000.00
	Total Increase in Annual Costs	**$**	**45,647.00**

APPENDIX B:

WELL SITING STUDY

HYDROGEOLOGIC STUDY

Moroni City

Moroni City
80 South 200 West
PO Box 870
Moroni, UT 84646

June 2020

PREPARED BY:
Sunrise Engineering, Inc.

SUNRISE ENGINEERING
Salt Lake City Office
6875 South 900 East, Midvale, Utah 84047 | TEL 801.523.0100 | FAX 801.523.0990

June 24, 2020

Mayor Paul Bailey
Moroni City
80 South 200 West
P.O. Box 870
Moroni, UT 84646

Subject: Hydrogeologic Study – Moroni City
Moroni, Utah

Mayor Bailey,

Enclosed herein is the hydrogeologic study for Moroni City, Utah as part of the Nitrate Blending Plan.

If you have any questions concerning this report, or if we may be of further assistance, please let us know.

Prepared by:

Dao Yang, P.E.
Project Engineer/Hydrogeologist

Reviewed by:

Derek Anderson, P.E.
Principal/Division Manager

HYDROGEOLOGIC STUDY – MORONI CITY, UTAH

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1 INTRODUCTION

1.1 Background

Moroni City (City) is a rural community located in Sanpete County, Utah which owns and operates a culinary water system that provides culinary water to residential, commercial, and institutional water users within the City's service limits. The system supplies water to approximately 1,460 people, several commercial connections, and institutional entities. Presently, the City has two active well sources: Well #2 (WS001) and Well #3 (WS007). The City owns one other inactive well (Well #1) which has not been used since 1990 due to a high level of nitrate in the water produced from the well. The two active sources are pumped into a shared pipeline that feeds the City's tanks.

According to the drinking water quality database administered by the Utah Division of Drinking Water (DDW), laboratory testing results of historic samples from Well #2 showed a maximum nitrate level of 10.23 mg/L, which is above the maximum contaminant level (MCL) of 10.0 mg/L for nitrate in drinking water set forth by the U.S Environmental Protection Agency (EPA) and adopted by DDW. The database also indicates that nitrate levels in the historic water samples collected from Well #3 exhibited a maximum level of 1.27 mg/L. Therefore, blending the water pumped from the two wells and then distributing the blended water to the system may maintain the system in compliance with the water quality standard in terms of nitrate. An alternative to the blending option is to construct a new well with good quality water to replace Well #2. Well #2 currently produces approximately 360 gallons per minute (gpm).

Moreover, the City does not have a backup well for Well #3. If Well #3 is down, the City does not have a well that can produce good quality water to meet the drinking water standard with respect to nitrate. Well #3 was down during 2019 and the residents of the City had to purchase bottled water for culinary purposes.

1.2 Purpose and Scope

The purpose of this study is to locate a well site or sites that can produce enough water to both replace Well #2 and produce additional water to meet the projected future demand. To accomplish this purpose, the following tasks were performed:

1. Data Collection: Collect, review and compile available data including topographic and geologic maps, geologic data, well logs, water quality data, and groundwater studies.
2. Site Inspection: Conduct a site visit to the area in the vicinity of the project to understand site conditions for new source development.
3. Data Analysis: Analyze collected/compiled data. The analysis focused on nitrate issues and relatively high production well locations.
4. Summary Report: Prepare a report to summarize the results and provide recommendations for test well sites based on the study results and coordination/discussion with the City.

2 HYDROGEOLOGIC ENVIRONMENT

2.1 Study Area

The study area includes the area within and surrounding Moroni, as shown in Figure 1.

2.2 General Hydrologic Setting

Moroni lies in the northern Sanpete Valley, an approximately 40-mile long north-northeast trending valley. To the north of Moroni, the valley is divided into two branches: a northeast branch and a northwest branch, which is shaped like a “Y”. According to Wilberg and Heilweil (1995), the northwestern part of the valley consists of the Silver Creek drainage from Fountain Green to Moroni; the northeastern portion of the valley is composed of the San Pitch River from Fairview to Moroni; and the southern or main portion of the valley is comprised of the San Pitch River from Moroni to Gunnison Reservoir. The Valley is bordered by the San Pitch Mountains to the west, the Cedar Hills to the north, and the Wasatch Plateau to the east. Sanpete Valley is in a geologic transition area between the more stable Colorado Plateau Physiographic Province to the east and the less stable Basin and Range Physiographic Province to the west. The valley generally receives recharge from the surrounding mountains. The following diagram (Exhibit 1) shows the general hydrologic setting of the project area.

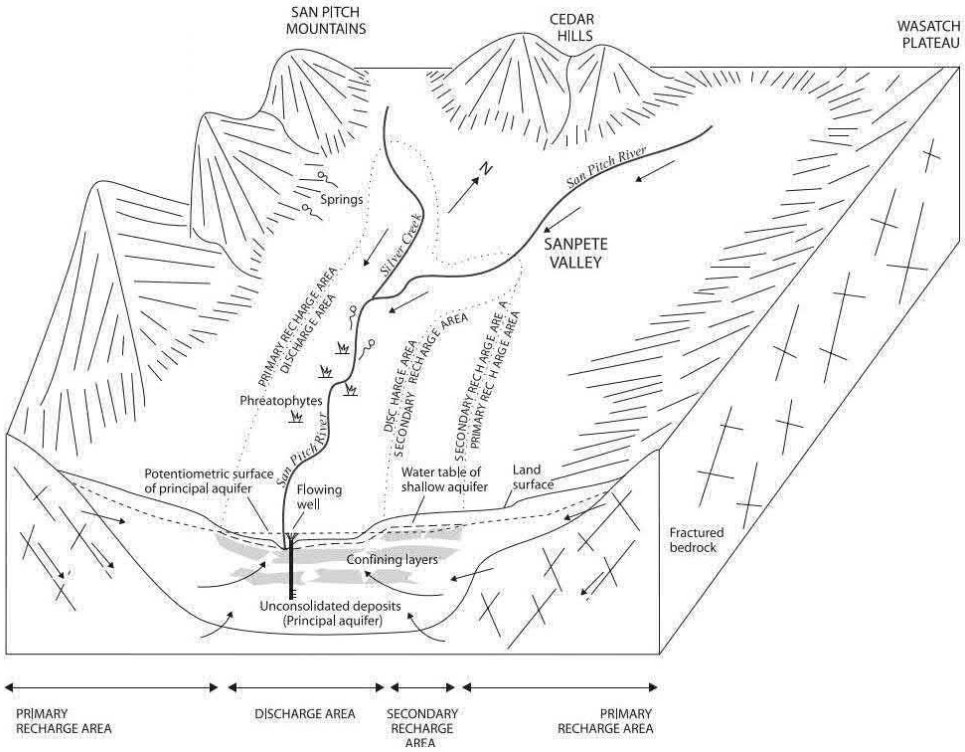

Exhibit 1. Schematic Block Diagram Showing Recharge Areas and Direction of Groundwater Flow (Arrows) in Sanpete Valley, Sanpete County, Utah (from Snyder and Lowe, 1998)

2.3 Geologic and Hydrogeologic Conditions

Figure 2 is the geologic map of the study area which was modified from portions of the Geologic Maps of the Manti 30' x 60' Quadrangle, Carbon, Emery, Juab, Sanpete and Sevier Counties, Utah (Witkind, Weiss and Brown, 1987) and the Nephi 30' x 60' Quadrangle, Carbon, Emery, Juab, Sanpete and Wasatch Counties, Utah (Witkind and Weiss, 1991). Figure 2 indicates that Quaternary and Tertiary period unconsolidated deposits (QTcf, QTpm, Qal, Qf, Qtu, Qsw and Qvf) are present in the valley floors and consolidated bedrocks (Tm, TKn, Tg, Tc, Jtg and Kpr) are exposed on valley slopes, mountains and hills, and range in epoch from Jurassic to Pleistocene. A description of the geologic formations is shown in Figure 3.

The Wasatch Monocline was formed by uplift of the Colorado Plateau that began during the mid-Miocene Epoch, about 15-20 million year ago. Dip of the beds of Cretaceous and Tertiary age that are exposed in the monocline progressively increase from horizontal at the crest of the Wasatch Plateau to 20 to 40 degrees westward in the hogbacks at the canyon mouths. High-angled, north-trending, fractures and normal faults displace the bedrock which could provide a path for water to enter the bedrock (Wilberg and Heilweil, 1995).

Analysis of well logs indicates there are few clear trends in the type and location of unconsolidated deposits within the Sanpete Valley. Contrary to the classical view of basin-fill deposits as being coarse grained along the edge and transitioning to finer sediments toward the center of the valley, such trends are not apparent in the Sanpete Valley. Coarser deposits, where they exist along the mountain front, appear to be poorly sorted and intermixed with silts and clays, except near the mouths of tributaries. This poor sorting could be a result of mass-wasting processes, such as various Quaternary landslide deposits along the perimeter of the valley (Wilberg and Heilweil, 1995).

One trend that is apparent at most locations in the Sanpete Valley is a shallow layer of clays and silts overlying coarser deposits. These fine-grained shallow sediments could have been deposited as lacustrine sediments at a time when the Sanpete Valley was covered by a shallow lake.

The thickness of the valley-fill material, as determined from driller's reports, generally reaches 300 feet or greater in the vicinity of Moroni. The contact between consolidated rock and the overlying valley-fill material, as evidenced from the irregular thickness of valley-fill material, could result from a variety of processes. These processes could include erosion by ancestral streams that carved channels in the paleo-topography. The channels were later covered by valley-fill deposits, and/or deposition on unevenly tilted and displaced fault blocks. In general, the valley-fill material is thinner along the margins of the valley near the mountain fronts, and thicker toward the valley center.

2.4 Groundwater Movement of Valley-Fill Aquifer

Based on the data by Wilberg and Heilweil (1995), a potentiometric surface map for the valley-fill aquifer is presented in Figures 1 and 2. Since the study area is located at the confluence of Silver Creek and the San Pitch River, the groundwater movement is controlled by the distinct topographic and hydrogeologic characteristics. Two branches of groundwater join into one like a "Y" in the vicinity of Moroni. Due to the flow pattern, a stagnant groundwater zone occurs in the vicinity of City Wells #1 and #2.

2.5 Valley-Fill Aquifer Properties

Aquifer properties describe the ability of a groundwater system to transmit and store water. The distribution of the properties of the valley-fill aquifer vary by location within the study area. Aquifer properties can be estimated with aquifer tests by pumping groundwater from a well and monitoring the water-level changes in the pumped well or in nearby observation wells. Since this method results in localized values that are generally representative of conditions near the pumped well, it may not represent the variability and heterogeneity throughout the aquifer.

Aquifer test data is commonly used to estimate values of transmissivity (T) and hydraulic conductivity (K). Both are measurements that describe the ease with which water can move through the pore spaces or conduits within an aquifer. More specifically, K is the volume of water flowing through a unit cross-sectional area of an aquifer under a unit hydraulic gradient in a given amount of time, and T is the volume of water flowing through a cross-sectional area that is one unit wide multiplied by the aquifer thickness in a given amount of time.

The permeability of each of the components of the valley-fill aquifer differs from place to place. In addition, the permeability of a particular high (or low) permeability zone in any locality may be more or less than that of the other zones of high (or low) permeability in the same locality. Locally, the high-permeability zones include small units of low permeability that have not been distinguished in the lithologic section.

The transmissivity of the valley-fill aquifer ranges from 300 to 2,800 feet^2/day (Sunrise, 1999) in the Moroni area.

2.6 Water Quality

Table 1 summarizes the latest available nitrate concentration data for both the City's and the Turkey Plant's wells, as retrieved from DDW's database.

Table 1. Available Nitrate Concentrations at Wells within the Study Area

Well	Recent Sampling Date	Nitrate Concentration (mg/L)
City Well #1	3/8/1999	11.27
City Well #2	12/17/2019	10.12
City Well #3	12/17/2019	1.24
Turkey Plant Well #1	9/25/2019	2.55
Turkey Plant Well #2	9/25/2019	2.61
Turkey Plant Well #3	9/25/2019	0.80

Note: Red values indicate the concentrations are above the MCL for nitrate (10 mg/L)

Table 1 indicates that the nitrate concentrations of water samples collected from City Wells #1 and #2 are above the MCL of 10 mg/L, while the nitrate levels of water samples collected from the other four wells are well below the MCL of 10 mg/L. Nitrate is a main form of dissolved nitrogen in groundwater and is generally considered as a non-adsorbed solute. As a non-adsorbed solute, nitrate moves with groundwater with no transformation and little or no retardation, and thus, it is very mobile in groundwater (Freeze and Cherry, 1979). Naturally-occurring nitrate in groundwater typically originates from nitrate sources on the land surface, in the soil zone, in shallow subsoil zones, or from contact with certain rock formations (e.g., pitchblende).

Persistent high concentrations of nitrate detected at water samples collected from City Wells #1 and #2 indicate there are nitrate sources near the wells and groundwater does not move much in the vicinity of the wells. As described in Section 2.4, two branches of groundwater join into one like a "Y" in the vicinity of Moroni, which creates a stagnant groundwater zone in the vicinity of City Wells #1 and #2. Therefore, the groundwater flow pattern in the area has caused the high levels of nitrate in the water derived from the two wells.

3 WELL SITING

Well logs were collected from the Utah Division of Water Rights. The logs were analyzed, and 24 selected wells were plotted in Figures 1 and 2. Selected well logs are attached and summarized in Appendix A. Based on the hydrogeologic data, three test well sites (A through C) are recommended as shown in Figures 1, 2 and 4.

The proposed site for Test Well A is located on the northwestern corner of a City-owned property. If the well derives water from a protected aquifer, the City can protect the well without the need to acquire land from adjacent property owners. If the City can acquire adjacent land, the best location for the test well would be further northwest of the site and near the Silver Creek 100-year floodplain (see Figure 4).

The proposed site for Test Well B is located southwest of Test Well A and adjacent to two roads. This well site may have higher production potential if the land is available to the City.

The proposed site for Test Well C is located west of the Silver Creek 100-year floodplain (see Figure 4).

The recommended procedures for developing a new well site are as follows:

1. Drill a test well at one of the three recommended locations to a depth of approximately 400 feet below grade. Install an 8-inch diameter steel casing. Perforate the casing at water-bearing strata as determined during drilling.
2. Develop the well.
3. Perform a step-drawdown pumping test following well development.
4. Perform a constant-rate pumping test. The constant-rate will be determined from the step-drawdown test.
5. At the end of the pumping test, collect a water sample for laboratory testing of nitrate. If the production of the test well meets the desired quantity, the sample should be analyzed for all chemical compounds as required by the Utah Division of Drinking Water (DDW).
6. Convert the test well to a production well if the water quality meets the drinking water standard as set forth by DDW, and after a preliminary evaluation report (PER) and well construction specifications are approved by DDW, and appropriate water rights are transferred.

4 GENERAL COMMENTS

The services provided for this project, as described in this report, include professional opinions and judgments based on the data collected and analyzed. These services were performed in accordance with current generally accepted water resources engineering principles and practices.

This report does not provide a warranty as to variable subsurface conditions (including production) that may exist. This report does not apply to the areas outside of the study area. In addition, evaluation of geologic and hydrogeologic conditions is a difficult task. Engineers and hydrogeologists must occasionally make general judgments leading to conclusions with incomplete knowledge of the geologic history, subsurface conditions, and hydraulic characteristics present. The estimated aquifer parameter values are based on geologic information gathered from geologic maps, published and unpublished reports, and have not been verified by subsurface field investigations. As additional information becomes available, the interpretations and recommendations expressed in this report will be subject to revision.

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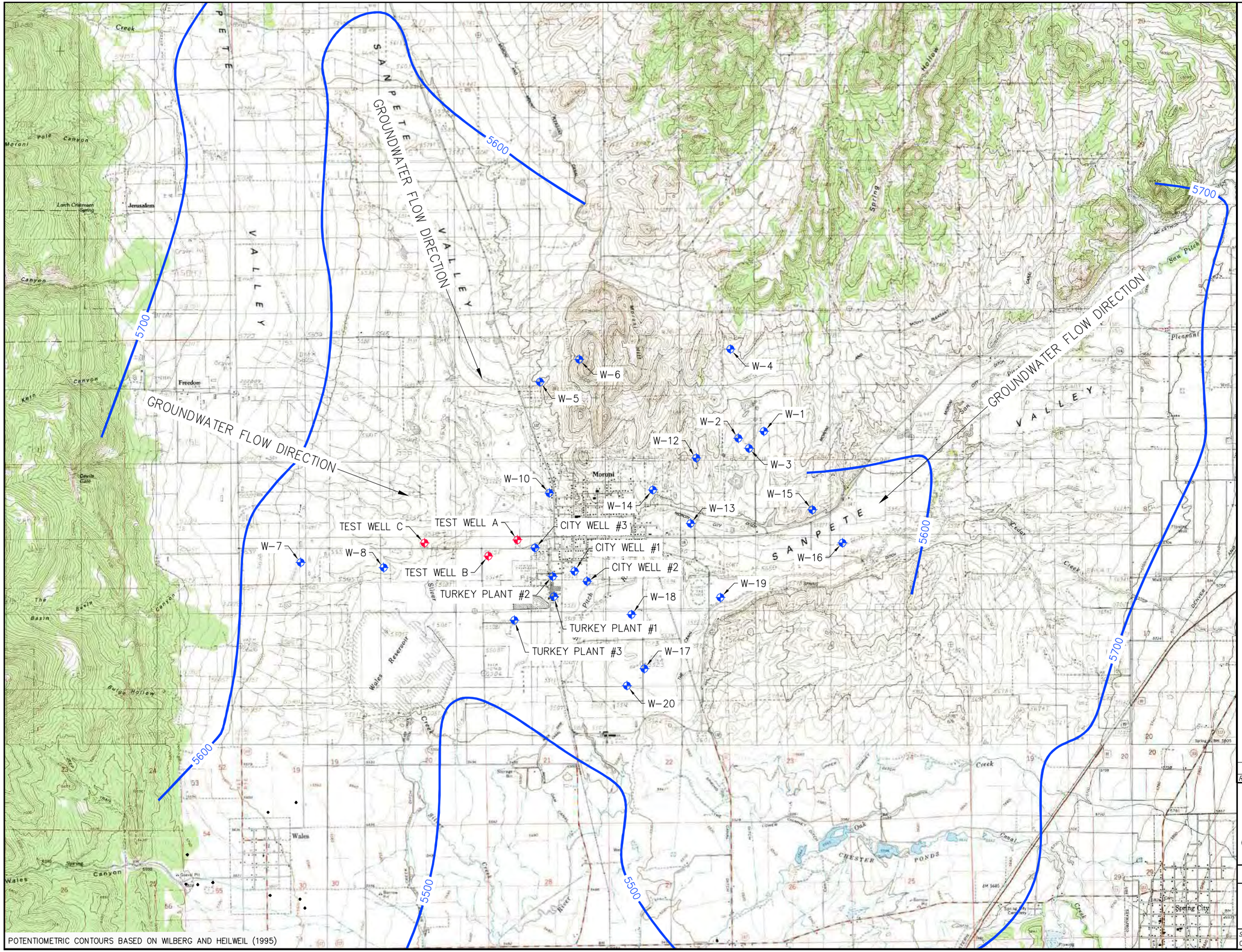
Figures



NORTH

SCALE
2000' 0 2000'

LEGEND

5600 — POTENTIOMETRIC SURFACE ELEVATION (FT)

EXISTING WELL

RECOMMENDED NEW WELL SITE

AREA MAP

REV NO.	COMMENT	DATE

FOR REVIEW ONLY
NOT
FOR CONSTRUCTION
DATE

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6875 SOUTH 900 EAST
SALT LAKE CITY, UTAH 84047
TEL 801.523.0100 - FAX 801.523.0990
www.sunrise-eng.com

MORONI CITY

NITRATE BLENDING PLAN
HYDROGEOLOGIC STUDY
PROJECT LOCATION MAP

SEI NO.	DESIGNED	DRAWN	CHECKED	SHEET NO.
07311	DY	DY	DSA	01 of 04

FIG. 1

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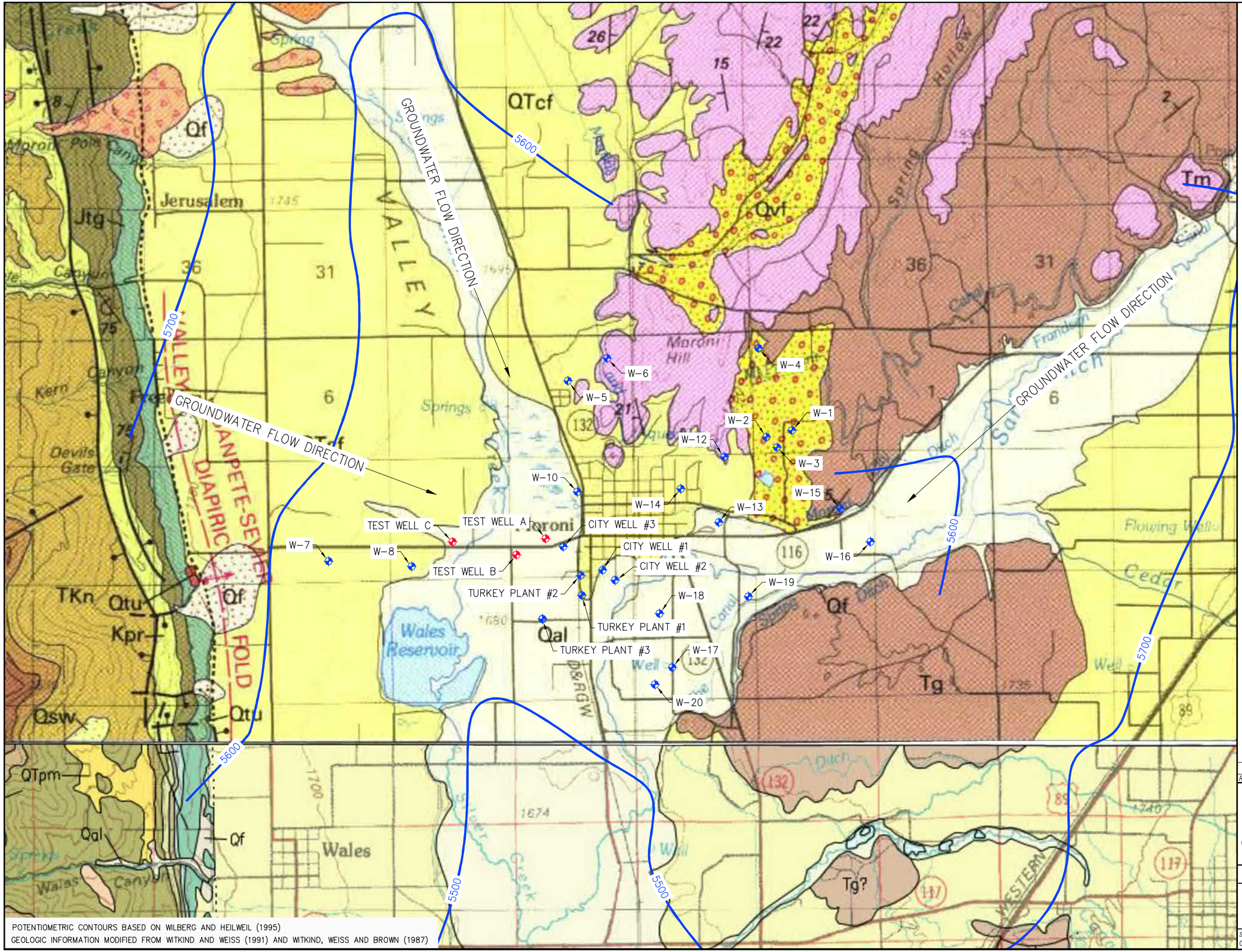

NORTH

SCALE
2000' 0 2000'

LEGEND

- 5600 — POTENTIOMETRIC SURFACE ELEVATION (FT)
- EXISTING WELL
- RECOMMENDED NEW WELL SITE

AREA MAP

REV NO.	COMMENT	DATE

FOR REVIEW ONLY
NOT
FOR CONSTRUCTION
DATE

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MORONI CITY
NITRATE BLENDING PLAN HYDROGEOLOGIC STUDY
GEOLOGIC MAP

SEI NO.	DESIGNED	DRAWN	CHECKED	SHEET NO.
07311	DY	DY	DSA	02 of 04

FIG. 2

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DESCRIPTION OF MAP UNITS

QUATERNARY DEPOSITS

Alluvium (Holocene)—Dark brown to gray, thin to thick bedded, locally massive, moderately well sorted, clayey silt, sand, gravel, cobbles, and boulders in stream channels and on floodplains of the Sanpete Valley and tributary canyons. Deposits are generally less than 15 m (50 ft) thick.

Colluvium (Holocene)—Dark brown, heterogeneous, unsorted mixture of fragments of many sizes that locally mantles lower valley walls and accumulates at the base of some steep cliffs. Unconsolidated to moderately consolidated. Thickness is variable but rarely more than a few centimeters (1 ft) or as much as 15 m (50 ft).

Dune sand (Quaternary)—Light-brown, unconsolidated, loose quartzose sand. Forms small, active dunes on the floor of Sanpete Valley and is partially covered by vegetation. Thickness ranges from 0 to 25 m (0 to 80 ft).

Alluvial fan deposits (Holocene)—Light-brown, to brown, locally gray, unconsolidated to moderately consolidated, poorly sorted silt, sand, granules, pebbles, and cobbles at deposit mouths. Of fluvial origin. Thickness ranges from 0 to 15 m (50 ft).

Coalmont alluvial-lake deposits (Holocene)—Brown to dark-brown or gray, thin to thick bedded, unconsolidated, poorly sorted silt, sand, granules, pebbles, cobbles, and sparse boulders. Formed as a result of the overlapping and interfingering of alluvial fans, fans coalescing into alluvial aprons, and alluvial deposits of the Manti-La Sal National Forest. Thickness is variable but rarely more than 15 m (50 ft).

Valley-fill deposits (Holocene)—Light-brown to brown, unconsolidated, poorly sorted silt, sand, granules, pebbles, cobbles, and boulders deposited on valley floors. Of fluvial origin. Consists of clay, silt, sand, granules, and some pebbles. Forms broad, gently sloping flood plains. Thickness ranges from 0 to as much as 46 m (0–150 ft) near center of deposition.

Eolian deposits (Holocene)—Light-brown, unconsolidated to semi-consolidated, thin to thick-bedded, moderately well sorted clay, silt, sand, and gravel. May be related to deposits of alluvial fans and valley floors. Thickness is variable but rarely more than a few meters.

Slide deposits (Quaternary)—Light-brown to tan, unconsolidated silt, sand, and stone clay that is locally interbedded with pebbles, cobbles, and boulders. Deposited by mass movement of material from the upper part of the Manning Canyon Shale. Thickness is variable but rarely more than a few meters.

Manning Canyon Shale (Lower Pennsylvanian and Upper Mississippian)—Dark- to brownish-gray shale containing interbedded lenses of limestone and sandstone. Weathers to a characteristic rounded slope. Underlies most of the valley floor and forms the lower part of the Wasatch Plateau. Thickness ranges from 0 to as much as 610 m (0–2,000 ft) thick.

Great Blue Limestone (Upper Mississippian)—Light-brown to gray, thin to massive-bedded limestone and some shale. The limestone is chiefly rock flour composed of fragments of crinoid stems and other fossils. Thickness is variable but rarely more than 305 m (1,000 ft).

Humbug Formation (Upper Mississippian)—Light-brown to brown, thin to massive-bedded, fine-grained, quartzose sandstone and limestone and minor shale and dolomite. Sandstone beds are locally quartzitic. A section measured through part of the Humbug totaled 1,100 m (3,600 ft) thick (Baker, Huddle, and Kinney, 1949, p. 1230). The formation ranges from 183 to 274 m (600–900 ft) thick in the southern Wasatch Range (Rigby and Clark, 1962, p. 21).

Deseret Limestone, Upper and Lower Mississippian—Dark-blue-gray, thin to massive-bedded limestone and dolomite. Contains abundant black lenticular to bedlike chert. Chert is characteristic, and is found wherever the formation is exposed. Limestone is commonly medium grained and is composed chiefly of crinoid stems. Dolomite is commonly fine grained and is composed of minute rhombs. Weathers to a characteristic mottled, dark-gray and white color. Thickness ranges from 183 to 275 m (600–900 ft) (Rigby and Clark, 1962, p. 19).

Gardison Limestone (Upper Mississippian)—Light-gray to dark-gray, thin-bedded fossiliferous limestone containing minor interbedded dolomite. Highly fossiliferous beds are horizontally continuous and can be traced for long distances in the canyons of the Wasatch Plateau. Lower part of formation is marked by scree-covered slopes; upper part forms prominent cliffs and steep slopes. Likely correlates with part of the Manning Canyon Shale and Great Blue Limestone exposed in the Book Cliffs. Ranges in thickness from 183 to 275 m (600–900 ft) in the southern Wasatch Range (Rigby and Clark, 1962, p. 19).

Fitchville Formation (Upper Mississippian and Upper Devonian)—Dark-gray to black, medium-bedded to massive-bedded limestone and dolomite interbedded black shale. The dolomite has a faint color banding and is medium grained. Limestone is fine grained and contains abundant fossils. Thickness ranges from about 61 to 91 m (200–300 ft) in the southern Wasatch Range (Rigby and Clark, 1962, p. 19).

Mississippian and Devonian rocks, undivided—Includes units of the following formations in descending order: Gardison Limestone, Deseret Limestone, Humbug Formation, and Fitchville Formation. Ranges in thickness from 305 to 610 m (1,000–2,000 ft) in the southern Wasatch Range.

Upper Devonian rocks, of uncertain correlation—Brown to dark-brown, fine-grained, thin-bedded quartzite and quartzitic sandstone. Ranges in thickness from 0 to 61 m (0–200 ft) in the southern Wasatch Range.

Pilgrim Peak(?) Limestone—Dark-gray to gray silty to argillaceous limestone. Commonly mapped as part of the Fitchville Formation (Rigby and Clark, 1962, p. 19).

Victoria(?) Formation—See following description.

Bowman Limestone (Upper Devonian)—Light-brown limestone and dolomite and minor interbedded dolomite. About 2 m (7 ft) thick on Long Ridge; possibly absent from the southern Wasatch Range (Rigby and Clark, 1962, p. 19).

Oquirrh Limestone (Lower Pennsylvanian and Upper Mississippian)—Light-brown to brown, thin to massive-bedded limestone containing minor interbedded dolomite. Highly fossiliferous beds are horizontally continuous and can be traced for long distances in the canyons of the Wasatch Plateau. Lower part of formation is marked by scree-covered slopes; upper part forms prominent cliffs and steep slopes. Likely correlates with part of the Manning Canyon Shale and Great Blue Limestone exposed in the Book Cliffs. Ranges in thickness from 183 to 275 m (600–900 ft) in the southern Wasatch Range (Rigby and Clark, 1962, p. 19).

Upper Cambrian rocks, undivided—Includes units of the Ajax Dolomite and Opex Formation.

Ajax Dolomite—Light-gray to light-gray, mottled dolomite and minor limestone. Uncertain if restricted to the southern Wasatch Range (Hintze, 1962, p. 13).

Opex Formation—Dark-blue-gray, dolomitic shale that contains some thin beds and a few entire beds. Ranges in thickness from about 30 to 183 m (100–600 ft).

Middle Cambrian rocks, undivided—Includes units of the following formations in descending order: Cole Canyon Dolomite, Bluebird Dolomite, Herkimer Limestone, Dagmar Dolomite, and Tintonia Dolomite.

Cole Canyon Dolomite—Alternating light- and dark-gray, beds of dolomite that locally contain sparse, small ball like reefs. Ranges in thickness from 70 to 140 m (230–460 ft) in the southern Wasatch Range (Hintze, 1962, p. 13).

Bluebird Dolomite—Dark-gray to black, dense, thin bedded dolomite and minor limestone. Ranges in thickness from 30 to 92 m (100–170 ft) on Long Ridge, and from 30 to 58 m (100–190 ft) in the southern Wasatch Range.

Herkimer Limestone—Blue-gray limestone characterized by abundant gastropod-shell debris. Shale and sparse lenses of fine-grained limestone. Commonly mapped as part of the Dagmar Dolomite. Cliff former. About 91 m (300 ft) thick on Long Ridge. Ranges in thickness from 76 to 137 m (250–450 ft) in the southern Wasatch Range (Hintze, 1962, p. 13).

Dagmar Dolomite—Light-gray to tan, dense, thin bedded dolomite that contains some thin beds of limestone. Ranges in thickness from 30 to 58 m (100–190 ft) in the southern Wasatch Range (Hintze, 1962, p. 13).

Tintonia Dolomite—Dark-gray, dolomitic shale covered by talus, part of the Tintic Quartzite (Cl). Crops out between North Creek canyon and Dry Canyon in the southern Wasatch Range. Primary contact is concealed by talus. Ranges in thickness from about 30 to locally been altered to serpentine, kaolinite, sericite, calcite, and iron oxides (Bullock and Abbott, 1951, p. 1119). Ranges in thickness from 6 to 30 m (20–100 ft) in the Gunnison Plateau. [Tdi]

Tintic Quartzite (Middle Cambrian)—Pale-brown to brown, orange-brown, thin- to medium-bedded, fine- to medium-grained quartzite. Grains are coated with limonite. Locally contains beds of limonite conglomerate. Forms resistant ledges and cliffs. Thickness about 150 m (500 ft). [Ct]

Ophir Formation and Tintic Quartzite, undivided (Middle and Lower Cambrian)—Units combined locally for cartographic purposes.

Mesozoic and Paleozoic rocks, undivided—Only shown in cross sections. Includes Tertiary and Cretaceous rocks in the Gunnison Plateau, Woodside Formation (Pw), Park City Formation (Ppc), Thaynes Creek Sandstone (Ptcr), Ankareh Limestone (Pa), Osmond Formation (Mo), Geneva Limestone (Mg), Fitchville Formation (Mdf), Upper Deseret Limestone (Mdu), Lower Deseret Limestone (Mdl), Humbug Formation (Mh), Deseret Limestone (Mdl), Gardison Limestone (Mg), Fitchville Formation (MDf), Upper Devonian rocks (Du), Upper Cambrian rocks, undivided (Cu), Middle Cambrian rocks, undivided (Cm), Opex Formation (Co), Tintonia Dolomite (Ct), and Tintic Quartzite (Ct).

PROTEROZOIC AND ARCHEAN METAMORPHIC ROCKS

Big Cottonwood Formation (Middle Proterozoic)—Dark-gray to black, thin- to thick-bedded, fine- to medium-grained, micaceous quartzite, schistose sandstone, and siltstone containing interbedded gneiss, ironstone lenses, and quartz veins. Ranges in thickness from 1,220 to 1,830 m (4,000–6,000 ft).

Farmington Canyon Complex (Early Proterozoic and Archean)—Dark-gray to reddish-gray foliated mafic gneiss, dark-gray schist, and light-gray to pink granitic gneiss. Ranges in thickness from about 1,830 to 2,440 m (6,000–8,000 ft).

Devonian, Ordovician, Cambrian, Proterozoic, and Archean rocks, undivided—Includes Fitchville Formation (MDf), Devonian rocks of Deseret Limestone (Dd), Ordovician rocks, undivided (Ou), Cambrian rocks, undivided (Cu), Middle Cambrian rocks, undivided (Cm), Opex Formation (Co), Tintonia Dolomite (Ct), and Tintic Quartzite (Ct).

EXTRUSIVE IGNEOUS ROCKS AND THEIR PRODUCTS

Laguna Springs Volcanic Group (Oligocene and Eocene)—Chiefly latite and andesite tuffs having interbedded volcanic lava flows and volcanic mudflows. Includes Wasatch Formation of Eocene age, possibly as much as 300 m (1,000 ft) (Mansfield, 1951, p. 119).

Main body—Tuff is light to dark gray, fine to coarse grained, and contains abundant phenocrysts of feldspar and ferromagnesian minerals. Flows are dark gray and coarsely porphyritic and contain orthoclase, oligoclase, hornblende, and biotite as common phenocrysts. Thickness ranges from 0 to 1,800 ft. Where breccia predominates, it is mapped as a separate unit (Tbx).

Volcanic mudflow breccia—Dark- to brownish-gray, locally reddish-brown, poorly sorted, coarse-grained breccia. Consists of angular fragments of andesite or basalt in very large, irregular to subangular fragments of dark-gray andesite, gray latite, and some blocks of sedimentary rock in a matrix of tuff and volcanic sandstone. Thickness ranges from 0 to 1,000 ft.

Goldens Ranch Formation of Moresby (1953) (Lower Oligocene to upper Eocene)—Light-gray to light-brown, fine- to coarse-grained, tuffaceous sandstone containing scattered pebbles and boulders of light-gray andesite and latite porphyry. Includes Sage Valley Limestone Member and a few interbedded lava flows. Sage Valley Limestone Member is a light-gray limestone that is exposed in the Sage Valley area and in the Nebo Mountains. Ranges in thickness from 0 to 1,000 ft (Stokker, 1981, p. 136).

Green River and Colton Formations—Only shown in cross sections

Flagstaff Limestone (Eocene and Paleocene)—Light-gray to yellowish-gray to light-brown, thin to thick bedded, locally massive, fine grained limestone. Contains subordinate amounts of light-gray shale and sandstone. The main rock unit is a light-gray to gray conglomeratic sandstone containing scattered pebbles and boulders of light-gray limestone and chert. Pinnacles and sandstone dikes are abundant and consist of light-gray, fine- to medium-grained, tuffaceous sandstone. Includes Sage Valley Limestone Member and a few interbedded lava flows. Sage Valley Limestone Member is a light-gray limestone that is exposed in the Sage Valley area and in the Nebo Mountains. Ranges in thickness from 0 to about 1,000 ft (Bissell, 1951, p. 968); contains abundant plant remains. Goldens Ranch Formation interfingers with breccia associated with the Laguna Springs Volcanic Group. Ranges in thickness from about 1,640 to 1,970 ft (Cooper, 1956, p. 21). Probably correlates with the Goldens Ranch Formation of Moresby (1953).

Manti Formation (Eocene)—Light-gray, thin to thick bedded, fine- to coarse-grained sandstone and pebble conglomerate. Contains subordinate amounts of dark-gray and reddish-brown shale and pebble and boulder conglomerate. Ranges in thickness from 0 to about 2,000 ft (Spieker and Reeside, 1925, p. 455).

North Horn Formation (Paleocene and Upper Cretaceous)—Red to reddish-brown to brown, massive, coarse-grained sandstone and pebble conglomerate. Sandstone is commonly cross-bedded and contains abundant fragments of dinosaur bones. Conglomerate is commonly well rounded and contains pebbles and boulders of quartzite, light-gray sandstone, and limestone. Ranges in thickness from about 1,640 to 2,460 ft (Spieker and Reeside, 1925, p. 455).

Flagstaff Limestone and North Horn Formation, undivided (Paleocene and Upper Cretaceous)—Units combined locally for cartographic purposes.

MESOZOIC SEDIMENTARY ROCKS

Price River Formation (Upper Cretaceous)—Gray to light-gray, thin to thick-bedded, locally massive, commonly well-cemented conglomeratic sandstone and pebble conglomerate. Sandstone is commonly conglomeratic locally contains well-rounded clasts of light-brown and purple quartzite, light-gray quartz, light-gray and black chert, and light-gray limestone. Clasts are probably derived from the Sanpete-Sevier (Nebo) terrane. Forms steep slopes and low cliffs. Includes Castlegate Sandstone (Kc) in cross sections. Ranges in thickness from 0 to about 3,000 ft (Spieker and Reeside, 1925, p. 455).

Castlegate Sandstone (Upper Cretaceous)—Brownish-gray, locally conglomeratic (irregularly bedded massive fine- to coarse-grained sandstone. Contains abundant carbonaceous shale, carbonaceous shale, and some beds of carbonaceous shale. Of fluvial origin. Included with Price River Formation in cross sections. Ranges in thickness from 0 to about 1,000 ft (Spieker, 1946, p. 19).

Indianola Group, undivided (Upper Cretaceous)

Chalky Sun Pitch Mountains—Reddish-brown and gray, thick-bedded, locally massive, coarse-grained sandstone and pebble conglomerate. Pebbles and well-rounded cobbles of white, purple, green, grayish-green, and light-brown quartzite; light-brown to light-gray chert; white, light-gray, and light-brown limestone; and dark-gray to black orthoquartzite. Many units exposed closely near Black Creek southeast of Fountain Green and have mapped as part of the Indianola Group (Spieker, 1946, p. 19). Probably correlates with the Sanpete Formation (Ks) of Lowell (1948). The Sun Pitch Mountains have been named the Sun Pitch Formation (Ksp) by Lowell (1948). Ranges in thickness from about 2,000 to 3,000 ft (Spieker, 1946, p. 19).

Blackhawk Formation (Upper Cretaceous)—Sandstone, thick-bedded, locally massive, coarse-grained, commonly conglomeratic; contains abundant carbonaceous shale and coal in commercial deposits. Sandstone beds are light gray, light brown, yellowish gray, and light brown. Sandstone beds are commonly conglomeratic and contain pebbles and boulders as exposed in Straight Canyon and Price River in the Castlegate area on the east flank of the Wasatch Plateau (in descending order): Castlegate Sandstone Member, Spring Canyon Member, Aberdeen Member, Kenilworth Member, Sunnyside Member, and Tusher Member. Ranges in thickness from about 200 m (650 ft) to about 1,000 m (3,300 ft).

Star Point Sandstone(?) (Upper Cretaceous)—Light-brown to brown, thick-bedded, locally massive, coarse-grained sandstone and pebble conglomerate. Sandstone and conglomerate are commonly cross-bedded and contain beds of carbonaceous shale. Sandstone beds are commonly well rounded and very hard. Ranges in thickness from about 1,000 to 1,500 ft (Spieker, 1946, p. 19).

Mancos Shale (Upper Cretaceous)—Thin-bedded, marine shale with many thin beds of fine-grained sandstone. Includes Emery Sandstone Member, Tununk Member, and Ferron Sandstone Member. Ranges in thickness from about 1,000 to 1,500 ft (Spieker, 1946, p. 19).

Upper part of Blue Gate Member—Light-gray, fine- to medium-bedded, even-bedded shale, shaly siltstone, and minor amounts of fine-grained sandstone. Ranges in thickness from 0 to about 1,000 ft (Spieker, 1946, p. 19).

Emery Sandstone Member—Consists of upper and lower sandstone units separated by a middle shale unit. Member exposed in the Emery area. Ranges in thickness from 0 to about 1,000 ft (Spieker, 1946, p. 19).

Lower part of Mancos Shale—Only shown in cross sections. Includes Blue Gate Member, Ferron Sandstone Member, and Tununk Member.

Blue Gate Member—Light-bluish-gray, thin- to medium-bedded, even-bedded shale and shaly siltstone. Includes sparse, discontinuous, thin beds of fine-grained sandstone. Ranges in thickness from about 1,000 to 1,500 ft (Spieker, 1946, p. 19).

Ferron Sandstone Member—Chiefly light-brown, thin and even-bedded, crossbedded, very fine to fine-grained sandstone. Locally contains abundant carbonaceous shale and coal in commercial deposits. Ranges in thickness from 0 to 900 ft (Spieker, 1946, p. 19).

Tununk Member—Light- to dark-gray, thin to medium-bedded, even-bedded shale, shaly siltstone, and minor amounts of fine-grained sandstone. Ranges in thickness from 0 to about 1,000 ft (Spieker, 1946, p. 19).

Dakota Sandstone (Upper Cretaceous)—Only shown in cross sections. Tan to light-brown, thick-bedded, crossbedded, fine- to medium-grained sandstone. Contains abundant fragments of fossil dinosaur bones. Ranges in thickness from 0 to 400 ft (Spieker, 1946, p. 19).

Cedar Mountain Formation (Lower Cretaceous)—Dominantly massive to thick-bedded sandstone, variegated in shades of purple, red, gray, and brown. Contains subordinate amounts of light-gray, thin-bedded conglomeratic sandstone, and freshwater limestone. Commonly characterized by abundant fossil dinosaur bones. Ranges in thickness from 0 to about 300 ft (Spieker, 1946, p. 19).

Twist Gulch Formation (Middle Jurassic)—Reddish-brown, thin- to medium-bedded, fine-grained, massive sandstone, and siltstone. Contains abundant fragments of fossil dinosaur bones. Ranges in thickness from 0 to about 1,000 ft (Spieker, 1946, p. 19).

Arapien Shale (Middle Jurassic)—Only shown in cross sections. Dominantly light to dark-gray, thin-bedded, even-bedded shale and limestone. Includes Twin Creek Limestone (Jtc). Ranges in thickness from 0 to about 1,000 ft (Spieker, 1946, p. 19).

Twin Creek Limestone (Middle Jurassic)—Dominantly light to dark-gray, thin-bedded, even-bedded limestone. Includes sparse, discontinuous, thin beds of fine-grained sandstone. Crossbedded in large weathering fragments. Moderately well cemented by calcium carbonate and iron oxide. Ranges in thickness from 0 to about 1,000 ft (Spieker, 1946, p. 19).

Nugget Sandstone (Upper and Lower Triassic)—Reddish-brown to brown, thick-bedded, crossbedded, fine- to medium-grained sandstone and siltstone, and fine to medium-grained, ripple-marked sandstone. Sandstone units are cemented and fractured. Includes the following seven members in descending order: Giraffe Creek, Lodo, Gypsum Spring, and Sphinx Members. Ranges in thickness from 0 to about 1,000 ft (Spieker, 1946, p. 19).

Navajo Sandstone (Lower Jurassic and Upper Triassic)—Light-tan, thick-bedded, crossbedded, fine-grained sandstone. Moderately well cemented by calcium carbonate and iron oxide. Crossbedded in large weathering fragments. Ranges in thickness from 0 to about 1,000 ft (Spieker, 1946, p. 19).

Ankareh Formation (Upper and Lower Triassic)—Reddish-brown to brown, thin- to medium-bedded, even-bedded shale, siltstone, and sandstone, and fine to medium-grained, ripple-marked sandstone. Sandstone units are cemented and fractured. Includes the following seven members in descending order: Giraffe Creek, Lodo, Gypsum Spring, and Sphinx Members. Ranges in thickness from 0 to about 1,000 ft (Spieker, 1946, p. 19).

Thaynes Limestone (Lower Triassic)—Reddish-gray, thin- to medium-bedded, even-bedded limestone containing scattered thin beds of fine-grained sandstone. Ranges in thickness from 0 to about 1,000 ft (Spieker, 1946, p. 19).

Woodside Formation (Lower Triassic)—Reddish-brown to dark-red, thin-bedded, even-bedded shale, siltstone, and fine-grained sandstone. Weakly cemented by iron oxide and calcium carbonate. Moderately resistant to erosion. Thickness ranges from 0 to about 610 m (2,000 ft).

AREA MAP

GEOLOGIC INFORMATION MODIFIED FROM WITKIND AND WEISS (1991)

REV NO.	COMMENT	DATE

FOR REVIEW ONLY
NOT
FOR CONSTRUCTION
DATE

SUNRISE ENGINEERING
6875 SOUTH 900 EAST
SALT LAKE CITY, UTAH 84047
TEL 801.523.0100 · FAX 801.523.0990
www.sunrise-eng.com

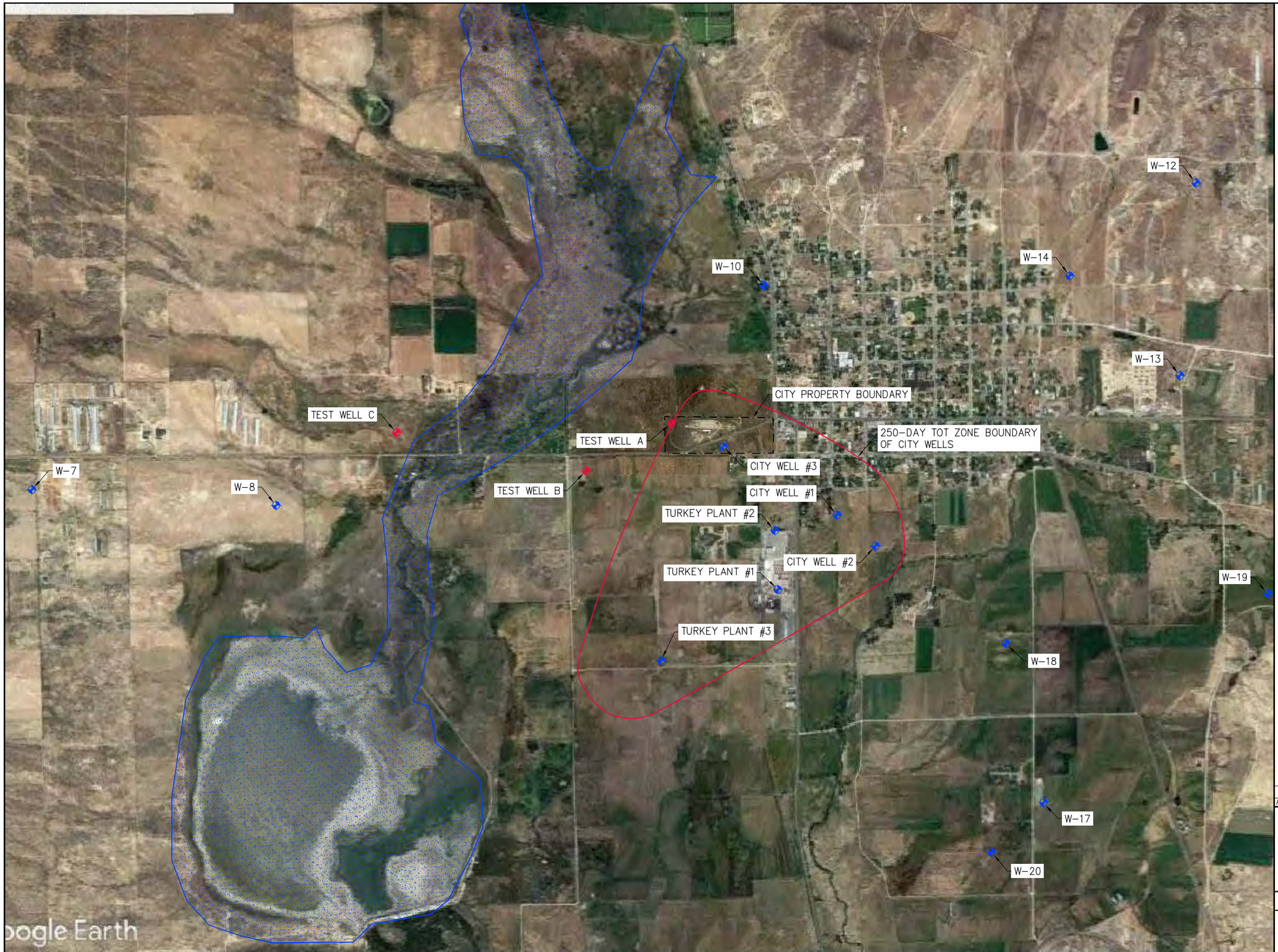
MORONI CITY

NITRATE BLENDING PLAN
HYDROGEOLOGIC STUDY
GEOLOGIC UNIT DESCRIPTION

SEI NO.	DESIGNED	DRAWN	CHECKED	SHEET NO.
07311	DY	DY	DSA	03 of 04

FIG. 3

P:\Moroni City\07311 Hydrogeologic Study\Design\03\Hydrogeologic.dwg Jun 29, 2020 3:36pm danderson



NORTH

SCALE

700' 0 700'

LEGEND

- EXISTING WELL
- RECOMMENDED NEW WELL SITE
- FLOODPLAIN

AREA MAP

REV NO.	COMMENT	DATE

FOR REVIEW ONLY
NOT
FOR CONSTRUCTION
DATE

SUNRISE ENGINEERING
6875 SOUTH 900 EAST
SALT LAKE CITY, UTAH 84047
TEL 801.523.0100 · FAX 801.523.0990
www.sunrise-eng.com

MORONI CITY

NITRATE BLENDING PLAN
HYDROGEOLOGIC STUDY
RECOMMENDED WELL SITES

SEI NO.	DESIGNED	DRAWN	CHECKED	SHEET NO.
07311	DY	DY	DSA	04 of 04

FIG. 4

P:\Moroni City\07311 Hydrogeologic Study\Design3D\Hydrogeologic.dwg Jun 29, 2020 4:07pm danderson

Appendix A

Selected Well Logs and Summary of Well Data

Well #	Well Location (All in T15S, R3E)	Sec.	Well Depth (ft)	Well Diameter (in)	Yield (gpm)	Draw-down (feet)	Specific Capacity (gpm/ft)	Depth to Water (ft)	Water Bearing (ft)	Comments
1	N 1026' E 441', SW	2	400	4	25	380	0.07	14	40-400	Shale & Sandstone
2	N 740' W 700', SE	3	250	6	NA	NA	NA	50	190-230	Fractured bedrock
3	N 300' W 225', SE	3	440	6	NA	NA	NA	60	420-440	Shale
4	S 670' E 1040', NW	3	120	6	100	0	NA	40	80-120	Bedrock
5	S 1980' W 30', N1/4	4	120	6	NA	NA	NA	68	100-110	Gravel
6	S 990' W 990' NE	4	143	10	300	58	5.17	2	121-143	Conglomerate (open hole)
7	N 944' E 27', S1/4	7	222	6	NA	NA	NA	10	220-222	Gravel
8	N 660' E 1020', SW	8	155	6	NA	NA	NA	10	100-155	Sand and gravel
9	N 1460' W 2958', SE	9	300	12	480	180	2.67	-13.8 (6psi)	150-290	Sand and gravel (City Well #3)
10	N 1450' W 2598', SE	9	338	12	305	96	3.18	4	170-338	Sandstone and conglomerate
11	N 350' W 1250', SE	9	607	12	350	86	4.07	4	60-340	City Well #1
12	S 66' E 726', N1/4	10	300	6	30	125	0.24	55	90-185	Sand
13	N 2310' W 1450', SE	10	185	6	NA	NA	NA	100	140-160	Shale
14	S 1400' E 2200', NW	10	260	6	100	NA	NA	NA	220-260	Sandstone
15	N 220' W 1370', E1/4	11	274	6	25	NA	NA	95	260-270	Silt, sand and gravel
16	S 1230' W 32', E1/4	11	243	6	100	NA	NA	-34.6 (15psi)	160-243	Shale
17	N 1385' W 95', S1/4	15	160	6	35	NA	NA	9	90-160	Fractured shale
18	S 1550' E 1250', NW	15	185	6	NA	NA	NA	2	140-185	Sand and gravel
19	S 950 W 150', NW	15	215	6	NA	NA	NA	30	165-215	Gravel
20	N 670' E 954', SW	15	151	12	525	58.5	8.97	14	40-151	Serpentine
21	S 745' W 2165', NE	16	245	10	500	45	11.11	Artesian	112-230	Sand and gravel (Turkey Plant Well #1)
22	S 80' W 700', NE	16	340	12	1280	190	6.74	8	120-340	Sandstone and conglomerate (City Well #2)
23	S 1700' E 1400', NW	16	387	14	30	NA	NA	Artesian	339-393	Gravel (Turkey Plant Well #3)
24	N 231' W 2258', SE	9	258	12	540	78	6.92	2	55-258	Gravel (Turkey Plant Well #2)

WELL DRILLER'S REPORT

State of Utah
Division of Water Rights
For additional space, use "Additional Well Data Form" and attach

W-1 (1/2)

RECEIVED
NOV 09 2000
WATER RIGHTS
SALT LAKE

Well Identification

WATER RIGHT APPLICATION: 65-2432(A64395)

Owner *Note any changes*

Bailey, David
P.O. Box 405
Moroni, UT 84646

Contact Person/Engineer: _____

Well Location *Note any changes*

COUNTY: Sanpete
NORTH 1026 feet EAST 441 feet from the SW Corner of
SECTION 2, TOWNSHIP 15S, RANGE 3E, SLB&M.

Location Description: (address, proximity to buildings, landmarks, ground elevation, local well #) _____

Drillers Activity

1 mile NE of Moroni
Start Date: 10-19-00 Completion Date: 10-26-00

Check all that apply: ☐ New ☐ Repair ☐ Deepen ☐ Clean ☒ Replace ☐ Public Nature of Use:

If a replacement well, provide the location of the new well. ____ feet north/south and 150 feet STK east/[redacted] of the existing well.

DEPTH (feet) FROM	TO	BOREHOLE DIAMETER (in)	DRILLING METHOD	DRILLING FLUID
0'	38'	8"	Air Rotary	Air + Water
38'	400'	6"	Air Rotary	" "

Well Log

DEPTH (feet) FROM	TO	WATER	PERMEABLE high	PERMEABLE low	UNCONSOLIDATED CLAY	SILT	SAND	GRAVEL	COBBLES	BOULDER	OTHER	CONSOLIDATED ROCK TYPE	COLOR	DESCRIPTIONS AND REMARKS (e.g., relative %, grain size, sorting, angularity, bedding, grain composition, density, plasticity, shape, cementation, consistancy, water bearing, odor, fracturing, minerology, texture, degree of weathering, hardness, water quality, etc.)
0'	12'			X	X	X	X						TAN	TOPSOIL
12'	40'										X	Shale	Green	
40	253	X									X	shale	Green	, tan, white, Brown
253'	257'	X									X	sandstone	Gray	
257'	400	X									X	Shale	Tan and Green	

SCANNED

Static Water Level

Date 10-26-00 Water Level 14 feet Flowing? ☐ Yes ☒ No
Method of Water Level Measurement TAPE If Flowing, Capped Pressure NA PSI
Point to Which Water Level Measurement was Referenced Ground Ground Elevation (If known) NK
Height of Water Level reference point above ground surface 0 feet Temperature NT ☐ °C ☐ °F

[redacted] *Well Log* [redacted]

Construction Information

DEPTH (feet) FROM	TO	CASING: CASING TYPE AND MATERIAL/GRADE	WALL THICK (in)	NOMINAL DIAM. (in)
+2'	38'	Steel	.250	6"
20'	400'	PVC	.219	4"

DEPTH (feet) FROM	TO	☐ SCREEN ☒ PERFORATIONS ☒ OPEN BOTTOM: SCREEN SLOT SIZE OR PERF SIZE (in)	SCREEN DIAM. OR PERF LENGTH (in)	SCREEN TYPE OR NUMBER PERF (per round/interval)
40	80	1/16"	6"	4 Rows
100	400'	1/8	6"	4 Rows
Perf - Every other 20'				Section
from 40' TO		400'		

Well Head Configuration: Pitless — Access Port Provided? ☒ Yes ☐ No

Casing Joint Type: welded — Perforator Used: saw

Was a Surface Seal installed? ☒ Yes ☐ No — Depth of Surface Seal: 38 feet — Drive Shoe? ☐ Yes ☒ No

Surface Seal Material Placement Method: Bentonite, Dumped IN

Provide Seal Material description below:

DEPTH (feet) FROM	TO	SURFACE SEAL / INTERVAL SEAL / FILTER PACK / PACKER INFORMATION: SEAL MATERIAL, FILTER PACK and PACKER TYPE and DESCRIPTION	Quantity of Material Used (if applicable)	GROUT DENSITY (lbs./gal.,# bag mix, gal./sack etc.)
0'	38'	Bentonite	3 Bags	# 100

Well Development and Well Yield Test Information

Date	Method	Yield	Units Check One GPM	Units Check One CFS	DRAWDOWN (ft)	TIME PUMPED (hrs & min)
10-26-00	Air Lift	25 +	X		Total	2 Hrs

Pump (Permanent)

Pump Description: _____ Horsepower: _____ Pump Intake Depth: _____ feet

Approximate maximum pumping rate: _____ Well disinfected upon completion? ☐ Yes ☐ No

Comments

Description of construction activity, additional materials used, problems encountered, extraordinary circumstances, abandonment procedures. *Use additional well data form for more space.*

Well Driller Statement

This well was drilled and constructed under my supervision, according to applicable rules and regulations, and this report is complete and correct to the best of my knowledge and belief.

Name Miller Drilling INC (Person, Firm, or Corporation - Print or Type) License No. 292

Signature Everett Miller (Licensed Well Driller) Date 11-10-00

W-2

Form 113—5M—12-60

Examined .....
Recorded: B. C. ..... T. B. .....
Inspection Sheet .....
Copied .....

REPORT OF WELL DRILLER
STATE OF UTAH

Application No. 65-2392
Claim No. (A-63327)
Coordinate No. .....

GENERAL STATEMENT: Report of well driller is hereby made and filed with the State Engineer, in accordance with the laws of Utah. (This report shall be filed with the State Engineer within 30 days after the completion or abandonment of the well. Failure to file such reports constitutes a misdemeanor.)

(1) WELL OWNER:
Name Bailey David
Address P.O. Box 405, Moroni, Ut. 84646

(2) LOCATION OF WELL:
County Sanpete Ground Water Basin (leave blank)
North 740 feet, ~~South~~ West 700 feet from SE Corner of Section 3, T. 15 S, R. 3 E SLBM (strike out words not needed)

(3) NATURE OF WORK (check): New Well ☑
Replacement Well ☐ Deepening ☐ Repair ☐ Abandon ☐
If abandonment, describe material and procedure: .....

(4) NATURE OF USE (check):
Domestic ☐ Industrial ☐ Municipal ☐ Stockwater ☑
Irrigation ☐ Mining ☐ Other ☐ Test Well ☐

(5) TYPE OF CONSTRUCTION (check):
Rotary ☑ Dug ☐ Jetted ☐
Cable ☐ Driven ☐ Bored ☐

(6) CASING SCHEDULE: Threaded ☐ Welded ☑
8 " Diam. from 0 feet to 30 feet Gage Std.
6 " Diam. from 20 feet to 250 feet Gage "
" Diam. from feet to feet Gage
New ☑ Reject ☐ Used ☐

(7) PERFORATIONS: Perforated? Yes ☑ No ☐
Type of perforator used Torch
Size of perforations 3 inches by 1/4 inches
45 perforations from 250 feet to 240 feet
perforations from feet to feet
perforations from feet to feet
perforations from feet to feet
perforations from feet to feet

(8) SCREENS: Well screen installed? Yes ☐ No ☑
Manufacturer's Name .....
Type ..... Model No. .....
Diam. ..... Slot size ..... Set from ..... ft. to .....
Diam. ..... Slot size ..... Set from ..... ft. to .....

(9) CONSTRUCTION:
Was well gravel packed? Yes ☐ No ☑ Size of gravel: .....
Gravel placed from ..... feet to ..... feet
Was a surface seal provided? Yes ☐ No ☑
To what depth? ..... feet
Material used in seal: .....
Did any strata contain unusable water? Yes ☐ No ☑
Type of water: ..... Depth of strata .....
Method of sealing strata off: .....

Was surface casing used? Yes ☐ No ☑
Was it cemented in place? Yes ☐ No ☑

(10) WATER LEVELS:
Static level 50 feet below land surface Date 6/27/88
Artesian pressure ..... feet above land surface Date .....

RECEIVED
LOG RECEIVED: JUL 12 1988
WATER RIGHTS
SALT LAKE

(11) FLOWING WELL:
Controlled by (check) Valve ☐
Cap ☐ Plug ☐ No Control ☐
Does well leak around casing? Yes ☐
No ☐

(12) WELL TESTS: Drawdown is the distance in feet the water level is lowered below static level.
Was a pump test made? Yes ☐ No ☐ If so, by whom? .....
Yield: ..... gal./min. with ..... feet drawdown after ..... hours
" ..... " ..... " ..... "
" ..... " ..... " ..... "
Bailer test ..... gal./min. with ..... feet drawdown after ..... hours
Arterian flow ..... g.p.m. Date .....
Temperature of water ..... Was a chemical analysis made? No ☐ Yes ☐

(13) WELL LOG: Diameter of well 8 - 6 inches
Depth drilled 250 feet. Depth of completed well 250 feet.

NOTE: Place an "X" in the space or combination of spaces needed to designate the material or combination of materials encountered in each depth interval. Under REMARKS make any desirable notes as to occurrence of water and the color, size, nature, etc., of material encountered in each depth interval. Use additional sheet if needed.

DEPTH From	DEPTH To	Clay	Silt	Sand	Gravel	Cobbles	Boulders	Hardpan	Conglomerate	Bedrock	Other	REMARKS
0	20										X	Shale - Green
20	40										X	
40	60										X	
60	80										X	
80	100										X	
100	120										X	
120	140										X	
140	170										X	
170	190										X	
190	210										X	Water - Fractures
210	230										X	Water - Fractures
230	250										X	

Work started June 25, 1988 Completed June 27, 1988

(14) PUMP:
Manufacturer's Name .....
Type: ..... H. P. .....
Depth to pump or bowles ..... feet

Well Driller's Statement:
This well was drilled under my supervision, and this report is true to the best of my knowledge and belief.
Name Binning Drilling Co. (Person, firm, or corporation) (Type or print)
Address 1085 E. 150 N., Fairview, Utah 84629
(Signed) L. Binning (Well Driller)
License No. 243 Date July 7, 1988

USE OTHER SIDE FOR ADDITIONAL REMARKS

Form 113—5M—12-60

W-3

Examined .....
Recorded: B. C. ..... T. B. .....
Inspection Sheet .....
Copied .....

REPORT OF WELL DRILLER
STATE OF UTAH

Application No. A-61784
Claim No. (65-2345)
Coordinate No. .....

9

GENERAL STATEMENT: Report of well driller is hereby made and filed with the State Engineer, in accordance with the laws of Utah. (This report shall be filed with the State Engineer within 30 days after the completion or abandonment of the well. Failure to file such reports constitutes a misdemeanor.)

(1) WELL OWNER:
Name Bailey, David
Address Box 406, Monroe, Ut. 84716

(2) LOCATION OF WELL:
County Sanpete Ground Water Basin (leave blank)
North 300 feet, ~~East~~ West 225 feet from SE Corner of Section 3, T. 15 S, R 3 E SLBM (strike out words not needed)

(3) NATURE OF WORK (check): New Well ☐ Replacement Well ☐ Deepening ☑ Repair ☐ Abandon ☐
If abandonment, describe material and procedure: .....

(4) NATURE OF USE (check):
Domestic ☐ Industrial ☐ Municipal ☐ Stockwater ☑
Irrigation ☐ Mining ☐ Other ☐ Test Well ☐

(5) TYPE OF CONSTRUCTION (check):
Rotary ☑ Dug ☐ Jetted ☐
Cable ☐ Driven ☐ Bored ☐

(6) CASING SCHEDULE: Threaded ☐ Welded ☑
4 " Diam. from 20 feet to 440 feet Gage .237
" Diam. from ..... feet to ..... feet Gage .....
" Diam. from ..... feet to ..... feet Gage .....
New ☐ Reject ☐ Used ☐

(7) PERFORATIONS: Perforated? Yes ☑ No ☐
Type of perforator used Torch
Size of perforations ..... inches by ..... inches
40 perforations from 440 feet to 420 feet
..... perforations from ..... feet to ..... feet
..... perforations from ..... feet to ..... feet
..... perforations from ..... feet to ..... feet
..... perforations from ..... feet to ..... feet

(8) SCREENS: Well screen installed? Yes ☐ No ☑
Manufacturer's Name .....
Type ..... Model No. .....
Diam. ..... Slot size ..... Set from ..... ft. to .....
Diam. ..... Slot size ..... Set from ..... ft. to .....

(9) CONSTRUCTION:
Was well gravel packed? Yes ☐ No ☑ Size of gravel: .....
Gravel placed from ..... feet to ..... feet
Was a surface seal provided? Yes ☑ No ☐
To what depth? 30 feet
Material used in seal: clay
Did any strata contain unusable water? Yes ☐ No ☑
Type of water: ..... Depth of strata .....
Method of sealing strata off: .....
Was surface casing used? Yes ☑ No ☐
Was it cemented in place? Yes ☐ No ☑

(10) WATER LEVELS:
Static level 60 feet below land surface Date 5/8/87
Artesian pressure ..... feet above land surface Date .....

RECEIVED
LOG RECEIVED: MAY 18 1987
WATER RIGHTS SALT LAKE

(11) FLOWING WELL:
Controlled by (check) Valve ☐
Cap ☐ Plug ☐ No Control ☐
Does well leak around casing? Yes ☐ No ☐

(12) WELL TESTS: Drawdown is the distance in feet the water level is lowered below static level.
Was a pump test made? Yes ☐ No ☑ If so, by whom? .....
Yield: ..... gal./min. with ..... feet drawdown after ..... hours
" " " " " "
" " " " " "
Bailer test ..... gal./min. with ..... feet drawdown after ..... hours
Artesian flow ..... g.p.m. Date .....
Temperature of water ..... Was a chemical analysis made? No ☐ Yes ☐

(13) WELL LOG: Diameter of well 6 inches
Depth drilled 440 feet. Depth of completed well 440 feet.

NOTE: Place an "X" in the space or combination of spaces needed to designate the material or combination of materials encountered in each depth interval. Under REMARKS make any desirable notes as to occurrence of water and the color, size, nature, etc., of material encountered in each depth interval. Use additional sheet if needed.

DEPTH From	DEPTH To	Clay	Silt	Sand	Gravel	Cobbles	Boulders	Hardpan	Conglomerate	Bedrock	Other	REMARKS
105	120										X	Shale Green
120	140										X	" "
140	160										X	" "
160	180										X	" "
180	200										X	" "
200	220										X	" "
220	240										X	" "
240	260										X	" "
260	280										X	" "
280	300										X	" "
300	320										X	" "
320	340										X	" "
340	360										X	" "
360	380										X	" "
380	400										X	" "
400	420										X	" "
420	440											Water

Work started May 4, 1987 Completed May 8, 1987

(14) PUMP:
Manufacturer's Name .....
Type: ..... H. P. .....
Depth to pump or bowles ..... feet

Well Driller's Statement:
This well was drilled under my supervision, and this report is true to the best of my knowledge and belief.
Name BINNING DRLG. CO. (Person, firm, or corporation) (Type or print)
Address 1085 E. 150 North, Fairview, Ut.
(Signed) Lester C. Binning (Well Driller)
License No. 243 Date May 14, 1987

USE OTHER SIDE FOR ADDITIONAL REMARKS

Form 115—514—12-60

W-4

Examined .....
Recorded: B. C. ..... T. B. .....
Inspection Sheet .....
Copied .....

REPORT OF WELL DRILLER
STATE OF UTAH

Application No. 49958 (65-19
Claim No. .....
Coordinate No. .....

GENERAL STATEMENT: Report of well driller is hereby made and filed with the State Engineer, in accordance with the laws of Utah. (This report shall be filed with the State Engineer within 30 days after the completion or abandonment of the well. Failure to file such reports constitutes a misdemeanor.)

(1) WELL OWNER:
Name DAN TIDWELL
Address Mt. Pleasant Ut

(2) LOCATION OF WELL:
County SANPETE Ground Water Basin (leave blank)
~~North~~ South 620 feet, ~~East~~ West 1040 feet from N/W Corner
of Section 3, T. 15 ~~N~~ S, R. 3 E SLBM (strike out words not needed)

(3) NATURE OF WORK (check):
New Well ☑ Replacement Well ☐ Deepening ☐ Repair ☐ Abandon ☐
If abandonment, describe material and procedure: .....

(4) NATURE OF USE (check):
Domestic ☑ Industrial ☐ Municipal ☐ Stockwater ☑
Irrigation ☐ Mining ☐ Other ☐ Test Well ☐

(5) TYPE OF CONSTRUCTION (check):
Rotary ☐ Dug ☐ Jetted ☐
Cable ☐ Driven ☐ Bored ☐

(6) CASING SCHEDULE:
Threaded ☐ Welded ☐
6 " Diam. from 0 feet to 100 feet Gage .282
..... " Diam. from ..... feet to ..... feet Gage .....
..... " Diam. from ..... feet to ..... feet Gage .....
New ☑ Reject ☐ Used ☐

(7) PERFORATIONS:
Perforated? Yes ☑ No ☐
Type of perforator used Cutting Torch
Size of perforations 3½ inches by ¼ inches
24 perforations from 80 feet to 100 feet
..... perforations from ..... feet to ..... feet
..... perforations from ..... feet to ..... feet
..... perforations from ..... feet to ..... feet
..... perforations from ..... feet to ..... feet

(8) SCREENS:
Well screen installed? Yes ☐ No ☑
Manufacturer's Name .....
Type ..... Model No. .....
Diam. ..... Slot size ..... Set from ..... ft. to .....
Diam. ..... Slot size ..... Set from ..... ft. to .....

(9) CONSTRUCTION:
Was well gravel packed? Yes ☐ No ☑ Size of gravel: .....
Gravel placed from ..... feet to ..... feet
Was a surface seal provided? Yes ☑ No ☐
To what depth? 10 feet
Material used in seal: Cement grout
Did any strata contain unusable water? Yes ☐ No ☑
Type of water: ..... Depth of strata .....
Method of sealing strata off: .....
Was surface casing used? Yes ☐ No ☑
Was it cemented in place? Yes ☐ No ☐

(10) WATER LEVELS:
Static level 40 feet below land surface Date Aug 17 72
Artesian pressure ..... feet above land surface Date .....

LOG RECEIVED: RECEIVED SEP 7 1972 WATER

(11) FLOWING WELL:
Controlled by (check) Valve ☐ Cap ☐ Plug ☐ No Control ☐
Does well leak around casing? Yes ☐ No ☐

(12) WELL TESTS:
Drawdown is the distance in feet the water level is lowered below static level.
Was a pump test made? Yes ☑ No ☐ If so, by whom? Eng. Tested by air on
Yield: 100 gal./min. with 0 feet drawdown after 1 hours
" " " " "
" " " " "
Bailer test ..... gal./min. with ..... feet drawdown after ..... hours
Artesian flow ..... g.p.m. Date .....
Temperature of water 68° Was a chemical analysis made? No ☑ Yes ☐

(13) WELL LOG:
Diameter of well 6 inches
Depth drilled 120 feet. Depth of completed well 100 feet.

NOTE: Place an "X" in the space or combination of spaces needed to designate the material or combination of materials encountered in each depth interval. Under REMARKS make any desirable notes as to occurrence of water and the color, size, nature, etc., of material encountered in each depth interval. Use additional sheet if needed.

DEPTH From	DEPTH To	Clay	Silt	Sand	Gravel	Cobbles	Boulders	Hardpan	Conglomerate	Bedrock	Other	REMARKS
0	10	✓	✓				✓			✓		
10	60					✓	✓			✓		Large cobbles - Boulde
60	120						✓			✓		large boulder tunn solid limestone with numerous fracte
												First acquifer at 70 Ft. with steady flow to Bott. Very clear water - no sand.
												Drive casing to 100' unable to get casing to 120' be cause of bond in hole due to cobble rock Falling down + washing Landowner was satisfied.

Work started Aug 15, 19 72 Completed Aug 17, 19 72

(14) PUMP:
Manufacturer's Name .....
Type: ..... H. P. .....
Depth to pump or bowls ..... feet

Well Driller's Statement:
This well was drilled under my supervision, and this report is true to the best of my knowledge and belief.
Name Clearwater Drilling (Person, firm, or corporation) (Type or print)
Address Box 142 Spring City, UTAH
(Signed) U. E. Gyde (Well Driller)
License No. 432 Date Sept 3, 1972

USE OTHER SIDE FOR ADDITIONAL REMARKS

W-5 (1/2)

WELL DRILLER'S REPORT
State of Utah
Division of Water Rights

RECEIVED
JUL 15 2002
WATER RIGHTS
SALT LAKE

For additional space, use "Additional Well Data Form" and attach

Well Identification

CHANGE APPLICATION: a25804(65-2983)

Owner *Note any changes*

Moroni Hills Ranches Inc.
P.O. Box 208
Moroni, UT 84646

Contact Person/Engineer: _____

Well Location *Note any changes*

COUNTY: Sanpete
SOUTH 1980 feet WEST 30 feet from the N4 Corner of
SECTION 4, TOWNSHIP 15S, RANGE 3E, SLB&M.

Location Description: (address, proximity to buildings, landmarks, ground elevation, local well #)
0.75 miles North of Moroni

Drillers Activity

Check all that apply: Start Date: July 1, 2002 Completion Date: July 2, 2002

☒ New ☐ Repair ☐ Deepen ☐ Clean ☐ Replace ☐ Public Nature of Use:

If a replacement well, provide the location of the new well. _____ feet north/south and _____ feet east/west of the existing well.

DEPTH (feet) FROM	TO	BOREHOLE DIAMETER (in)	DRILLING METHOD	DRILLING FLUID
0	30	8 3/4"	AIR ROTARY	WATER/FOAM
30	120	6"	"	"

Well Log

DEPTH (feet) FROM	TO	WATER	PERMEABLE high	PERMEABLE low	UNCONSOLIDATED CLAY	SILT	SAND	GRAVEL	COBBLES	BOULDER	OTHER	CONSOLIDATED ROCK TYPE	COLOR	DESCRIPTIONS AND REMARKS (e.g., relative %, grain size, sorting, angularity, bedding, grain composition, density, plasticity, shape, cementation, consistancy, water bearing, odor, fracturing, minerology, texture, degree of weathering, hardness, water quality, etc.)
0	25				X		X	X					GRAY	
25	37				X								TAN	
37	40				X		X	X					GRAY/TAN	
40	60				X		X	X					"	
60	80	X		X	X		X	X					"	
80	100				X		X	X					"	
100	120	X	X					X					"	

Static Water Level

Date 7-3-02 Water Level 68 feet Flowing? Yes ☒ No ☐

Method of Water Level Measurement TAPE If Flowing, Capped Pressure _____ PSI

Point to Which Water Level Measurement was Referenced TOP OF CASING Ground Elevation (If known) _____

Height of Water Level reference point above ground surface 18" feet Temperature N/A ☐ °C ☐ °F

[redacted] Well Log [redacted]

Construction Information

DEPTH (feet) FROM	TO	CASING: CASING TYPE AND MATERIAL/GRADE	WALL THICK (in)	NOMINAL DIAM (in)	DEPTH (feet) FROM	TO	☐ SCREEN ☒ PERFORATIONS ☒ OPEN BOTTOM: SCREEN SLOT SIZE OR PERF SIZE (in)	SCREEN DIAM OR PERF LENGTH (in)	SCREEN TYPE OR NUMBER PERF (per round/interval)
0	120	A53B	.250	6.625	110	100	1/8"	3"	API 120

Well Head Configuration: WELDED TID Access Port Provided? ☐ Yes ☒ No

Casing Joint Type: WELDED Perforator Used: MILL SLOT

Was a Surface Seal installed? ☒ Yes ☐ No Depth of Surface Seal: 30 feet Drive Shoe? ☒ Yes ☐ No

Surface Seal Material Placement Method: UNHYDRATED BENTONITE WAS POURED INTO ANNULAS AND FILLED FROM BOTTOM TO THERE Provide Seal material description below:

DEPTH (feet) FROM	TO	SURFACE SEAL / INTERVAL SEAL / FILTER PACK / PACKER INFORMATION: SEAL MATERIAL, FILTER PACK and PACKER TYPE and DESCRIPTION	Quantity of Material Used (if applicable)	GROUT DENSITY (lbs./gal.,#bag mix, gal./sack etc.)
0	30	UNHYDRATED BENTONITE	450 lbs	

Well Development and Well Yield Test Information

Date	Method	Yield	Units Check One GPM	CFS	DRAWDOWN (ft)	TIME PUMPED (hrs & min)

Pump (Permanent)

Pump Description: _____ Horsepower: _____ Pump Intake Depth: _____ feet

Approximate maximun pumping rate: _____ Well disinfected upon completion? ☒ Yes ☐ No

Comments

Description of construction activity, additional materials used, problems encountered, extraordinary circumstances, abandonment procedures. *Use additional well data form for more space*

Well Driller Statement

This well was drilled and constructed under my supervision, according to applicable rules and regulations, and this report is complete and correct to the best of my knowledge and belief.

Name FAIRVIEW DRILLING & PUMP SERVICE License No. 728
(Person, Firm, or Corporation - Print or Type)

Signature KEITH FOULSON Date 7-8-02
(Licensed Well Driller)

W-6

Form 115 SM 4-60

Recorded 10-18-60

Recorded: B. C. 10-18-60 T. B. ACT

Approved Sheet 10-31-60

Approved 11-30-60 ajc

REPORT OF WELL DRILLER
STATE OF UTAH

Application No. 23423

Claim No.

Coordinate No. (8-15-3)14aac

2-57 76n

GENERAL STATEMENT: Report of well driller is hereby made and filed with the State Engineer, in accordance with the laws of Utah. (This report shall be filed with the State Engineer within 30 days after the completion or abandonment of the well. Failure to file such reports constitutes a misdemeanor.)

(1) WELL OWNER:

Name Merrill L. Johnson

Address Moroni, Utah

(2) LOCATION OF WELL:

County San Pete Ground Water Basin (leave blank)

~~North~~ South 990 feet, ~~East~~ West 990 feet from NE Corner

of Section 4, T 15 N S, R 3 E ~~W~~ SLBM (strike out words not needed)

(3) NATURE OF WORK (check):

New Well ☐ Replacement Well ☒ Deepening ☒ Repair ☐ Abandon ☐

If abandonment, describe material and procedure:

(4) NATURE OF USE (check):

Domestic ☐ Industrial ☐ Municipal ☐ Stockwater ☐

Irrigation ☒ Mining ☐ Other ☐ Test Well ☐

(5) TYPE OF CONSTRUCTION (check):

Rotary ☐ Dug ☐ Jetted ☐

Cable ☒ Driven ☐ Bored ☐

(6) CASING SCHEDULE:

Threaded ☐ Welded ☒

10 " Diam. from 0 feet to 121 feet Gage Std

" Diam. from feet to feet Gage

" Diam from feet to feet Gage

New ☐ Reject ☐ Used ☐

(7) PERFORATIONS:

Perforated? Yes ☐ No ☒

Type of perforator used

Size of perforations inches by inches

perforations from feet to feet

perforations from feet to feet

perforations from feet to feet

perforations from feet to feet

perforations from feet to feet

(8) SCREENS:

Well screen installed? Yes ☐ No ☒

Manufacturer's Name

Type Model No.

Diam. Slot size Set from ft. to

Diam. Slot size Set from ft. to

(9) CONSTRUCTION:

Was well gravel packed? Yes ☐ No ☒ Size of gravel:

Gravel placed from feet to feet

Was a surface seal provided? Yes ☐ No ☐

To what depth? feet

Material used in seal:

Did any strata contain unusable water? Yes ☐ No ☐

Type of water: Depth of strata

Method of sealing strata off:

Was surface casing used? Yes ☐ No ☒

Was it cemented in place? Yes ☐ No ☐

(10) WATER LEVELS:

Static level 2' feet below land surface Date 7-8-60

Artesian pressure feet above land surface Date

LOG RECEIVED: RECEIVED OCT 14 1960 STATE ENGINEER'S OFFICE

(11) FLOWING WELL:

Controlled by (check) Valve ☐

Cap ☐ Plug ☐ No Control ☐

Does well leak around casing? Yes ☐ No ☐

(12) WELL TESTS:

Drawdown is the distance in feet the water level is lowered below static level.

Was a pump test made? Yes ☒ No ☐ If so, by whom? Driller

Yield: 300 gal./min. with 58 feet drawdown after 8 hours

" " " " "

" " " " "

Bailer test gal./min. with feet drawdown after hours

Artesian flow g.p.m. Date

Temperature of water 58 Was a chemical analysis made? No ☒ Yes ☐

(13) WELL LOG:

Diameter of well 10 inches

Depth drilled 143 feet. Depth of completed well incomplete feet.

NOTE: Place an "X" in the space or combination of spaces needed to designate the material or combination of materials encountered in each depth interval. Under REMARKS make any desirable notes as to occurrence of water and the color, size, nature, etc., of material encountered in each depth interval. Use additional sheet if needed.

DEPTH From	DEPTH To	MATERIAL Clay	Silt	Sand	Gravel	Cobbles	Boulders	Hardpan	Conglomerate	Bedrock	Other	REMARKS
0	50	x										Tough
50	65			x								Coarse & water
65	87	x			x							
87	95				x							and water
95	105				x							Tight
105	118				x							Water
118	121								x			left pipe
121	143								x			
												Well not finished, as water was needed for crops. To complete, must reduce size of pipe.

Work started 6-24-60, 19 Completed 7-8-60, 19

(14) PUMP:

Manufacturer's Name

Type: H. P.

Depth to pump or bowles feet

Well Driller's Statement:

This well was drilled under my supervision, and this report is true to the best of my knowledge and belief.

Name Thomas Woodhouse (Person, firm, or corporation) (Type or print)

Address RFD, Payson, Utah

(Signed) (Well Driller)

License No. 17 Date 7-8-60, 19

USE OTHER SIDE FOR ADDITIONAL REMARKS

W-7

Form 113—5M—12-60

Examined .....
Recorded: B. C. ..... T. B. .....
Inspection Sheet .....
Copied .....

REPORT OF WELL DRILLER
STATE OF UTAH

Application No. 65-1702
Claim No. (40724)
Coordinate No. .....

GENERAL STATEMENT: Report of well driller is hereby made and filed with the State Engineer, in accordance with the laws of Utah. (This report shall be filed with the State Engineer within 30 days after the completion or abandonment of the well. Failure to file such reports constitutes a misdemeanor.)

(1) WELL OWNER:
Name Christensen, Glen D.
Address Moroni, Ut. 84646

(2) LOCATION OF WELL:
County Sanpete Ground Water Basin (leave blank)
North 944 feet, East 27 feet from 5 1/4 Corner
~~South~~ ~~West~~
of Section 7, T 15 ~~N~~ S, R 3 E SLBM ~~W USM~~ (strike out words not needed)

(3) NATURE OF WORK (check): New Well ☐
Replacement Well ☑ Deepening ☐ Repair ☐ Abandon ☐
If abandonment, describe material and procedure: .....

(4) NATURE OF USE (check):
Domestic ☐ Industrial ☐ Municipal ☐ Stockwater ☑
Irrigation ☐ Mining ☐ Other ☐ Test Well ☐

(5) TYPE OF CONSTRUCTION (check):
Rotary ☑ Dug ☐ Jetted ☐
Cable ☐ Driven ☐ Bored ☐

(6) CASING SCHEDULE: Threaded ☐ Welded ☑
6 " Diam. from 0 feet to 220 feet Gage .250
..... " Diam. from ..... feet to ..... feet Gage .....
..... " Diam. from ..... feet to ..... feet Gage .....
New ☑ Reject ☐ Used ☐

(7) PERFORATIONS: Perforated? Yes ☐ No ☑
Type of perforator used .....
Size of perforations ..... inches by ..... inches
..... perforations from ..... feet to ..... feet
..... perforations from ..... feet to ..... feet
..... perforations from ..... feet to ..... feet
..... perforations from ..... feet to ..... feet
..... perforations from ..... feet to ..... feet

(8) SCREENS: Well screen installed? Yes ☐ No ☑
Manufacturer's Name .....
Type ..... Model No. .....
Diam. ..... Slot size ..... Set from ..... ft. to .....
Diam. ..... Slot size ..... Set from ..... ft. to .....

(9) CONSTRUCTION:
Was well gravel packed? Yes ☐ No ☑ Size of gravel: .....
Gravel placed from ..... feet to ..... feet
Was a surface seal provided? Yes ☑ No ☐
To what depth? 220 feet
Material used in seal: Casing
Did any strata contain unusable water? Yes ☐ No ☑
Type of water: ..... Depth of strata .....
Method of sealing strata off: .....

Was surface casing used? Yes ☐ No ☑
Was it cemented in place? Yes ☐ No ☑

(10) WATER LEVELS:
Static level ..... feet below land surface Date .....
Artesian pressure 16 feet above land surface Date 7-12-89

LOG RECEIVED:

(11) FLOWING WELL:
Controlled by (check) Valve ☐
Cap ☐ Plug ☐ No Control ☐
Does well leak around casing? Yes ☐ No ☐

(12) WELL TESTS: Drawdown is the distance in feet the water level is lowered below static level.
Was a pump test made? Yes ☐ No ☐ If so, by whom? .....
Yield: ..... gal./min. with ..... feet drawdown after ..... hours
" ..... " ..... " ..... "
" ..... " ..... " ..... "
Bailer test ..... gal./min. with ..... feet drawdown after ..... hours
Artesian flow ..... g.p.m. Date .....
Temperature of water ..... Was a chemical analysis made? No ☐ Yes ☐

(13) WELL LOG: Diameter of well 6 inches
Depth drilled 225 feet. Depth of completed well 222 feet.

NOTE: Place an "X" in the space or combination of spaces needed to designate the material or combination of materials encountered in each depth interval. Under REMARKS make any desirable notes as to occurrence of water and the color, size, nature, etc., of material encountered in each depth interval. Use additional sheet if needed.

DEPTH From	DEPTH To	Clay	Silt	Sand	Gravel	Cobbles	Boulders	Hardpan	Conglomerate	Bedrock	Other	REMARKS
0	5											Top Soil
5	20	X										
20	40	X										
40	60	X										Water
60	80	X										
80	100	X										
100	120	X										
120	140	X										
140	160	X										
160	180	X										
180	200	X										
200	220	X										
220	225				X							Water

Work started July 10, 19 89 Completed July 12, 19 89

(14) PUMP:
Manufacturer's Name .....
Type: ..... H. P. .....
Depth to pump or bowles ..... feet

Well Driller's Statement:
This well was drilled under my supervision, and this report is true to the best of my knowledge and belief.
Name BINNING DRILLING CO. (Person, firm, or corporation) (Type or print)
Address R.R.1, Box 27-A, Fairview, Utah
(Signed) L. Binning (Well Driller)
License No. 243 Date July 13, 19 89

USE OTHER SIDE FOR ADDITIONAL REMARKS

W-8

Form 113—5M—12-60

Examined .....
Recorded: B. C. ..... T. B. .....
Inspection Sheet .....
Copied .....

REPORT OF WELL DRILLER
STATE OF UTAH

Application No. A 61799
Claim No. 65-2347
Coordinate No. .....

GENERAL STATEMENT: Report of well driller is hereby made and filed with the State Engineer, in accordance with the laws of Utah. (This report shall be filed with the State Engineer within 30 days after the completion or abandonment of the well. Failure to file such reports constitutes a misdemeanor.)

(1) WELL OWNER: ROBERT Morley
Name .....
Address MORONI UTAH

(2) LOCATION OF WELL:
County SANPETE Ground Water Basin (leave blank) .....
North 660 feet, East 1020 feet from SW Corner
of Section 8, T. 15 S, R. 3 E SLBM (strike out words not needed)

(3) NATURE OF WORK (check): New Well ☑
Replacement Well ☐ Deepening ☐ Repair ☐ Abandon ☐
If abandonment, describe material and procedure: .....

(4) NATURE OF USE (check):
Domestic ☑ Industrial ☐ Municipal ☐ Stockwater ☑
Irrigation ☐ Mining ☐ Other ☐ Test Well ☐

(5) TYPE OF CONSTRUCTION (check):
Rotary ☐ Dug ☐ Jetted ☐
Cable ☑ Driven ☐ Bored ☐

(6) CASING SCHEDULE: Threaded ☐ Welded ☑
6" Diam. from 0 feet to 150 feet Gage .250
..... " Diam. from ..... feet to ..... feet Gage .....
..... " Diam. from ..... feet to ..... feet Gage .....
New ☑ Reject ☐ Used ☐

(7) PERFORATIONS: Perforated? Yes ☐ No ☑
Type of perforator used .....
Size of perforations ..... inches by ..... inches
..... perforations from ..... feet to ..... feet
..... perforations from ..... feet to ..... feet
..... perforations from ..... feet to ..... feet
..... perforations from ..... feet to ..... feet
..... perforations from ..... feet to ..... feet

(8) SCREENS: Well screen installed? Yes ☐ No ☑
Manufacturer's Name .....
Type ..... Model No. .....
Diam. ..... Slot size ..... Set from ..... ft. to .....
Diam. ..... Slot size ..... Set from ..... ft. to .....

(9) CONSTRUCTION:
Was well gravel packed? Yes ☐ No ☐ Size of gravel: .....
Gravel placed from ..... feet to ..... feet
Was a surface seal provided? Yes ☐ No ☐
To what depth? CLAY feet
Material used in seal: .....
Did any strata contain unusable water? Yes ☐ No ☑
Type of water: ..... Depth of strata .....
Method of sealing strata off: CASED

Was surface casing used? Yes ☐ No ☑
Was it cemented in place? Yes ☐ No ☑

(10) WATER LEVELS:
Static level ..... feet below land surface Date .....
Artesian pressure 10 feet above land surface Date Oct 86

LOG RECEIVED: OCT 10 1986
WATER RIGHTS SALT LAKE

(11) FLOWING WELL:
Controlled by (check) Valve ☐
Cap ☐ Plug ☐ No Control ☐
Does well leak around casing? Yes ☐
No ☑

(12) WELL TESTS: Drawdown is the distance in feet the water level is lowered below static level.
Was a pump test made? Yes ☐ No ☐ If so, by whom? .....
Yield: ..... gal./min. with ..... feet drawdown after ..... hours
" ..... " ..... " ..... "
" ..... " ..... " ..... "
Bailer test ..... gal./min. with ..... feet drawdown after ..... hours
Artesian flow ..... g.p.m. Date .....
Temperature of water ..... Was a chemical analysis made? No ☐ Yes ☐

(13) WELL LOG: Diameter of well 6 inches
Depth drilled 185 feet. Depth of completed well 180 feet.

NOTE: Place an "X" in the space or combination of spaces needed to designate the material or combination of materials encountered in each depth interval. Under REMARKS make any desirable notes as to occurrence of water and the color, size, nature, etc., of material encountered in each depth interval. Use additional sheet if needed.

DEPTH From	DEPTH To	Clay	Silt	Sand	Gravel	Cobbles	Boulders	Hardpan	Conglomerate	Bedrock	Other	REMARKS
0	3											TOP SOIL
3	20	X										BROWN
20	40	X										"
40	42				X							WATER
42	60	X										BROWN
60	80	X										"
80	100	X										GREEN
100	108	X										"
108	110			X	X							WATER
110	125	X										BROWN
125	127			X	X							FINE GRAVEL WATER
127	140	X										BROWN
140	142			X	X							FINE GRAVEL WATER
142	155			X								STRATIFIED SAND
155	175	X										BROWN
175	180	X										"
180	185			X	X							WATER

Work started 22 Sept 86 Completed Oct 8 86

(14) PUMP:
Manufacturer's Name .....
Type: ..... H. P. .....
Depth to pump or bowles ..... feet

Well Driller's Statement:
This well was drilled under my supervision, and this report is true to the best of my knowledge and belief.
Name FAIRVIEW DRILLING
(Person, firm, or corporation) (Type or print)
Address PO BOX 287 FAIRVIEW UTAH
(Signed) Eugene Nielson (Well Driller)
License No. 54 Date Oct 8, 1986

USE OTHER SIDE FOR ADDITIONAL REMARKS

W-9 (1/2) (City Well #3)

State of Utah
Division of Water Rights

For additional space, use "Additional Well Data Form" (attached)

RECEIVED
DEC 4 1995
WATER RIGHTS
SALT LAKE

Well Identification CHANGE APPLICATION: a18769(65-273)

Owner *Note any changes*
Moroni City Corporation
Moroni, UT 84646

Contact Person/Engineer:

Well Location *Note any changes*
COUNTY: Sanpete
NORTH 1460 feet WEST 2958 feet from the SE Corner of SECTION 9, TOWNSHIP 15S, RANGE 3E, SLB&M.

Location Description: (address, proximity to buildings, landmarks, ground elevation, local well #) South Moroni & West Moroni

Drillers Activity
Start Date: July 12, 1995 Completion Date: OCT. 17, 1995
Check all that apply:
[X] New [ ] Repair [ ] Deepen [ ] Abandon [ ] Replace [ ] Public Nature of Use:

DEPTH (feet) FROM	TO	BOREHOLE DIAMETER (in)	DRILLING METHOD	DRILLING FLUID
0	300	20"	CABLE TOOL	WATER / Chlorinated

Well Log

DEPTH (feet) FROM	TO	WATER	PERMEABLE high	PERMEABLE low	UNCONSOLIDATED CLAY	SILT	SAND	GRAVEL	COBBLES	BOULDER	OTHER	CONSOLIDATED ROCK TYPE	COLOR	DESCRIPTIONS AND REMARKS (include comments on *water quality* if known.)
0	2													TOPSOIL
2	36			X	X								BROWN	
36	59			X	X							FINE GRAVEL	BROWN	
59	64			X							X		BLACK	ORGANIC VEGATATION
64	149			X	X								BROWN/GREY	
149	183	X	X		X			X					BROWN	SOME CEMENTED MATERIAL
183	221				X	X							BROWN	
220	300				X		X	X					BROWN	CEMENTED / VOLCANIC

Static Water Level
Date 10-17-95 Water Level feet Flowing? [X] Yes [ ] No
Method of Water Level Measurement If Flowing, Capped Pressure 6 PSI
Point to Which Water Level Measurement was Referenced Ground level
Height of Water Level reference point above ground surface 15 feet Temperature 64 [ ] °C [X] °F

Well Log

Construction Information

DEPTH (feet) FROM	TO	CASING: CASING TYPE AND MATERIAL/GRADE	WALL THICK (in)	NOMINAL DIAM. (in)	DEPTH (feet) FROM	TO	SCREEN X PERFORATIONS X: SLOT SIZE OR PERF SIZE (in)	SCREEN DIAM. OR PERF LENGTH (in)	SCREEN TYPE OR NUMBER PERF (per round/interval)
0	160	ASTM A-53B	375	20"	0	160	3/8	3½"	8/2FT.
0	150	" " "	375	14"	150	180	.060	14"	Hi-CAP Johnson
180	205	" " "	375	12"	205	290	.040	12"	Hi CAP Johnson
290	300	" " "	375	12"					

Well Head Configuration: 14"x 20" Access Port Provided? ☒ Yes ☐ No

Casing Joint Type: WELDED Perforator Used: Mills

DEPTH (feet) FROM	TO	FILTER PACK / GROUT / PACKER / ABANDONMENT MATERIAL: ANNULAR MATERIAL, ABANDONMENT MATERIAL and/or PACKER DESCRIPTION	Quantity of Material Used (if applicable)	GROUT DENSITY (lbs./gal.,# bag mix, gal./sack etc.)
300	195	8-16 Colorado Silica	5-6 YRDS.	
195	185	Bentonite Clay		
185	110	8-16 Colorado Silica	2-3 YRDS	
110	100	Bentonite Clay		
100	0	NEAT Cement Grout	5 YRDS.	6 Bags to 7 Gallons water

Well Development / Pump or Bail Tests

Date	Method	Yield	Units Check One GPM	Units Check One CFS	DRAWDOWN (ft)	TIME PUMPED (hrs & min)
12/6/95	VERTICAL Turbine - Des. Dive	480	X		180	60 HRS.

Pump (Permanent)

Pump Description: Horsepower: Pump Intake Depth: feet

Approximate maximum pumping rate: Well disinfected upon completion? ☐ Yes ☐ No

Comments Description of construction activity, additional materials used, problems encountered, extraordinary circumstances, abandonment / procedures. *Use additional well data form for more space.*

WELL WAS Developed & Gravel pack Seattle using Surge Blocks & Tools.

Well Driller Statement

This well was drilled or abandoned under my supervision, according to applicable rules and regulations, and this report is complete and correct to the best of my knowledge and belief.

Name Water Well Services Inc. (Person, Firm, or Corporation – Print or Type) License No. 493

Signature (Licensed Well Driller) Date 12-4-95

11 ZM 10-56

W-10

Copied cb 5-21-57
Exam. & Recorded js 3-22-57
Exam. for filing mv 3-27-57
Final Copy checked
Indexed cb 5-15-57
Well No. (D-15-3) 1 acb-1

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Report No. 12709
Filed Dec. 26, 1956
Rec. By: mv
Ret'd

Report of Well and Tunnel Driller
STATE OF UTAH

(Separate report shall be filed for each well or tunnel)

GENERAL INFORMATION:

Report of well or tunnel driller is hereby made and filed with the State Engineer, in accordance with the laws of Utah. (This report shall be filed with the State Engineer within 30 days after the completion or abandonment of well or tunnel. Failure to file such reports constitutes a misdemeanor.)

1. Name and address of ~~person~~, company ~~or corporation boring or~~ drilling well ~~or tunnel~~. (Strike words not needed)

   J.S. Lee and Sons 4091 So. state Street Salt Lake City, Utah

2. Name and address of owner of well ~~or tunnel~~ (Strike Words not needed) Moroni City

   Moroni Utah

3. Source of supply is in Sanpete County; ..... (Leave blank) drainage area; ..... (Leave blank) artesian basin

4. The number of approved application to appropriate water is 27170

5. Location of well ~~or mouth of tunnel~~ is situated at a point

   So. 1460 ft. and E. 2995 ft. from NW Cor. Sec. 9, T15S, R3E, SLB&M.

   (Describe by rectangular co-ordinates or by one course and distance with reference to U. S. Government Survey Corner — Copy description from well owner's approved application)

6. Date on which work on well or ~~tunnel~~ (Strike words not needed) was begun November 1, 1956

7. Date on which work on well ~~or tunnel~~ was completed ~~or abandoned~~ (Strike words not needed) November 16, 1956

8. Maximum quantity of water measured as ~~flowing~~ (Strike words not needed), pumped or ..... on completion of well ~~or tunnel in sec. ft.~~ ..... ; or in gals. per minute 305 Date 11/15/56

DETAIL OF COLLECTING WORKS:

9. **WELL:** It is drilled, ~~dug, flowing or~~ (Strike words not needed) pump well. Temperature of water ..... °F.

   (a) Total depth of well is 338 ft. below ground surface.

   (b) If flowing well, give water pressure (hydrostatic head) above ground surface ..... ft.

   (c) If pump well, give depth from ground surface to water surface before pumping 4 feet ; during pumping 100 feet

   (d) Size and kind of casing 12" Steel (If only partially cased, give details)

   (e) Depth to water-bearing stratum 170' to 338' (If more than one stratum, give depth to each)

   (f) If casing is perforated, give depth from ground surface to perforations .....

   (g) Log of well 0-4 Top Soil 4-13 Clay and Gravel 13-47 Gravel and Bolders 47-90 Hard Pan 90-117 Lava 117-167 Shale 167-318 Sand Stone Streak and lava 318-338 Conglomerate.

   (h) Well was equipped with cap, ~~valve, or~~ (Strike words not needed) Cap to control flow.

(Over)

Entered in Record [illegible]
Entered & Scored 1-21-59
Entered for Filing 1-21-59
Final Copy checked
Indexed
Well No. [illegible]

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Report No. 13817
Filed 1-21-59, 19
Rec. By G.C.F.
Ret'd

Report of Well and Tunnel Driller
STATE OF UTAH

(Separate report shall be filed for each well or tunnel) Job Ld

GENERAL INFORMATION: Mu-3-26 Ah copy OK.

Report of well or tunnel driller is hereby made and filed with the State Engineer, in accordance with the laws of Utah. (This report shall be filed with the State Engineer within 30 days after the completion or abandonment of well or tunnel. Failure to file such reports constitutes a misdemeanor.)

1. Name and address of person, ~~company or corporation~~ doing or drilling well ~~or tunnel~~. (Strike words not needed)
Ben B. Gardner - 868 S. 14th E., Salt Lake City, Utah

2. Name and address of owner of well ~~or tunnel~~ (Strike Words not needed) Moroni City

3. Source of supply is in Sanpete County;
(Leave blank) drainage area; (Leave blank) artesian basin

4. The number of approved application to appropriate water is No. 27170 To Deepen

5. Location of well ~~or tunnel~~ is situated at a point See App. #27170
This report is for deepening job only.
approx 275' W. & 20' N. of SE Cor. Sec. 9, T. 15 S. R. 3 E. (Tie scaled from plat sheets
(Describe by rectangular co-ordinates or by the course and distance with reference to U. S. Government survey Corner — Copy description from well owner's approved application) Quad?

6. Date on which work on well ~~or tunnel~~ was begun (Strike words not needed) Aug. 15, 1958

7. Date on which work on well ~~or tunnel~~ was completed (Strike words not needed) Aug. 20, 1958

8. Maximum quantity of water measured as flowing, pumped or (Strike words not needed) on completion of well or tunnel in sec. ft.; or in gals. per minute 350 Approx Date 8/22/58

DETAIL OF COLLECTING WORKS:

9. WELL: It is drilled, ~~dug, flowing or~~ (Strike words not needed) pump well. Temperature of water °F.

(a) Total depth of well is 607 ft. below ground surface.

(b) If flowing well, give water pressure (hydrostatic head) above ground surface ft.

(c) If pump well, give depth from ground surface to water surface before pumping 4 ft.; during pumping 90 ft.

(d) Size and kind of casing 12" from 0 to 340 ft; ~~10" from 340 to 607 ft.~~
no casing from 340 to 607 as no new water was found

(e) Depth to water-bearing stratum see report for 0 to 340 ft.
(If more than one stratum, give depth to each)

(f) If casing is perforated, give depth from ground surface to perforations
60' to 134 ft.,

(g) Log of well 0 to 340 previously drilled; this job is for deepening from 340 to 607 ft. No new water was found, therefore, hole not cased.
340-404 sandy clay; 404-435 hardpan; 435-537 stickyblue clay; 537-545 hardpan; 545-567 sticky blue clay; 567-575 blueshale; 575-607 gray shale.

(h) Well was equipped with cap, valve, or (Strike words not needed) to control flow.

(Over)

Copied vgh 6-13-50
Exam. & Recorded mv 5-18-50
Exam. for filing
Final Copy checked vgh 6-13-50
Indexed vgh 5-29-50
Well No. D-15-3)10aba-1

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Report No. 7513
Filed Dec. 13, 19 49
Rec. By mv
Ret'd

Report of Well and Tunnel Driller
STATE OF UTAH

(Separate report shall be filed for each well or tunnel)

GENERAL INFORMATION:

Report of well or tunnel driller is hereby made and filed with the State Engineer, in compliance with Sec. 100-3-22, Utah Code Annotated, 1943. (This report shall be filed with the State Engineer within 30 days after the completion or abandonment of well or tunnel. Failure to file such report constitutes a misdemeanor.)

1. Name and address of person, ~~corporation having~~ drilling well ~~or tunnel~~. (Strike words not needed)

Vernon Dimick Manti, Utah

2. Name and address of owner of well ~~or tunnel~~ LaMont Blackham, Moroni, Utah (Strike Words not needed)

3. Source of supply is in Sanpete County;
(Leave blank) drainage area; (Leave blank) artesian basin

4. The number of approved application to appropriate water is A-20680

5. Location of well ~~or mouth of tunnel~~ is situated at a point

South 66 ft. & E. 726 ft. from N¼ Cor. Sec. 10, T15S, R3E, SLB&M.

(Describe by rectangular co-ordinates or by one course and distance with reference to U. S. Government Survey Corner — Copy description from well owner's approved application)

6. Date on which work on well ~~or tunnel~~ was begun June 19,1949 (Strike words not needed)

7. Date on which work on well ~~or tunnel~~ was completed ~~or abandoned~~ Nov. 10, 1949 (Strike words not needed)

8. Maximum quantity of water measured ~~or flowing~~, pumped or on completion of (Strike words not needed)
well ~~or tunnel in excess~~; or in gals. per minute 30 Date 11/10/49

DETAIL OF COLLECTING WORKS:

9. WELL: It is drilled, ~~dug, flowing or~~ pump well. Temperature of water 50 °F. (Strike words not needed)

(a) Total depth of well is 300 ft. below ground surface.

(b) If flowing well, give water pressure (hydrostatic head) above ground surface ft.

(c) If pump well, give depth from ground surface to water surface before pumping 55
; during pumping 180 ft.

(d) Size and kind of casing 6" New Standard 180' of casing (If only partially cased, give details)

(e) Depth to water-bearing stratum 90' 120' 185' (If more than one stratum, give depth to each)

(f) If casing is perforated, give depth from ground surface to perforations None

(g) Log of well 0-5 gravely top soil; 5 to 20 gravel & clay; 20 to 30 clay; 30 to 50 clay & shale; 50 to 55 white sand; 55 to 75 Blue shale; 75 -90 Blue shale; 90-92 sand; 92-120 shale;120-122 sand;122-145 shale;145-185-shale;185-187 sand; 187-200 shale;200-220 clay & shale;220-260 shale; 260-300 shale;

(h) Well was equipped with cap, valve, or to control flow. (Strike words not needed)

(Over)

W-13

Form 113—5M—12-60

Examined .....
Recorded: B. C. ..... T. B. .....
Inspection Sheet .....
Copied .....

REPORT OF WELL DRILLER
STATE OF UTAH

Application No. A65524)
Claim No. 65-2483
Coordinate No. .....

GENERAL STATEMENT: Report of well driller is hereby made and filed with the State Engineer, in accordance with the laws of Utah. (This report shall be filed with the State Engineer within 30 days after the completion or abandonment of the well. Failure to file such reports constitutes a misdemeanor.)

(1) WELL OWNER:
Name Hickenlooper, Sherd, Burke or Dixie
Address P.O. Box 283, Moroni, Ut. 84646

(2) LOCATION OF WELL:
County Sanpete Ground Water Basin (leave blank)
North 2310 feet, ~~East~~ West 1450 feet from SE Corner
of Section 10, T. 15 ~~N~~ S, R. 3 E SLBM (strike out words not needed)

(3) NATURE OF WORK (check): New Well ☑
Replacement Well ☐ Deepening ☐ Repair ☐ Abandon ☐
If abandonment, describe material and procedure: .....

(4) NATURE OF USE (check):
Domestic ☑ Industrial ☐ Municipal ☐ Stockwater ☑
Irrigation ☑ Mining ☐ Other ☐ Test Well ☐

(5) TYPE OF CONSTRUCTION (check):
Rotary ☑ Dug ☐ Jetted ☐
Cable ☐ Driven ☐ Bored ☐

(6) CASING SCHEDULE: Threaded ☐ Welded ☑
6 " Diam. from 0 feet to 40 feet Gage .250
4 " Diam. from 30 feet to 185 feet Gage .237
..... " Diam. from ..... feet to ..... feet Gage .....
New ☑ Reject ☐ Used ☐

(7) PERFORATIONS: Perforated? Yes ☑ No ☐
Type of perforator used Torch
Size of perforations 1/4 inches by 3 inches
25 perforations from 185 feet to 145 feet
..... perforations from ..... feet to ..... feet
..... perforations from ..... feet to ..... feet
..... perforations from ..... feet to ..... feet
..... perforations from ..... feet to ..... feet

(8) SCREENS: Well screen installed? Yes ☐ No ☑
Manufacturer's Name .....
Type ..... Model No. .....
Diam. ..... Slot size ..... Set from ..... ft. to .....
Diam. ..... Slot size ..... Set from ..... ft. to .....

(9) CONSTRUCTION:
Was well gravel packed? Yes ☐ No ☑ Size of gravel: .....
Gravel placed from ..... feet to ..... feet
Was a surface seal provided? Yes ☑ No ☐
To what depth? ..... feet
Material used in seal: Clay
Did any strata contain unusable water? Yes ☐ No ☑
Type of water: ..... Depth of strata .....
Method of sealing strata off: Cased
.....
Was surface casing used? Yes ☐ No ☑
Was it cemented in place? Yes ☐ No ☑

(10) WATER LEVELS:
Static level 100 feet below land surface Date 12/7/91
Artesian pressure ..... feet above land surface Date .....

LOG RECEIVED: DEC 11 1991

(11) FLOWING WELL:
Controlled by (check) Valve ☐
Cap ☐ Plug ☐ No Control ☐
Does well leak around casing? Yes ☐ No ☐

(12) WELL TESTS: Drawdown is the distance in feet the water level is lowered below static level.
Was a pump test made? Yes ☐ No ☐ If so, by whom? .....
Yield: ..... gal./min. with ..... feet drawdown after ..... hours
" ..... " ..... " ..... " .....
" ..... " ..... " ..... " .....
Bailer test ..... gal./min. with ..... feet drawdown after ..... hours
Artesian flow ..... g.p.m. Date .....
Temperature of water ..... Was a chemical analysis made? No ☐ Yes ☐

(13) WELL LOG: Diameter of well 6 inches
Depth drilled 185 feet. Depth of completed well 185 feet.

NOTE: Place an "X" in the space or combination of spaces needed to designate the material or combination of materials encountered in each depth interval. Under REMARKS make any desirable notes as to occurrence of water and the color, size, nature, etc., of material encountered in each depth interval. Use additional sheet if needed.

DEPTH From	DEPTH To	MATERIAL Clay	Silt	Sand	Gravel	Cobbles	Boulders	Hardpan	Conglomerate	Bedrock	Other	REMARKS
0	5											Top Soil
5	18	X										Brown
18	19				X							Water
19	20	X										Brown
20	25				X							Water
25	40	X										
40	60										X	Shale, Green, Water
60	80										X	" "
80	100										X	"
100	120										X	"
120	140										X	"
140	160										X	" Water
160	185										X	" Water

Work started Dec. 3 1991 Completed Dec 7 1991

(14) PUMP:
Manufacturer's Name .....
Type: ..... H. P. .....
Depth to pump or bowles ..... feet

Well Driller's Statement:
This well was drilled under my supervision, and this report is true to the best of my knowledge and belief.
Name BINNING DRILLING COMPANY (Person, firm, or corporation) (Type or print)
Address R.R.1, Box 27-A
(Signed) L. Binning (Well Driller)
License No. 243 Date Dec. 9, 1991

USE OTHER SIDE FOR ADDITIONAL REMARKS

updated Other Item

Need Permit No

Verbal

W-14

Form 113—5M—12-60

Examined MAR - 6 1980 KKL

Recorded: B. C. T. B.

Inspection Sheet

Copied

REPORT OF WELL DRILLER
STATE OF UTAH

Application No. 53171 (65-2045)

Claim No.

Coordinate No. (D 15-7) 10 bda

GENERAL STATEMENT: Report of well driller is hereby made and filed with the State Engineer, in accordance with the laws of Utah. (This report shall be filed with the State Engineer within 30 days after the completion or abandonment of the well. Failure to file such reports constitutes a misdemeanor.)

(1) WELL OWNER:
Name Bill Davidson
Address Murray, UT

(2) LOCATION OF WELL:
County Sanpete Ground Water Basin (leave blank)
~~North~~ South 1400 feet, East ~~West~~ 2200 feet from NW Corner of Section 10, T 15S, R 3E E SLBM (strike out words not needed)

(3) NATURE OF WORK (check): New Well ☑ Replacement Well ☐ Deepening ☐ Repair ☐ Abandon ☐
If abandonment, describe material and procedure:

(4) NATURE OF USE (check):
Domestic ☑ Industrial ☐ Municipal ☐ Stockwater ☑
Irrigation ☑ Mining ☐ Other ☐ Test Well ☐

(5) TYPE OF CONSTRUCTION (check):
Rotary ☑ Dug ☐ Jetted ☐
Cable ☐ Driven ☐ Bored ☐

(6) CASING SCHEDULE: Threaded ☐ Welded ☑
10 " Diam. from 0 feet to 41 feet Gage .250
" Diam. from feet to feet Gage
" Diam. from feet to feet Gage
New ☑ Reject ☐ Used ☐

(7) PERFORATIONS: Perforated? Yes ☑ No ☐
Type of perforator used CUTTING TORCH
Size of perforations 4½ inches by ¼ inches
100 perforations from 220 feet to 260 feet
perforations from feet to feet
perforations from feet to feet
perforations from feet to feet
perforations from feet to feet

(8) SCREENS: Well screen installed? Yes ☐ No ☑
Manufacturer's Name
Type Model No.
Diam. Slot size Set from ft. to
Diam. Slot size Set from ft. to

(9) CONSTRUCTION:
Was well gravel packed? Yes ☐ No ☑ Size of gravel:
Gravel placed from feet to feet
Was a surface seal provided? Yes ☑ No ☐
To what depth? 18 feet
Material used in seal: BENT CLAY
Did any strata contain unusable water? Yes ☐ No ☐
Type of water: Depth of strata
Method of sealing strata off:

Was surface casing used? Yes ☑ No ☐
Was it cemented in place? Yes ☐ No ☑

(10) WATER LEVELS:
Static level feet below land surface Date
Artesian pressure feet above land surface Date

DATE RECEIVED: FEB 25 1980
WATER RIGHTS

(11) FLOWING WELL:
Controlled by (check) Valve ☐
Cap ☐ Plug ☐ No Control ☐
Does well leak around casing? Yes ☐ No ☐

(12) WELL TESTS: Drawdown is the distance in feet the water level is lowered below static level.
Was a pump test made? Yes ☑ No ☐ If so, by whom? Artesian flow
Yield: 100 gal./min. with feet drawdown after hours
" " " " " "
" " " " " "
Bailer test gal./min. with feet drawdown after hours
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? No ☐ Yes ☐

(13) WELL LOG: Diameter of well 6" inches
Depth drilled 260 feet. Depth of completed well 260 feet.

NOTE: Place an "X" in the space or combination of spaces needed to designate the material or combination of materials encountered in each depth interval. Under REMARKS make any desirable notes as to occurrence of water and the color, size, nature, etc., of material encountered in each depth interval. Use additional sheet if needed.

DEPTH From	DEPTH To	Clay	Silt	Sand	Gravel	Cobbles	Boulders	Hardpan	Conglomerate	Bedrock	Other	REMARKS
0	41	X	X	X								Silty Sand, Clay, Large amount of surface water at 25 Ft. Will cased this off due to being sandy
41	220	X						X				White, Bentinite type clay hardpan
220	260	X							X			Blue clay, with layer of soft Brown Sandstone water in all these Sandstone layers

Work started JAN 2, 19 80 Completed JAN 3, 19 80

(14) PUMP:
Manufacturer's Name
Type: H. P.
Depth to pump or bowles feet

Well Driller's Statement:
This well was drilled under my supervision, and this report is true to the best of my knowledge and belief.
Name Clear Water Drilling (Person, firm, or corporation) (Type or print)
Address P.O. Box 142, Spring City, UT 84662
(Signed) C. E. Epple (Well Driller)
License No. 432 Date Jan 26, 19 80

USE OTHER SIDE FOR ADDITIONAL REMARKS

W-15 (1/3)

WELL DRILLER'S REPORT

State of Utah
Division of Water Rights
For additional space, use "Additional Well Data Form" and attach

RECEIVED
AUG 27 2001
WATER RIGHTS
SALT LAKE

Well Identification CHANGE APPLICATION: a25621(65-2992)

Owner *Note any changes*

Despain, Reta C. and Irell O.
1171 East 300 N.
Orem, UT 84097

Contact Person/Engineer: _____

Well Location *Note any changes*

COUNTY: Sanpete
NORTH 220 feet WEST 1370 feet from the E4 Corner of
SECTION 11, TOWNSHIP 15S, RANGE 3E, SLB&M.

Location Description: (address, proximity to buildings, landmarks, ground elevation, local well #) 2 miles East of Moroni

Drillers Activity

Start Date: Aug 7 01 Completion Date: Aug 20, 01

Check all that apply: ☑ New ☐ Repair ☑ Deepen ☐ Clean ☐ Replace ☐ Public Nature of Use:

If a replacement well, provide the location of the new well. ____ feet north/south and ____ feet east/west of the existing well.

DEPTH (feet) FROM	TO	BOREHOLE DIAMETER (in)	DRILLING METHOD	DRILLING FLUID
0	30	10"	Mud Rotary	Water
30	274	7⅞	Air Lobby	"

Well Log

DEPTH (feet) FROM	TO	WATER	PERMEABLE high	PERMEABLE low	UNCONSOLIDATED CLAY	SILT	SAND	GRAVEL	COBBLES	BOULDER	OTHER	CONSOLIDATED ROCK TYPE	COLOR	DESCRIPTIONS AND REMARKS (e.g., relative %, grain size, sorting, angularity, bedding, grain composition, density, plasticity, shape, cementation, consistancy, water bearing, odor, fracturing. minerology, texture. degree of weathering, hardness, water quality, etc.)
0	10				✓	✓	✓					Sedimentary	grey + tan	
10	22				✓	✓							white	
22	57				✓	✓	✓						grey	
57	59							✓					"	⅜" Streambed gravel
59	87				✓	✓							"	
87	90							✓					"	⅛" gravel
90	112					✓			✓				"	
112	187				✓				✓				grey/tan	Periodic Rocks
187	190	✓	✓	✓	✓	✓							"	not enough water to bring to surface without foam
190	259				✓				✓				"	

Static Water Level

Date Aug 20, 01 Water Level 95' feet Flowing? ☐ Yes ☑ No

Method of Water Level Measurement Dry String If Flowing. Capped Pressure NA PSI

Point to Which Water Level Measurement was Referenced ground Surface Ground Elevation (If known) _____

Height of Water Level reference point above ground surface 0 feet Temperature 53 approx ☐ °C ☑ °F

SCANNED

Well Log

Construction Information

DEPTH (feet) FROM	DEPTH (feet) TO	CASING: CASING TYPE AND MATERIAL/GRADE	WALL THICK (in)	NOMINAL DIAM. (in)	DEPTH (feet) FROM	DEPTH (feet) TO	☐ SCREEN ☑ PERFORATIONS ☐ OPEN BOTTOM: SCREEN SLOT SIZE OR PERF SIZE (in)	SCREEN DIAM. OR PERF LENGTH (in)	SCREEN TYPE OR NUMBER PERF (per round/interval)
+2'	270	Steel 6"	.250	6 5/8 OD	260	270	1/8	4"	60 total

Well Head Configuration: Steel Pipe 2' above ground — Access Port Provided? ☑ Yes ☐ No

Casing Joint Type: Welded — Perforator Used: torch cut

Was a Surface Seal installed? ☑ Yes ☐ No — Depth of Surface Seal: 30' feet — Drive Shoe? ☐ Yes ☑ No

Surface Seal Material Placement Method: Grout Pump & Tremmie Pipe

Provide Seal Material description below:

DEPTH (feet) FROM	DEPTH (feet) TO	SURFACE SEAL / INTERVAL SEAL / FILTER PACK / PACKER INFORMATION: SEAL MATERIAL, FILTER PACK and PACKER TYPE and DESCRIPTION	Quantity of Material Used (if applicable)	GROUT DENSITY (lbs./gal.,# bag mix, gal./sack etc.)
0	30	Bentonite - Baroid Benseal	350#	

Well Development and Well Yield Test Information

Date	Method	Yield	Units Check One GPM	Units Check One CFS	DRAWDOWN (ft)	TIME PUMPED (hrs & min)
Aug 2001	Air Lift + Bailer	25	✓		—	2 hrs.

Pump (Permanent)

Pump Description: _____ Horsepower: _____ Pump Intake Depth: _____ feet

Approximate maximum pumping rate: _____ Well disinfected upon completion? ☑ Yes ☐ No

Comments

Description of construction activity, additional materials used, problems encountered, extraordinary circumstances, abandonment procedures. *Use additional well data form for more space.*

Well Driller Statement

This well was drilled and constructed under my supervision, according to applicable rules and regulations, and this report is complete and correct to the best of my knowledge and belief.

Name Ralph Brotherson Drilling (Person, Firm, or Corporation - Print or Type) License No. 657

Signature Ralph McKean Brotherson (Licensed Driller) Date Aug 20, 01

ADDITIONAL WELL DATA FORM

W-15 (3/3)

Water Right # a25621 (65-2992)

OWNER NAME Orell D. + Reta C. Despain

Well Log DEPTH (feet) FROM	TO	WATER	PERMEABLE high	PERMEABLE low	UNCONSOLIDATED CLAY	SILT	SAND	GRAVEL	COBBLES	BOULDER	OTHER	CONSOLIDATED ROCK TYPE	COLOR	DESCRIPTIONS AND REMARKS (e.g. relative %, grain size, sorting, angularity, bedding, grain composistion, density, plasticity, shape, cementation, consistancy, water bearing, odor, fracturing, minerology, texture, degree of weathering, hardness, water quality, etc.)
259	270	✓	✓			✓	✓	✓				gray	gray	
270	274				✓							tan gray	tan gray	

WLI

WELL DRILLER'S REPORT
State of Utah
Division of Water Rights

96160

W-16 (1/2)

For additional space, use "Additional Well Data Form" and attach

RECEIVED
MAR 14 1996
WATER RIGHTS
SALT LAKE

Well Identification WATER RIGHT APPLICATION: 65-2684(A69207)

Owner *Note any changes*
Alsop, Michael and Nancy
488 East Magellan Ln
Elk ridge, UT 84651

Contact Person/Engineer:

Well Location *Note any changes*
COUNTY: Sanpete
SOUTH 1230 feet WEST 52 feet from the E¼ Corner of
SECTION 11, TOWNSHIP 15S, RANGE 3E, SLB&M.

Location Description: (address, proximity to buildings, landmarks, ground elevation, local well #) 2 miles east of Moroni

Drillers Activity Start Date: 3-4-96 Completion Date: 3-16-96

Check all that apply:
☒ New ☐ Repair ☐ Deepen ☐ Abandon ☐ Replace ☐ Public Nature of Use: IRR, STK, DOM

DEPTH (feet) FROM	TO	BOREHOLE DIAMETER (in)	DRILLING METHOD	DRILLING FLUID
0	243'	6"	Air Rotary	Air + water

Well Log

DEPTH (feet) FROM	TO	WATER	PERMEABLE high	PERMEABLE low	UNCONSOLIDATED CLAY	SILT	SAND	GRAVEL	COBBLES	BOULDER	OTHER	CONSOLIDATED ROCK TYPE	COLOR	DESCRIPTIONS AND REMARKS (include comments on *water quality* if known.)
0'	9'			X	X								TAN	
9'	16'	X	X					X					"	
16'	18'			X									"	
18	160			X							X	Shale	Green	Green / Gray 5 GPM at 160'
160	243	X									X	"	"	230' water 100 GPM

Static Water Level

Date 3-16-96 Water Level +2' feet Flowing? ☒ Yes ☐ No

Method of Water Level Measurement _____ If Flowing, Capped Pressure 15 PSI

Point to Which Water Level Measurement was Referenced top of Casing

Height of Water Level reference point above ground surface 2' feet Temperature _____ ☐ °C ☐ °F

[redacted] *Well Log* [redacted]

Construction Information

DEPTH (feet) FROM	DEPTH (feet) TO	CASING: CASING TYPE AND MATERIAL/GRADE	CASING: WALL THICK (in)	CASING: NOMINAL DIAM. (in)	DEPTH (feet) FROM	DEPTH (feet) TO	SCREEN ☐ PERFORATIONS ☐: SLOT SIZE OR PERF SIZE (in)	SCREEN DIAM. OR PERF LENGTH (in)	SCREEN TYPE OR NUMBER PERF (per round/interval)
0	20'	STeel	.250	6"	200	243'	1/16"	6"	4 Row's
5'	243'	P.V.C., Sec, 40		4"					

Well Head Configuration: Well Seal 6" Access Port Provided? ☒ Yes ☐ No

Casing Joint Type: Welded Perforator Used: SAW

DEPTH (feet) FROM	DEPTH (feet) TO	FILTER PACK / GROUT / PACKER / ABANDONMENT MATERIAL: ANNULAR MATERIAL, ABANDONMENT MATERIAL and/or PACKER DESCRIPTION	Quantity of Material Used (if applicable)	GROUT DENSITY (lbs./gal.,# bag mix, gal./sack etc.)
0'	18'	Bentonite	1-Bag	Dry

Well Development / Pump or Bail Tests

Date	Method	Yield	Units Check One: GPM	Units Check One: CFS	DRAWDOWN (ft)	TIME PUMPED (hrs & min)
3-16-96	Flowing well	100	X		0	1 Hr

Pump (Permanent)

Pump Description: Horsepower: Pump Intake Depth: feet

Approximate maximum pumping rate: Well disinfected upon completion? ☐ Yes ☐ No

Comments Description of construction activity, additional materials used, problems encountered, extraordinary circumstances, abandonment / procedures. *Use additional well data form for more space.*

Flowing well

Well Driller Statement

This well was drilled or abandoned under my supervision, according to applicable rules and regulations, and this report is complete and correct to the best of my knowledge and belief.

Name Miller Drilling INC (Person, Firm, or Corporation – Print or Type) License No. 292

Signature Everett Miller (Licensed Well Driller) Date 3-13-96

W-17 (1/3)

WELL DRILLER'S REPORT

State of Utah
Division of Water Rights
For additional space, use "Additional Well Data Form" and attach

RECEIVED
DEC 30 2002
WATER RIGHTS
SALT LAKE

Well Identification CHANGE APPLICATION: a26145(65-3423)

Owner *Note any changes*
PSA & Sons Inc.
P.O. Box 185
Moroni, UT 84646

Contact Person/Engineer: _____

Well Location *Note any changes*
COUNTY: Sanpete
NORTH 1385 feet WEST 915 feet from the S4 Corner of
SECTION 15, TOWNSHIP 15S, RANGE 3E, SLB&M.

Location Description: (address, proximity to buildings, landmarks, ground elevation, local well #) 1 mile South of Moroni

Drillers Activity
Start Date: Aug 14, 2002 Completion Date: Aug 20, 2002
Check all that apply: ☐ New ☐ Repair ☐ Deepen ☐ Clean ☒ Replace ☐ Public Nature of Use:
If a replacement well, provide the location of the new well. ____ feet north/south and ____ feet east/west of the existing well.

DEPTH (feet) FROM	TO	BOREHOLE DIAMETER (in)	DRILLING METHOD	DRILLING FLUID
0	16	8 3/4"	AIR ROTARY	FOAM WATER
16	100	6"	"	"
100	160	5 7/8"	"	"

Well Log

DEPTH (feet) FROM	TO	WATER	PERMEABLE high	PERMEABLE low	UNCONSOLIDATED CLAY	SILT	SAND	GRAVEL	COBBLES	BOULDER	OTHER	CONSOLIDATED ROCK TYPE	COLOR	DESCRIPTIONS AND REMARKS (e.g., relative %, grain size, sorting, angularity, bedding, grain composition, density, plasticity, shape, cementation, consistancy, water bearing, odor, fracturing, minerology, texture, degree of weathering, hardness, water quality, etc.)
0	6				X									
6	16						X	X	X					
16	30	X	X				X	X	X					
30	35				X									
35	40	X	X				X	X	X					
40	60				X			X						
60	80											SHALE	GREEN GRAY	
80	100	X		X								"	"	FRACTURING 90'
100	120											"	GRAY	
120	140											"	"	

Static Water Level
Date Aug 20, 2002 Water Level 9 feet Flowing? ☐ Yes ☒ No
Method of Water Level Measurement TAPE If Flowing, Capped Pressure _____ PSI
Point to Which Water Level Measurement was Referenced TOP OF CASING Ground Elevation (If known) _____
Height of Water Level reference point above ground surface 18" feet Temperature N/A ☐ °C ☐ °F

Well Log

W-17 (2/3)

Construction Information

DEPTH (feet) FROM	TO	CASING: CASING TYPE AND MATERIAL/GRADE	WALL THICK (in)	NOMINAL DIAM. (in)	DEPTH (feet) FROM	TO	☐ SCREEN ☒ PERFORATIONS ☒ OPEN BOTTOM: SCREEN SLOT SIZE OR PERF SIZE (in)	SCREEN DIAM. OR PERF LENGTH (in)	SCREEN TYPE OR NUMBER PERF (per round/interval)
0	100	A53.B	.250	6"	90	100	1/8"	8"	6PERS PER FT
91	160	"	.237	4"	140	160	"	"	"

Well Head Configuration: WELDED lid — Access Port Provided? ☐ Yes ☒ No

Casing Joint Type: WELDED — Perforator Used: Mill Slot

Was a Surface Seal installed? ☒ Yes ☐ No — Depth of Surface Seal: 30 feet — Drive Shoe? ☒ Yes ☐ No

Surface Seal Material Placement Method: UNHYDRATED BENTONITE POURED INTO ANNULAS AND FILLED FROM BOTTOM UP — Provide Seal Material description below:

DEPTH (feet) FROM	TO	SURFACE SEAL / INTERVAL SEAL / FILTER PACK / PACKER INFORMATION: SEAL MATERIAL, FILTER PACK and PACKER TYPE and DESCRIPTION	Quantity of Material Used (if applicable)	GROUT DENSITY (lbs./gal.,# bag mix, gal./sack etc.)
0	30	UNHYDRATED BENTONITE	200 lbs	

Well Development and Well Yield Test Information

Date	Method	Yield	Units Check One GPM	Units Check One CFS	DRAWDOWN (ft)	TIME PUMPED (hrs & min)
8-20-2002	AIR LIFT		35			2HRS

Pump (Permanent)

Pump Description: _____ Horsepower: _____ Pump Intake Depth: _____ feet

Approximate maximum pumping rate: _____ Well disinfected upon completion? ☒ Yes ☐ No

Comments

Description of construction activity, additional materials used, problems encountered, extraordinary circumstances, abandonment procedures. *Use additional well data form for more space.*

5/8" STEEL RING WAS WELDED AROUND CASING TO HELP TAKE SEAL DEEPER. STEEL RING IS SET AT 40'.

Well Driller Statement

This well was drilled and constructed under my supervision, according to applicable rules and regulations, and this report is complete and correct to the best of my knowledge and belief.

Name FAIRVIEW Drilling & Pump Service (Person, Firm, or Corporation - Print or Type) License No. 728

Signature KEITH Young (Licensed Well Driller) Date 12-7-02

ADDITIONAL WELL DATA FORM

W-17 (3/3)

Water Right # 926145 (65-3493

OWNER NAME PSA & Sons INC

Page ____ of ____

Well Log DEPTH (feet) FROM	TO	WATER	PERMEABLE high	PERMEABLE low	UNCONSOLIDATED CLAY	SILT	SAND	GRAVEL	COBBLES	BOULDER	OTHER	CONSOLIDATED ROCK TYPE	COLOR	DESCRIPTIONS AND REMARKS (e.g. relative %, grain size, sorting, angularity, bedding, grain composition, density, plasticity, shape, cementation, consistency, water bearing, odor, fracturing, mineralogy, texture, degree of weathering, hardness, water quality, etc.)
140	160											STAK	GRAY	FRACTURES 135-160

Form 113—5M—12-60

Examined .....
Recorded: E. C. ..... T. B. .....
Inspection Sheet .....
Copied .....

REPORT OF WELL DRILLER
STATE OF UTAH

Application No. A 63256
Claim No. (65-2389)
Coordinate No. .....

GJ

GENERAL STATEMENT: Report of well driller is hereby made and filed with the State Engineer, in accordance with the laws of Utah. (This report shall be filed with the State Engineer within 30 days after the completion or abandonment of the well. Failure to file such reports constitutes a misdemeanor.)

(1) WELL OWNER: Joel Ipsen and Mary Franklin
Name .....
Address P.O. Box 204, Mapleton, Ut.

(2) LOCATION OF WELL:
County Sanpete Ground Water Basin ..... (leave blank)
South 1550 feet, East 1250 feet from NW Corner of Section 15, T. 15 S, R. 3 E SLBM (strike out words not needed)

(3) NATURE OF WORK (check): New Well ☑
Replacement Well ☐ Deepening ☐ Repair ☐ Abandon ☐
If abandonment, describe material and procedure: .....

(4) NATURE OF USE (check):
Domestic ☑ Industrial ☐ Municipal ☐ Stockwater ☑
Irrigation ☑ Mining ☐ Other ☐ Test Well ☐

(5) TYPE OF CONSTRUCTION (check):
Rotary ☑ Dug ☐ Jetted ☐
Cable ☐ Driven ☐ Bored ☐

(6) CASING SCHEDULE: Threaded ☐ Welded ☑
6 " Diam. from 0 feet to 80 feet Gage Std.
40 " Diam. from 75 feet to 185 feet Gage .137
" Diam. from ..... feet to ..... feet Gage .....
New ☑ Reject ☐ Used ☐

(7) PERFORATIONS: Perforated? Yes ☑ No ☐
Type of perforator used Torch
Size of perforations 1/4 inches by 2 inches
20 perforations from 160 feet to 185 feet
..... perforations from ..... feet to ..... feet
..... perforations from ..... feet to ..... feet
..... perforations from ..... feet to ..... feet
..... perforations from ..... feet to ..... feet

(8) SCREENS: Well screen installed? Yes ☐ No ☑
Manufacturer's Name .....
Type ..... Model No. .....
Diam. ..... Slot size ..... Set from ..... ft. to .....
Diam. ..... Slot size ..... Set from ..... ft. to .....

(9) CONSTRUCTION:
Was well gravel packed? Yes ☐ No ☑ Size of gravel: .....
Gravel placed from ..... feet to ..... feet
Was a surface seal provided? Yes ☐ No ☑
To what depth? ..... feet
Material used in seal: .....
Did any strata contain unusable water? Yes ☐ No ☑
Type of water: ..... Depth of strata .....
Method of sealing strata off: .....

Was surface casing used? Yes ☐ No ☑
Was it cemented in place? Yes ☐ No ☑

(10) WATER LEVELS:
Static level 2 feet below land surface Date 7/17/88
Artesian pressure ..... feet above land surface Date .....

RECEIVED
LOG RECEIVED: JUL 22 1988
WATER RIGHTS SALT LAKE

(11) FLOWING WELL:
Controlled by (check) Valve ☐
Cap ☐ Plug ☐ No Control ☐
Does well leak around casing? Yes ☐ No ☐

(12) WELL TESTS: Drawdown is the distance in feet the water level is lowered below static level.
Was a pump test made? Yes ☐ No ☐ If so, by whom? .....
Yield: ..... gal./min. with ..... feet drawdown after ..... hours
" ..... " ..... " ..... "
" ..... " ..... " ..... "
Bailer test ..... gal./min. with ..... feet drawdown after ..... hours
Artesian flow ..... g.p.m. Date .....
Temperature of water ..... Was a chemical analysis made? No ☐ Yes ☐

(13) WELL LOG: Diameter of well 6 inches
Depth drilled 185 feet. Depth of completed well 185 feet.

NOTE: Place an "X" in the space or combination of spaces needed to designate the material or combination of materials encountered in each depth interval. Under REMARKS make any desirable notes as to occurrence of water and the color, size, nature, etc., of material encountered in each depth interval. Use additional sheet if needed.

DEPTH From	DEPTH To	Clay	Silt	Sand	Gravel	Cobbles	Boulders	Hardpan	Conglomerate	Bedrock	Other	REMARKS
0	6	X			X							
6	20	X			X							
20	40	X			X							Water
40	60	X			X							
60	80	X			X							
80	100	X			X							
100	120	X			X							
120	140	X			X							
140	160			X	X							Water
160	185			X	X							

Work started July 14, 1988 Completed July 17, 1988

(14) PUMP:
Manufacturer's Name .....
Type: ..... H. P. .....
Depth to pump or bowles ..... feet

Well Driller's Statement:
This well was drilled under my supervision, and this report is true to the best of my knowledge and belief.
Name BINNING Drlg. Co. (Person, firm, or corporation) (Type or print)
Address 1085 E. 150 North, Fairview, Ut. 84629
(Signed) L. Binning (Well Driller)
License No. 243 Date July 20, 1988

USE OTHER SIDE FOR ADDITIONAL REMARKS

Card sent 11-16-84
Log sent 12-3-84

Form 115—SM—12-60

W-19

Examined .....
Recorded: B. C. ..... T. B. .....
Inspection Sheet .....
Copied .....

REPORT OF WELL DRILLER
STATE OF UTAH

Application No. C23166 (T)
Claim No. (65-2305)
Coordinate No. .....

GENERAL STATEMENT: Report of well driller is hereby made and filed with the State Engineer, in accordance with the laws of Utah. (This report shall be filed with the State Engineer within 30 days after the completion or abandonment of the well. Failure to file such reports constitutes a misdemeanor.)

(1) WELL OWNER:
Name Evans, Bruce
Address Box 346, Moroni

(2) LOCATION OF WELL:
County Sanpete Ground Water Basin (leave blank)
950 feet, South East 150 feet from NW Corner
of Section 15, T. 15 S, R. 3 E SLBM (strike out words not needed)

(3) NATURE OF WORK (check): New Well ☐
Replacement Well ☑ Deepening ☐ Repair ☐ Abandon ☐
If abandonment, describe material and procedure: .....

(4) NATURE OF USE (check):
Domestic ☑ Industrial ☐ Municipal ☐ Stockwater ☑
Irrigation ☑ Mining ☐ Other ☐ Test Well ☐

(5) TYPE OF CONSTRUCTION (check):
Rotary ☑ Dug ☐ Jetted ☐
Cable ☐ Driven ☐ Bored ☐

(6) CASING SCHEDULE: Threaded ☐ Welded ☑
6 " Diam. from 0 feet to 140 feet Gage 280
" Diam. from ..... feet to ..... feet Gage .....
" Diam. from ..... feet to ..... feet Gage .....
New ☑ Reject ☐ Used ☐

(7) PERFORATIONS: Perforated? Yes ☐ No ☑
Type of perforator used .....
Size of perforations ..... inches by ..... inches
..... perforations from ..... feet to ..... feet
..... perforations from ..... feet to ..... feet
..... perforations from ..... feet to ..... feet
..... perforations from ..... feet to ..... feet
..... perforations from ..... feet to ..... feet

(8) SCREENS: Well screen installed? Yes ☐ No ☑
Manufacturer's Name .....
Type ..... Model No. .....
Diam. ..... Slot size ..... Set from ..... ft. to .....
Diam. ..... Slot size ..... Set from ..... ft. to .....

(9) CONSTRUCTION:
Was well gravel packed? Yes ☐ No ☑ Size of gravel: .....
Gravel placed from ..... feet to ..... feet
Was a surface seal provided? Yes ☐ No ☑
To what depth? ..... feet
Material used in seal: .....
Did any strata contain unusable water? Yes ☐ No ☑
Type of water: ..... Depth of strata .....
Method of sealing strata off: .....
Was surface casing used? Yes ☐ No ☑
Was it cemented in place? Yes ☐ No ☑

(10) WATER LEVELS:
Static level 30 feet below land surface Date Nov 16, 84
Artesian pressure ..... feet above land surface Date .....

(11) FLOWING WELL:
Controlled by (check) Valve ☐
Cap ☐ Plug ☐ No Control ☐
Does well leak around casing? Yes ☐ No ☐

(12) WELL TESTS: Drawdown is the distance in feet the water level is lowered below static level.
Was a pump test made? Yes ☐ No ☐ If so, by whom? .....
Yield: ..... gal./min. with ..... feet drawdown after ..... hours
" ..... " ..... " ..... "
" ..... " ..... " ..... "
Bailer test ..... gal./min. with ..... feet drawdown after ..... hours
Artesian flow ..... g.p.m. Date .....
Temperature of water ..... Was a chemical analysis made? No ☐ Yes ☐

(13) WELL LOG: Diameter of well 6 inches
Depth drilled 215 feet. Depth of completed well 215 feet.

NOTE: Place an "X" in the space or combination of spaces needed to designate the material or combination of materials encountered in each depth interval. Under REMARKS make any desirable notes as to occurrence of water and the color, size, nature, etc., of material encountered in each depth interval. Use additional sheet if needed.

DEPTH From	DEPTH To	Clay	Silt	Sand	Gravel	Cobbles	Boulders	Hardpan	Conglomerate	Bedrock	Other	REMARKS
0	5											Top Soil
5	20	X										
20	40			X	X							Water
40	80	X										
80	100	X		X								
100	120	X										
120	140	X										
140	165	X										Grey Clay
165	167			X	X							Water
167	180	X			X							
180	200	X										
200	215		X		X							Water

Work started Nov. 14, 1984 completed Nov. 16, 1984

(14) PUMP:
Manufacturer's Name .....
Type: ..... H. P. .....
Depth to pump or bowles ..... feet

Well Driller's Statement:
This well was drilled under my supervision, and this report is true to the best of my knowledge and belief.
Name Binning Drilling Co. (Person, firm, or corporation) (Type or print)
Address 227 S. 400 West, Payson, Ut.
(Signed) Peter L. Binning (Well Driller)
License No. 243 Date Dec. 3, 1984

RECEIVED
JAN 14 1985
WATER RIGHTS
SALT LAKE

USE OTHER SIDE FOR ADDITIONAL REMARKS

U-2064

c# 8259

UTAH EMERGENCY DROUTH RELIEF WELLS AND SUMPS

Well #1

Project No. 796, 1282 & 1544 Flowing Pump Well X Sump

Sponsor Will L. Irons & Son, Moroni, Ut. Agent Elmo L. Irons

County Sanpete. P.O. Adress Moroni

General Location Blackhams Ranch - Field Road - Lot 16.

N 54° 55' E 1156.5' from

Location E. ½ SW¼, Section 16 / 5 Township 15 S. Range 3 E. [(D-15-3)15ccd-1]

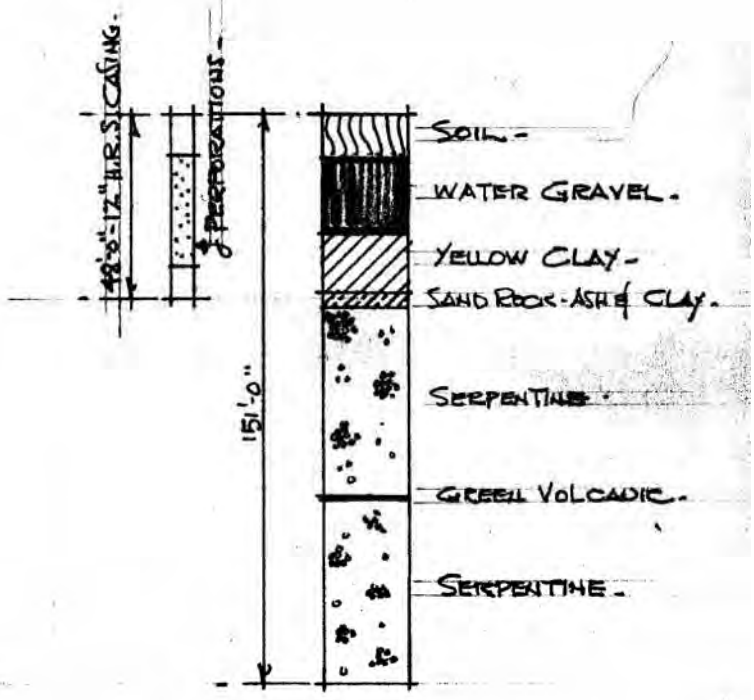
Elevation _____ Total Depth 151' Size 12" G.P.M. 525

Static Head _____ Depth to Water Surface 14' Draw Down 58 ½

Driller Charles M. Erb. (D-15-3) 15ccd-1)

L O G

0-11	Soil
11-31	(Water) gravel
31-47	Yellow clay
47-50	Sand rock ash & clay
50-101	Serpentine
101-102	Green Volcanic
102-151	Serpentine



Remarks: Completed Aug. 26, 1934 in 3 days.

Casing and Pump Data: 151' deep - cased 48' of 12" H. R. S. Perforated 10-40'. 200 holes each 1½".

Copied vgh 1-21-51
Exam. & Recorded mv 12-10-51
Exam. for filing mv 12-10-51
Final Copy checked
Indexed vgh 12-11-51
Well No. D-15-3)16abc-1

W-21 (Turkey Plant Well #1

PAGE (Leave Blank)

Report No. 8985
Filed Dec. 6, 19 51
Rec. By mv
Ret'd

Report of Well and Tunnel Driller
STATE OF UTAH

(Separate report shall be filed for each well or tunnel)

GENERAL INFORMATION:

Report of well or tunnel driller is hereby made and filed with the State Engineer, in compliance with Sec. 100-3-22, Utah Code Annotated, 1943. (This report shall be filed with the State Engineer within 30 days after the completion or abandonment of well or tunnel. Failure to file such report constitutes a misdemeanor.)

1. Name and address of ~~person~~ company ~~or corporation~~ ~~boring~~ or drilling well ~~or tunnel~~. (Strike words not needed)
J.S.LEE & SONS 4091 South State St., Salt Lake City

2. Name and address of owner of well or ~~tunnel~~ Moroni Turkey Processing Plant (Strike Words not needed)
c/o Lamont Blackham, Moroni, Utah

3. Source of supply is in Sanpete County; (Leave blank) drainage area; (Leave blank) artesian basin

4. The number of approved application to appropriate water is A-23042

5. Location of well ~~or mouth of tunnel~~ is situated at a point
S. 745' & W. 2165 ft. of NE. cor. Sec.16,T15S,R3E, SLM.
(Describe by rectangular co-ordinates or by one course and distance with reference to U. S. Government Survey Corner — Copy description from well owner's approved application)

6. Date on which work on well ~~or tunnel~~ was begun June 26, 1951 (Strike words not needed)

7. Date on which work on well ~~or tunnel~~ was completed ~~or abandoned~~ July 12,1951 (Strike words not needed)

8. Maximum quantity of water measured as flowing/pumped or (Strike words not needed) on completion of well ~~or tunnel in case of~~; or in gals. per minute 500gpm pump. Date 7-12-51 100 gpm flow

DETAIL OF COLLECTING WORKS:

9. WELL: It is drilled, ~~dug~~, flowing ~~or~~ pump well. Temperature of water (Strike words not needed) °F.

(a) Total depth of well is 245 ft. below ground surface.

(b) If flowing well, give water pressure (hydrostatic head) above ground surface ft.

(c) If pump well, give depth from ground surface to water surface before pumping ; during pumping 45 ft

(d) Size and kind of casing 10" ID PE Std Black pipe to 245' (If only partially cased, give details)

(e) Depth to water-bearing stratum 18-27, 40-42, 70-87, 112-113, 150-156, 172-173, 192-194, 224-230 (If more than one stratum, give depth to each)

(f) If casing is perforated, give depth from ground surface to perforations 112-113, 150-156, 172-173, 192-194, 224-230

(g) Log of well 0-5 clay; 5-6 coarse sand;6-18 clay; 18-27 water gravel;27-40 sand clay;40-42 water gravel;42-60 sandy clay; 70-87 water sand; 87-94 clay;94-105 sand; 105-112 sandy clay; 112-113 water gravel; 113-122 sandy clay;122-129 conglomerate; 129-132 sand; 132-138 clay; 138-139 gravel;129-145 sand; 145-150 conglomerate; 150-156 water gravel; 156-160 conglomerate;160-163 sand; 163-172 conglomerate; 172-173 water gravel; 173-192 conglomerate;192-194 water gravel; 194-209 sandy clay; 209-224 conglomerate;224-230 water gravel; 230-245 sandstone.

(h) Well was equipped with cap, valve, or (Strike words not needed) to control flow.

(Over)

Form 115—5M—12-60

Examined
Recorded: B. C. T. B.
Inspection Sheet
Copied

W-22 (City Well #2)

REPORT OF WELL DRILLER
STATE OF UTAH

Application No. 33502 - (65-1704)
Claim No.
Coordinate No.

GENERAL STATEMENT: Report of well driller is hereby made and filed with the State Engineer, in accordance with the laws of Utah. (This report shall be filed with the State Engineer within 30 days after the completion or abandonment of the well. Failure to file such reports constitutes a misdemeanor.)

(1) WELL OWNER:
Name Morem City Corp.
Address Morem Utah

(2) LOCATION OF WELL:
County Sanpete Ground Water Basin (leave blank)
North/South 80 feet, East/West 1042 feet from NE Corner
of Section 16, T. 15 N/S, R. 3 E/W SLBM (strike out words not needed)

(3) NATURE OF WORK (check): New Well ☒
Replacement Well ☐ Deepening ☐ Repair ☐ Abandon ☐
If abandonment, describe material and procedure:

(4) NATURE OF USE (check):
Domestic ☒ Industrial ☒ Municipal ☒ Stockwater ☐
Irrigation ☐ Mining ☐ Other ☐ Test Well ☐

(5) TYPE OF CONSTRUCTION (check):
Rotary ☐ Dug ☐ Jetted ☐
Cable ☒ Driven ☐ Bored ☐

(6) CASING SCHEDULE: Threaded ☐ Welded ☒
12 3/4 OD Diam. from 0 feet to 341 feet Gage .375
" Diam. from feet to feet Gage
" Diam. from feet to feet Gage
New ☒ Reject ☐ Used ☐

(7) PERFORATIONS: Perforated? Yes ☒ No ☐
Type of perforator used Torch
Size of perforations 3/8 inches by 5 inches
220 # perforations from 120 feet to 340 feet
perforations from feet to feet
perforations from feet to feet
perforations from feet to feet
perforations from feet to feet

(8) SCREENS: Well screen installed? Yes ☐ No ☐
Manufacturer's Name
Type Model No.
Diam. Slot size Set from ft. to
Diam. Slot size Set from ft. to

(9) CONSTRUCTION:
Was well gravel packed? Yes ☐ No ☐ Size of gravel:
Gravel placed from feet to feet
Was a surface seal provided? Yes ☒ No ☐
To what depth? 100 + feet
Material used in seal: Cement Grout
Did any strata contain unusable water? Yes ☐ No ☐
Type of water: Depth of strata
Method of sealing strata off: Pumping By Pressure - From 100 ft To Ground Level
Was surface casing used? Yes ☒ No ☐
Was it cemented in place? Yes ☒ No ☐

(10) WATER LEVELS:
Static level 8 feet below land surface Date Feb. 6-78
Artesian pressure feet above land surface Date

LOG RECEIVED: FEB 16 1978

(11) FLOWING WELL:
Controlled by (check) Valve ☐
Cap ☐ Plug ☐ No Control ☐
Does well leak around casing? Yes ☐ No ☐

(12) WELL TESTS: Drawdown is the distance in feet the water level is lowered below static level.
Was a pump test made? Yes ☒ No ☐ If so, by whom? Clair H Stephenson
Yield: 450 gal./min. with 55 feet drawdown after 4 hours
" 625 " " 72 " 8 "
" 900 " " 168 " 12 "
Bailer test 1282 gal./min. with 145 feet drawdown after 24 hours
Artesian flow 195 g.p.m. Date
Temperature of water Was a chemical analysis made? No ☐ Yes ☒

(13) WELL LOG: Diameter of well 12 3/4 O.D. inches
Depth drilled 340 feet. Depth of completed well 340 feet.

NOTE: Place an "X" in the space or combination of spaces needed to designate the material or combination of materials encountered in each depth interval. Under REMARKS make any desirable notes as to occurrence of water and the color, size, nature, etc., of material encountered in each depth interval. Use additional sheet if needed.

DEPTH From	DEPTH To	Clay	Silt	Sand	Gravel	Cobbles	Boulders	Hardpan	Conglomerate	Bedrock	Other	REMARKS
0	5											Top Soil
5	20	X										
20	24	X			X							
24	30				X							Surface Water
30	36	X			X							
36	80											Sand Rock
80	112											Hard Sand Rock
112	298											Sand Rock Water
298	340											Sand Rock Conglomerate Water

Work started Dec. 12, 19 77 Completed Feb. 6, 19 78

(14) PUMP:
Manufacturer's Name
Type: H. P.
Depth to pump or bowles feet

Well Driller's Statement:
This well was drilled under my supervision, and this report is true to the best of my knowledge and belief.
Name Clair H. Stephenson Drlg Co (Person, firm, or corporation) (Type or print)
Address Box 116 Fillmore Utah 84631
(Signed) Clair H. Stephenson (Well Driller)
License No. 126 Date Feb. 6, 19 78

USE OTHER SIDE FOR ADDITIONAL REMARKS

W-23 (Turkey Plant Well #3

Form 113—5M—12-60

Examined
Recorded: B. C. T. B.
Inspection Sheet
Copied

REPORT OF WELL DRILLER
STATE OF UTAH

Change Application No. A-9280 (65-388)
Claim No.
Coordinate No.

GENERAL STATEMENT: Report of well driller is hereby made and filed with the State Engineer, in accordance with the laws of Utah. (This report shall be filed with the State Engineer within 30 days after the completion or abandonment of the well. Failure to file such reports constitutes a misdemeanor.)

(1) WELL OWNER:
Name Moroni Feed Company
Address Moroni, Utah 84646

(2) LOCATION OF WELL:
County Sanpete Ground Water Basin (leave blank)
~~North~~ South 1700 feet, ~~West~~ East 1400 feet from NW Corner of Section 16, T 15 ~~N~~ S, R 3 E SLBM (strike out words not needed)

(3) NATURE OF WORK (check): New Well XX
Replacement Well ☐ Deepening ☐ Repair ☐ Abandon ☐
If abandonment, describe material and procedure:

(4) NATURE OF USE (check):
Domestic ☐ Industrial XX Municipal ☐ Stockwater ☐
Irrigation ☐ Mining ☐ Other ☐ Test Well ☐

(5) TYPE OF CONSTRUCTION (check):
Rotary ☐ Dug ☐ Jetted ☐
Cable XX Driven ☐ Bored ☐

(6) CASING SCHEDULE: Threaded ☐ Welded XX
18 " Diam. from 0 feet to 100 feet Gage .312
14 " Diam. from 0 feet to 425 feet Gage .375
" Diam. from feet to feet Gage
New XX Reject ☐ Used ☐

(7) PERFORATIONS: Perforated? Yes XX No ☐
Type of perforator used Mills
Size of perforations 3 inches by 1/4 inches
30 perforations from 339 feet to 343 feet
15 perforations from 367 feet to 369 feet
30 perforations from 389 feet to 393 feet
perforations from feet to feet
perforations from feet to feet

(8) SCREENS: Well screen installed? Yes ☐ No XX
Manufacturer's Name
Type Model No.
Diam. Slot size Set from ft. to
Diam. Slot size Set from ft. to

(9) CONSTRUCTION:
Was well gravel packed? Yes ☐ No ☐ Size of gravel:
Gravel placed from feet to feet
Was a surface seal provided? Yes XX No ☐
To what depth? 120 feet Between 18" and 14"
Material used in seal: Cement
Did any strata contain unusable water? Yes ☐ No XX
Type of water: Depth of strata
Method of sealing strata off:

Was surface casing used? Yes XX No ☐
Was it cemented in place? Yes XX No ☐

(10) WATER LEVELS:
Static level 90 feet below land surface Date
Artesian pressure feet above land surface Date

LOG RECEIVED: RECEIVED SEP 1 1977 WATER RIGHTS

(11) FLOWING WELL:
Controlled by (check) Valve ✓
Cap ✓ Plug ☐ No Control ☐
Does well leak around casing? Yes ☐ No ✓

(12) WELL TESTS: Drawdown is the distance in feet the water level is lowered below static level.
Was a pump test made? Yes XX No ☐ If so, by whom? Rhodes Bros.
Yield: gal./min. with feet drawdown after hours
" " " " "
" " " " "
Bailer test gal./min. with feet drawdown after hours
Artesian flow 30 g.p.m. Date August 26, 1977
Temperature of water Was a chemical analysis made? No XX Yes ☐

(13) WELL LOG: Diameter of well 14 inches
Depth drilled 425 feet. Depth of completed well 425 feet.

NOTE: Place an "X" in the space or combination of spaces needed to designate the material or combination of materials encountered in each depth interval. Under REMARKS make any desirable notes as to occurrence of water and the color, size, nature, etc., of material encountered in each depth interval. Use additional sheet if needed.

DEPTH From	DEPTH To	Clay	Silt	Sand	Gravel	Cobbles	Boulders	Hardpan	Conglomerate	Bedrock	Other	REMARKS
0	5	X										Light Brown.
20	25											Sandy Clay.
25	28			X	X							
28	35				X							Water.
35	40											Gray Clay.
40	55											Sandy Clay.
55	65											Gray Clay.
65	98								X			
98	102				X							Water.
102	112								X			
112	145											Brown Clay.
145	160											Sandy Clay.
160	165				X							Water.
165	180											Sandy Clay & Gravel Streaks. Water.
180	198											Brown Clay.
198	205				X							Water.
205	215											Brown Clay.
215	220			Gravel Streaks and Brown Clay.								
220	225				X							Water.
225	240											Brown Clay.
240	285				X							Water.
285	290											Brown Clay.
290	300			Coarse Sand, Gravel, Water.								
300	305											Brown Clay.
305	315			X	X							Strdaks.
315	335											Sandy Clay.
335	345			Coarse Sand, Gravel, Water.								
345	365											Sandy Clay.
365	370				X							Water.
370	380											Light Brown Clay.
380	387								X			(See Reverse Side).

Work started July 8, 19 77 Completed August 31, 19 77

(14) PUMP:
Manufacturer's Name
Type: H. P.
Depth to pump bowles feet

Well Driller's Statement:
This well was drilled under my supervision, and this report is true to the best of my knowledge and belief.
Name Gardner Drilling Company (Person, firm, or corporation) (Type or print)
Address 7888 West 2400 South, Magna, Utah 84044
(Signed) Brian P. Gardner (Well Driller)
License No. 63 Date Sept. 1, 1977, 19

USE OTHER SIDE FOR ADDITIONAL REMARKS

W-24 (Turkey Plant Well #2

EVENS & WALLIS - 3-50

260- 23771

Copied
Exam. & Recorded
Exam. for filing
Final Copy checked
Indexed
Well No.

PAGE (Leave Blank)

Report No.
Filed 19
Rec. By
Ret'd

Report of Well and Tunnel Driller
STATE OF UTAH

(Separate report shall be filed for each well or tunnel)

GENERAL INFORMATION:

Report of well or tunnel driller is hereby made and filed with the State Engineer, in compliance with Sec. 100-3-22, Utah Code Annotated, 1943. (This report shall be filed with the State Engineer within 30 days after the completion or abandonment of well or tunnel. Failure to file such report constitutes a misdemeanor.)

Feed Co #2

1. Name and address of ~~driller~~ company ~~or corporation having charge of~~ drilling well ~~owner~~ (Strike words not needed)

J. S. LEE & SONS 4091 South State Street, Salt Lake City 7, Utah

2. Name and address of owner of well ~~owner~~ Moroni Feed Company (Strike Words not needed)

Moroni, Utah

3. Source of supply is in Sanpete County;

(Leave blank) drainage area; (Leave blank) artesian basin

4. The number of approved application to appropriate water is

5. Location of well ~~owner~~ is situated at a point

(Describe by rectangular co-ordinates or by one courses and distance with reference to U. S. Government Survey Corner — Copy description from well owner's approved application)

6. Date on which work on well ~~owner~~ was begun June 3, 1952 (Strike words not needed)

7. Date on which work on well ~~owner~~ was completed ~~owner~~ July 1, 1952 (Strike words not needed)

8. Maximum quantity of water measured as ~~flowing~~ pumped or on completion of (Strike words not needed)

well ~~flowing~~ in sec. ft.; or in gals. per minute 540 Date July 1, 195

DETAIL OF COLLECTING WORKS:

9. WELL: It is drilled, ~~dug or bored~~ pump well. Temperature of water °F. (Strike words not needed)

(a) Total depth of well is 268' ft. below ground surface.

(b) If flowing well, give water pressure (hydrostatic head) above ground surface ft.

(c) If pump well, give depth from ground surface to water surface before pumping 2 Ft.

; during pumping 80 Ft.

(d) Size and kind of casing 16" ID FE Std Black Pipe to 77' and 12" ID FE Std Black Pipe to 268' (If only partially cased, give details)

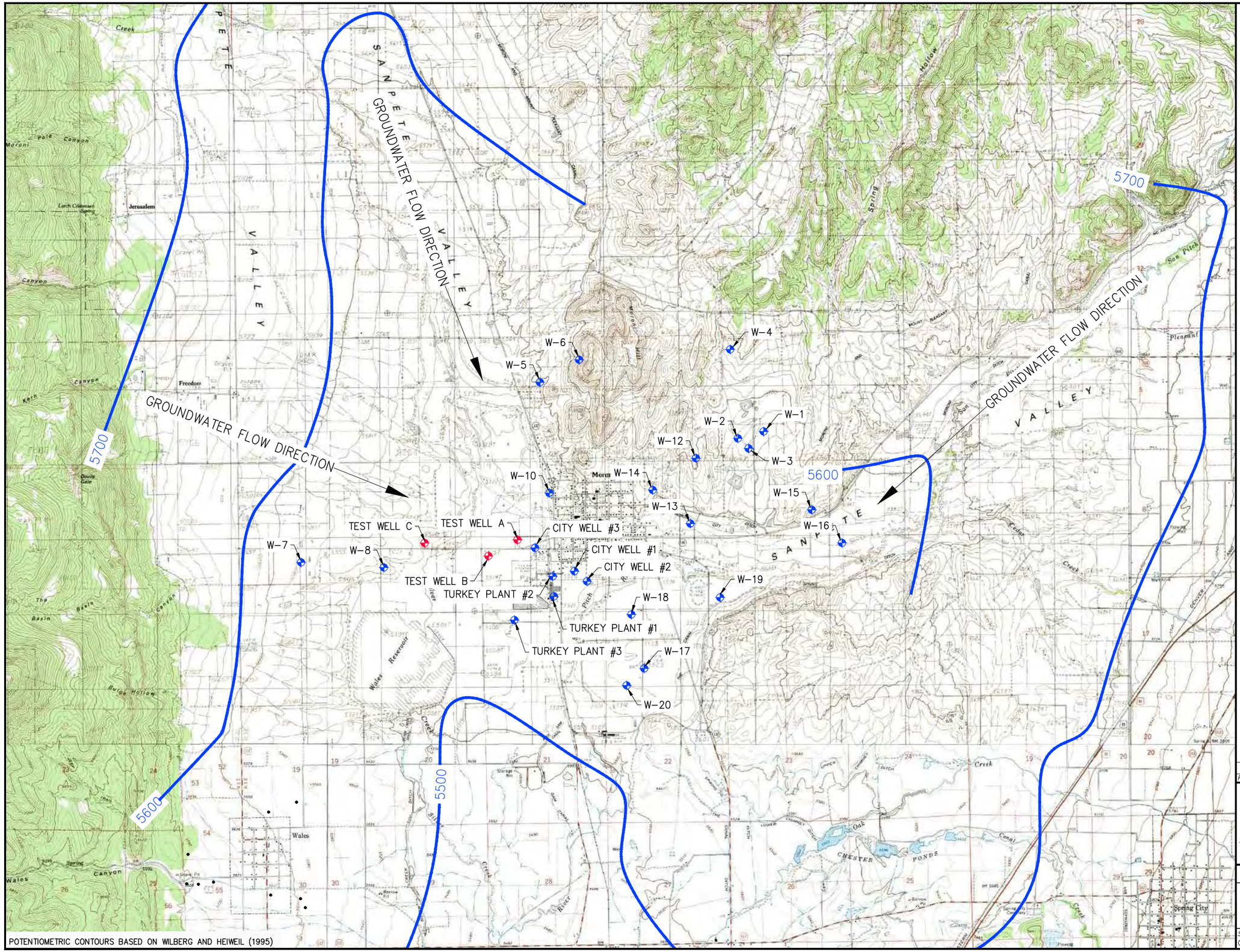
(e) Depth to water-bearing stratum 55-70, 202-207, 214-216, 210-268. (If more than one stratum, give depth to each)

(f) If casing is perforated, give depth from ground surface to perforations 55-70, 202-207, 214-216, 210-268.

(g) Log of well 0-10 Mucky Clay, 10-24 Loose Conglomerate, 24-40 Sandy Clay, 40-55 Sand & Gravel, 55-70 Water Gravel, 70-171 ~~Sandy~~ Clay, 171-175 Sand & Clay, 175-202 Clay, 202-207 Water Gravel, 207-214 Clay, 214-216 Water Gravel 216-210 Fine Sand, 210-260 Sand & Gravel.

(h) Well was equipped with cap, valve, or to control flow. (Strike words not needed)

(Over)



POTENTIOMETRIC CONTOURS BASED ON WILBERG AND HEIWEIL (1995)

NORTH

SCALE
2000' 0 2000'

LEGEND

5600 — POTENTIOMETRIC SURFACE ELEVATION (FT)

EXISTING WELL

RECOMMENDED NEW WELL SITE

AREA MAP

REV NO.	COMMENT	DATE

FOR REVIEW ONLY
NOT
FOR CONSTRUCTION
DATE

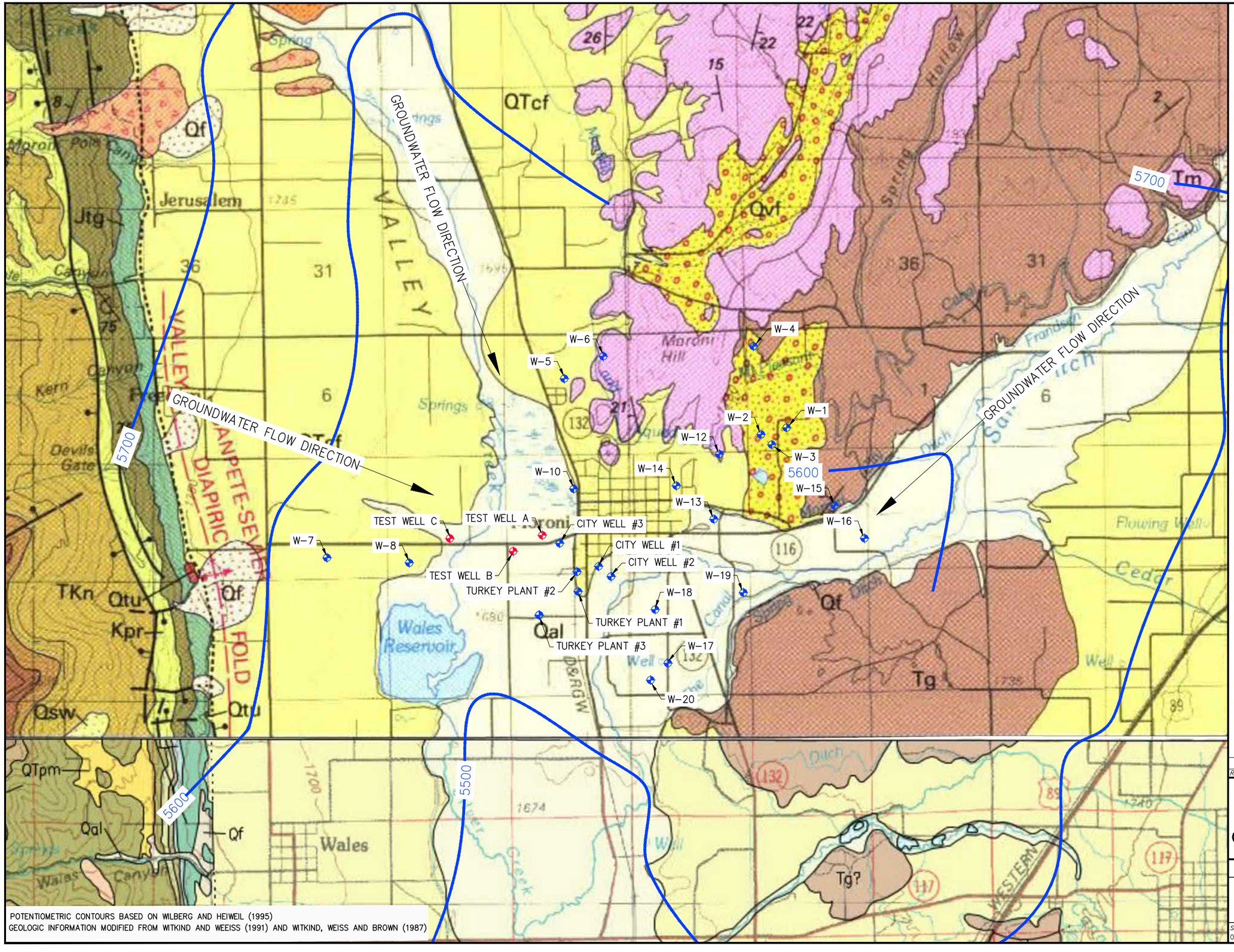
SUNRISE ENGINEERING
6875 SOUTH 900 EAST
SALT LAKE CITY, UTAH 84047
TEL 801.523.0100 • FAX 801.523.0990
www.sunrise-eng.com

MORONI CITY

NITRATE BLENDING PLAN
HYDROGEOLOGIC STUDY
PROJECT LOCATION MAP

SEI NO.	DESIGNED	DRAWN	CHECKED	SHEET NO.	
07311	DY	DY	DSA	01 of 04	FIG. 1

P:\Moroni City\07311 Hydrogeologic Study\Design\3D\Hydrogeologic.dwg Jun 05, 2020 3:13pm dyang



POTENTIOMETRIC CONTOURS BASED ON WILBERG AND HEIWEIL (1995)
GEOLOGIC INFORMATION MODIFIED FROM WITKIND AND WEEISS (1991) AND WITKIND, WEISS AND BROWN (1987)

NORTH

SCALE
2000' 0 2000'

LEGEND

5600 — POTENTIOMETRIC SURFACE ELEVATION (FT)

EXISTING WELL

RECOMMENDED NEW WELL SITE

AREA MAP

REV NO.	COMMENT	DATE

FOR REVIEW ONLY
NOT
FOR CONSTRUCTION
DATE

SUNRISE ENGINEERING
6875 SOUTH 900 EAST
SALT LAKE CITY, UTAH 84047
TEL 801.523.0100 • FAX 801.523.0990
www.sunrise-eng.com

MORONI CITY

NITRATE BLENDING PLAN
HYDROGEOLOGIC STUDY
GEOLOGIC MAP

SEI NO.	DESIGNED	DRAWN	CHECKED	SHEET NO.	
07311	DY	DY	DSA	02 of 04	FIG. 2

P:\Moroni City\07311 Hydrogeologic Study\Design3D\Hydrogeologic.dwg Jun 05, 2020 3:14pm dyang

DESCRIPTION OF MAP UNITS

SURFICIAL DEPOSITS

Qal **Alluvium (Holocene)**—Dark-brown to gray, thin to thick bedded, locally massive, crossbedded in places. Unconsolidated. Consists of clay, silt, sand, granules, pebbles, and sparse cobbles of fluvial origin. Deposits form narrow to broad, even surfaces of low relief. Locally includes higher patches of older alluvium (Qao). Thickness ranges widely, generally less than 15 m (50 ft) thick

Qcl **Colluvium (Holocene)**—Brown to dark-brown, heterogeneous, unsorted mixture of fragments of many sizes that locally mantles lower valley walls and accumulates at the base of some steep cliffs. Unconsolidated to semiconsolidated. Thickness ranges from a few centimeters (1 in.) to as much as 15 m (50 ft)

Qe **Dune sand (Quaternary)**—Light-brown, unconsolidated, loose quartzose sand of eolian origin. Forms low mounds and ridges. Surface is bare to sparsely covered by vegetation. Thickness ranges from 0 to as much as 10 m (0–35 ft)

Qf **Alluvial-fan deposits (Holocene)**—Light-brown to brown, locally gray, unconsolidated to semiconsolidated, moderately well sorted silt, sand, granules, pebbles, and cobbles at stream mouths. Of fluvial origin. Deposits commonly lobate. Thickness uncertain, probably as much as 15 m (50 ft) locally

Qcf **Coalesced alluvial-fan deposits (Holocene)**—Brown to dark-brown or gray, thin- to thick-bedded, commonly crossbedded, unconsolidated to semiconsolidated sediments of fluvial origin. Consists of silt, sand, granules, pebbles, cobbles, and sparse boulders. Formed as a result of the overlapping and interfingering of adjacent alluvial fans; form broad, low, sloping aprons at the foot of adjacent highlands. Thickness uncertain

Qvf **Valley-fill deposits (Holocene)**—Light-brown to brown, unconsolidated, interbedded clay, silt, sand, and gravel. Lithologies reflect rocks exposed on adjacent hills. Thickness ranges from 0 m to as much as 8 m (0–25 ft) near center of deposits

Qg **Gravel deposits (Quaternary)**—Light-brown, unconsolidated to semiconsolidated, thin- to thick-bedded, moderately well sorted clay, silt, sand, and gravel. May be related to deposits formed during the Bonneville lake cycle

Qs **Silt deposits (Quaternary)**—Light brown to tan, unconsolidated silt, marly sand, and some clay that is locally interbedded with pebble gravel. Contains some ripple marks. Thickness uncertain; possibly as much as 8 m (25 ft) thick. Probably related to lacustrine deposits of the Bonneville lake cycle

Qsw **Slope-wash deposits (Holocene)**—Light- to dark-gray, unconsolidated to weakly cemented, thin- to thick-bedded, faintly crossbedded detritus of fluvial origin. Consists of clay, silt, sand, granules, and some pebbles. Forms broad, gently sloping sheets. Thickness ranges from a thin film to as much as 8 m (25 ft)

Qt **Terrace deposits (Quaternary)**—Light- to dark-brown, unconsolidated to semiconsolidated, thin- to medium-bedded, crossbedded, river terrace deposits of silt, sand, granules, pebbles, cobbles, and a few boulders. Clasts—chiefly siltstone, sandstone, and limestone—are derived mainly from formations exposed in adjacent uplands. Forms narrow, sloping benches adjacent to major rivers and tributaries. Thickness ranges from about 3 to 6 m (10–20 ft)

Qtu **Tufa deposit (Quaternary)**—Light-gray to light-tan, low, rounded mound of calcium carbonate. Consists of thin, soft, cellular, porous layers. Deposit encircles spring that formed along a major high-angle normal fault that extends along the east front of the San Pitch Mountains (also known locally as the Gunnison Plateau)

Qb **Boulder deposits (Quaternary)**—Light-gray to brown, unconsolidated and unsorted chaotic debris of angular boulders on steep slopes. Deposits are hummocky and locally lobate. Ranges in thickness from about 5 m to as much as 45 m (10–150 ft)

Qe **Earthflow deposits (Quaternary)**—Brown to dark-brown, unconsolidated to semiconsolidated sand, granules, pebbles, cobbles, and boulders in an unsorted matrix of clay and silt. Consists of masses of debris that flowed downslope to form elongate, hummocky, lobate landforms. Thickness varies widely, probably as much as 45 m (150 ft) thick locally

Ql **Landslide deposits (Quaternary)**—Brown to dark-brown and gray, heterogeneous mixture of fragments of diverse size and shape. Forms irregular to lobate masses of bedrock that have slid downslope to form chaotic, hummocky accumulation of rubble. Some deposits form concentric ridges. Thickness varies widely, may be as much as 45 m (150 ft) thick locally

Qmw **Mass-wasting deposits (Quaternary)**—Brown to dark-brown, heterogeneous masses of mixed country rock of diverse size and shape that have slid downslope repeatedly as both small slumps and large debris flows. Locally includes small and large earthflows. Locally includes water-saturated till that flowed downslope. Thickness varies widely, probably does not exceed 61 m (200 ft)

Qm **Morainic deposits (Pleistocene)**—Brown to dark-brown masses of unsorted, unconsolidated to semiconsolidated morainal rubble of glacial origin. Fragments range in size from clay to boulders. Characterized by lobate outlines and knob-and-kettle topography. Water-saturated till that flowed downslope locally mapped as mass-wasting deposits (Qmw). Thickness as much as 61 m (200 ft)

Qao **Older alluvium (Quaternary)**—Much like alluvium (Qal) in color, bedding, and composition. Forms small, discrete, rounded to irregular masses of fluvial origin generally exposed 15 to 45 m (50 to 150 ft) above adjacent valley floors. Thickness varies greatly, ranging from about 3 to 61 m (10–200 ft)

QTgl **Landslide blocks of Green River Formation (Quaternary)**—Coherent blocks and detritus of the Green River Formation (Tg) that have slid into their present position along a westward-sloping glide plane. The blocks have rotated and been tilted somewhat in their downward movement and now discordantly overlie the country rocks

DEPOSITS OF THE BONNEVILLE LAKE CYCLE

Qbn **Nearshore deposits of the Bonneville lake cycle (Pleistocene)**—Light-gray to gray, moderately well sorted, even-bedded deposits of crossbedded silt, sand, gravel, and sparse cobbles. Chiefly of deltaic origin. Thickness uncertain, may be as much as 76 m (250 ft) thick

Qbo **Offshore deposits of the Bonneville lake cycle (Pleistocene)**—Light-gray to light-tan, well-sorted and even-bedded deposits of clay, silt, and some sand. Chiefly of lacustrine origin. Thickness uncertain

Qbs **Undifferentiated surficial deposits of the Bonneville lake cycle (Pleistocene)**—Includes generally well sorted, even-bedded deposits that form terraces, spits, and bars along the shoreline of former Lake Bonneville. Thickness varies widely; locally as much as 23 m (75 ft) thick

QUATERNARY AND TERTIARY DEPOSITS

QTcf **Coalesced alluvial-fan deposits (Holocene to Pliocene?)**—Brown to dark-brown or gray, unconsolidated to semiconsolidated, thin- to thick-bedded, commonly crossbedded sediments of fluvial origin. Deposits consist of silt, sand, granules, pebbles, cobbles, and sparse boulders. Formed by the overlapping and interfingering of adjacent alluvial fans; forms broad, low, sloping apron at foot of adjacent highlands. Includes Sevier River Formation, which probably ranges in age from Miocene to Pleistocene. Thickness uncertain; possibly as much as 30 m (100 ft) thick locally

QTvf **Valley-fill deposits (Holocene to Pliocene?)**—Light-brown to brown silt, sand, and gravel deposits that floor major valleys. Essentially an interbedded mixture of alluvium and colluvium. Thickness uncertain, possibly as much as 30 m (100 ft) thick locally

QTpm **Pediment mantle (Holocene to Pliocene)**—Light-brown to brown, gray, or locally reddish-brown, unconsolidated to well cemented, massive to crudely bedded sediments of fluvial origin. Consists of a poorly bedded mixture of silt, sand, granules, pebbles, cobbles, and boulders derived from adjacent uplands. Surfaces are even and slope gently away from the uplands but are somewhat deformed locally in the Sanpete Valley and Sevier River Valley (which is to the south and west beyond the boundaries of the Nephi quadrangle). Includes deposits near present gradient that formed essentially during the Pleistocene as well as older and higher deposits that probably began to form during the Miocene or Pliocene. Also includes deposits mapped by Spieker (1949, p. 38) as the Axtell Formation, which he suggests is "probably of late Tertiary" age. Ranges in thickness from about 3 m to more than 45 m (10–150 ft)

DIAPIRIC INTRUSIONS

TJai **Intrusive masses of Arapien Shale (Quaternary? to Middle Jurassic?)**—Calcareous mudstone, thin- to medium-bedded, even-bedded, locally amorphous, generally light gray marked by pale-red blotches, but, in places wholly dark gray or wholly reddish brown. Includes intercalated, thin, lenticular beds and seams of yellowish-gray to light-brown siltstone and sandstone and sparse limestone beds. Contains thick beds of rock salt (halite), gypsum, and other evaporites. Selenite crystals are abundant on many outcrops. Of marine saline-basin origin. Formation is complexly deformed and shows evidence of intense compression. Weathers to badlands topography. Thickness uncertain because of intense deformation; estimates range from about 1,220 m (4,000 ft) to as much as 3,960 m (13,000 ft) (Spieker, 1949, p. 17; Gilliland, 1948, p. 30; Hardy, 1949, p. 16, 17).

The salt (and possibly other evaporites) in the Arapien Shale has probably been moving ever since it was deposited during the Middle Jurassic (Witkind, 1982a). Some of this movement has been a slow, almost imperceptible upwelling. At times, however, the salt seemingly has surged upward rapidly and has forced the overlying mudstone of the Arapien Shale to bow up the country rock to form elongate, narrow diapiric folds. Subsequent removal of the salt resulted in collapse of the upwarps. Such major diapiric upwellings of the salt may have occurred during the Late Cretaceous, early Paleocene, and the late(?) Oligocene or Miocene. A localized upward surge of the salt, probably during the Pliocene, apparently deformed semiconsolidated sediments in the southern part of Sanpete Valley. Thus the formation has several ages: the depositional age is Middle Jurassic, but the emplacement ages have changed repeatedly. Symbol T(Jai) reflects both the depositional age (Ja, Jurassic) and the time of major emplacement (T, Tertiary)

TERTIARY SEDIMENTARY ROCKS

Tg **Green River Formation (Eocene)**

West of and western part of Wasatch Plateau—Consists of a limestone unit underlain by a shale unit; both of lacustrine origin. Millen (1982) discussed details of the stratigraphy and petrology of the San Pitch Mountains. Thickness of formation ranges widely, from about 150 to 365 m (500–1,200 ft)

Limestone unit—Pale-yellowish-gray to yellow-brown to light-brown, thin- to thick-bedded, even-bedded limestone and minor thin beds of sandstone and tuff. Limestone beds are dense, thinly laminated, and commonly oolitic; some thin limestone beds are stromatolitic and rich in ostracods. Forms resistant ledges and low cliffs

Shale unit—Light-green to grayish-green, thin-bedded, fissile, somewhat calcareous shale and sparse interbedded micritic limestone. Forms gentle slopes

East of Wasatch Plateau—Divided into upper, middle, and lower members (Moussa, 1965, p. 65–81)

Tgu **Upper member**—Consists chiefly of light-gray to light-brown interlayered thin beds of limestone, marlstone, siltstone, sandstone, and sparse fissile shale. Includes many gray to white resistant tuff beds. Upper oil-shale zone (OSZ-U) arbitrarily selected as base. Contains units commonly assigned to the "barren and saline facies" of Ryder and others (1976, fig. 2). As much as 457 m (1,500 ft) thick

Tgm **Middle member**—Consists almost completely of light-green to gray sandy mudstone. Also contains sparse light-gray beds of limestone, siltstone, and fissile shale, and a few lenticular sandstone beds that fill channels. Orange-weathering gray limestone bed marked by many thin tracks is at base throughout much of the outcrop. Member is commonly referred to as the "delta facies" of Ryder and others (1976, fig. 2). About 915 m (3,000 ft) thick

Tgl **Lower member**—Divisible into three units, an upper and lower lacustrine shale separated by fluvial deposits. Lacustrine shale deposits are light brown to light gray, fissile, and contain lenses and beds of gray to brown limestone and marlstone. Fluvial deposits consist chiefly of light-gray to light-brown siltstone and sandstone beds with intercalated beds of gray to brown calcareous mudstone. About 275 m (900 ft) thick

Tc **Colton Formation (Eocene)**

West of the Wasatch Plateau—Mostly claystone and mudstone variegated in shades of reddish brown, light gray, or light greenish gray. Locally includes beds of yellowish-gray to yellowish-brown siltstone and channel-fill sandstone and reddish-brown conglomerate as well as sparse, interlayered, thin beds of platy, light-gray, dense, finely crystalline limestone. Of mixed fluviatile and lacustrine origin. Volkert (1980) discussed details of the stratigraphy and petrology of rocks in the San Pitch Mountains. Ranges in thickness from 100 to 260 m (325–850 ft)

East of the Wasatch Plateau—Chiefly reddish-brown mudstone with intercalated beds of light-brown sandstone and siltstone that thicken and thin irregularly. Locally the mudstone is variegated in shades of brown, purple, and gray. Of fluvial origin. About 460 m (1,500 ft) thick (Spieker, 1946, p. 139)

Tgc **Green River and Colton Formations**—Only shown in cross sections

Tf **Flagstaff Limestone (Eocene and Paleocene)**—Light-gray to yellowish-gray, to light-brown, thin- to thick-bedded, locally massive, fine-grained, dense limestone and minor dolomite containing some algal nodules. Red to pink near subjacent red units of Jurassic age. Contains subordinate interbedded dark-gray, gray, and greenish-gray calcareous shale. Oncolite-rich limestone beds locally abundant (Weiss, 1969). Of lacustrine origin. Forms resistant ledges and prominent hogbacks. Ranges in thickness from 0 in the central part of the San Pitch Mountains to about 305 m (1,000 ft) on the Wasatch Plateau

Tcf **Colton Formation and Flagstaff Limestone, undivided (Eocene and Paleocene)**—Units combined locally for cartographic purposes

TERTIARY AND MESOZOIC SEDIMENTARY ROCKS

TKn **North Horn Formation (Paleocene and Upper Cretaceous)**—Red to reddish-brown to brown mudstone, claystone, sandstone, conglomeratic sandstone, conglomerate, all of fluvial origin, and sparse freshwater limestone. Lithologies alternate irregularly. Mudstone is thick bedded to massive; sandstone varies from thin to thick bedded, commonly crossbedded, and is fine to medium grained. Limestone beds are thin and dense, locally arenaceous. Formation contains minor coal beds and carbonaceous seams along east flank of the San Pitch Mountains near Wales (south of this quadrangle). Formation is unstable and is marked by many slumps, landslides, earthflows, and other forms of mass wasting. Ranges in thickness from about 150 to 915 m (500–3,000 ft)

TKfn **Flagstaff Limestone and North Horn Formation, undivided (Paleocene and Upper Cretaceous)**—Units combined locally for cartographic purposes

MESOZOIC SEDIMENTARY ROCKS

Kpr **Price River Formation (Upper Cretaceous)**—Gray to light-gray, thin- to thick-bedded, locally massive, commonly well cemented conglomerate, conglomeratic sandstone, and sandstone with minor shale. Coarse conglomerate beds contain well-rounded clasts of light-brown and purple quartzite, light-gray quartz, light-gray and black chert, and sparse dark-blue limestone. Sandstone is fine to coarse grained. Of fluvial origin. Forms steep slopes and low cliffs. Includes Castlegate Sandstone (Kc) in cross sections. Ranges in thickness from 0 to about 365 m (0–1,200 ft)

Kc **Castlegate Sandstone (Upper Cretaceous)**—Brownish-gray, locally conglomeratic, irregularly bedded, massive, fine- to coarse-grained sandstone. Locally includes some thin, dark-gray, shaly siltstone units and some beds of carbonaceous shale. Of fluvial origin. Included with Price River Formation in cross sections. Ranges in thickness from about 15 to 150 m (50–500 ft)

Ki **Indianola Group, undivided (Upper Cretaceous)**

Chiefly San Pitch Mountains—Reddish-brown and gray, thick-bedded to massive, well-cemented conglomerate. Consists of sand, granules, pebbles and well-rounded cobbles of white, purple, green, grayish-green, and light-brown quartzite, light-brown to light-gray chert, white quartz, and some gray to dark-blue limestone. Contains more carbonate clasts than Price River Formation (Kpr) and less than North Horn Formation (TKn). Of fluvial (synorogenic) origin. Ranges in thickness from 30 to 4,570 m (100–15,000 ft)

Stratigraphic units exposed chiefly near Birch Creek southwest of Fountain Green and here mapped as part of the Indianola Group have, in the past, been mapped as the South Flat Formation (Hunt, 1950, 1954). These beds are light-brown, brown, and grayish-brown, medium-grained, quartzose sandstone with intercalated lenses and beds of conglomerate. Sandstone beds are even bedded and vary from thin to thick bedded. These strata near Birch Creek locally contain discontinuous coal seams and carbonaceous material. Plant remains common. Exposures are generally limonite stained. These beds may be correlative with the Blackhawk Formation. As much as 870 m (2,850 ft) thick (Hunt, 1950, p. 60)

Chiefly Cedar Hills—Divisible into four interbedded marine and nonmarine units that are essentially correlative with the following formations as exposed in Salina Canyon (near Sterling, south of this quadrangle) along the west flank of the Wasatch Plateau (in descending order): Sixmile Canyon Formation (conglomerate, conglomeratic sandstone, and sandstone), Funk Valley Formation (conglomeratic sandstone and sandstone), Allen Valley Shale, and Sanpete Formation (conglomeratic sandstone and sandstone) (Jefferson, 1982)

Kbh **Blackhawk Formation (Upper Cretaceous)**—Sandstone, shaly siltstone, shale, carbonaceous shale, and coal of continental and deltaic origin. Sandstone beds are light gray, light brown, brownish gray, and locally reddish brown, thin to medium bedded, crossbedded, and fine to medium grained. Many thin to thick coal zones are in lower part; a major, thick coal zone at base directly overlies Star Point Sandstone. Includes Star Point Sandstone (Ksp) in cross sections. Ranges in thickness from about 200 m to 305 m (700–1,000 ft)

Ksp **Star Point Sandstone (Upper Cretaceous)**—Light-brown to brown, thin- to medium-bedded, sandstone, shale, and shaly siltstone of near-shore and beach origin. Sandstone is fine to medium grained. Locally consists of three sandstone units (in descending order): Spring Canyon, Storrs, and Panther Tongues. Sandstone units are separated by beds of shale and shaly siltstone. Included with Blackhawk Formation (Kbh) in cross sections. Formation ranges in thickness from about 61 to 305 m (200–1,000 ft); generally about 107 m (350 ft) thick

Mancos Shale (Upper Cretaceous)—Throughout much of the Wasatch Plateau, consists of the following five members in descending order: Upper part of the Blue Gate Member, Emery Sandstone Member, lower part of Blue Gate Member, Ferron Sandstone Member, and Tununk Member. In this quadrangle, most are concealed in the subsurface. The five members are grouped into three units: Upper part of the Blue Gate Member (Kmub), Emery Sandstone Member (Kme), and lower part of the Mancos Shale which includes the lower part of the Blue Gate, the Ferron Sandstone, and the Tununk Member (Kml)

Kmub **Upper part of Blue Gate Member**—Light-gray to gray, thin- to medium-bedded, even-bedded shale, shaly siltstone, and minor interbedded sandstone. Thickness uncertain, possibly as much as 245 m (800 ft) thick

Kme **Emery Sandstone Member**—Consists of upper and lower sandstone units separated by a middle shale unit. Member is about 90 m (280 ft) thick

Kml **Lower part of Mancos Shale**—Only shown in cross sections. Includes units of the Blue Gate, Ferron Sandstone, and Tununk Shale

Blue Gate Member—Light-, bluish-, and dark-gray, thin- to medium-bedded shale and shaly siltstone. Includes sparse discontinuous ledges of silicified shale. As much as 610 m (2,000 ft) thick

Ferron Sandstone Member—Chiefly light-brown, thin- and even-bedded, crossbedded, very fine to fine-grained sandstone. Locally contains many large round concretions. In places, contains a middle light-gray to dark-gray shale unit. About 50 m (160 ft) thick

Tununk Member—Light- to dark-gray, thin- to medium-bedded, even-bedded shale and shaly siltstone. Ranges in thickness from 120 to 200 m (400–650 ft)

Kd **Dakota Sandstone (Upper Cretaceous)**—Only shown in cross sections. Tan to light-brown, thin-bedded, crossbedded, fine- to medium-grained, quartzose sandstone. Contains thin, discontinuous, carbonaceous seams. Of beach- to marginal-marine and deltaic origin. Thickness ranges from 0 to 9 m (0–30 ft). Only in the subsurface in this quadrangle

Kcm **Cedar Mountain Formation (Lower Cretaceous)**—Dominantly massive to thick-bedded mudstone, variegated in shades of purple, red, gray and green. Contains sparse interleaved, discontinuous, thin beds of conglomerate, sandstone, and freshwater limestone. Commonly characterized by abundant lightgray, rounded limestone nodules. In San Pitch Mountains, from Chris Canyon northward, thin orange-red conglomerate beds in upper part grade upward to red and gray massive conglomerate beds of Indianola Group. Thickness ranges from about 20 m to 430 m (60–1,400 ft)

Jtg **Twist Gulch Formation (Middle Jurassic)**—Reddish-brown, thin- to medium-bedded, even-bedded, fine-grained, marine sandstone, shaly siltstone, and shale. Locally includes light-gray, interbedded, laminated to thin-bedded, crossbedded sandstone. North of this quadrangle, equivalent rocks are mapped with the Preuss Sandstone. Thickness estimated at about 915 m (3,000 ft) (Hardy, 1952, p. 23)

Ja **Arapien Shale (Middle Jurassic)**—Only shown in cross sections. Described in "Intrusive masses of Arapien Shale" (TJai)

Jtc **Twin Creek Limestone (Middle Jurassic)**—Dominantly light to dark gray, thin- to medium-bedded, even-bedded, dense, argillaceous, marine limestone. In places, intensely folded and fractured. Includes the following seven members in descending order: Giraffe Creek, Leeds Creek, Watton Canyon, Boundary Ridge, Rich, Sliderock, and Gypsum Spring. All members except the Giraffe Creek are exposed in this quadrangle. Twin Creek Limestone and Arapien Shale are complexly interrelated in this general area (Sprinkel, 1982). Thickness uncertain, possibly 150–305 m (500–1,000 ft)

Jn **Navajo Sandstone (Lower Jurassic and Upper Triassic?)**—Light-tan and reddish-brown, thick-bedded to massive, fine- to coarse-grained, friable, quartzose sandstone. Crossbedded in large sweeping tangential festoons. Moderately well cemented by calcium carbonate and iron oxide; forms cliffs and steep slopes. In places, sandstone is light tan and has large, irregular, reddish-brown mottles. Thickness ranges from 425 to 460 m (1,400–1,500 ft)

Ka? **Ankareh Formation (Upper and Lower Triassic)**—Reddish-brown to dark-reddish-brown, thin- to thick-bedded, even-bedded, shaly siltstone, and fine- to medium-grained, ripple-marked sandstone. Some sandstone units are crossbedded. Forms gentle to moderate slopes and long strike valleys. About 425 m (1,400 ft) thick

Trt **Thaynes Limestone (Lower Triassic)**—Reddish-gray, thin- to medium-bedded, even-bedded limestone containing some interlayered beds of red and gray shale. Forms moderate slopes and rounded hills. Thickness about 380 m (1,250 ft)

Trw **Woodside Formation (Lower Triassic)**—Reddish-brown to dark-red, thin- to medium-bedded, even-bedded, shaly siltstone and fine-grained sandstone. Weakly cemented by iron oxide and calcium carbonate. Moderately resistant, forms valleys and gentle slopes. Thickness about 60 m (200 ft)

Trtw **Thaynes Limestone and Woodside Formation, undivided (Lower Triassic)**—Only shown in cross sections. Units combined locally for cartographic purposes

Tru **Triassic strata, undivided**—Only shown in cross sections. Includes the Ankareh Formation, Thaynes Limestone, and Woodside Formation

PALEOZOIC SEDIMENTARY ROCKS

Ppc **Park City Formation (Lower Permian)**—Light-brown to light-gray, thin- to medium-bedded, even-bedded, resistant limestone that contains nodules and thin beds of light-gray to black chert. Forms rounded hills and moderate slopes. Thickness about 215 m (700 ft)

Pdc **Diamond Creek Sandstone (Lower Permian)**—Light-brown to orange-brown, thin- to medium-bedded, even-bedded, fine- to medium-grained, quartzose sandstone. Well cemented by calcium carbonate; forms cliffs and steep slopes. About 280 m (900 ft) thick

Pk **Kirkman Limestone (Lower Permian)**—Light- to dark-gray, thin- to medium-bedded, even-bedded, dense limestone that contains some intraformational breccia. About 90 m (300 ft) thick

Pdk **Diamond Creek Sandstone and Kirkman Limestone, undivided (Permian)**—Units combined locally for cartographic purposes

PPo **Oquirrh Formation (Permian and Pennsylvanian)**—Brown, grayish-brown, and grayish-blue interbedded limestone, sandstone, and quartzite. Carbonate rocks dominate the lower part of sequence; clastic rocks the upper part. Thickness uncertain but likely about 3,350 m (11,000 ft) (Johnson, 1959, p. 8)

PPu **Permian and Pennsylvanian rocks, undivided**—Only shown in cross sections. Includes Park City Formation (Ppc), Diamond Creek Sandstone (Pdc), Kirkman Limestone (Pk), and Oquirrh Formation (PPo)

PMmc **Manning Canyon Shale (Lower Pennsylvanian and Upper Mississippian)**—Dark- to brownish-gray shale containing interleaved lenses of brown quartzitic sandstone and bluish-gray limestone. Forms prominent strike valleys locally mantled by large landslides and lobate earthflows. Thickness ranges from 305 to 520 m (1,000–1,700 ft) (Rigby and Clark, 1962, p. 21)

Mgb **Great Blue Limestone (Upper Mississippian)**—Light-bluish-gray to bluish-gray limestone and some shale. The limestone is chiefly thick bedded to massive and has been much fractured. About 91 m (300 ft) thick

Mh **Humbug Formation (Upper Mississippian)**—Light-brown to brown, thin- to medium-bedded sandstone interbedded with light-gray sandy limestone and minor shale and dolomite. Sandstone beds are locally quartzitic. A section measured through part of the Humbug totaled about 107 m (350 ft) in the Long Ridge area (Muessig, 1951, p. 210). The formation ranges from 183 to 245 m (600–800 ft) thick in the southern Wasatch Range (Rigby and Clark, 1962, p. 21)

Md **Deseret Limestone (Upper and Lower Mississippian)**—Dark-bluish-gray, thin-bedded limestone that contains abundant interlayered lenticular thin beds of black chert. Chert is characteristic and is found wherever the formation is exposed. Limestone is commonly medium to coarsely crystalline. A few thin shale beds are near base. Includes minor interbedded dolomite. Thickness ranges from 183 to 275 m (600–900 ft) (Rigby and Clark, 1962, p. 19)

Mg **Gardison Limestone (Lower Mississippian)**—Dark-bluish-gray, thin-bedded fossiliferous limestone containing minor interleaved dolomite. Highly fossiliferous beds are characteristic. Contains abundant black and light-gray chert as nodules and thin seams. Lower part of formation is marked by scree-covered slopes; upper part forms prominent cliffs and steep slopes. Likely correlative with part of the Madison Limestone of Montana, Wyoming, and northern Utah. Ranges in thickness from 183 to 275 m (600–900 ft) in the southern Wasatch Range (Rigby and Clark, 1962, p. 19)

MDf **Fitchville Formation (Lower Mississippian and Upper Devonian)**—Dark-gray to black, medium-bedded to massive dolomite and minor interbedded black shale. The dolomite has a fetid odor when broken and locally is moderately fossiliferous, containing mostly horn corals but also crinoids and gastropods. Formation is about 70 m (230 ft) thick in the Long Ridge area (Brady, 1965, p. 34) but ranges from about 30 to 91 m (100–300 ft) in and near the southern Wasatch Range (Rigby and Clark, 1962, p. 19)

MDu **Mississippian and Devonian rocks, undivided**—Includes units of the Deseret Limestone (Md) and Gardison Limestone (Mg) and the Fitchville Formation (MDf). Units combined locally for cartographic purposes

Du **Upper Devonian rocks of uncertain correlation**—Probably includes units of the Pinyon Peak Limestone and the Victoria Formation

Pinyon Peak(?) Limestone—Dark-gray to gray silty to argillaceous limestone. Commonly mapped as part of the Fitchville Formation (MDf). Thickness ranges from 21 to 91 m (70–300 ft) (Rigby and Clark, 1962, p. 19)

Victoria(?) Formation—See following description

DO **Devonian and Ordovician rocks, undivided**—Includes the Victoria Formation and Opohonga Limestone. Units combined locally for cartographic purposes

Victoria Formation (Upper Devonian)—Light-brown quartzose sandstone and minor interbedded dolomite. About 2 m (7 ft) thick on Long Ridge; possibly absent from the southern Wasatch Range (Rigby and Clark, 1962, p. 18)

Opohonga Limestone (Lower Ordovician)—Bluish-gray limestone containing intraformational conglomerate beds. About 27 m (90 ft) thick on Long Ridge (Peterson, 1953, p. 14)

Cu **Upper Cambrian rocks, undivided**—Includes units of the Ajax Dolomite and Opex Formation

Ajax Dolomite—Light-gray to dark-gray, mottled dolomite and minor limestone. About 27 m (90 ft) of Ajax is exposed on Long Ridge. Uncertain if exposed in the southern Wasatch Range (Hintze, 1962, p. 14)

Opex Formation—Dark-bluish-gray dolomite that contains some cherty beds and a few oolite beds. Ranges in thickness from about 30 to 145 m (100–475 ft)

Cmu **Middle Cambrian rocks, undivided**—Includes units of the following formations (in descending order): Cole Canyon Dolomite, Bluebird Dolomite, Herkimer Limestone, Dagmar Dolomite, and Teutonic Limestone

Cole Canyon Dolomite—Alternating light- and dark-gray beds of dolomite that locally contain sparse, small twig-like rods. Ranges in thickness from 88 to 152 m (290 to 500 ft) on Long Ridge, and from 70 to 140 m (230–460 ft) in the southern Wasatch Range (Hintze, 1962, p. 13)

Bluebird Dolomite—Dark-bluish-gray dolomite characterized by white, sinuous twig-like rods of dolomite scattered irregularly through the formation. Ranges in thickness from 30 to 52 m (100–170 ft) on Long Ridge, and from 30 to 58 m (100–190 ft) in the southern Wasatch Range

Herkimer Limestone—Bluish-gray limestone characterized by abundant orange-mottled siltstone. Similar in appearance to the Teutonic Limestone but separated from that unit by the white Dagmar Dolomite. Cliff former. About 91 m (300 ft) thick on Long Ridge; ranges in thickness from 70 to 137 m (230–450 ft) in the southern Wasatch Range (Hintze, 1962, p. 12)

Dagmar Dolomite—Light-gray to white, dense, thin-bedded dolomite that contrasts sharply with both the underlying and overlying darker limestone units. About 30 m (100 ft) thick

Teutonic Limestone—Bluish-gray limestone characterized by abundant orange-mottled siltstone. Ranges in thickness from about 85 to 145 m (280–475 ft)

Co **Ophir Formation (Middle Cambrian)**—Pale-green to olive-green phyllitic shale. Light-green sandstone beds are interleaved in basal part and light-brown limestone beds are common in the middle. Forms gentle slopes between cliffs and steep slopes formed on underlying Tintic Quartzite (Ct) and overlying Teutonic Limestone (part of unit Cmu). About 91 m (300 ft) thick on Long Ridge and 76 m (250 ft) thick in the southern Wasatch Range (Hintze, 1962, p. 11)

Cdf **Diabasic lava flow (Cambrian)**—Dark-grayish-red to purplish-gray, porphyritic, amygdaloidal, diabasic lava flow. Occurs chiefly in lower part of the Tintic Quartzite (Ct). Crops out between North Creek canyon and Dry Canyon in the southern Wasatch Range. Primary minerals are labradorite, augite, magnetite, and ilmenite, which have locally been altered to serpentine, kaolinite, sericite, calcite, and iron oxides (Bullock and Abbott, 1951, p. 119). Ranges in thickness from 6 to 27 m (20–90 ft) (Abbott, 1951, p. 8)

Ct **Tintic Quartzite (Lower Cambrian)**—Light-brown to orange-brown, thin- to medium-bedded, fine- to medium-grained quartzite. Grains are coated with limonite. Locally contains basal conglomerate. Forms resistant, steep ledges and slopes. Ranges in thickness from about 275 to 335 m (900–1100 ft) in southern Wasatch Ranage (Hintze, 1962, p. 11)

Cot **Ophir Formation and Tintic Quartzite, undivided (Middle and Lower Cambrian)**—Units combined locally for cartographic purposes

MzPzu **Mesozoic and Paleozoic rocks, undivided**—Only shown in cross sections. Includes Ankareh Formation (Tra), Thaynes Limestone (Trt), Woodside Formation (Trw), Park City Formation (Ppc), Diamond Creek Sandstone (Pdc), Kirkman Limestone (Pk), Oquirrh Formation (PPo), Manning Canyon Shale (PMmc), Great Blue Limestone (Mgb), Humbug Formation (Mh), Deseret Limestone (Md), Gardison Limestone (Mg), Fitchville Formation (MDf), Upper Devonian rocks of uncertain correlation (Du), Devonian and Ordovician rocks, undivided (DO), Upper Cambrian rocks, undivided (Cu), Middle Cambrian rocks, undivided (Cmu), Ophir Formation (Co), Diabasic lava flow (Cdf), and Tintic Quartzite (Ct)

PROTEROZOIC AND ARCHEAN METAMORPHIC ROCKS

Ybc **Big Cottonwood Formation (Middle Proterozoic)**—Maroon quartzite, arkosic sandstone, and siltstone containing interbedded green, red, brown, and yellowish-green phyllitic shale. Thickness uncertain, possibly as much as 375 m (1230 ft) thick (Metter, 1955, p. 218)

XAf **Farmington Canyon Complex (Early Proterozoic and Archean)**—Dark-gray to reddish-gray foliated rocks, chiefly schist, granitoid gneiss, and amphibolite, that have been intruded by dikes of pegmatite and medium-to coarse-grained granite. Thickness unknown

DAu **Devonian, Ordovician, Cambrian, Proterozoic, and Archean rocks, undivided**—Includes Fitchville Formation (MDf), Devonian rocks of uncertain correlation (Du), Devonian and Ordovician rocks, undivided (DO); Upper Cambrian rocks, undivided (Cu), Middle Cambrian rocks, undivided (Cmu), Ophir Formation (Co), Diabasic lava flow (Cdf), and Tintic Quartzite (Ct)

EXTRUSIVE IGNEOUS ROCKS AND THEIR PRODUCTS

Tls **Laguna Springs Volcanic Group (Oligocene and Eocene)**—Chiefly latitic and andesitic tuffs having interbedded volcanic lava flows and volcanic mudflow breccia. Thickness of Laguna Springs uncertain, possibly as much as 300 m (1,000 ft) (Muessig, 1951, p. 119)

Main body—Tuff is light to dark gray, fine to coarse grained, and contains small to large fragments of sedimentary and igneous rock. Flows are dark gray and coarsely porphyritic and contain orthoclase, plagioclase, hornblende, and biotite as common phenocrysts. Thickness unknown. Where breccia predominates, it is mapped as a separate unit (Tlsv)

Tlsv **Volcanic mudflow breccia**—Dark- to brownish-gray, locally reddish-gray, thick-bedded to massive breccia consisting of a heterogeneous mixture of small to very large, angular to subangular fragments of dark-gray andesite, gray latite, and some blocks of sedimentary rock enclosed in a fine-grained matrix. Weathers to rounded slopes strewn with boulders. Thickness unknown

Tgr **Goldens Ranch Formation of Muessig (1951) (lower Oligocene to upper Eocene)**—Volcaniclastic and pyroclastic rocks, including ash-flow and welded tuff and stream-deposited conglomerate and sandstone. The main rock unit is a light-gray to grey conglomeratic sandstone containing rounded igneous (andesite and latite) and sedimentary (quartzite and limestone) clasts. Tuff is light gray to light brown and contains sparse andesite clasts. Includes Sage Valley Limestone Member and a few interbedded lava flows. Sage Valley Limestone Member is light-gray, crystalline, and about 30 m (100 ft) thick (Muessig, 1951, p. 98); it contains abundant plant remains. Goldens Ranch Formation intertongues with breccia associated with Laguna Springs Volcanic Group (Tls) (Morris and Lovering, 1961, p. 126). Thickness unknown; at least 305 m (1,000 ft) thick. Likely correlates with the Moroni Formation (Tm)

Tm **Moroni Formation (lower Oligocene to upper Eocene)**—Volcaniclastic and pyroclastic rocks including ash-flow and welded tuff and stream-deposited conglomerate and sandstone. Tuff commonly is porous and friable, but locally includes light-gray, gray, brown, light-red, and greenish-gray rhyolitic welded tuff containing rounded andesite clasts. Phenocrysts in ash-flow units are abundant and consist of quartz, alkalic feldspar, biotite, and some pumice (Cooper, 1956). Conglomerate beds are crudely bedded and commonly poorly sorted and contain volcanic cobbles and pebbles and well-rounded clasts of tan and maroon quartzite and dark-blue limestone. Thickness of unit ranges greatly throughout area; maximum thickness is about 610 m (2,000 ft) (Cooper, 1956, p. 21). Probably correlates with the Goldens Ranch Formation of Muessig (1951)

Tvu **Volcanic rocks of uncertain correlation and age**—Only shown in cross sections. Volcaniclastic and pyroclastic rocks similar to the Goldens Ranch (Tgr) and the Moroni Formations (Tm) in appearance, lithology, and contained clasts

INTRUSIVE IGNEOUS ROCKS OF THE LEVAN AREA (JOHN, 1972)

Tsp **Syenodiorite porphyry (lowermost Miocene to uppermost Oligocene)**—Light-greenish-gray syenite porphyry stock near Levan. Phenocrysts (20 percent of rock) consist of hornblende (about 15 percent) and feldspar (about 5 percent). Accessory minerals are magnetite, apatite, and sphene. Groundmass is aphanitic and includes andesine, orthoclase, and hornblende

Tm **Monzonite (lowermost Miocene to uppermost Oligocene)**—Light-gray to gray, fine-grained, slightly porphyritic monzonite intrusion in the Levan area. Phenocrysts (10 percent of rock) consist of plagioclase (oligoclase-andesine) (about 8 percent), hornblende (about 1 percent), and biotite (about 1 percent). Accessory minerals are apatite, sphene, and magnetite. Groundmass includes plagioclase, orthoclase, and sparse quartz

Tmp/Tmg **Monzonite porphyry (lowermost Miocene to uppermost Oligocene)**—Light-gray to gray, porphyritic dikes and two small stocks of monzonite porphyry in the Levan area. Phenocrysts (32 percent of rock) consist of plagioclase (andesine) (about 20 percent), hornblende (about 10 percent), and biotite (about 2 percent). Accessory minerals consist of apatite, magnetite, sphene, and zircon. Groundmass consists of plagioclase, orthoclase, and sparse quartz

Ti **Intrusive igneous rocks (lowermost Miocene to uppermost Eocene)**—Small dikes, sills, stocks, and bosses of differing composition. Most are exposed near Levan and consist of intermediate-composition rocks such as diabase, monzonite, and syenodiorite (John, 1972). Includes felsite dikes and sills in the Cedar Hills (Schoff, 1951, p. 636). Also includes, elsewhere in the area, a few dark-gray to black, thin (1–2 m (3–6 ft)), porphyritic lamprophyre dikes and sills, chiefly minette rich in biotite, that is intruded into the sedimentary rocks (Phillips, 1962, p. 68–69; Loughlin, 1918, p. 163)

GEOLOGIC INFORMATION MODIFIED FROM WITKIND AND WEEISS (1991)

AREA MAP

REV NO.	COMMENT	DATE

FOR REVIEW ONLY
NOT
FOR CONSTRUCTION
DATE

SUNRISE ENGINEERING
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MORONI CITY

NITRATE BLENDING PLAN
HYDROGEOLOGIC STUDY
GEOLOGIC UNIT DESCRIPTION

SEI NO.	DESIGNED	DRAWN	CHECKED	SHEET NO.	
07311	DY	DY	DSA	03 of 04	FIG. 3

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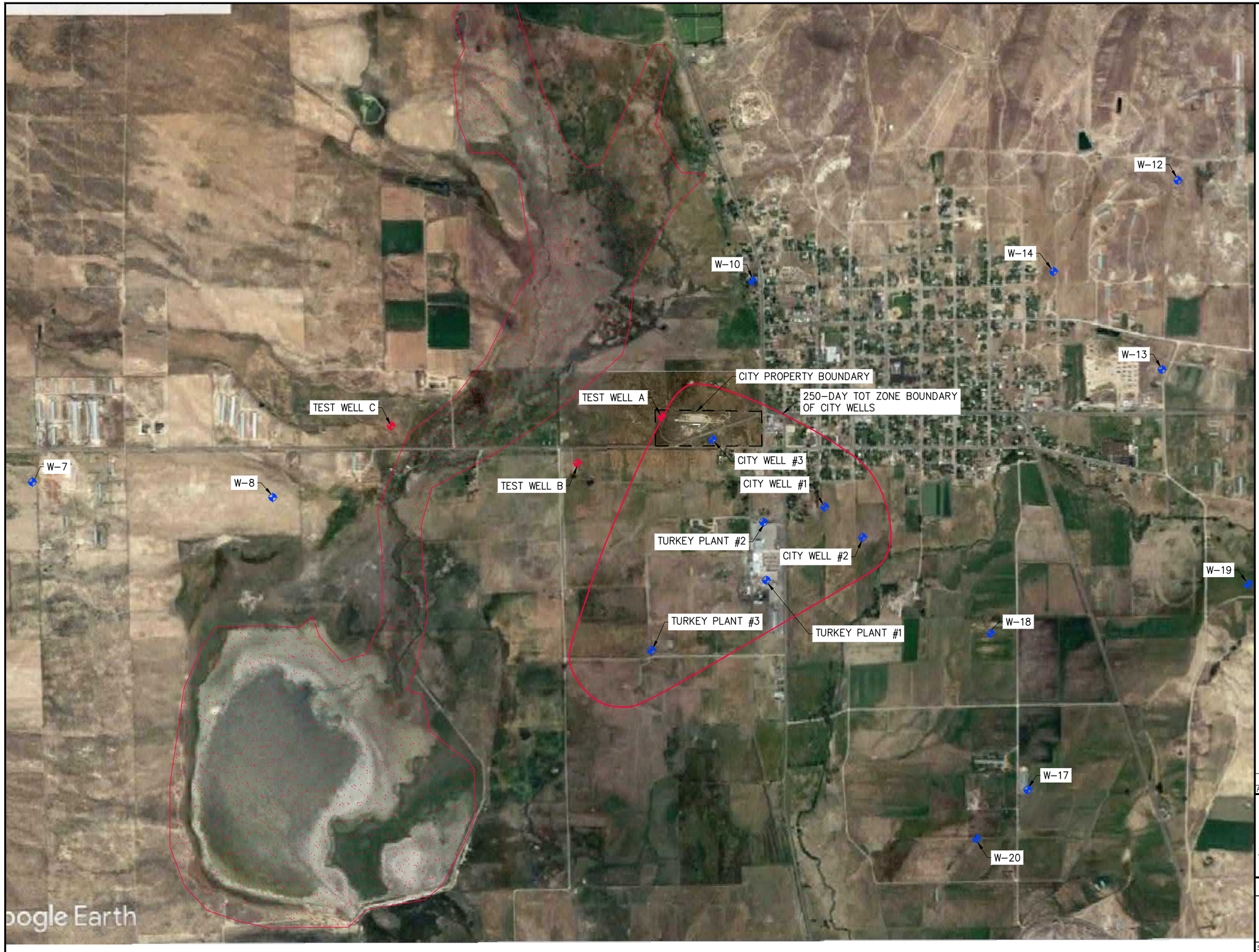

SCALE

700' 0 700'

LEGEND

- EXISTING WELL
- RECOMMENDED NEW WELL SITE
- FLOODPLAIN

AREA MAP

REV NO.	COMMENT	DATE

FOR REVIEW ONLY NOT FOR CONSTRUCTION DATE

SUNRISE ENGINEERING
6875 SOUTH 900 EAST
SALT LAKE CITY, UTAH 84047
TEL 801.523.0100 • FAX 801.523.0990
www.sunrise-eng.com

MORONI CITY

NITRATE BLENDING PLAN
HYDROGEOLOGIC STUDY
RECOMMENDED WELL SITES

SEI NO.	DESIGNED	DRAWN	CHECKED	SHEET NO.	
07311	DY	DY	DSA	04 of 04	FIG. 4

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APPENDIX C:

NITRATE WATER TREATMENT PLANT TECHNICAL INFORMATION

REVERSE OSMOSIS

WESTECH

Moroni City

Utah

Engineer
Sunrise Engineering

Representative
Mike Charnholm
Goble Sampson Associates
Salt Lake City, Utah
(801) 268-8790
mcharnholm@goblesampson.com

Contact
Adrian Williams
awilliams@westech-inc.com

Melissa Nichols
mnichols@westech-inc.com

WesTech®

Proposal Number: 2030231
Monday, June 08, 2020

Monday, June 08, 2020

RE: WesTech Engineering Membrane Filtration System Information Request

WesTech Engineering, Inc. appreciates the opportunity to provide budgetary pricing and preliminary information on a reverse osmosis system for the City of Moroni. The system consists of one (1) membrane filtration unit sized to achieve a net production capacity of 168 gpm. The unit is designed as a single-pass, two-stage system in a 4:2 7M configuration with 42 elements installed. Including the bypass flow rate of 150 gpm, the overall system recovery is targeted at 88% with a blended product flow of 318 gpm.

We would like to offer the following benefits for your consideration:

- Experience: WesTech has experience working with Sunrise Engineering in providing a membrane filtration system for the Greendale Water Company. Additionally, WesTech has supplied low pressure membrane filtration systems for over 18 years. Our Membrane Filtration Product Group has supplied or are under contract for more than 100 facilities in North America, ranging from 10 gpm to 10 MGD.
- Optimized Design for a Small Utility: WesTech has extensive experience supporting small utilities and has designed the system to minimize operator requirements. The controls package is fully automated with appropriate safety interlocks and alarms for reliable operation, as well as options for remote monitoring.
- Skid-Mounted, Pre-Assembled, and Low Footprint: Our membrane systems are largely pre-assembled and go through extensive factory testing prior to shipment to minimize installation and commissioning costs. System customization can be provided to reduce footprint and/or fit within the available space.
- Service: Customer-service, responsiveness, and long-term project support are WesTech priorities. With our headquarters located in Salt Lake City, the proximity to the site will allow for readily available field service and customer support. We take pride in our work and stand behind every project.

We would be interested in further discussion to ensure we are offering the best system and options to meet the project needs. We hope the provided information proves helpful, and please do not hesitate to contact us with any questions or for further discussion.

Best regards,

Melissa Nichols
Applications Engineer, Membrane Filtration
WesTech Engineering, Inc.

Table of Contents

Technical Proposal

Item A – Reverse Osmosis System, Model ROT51B

Design Overview		
Description	Unit	Dimension/Capacity
Application	-	Municipal Drinking Water
WesTech System Model	-	ROT51B, Reverse Osmosis System
Membrane Element	-	Toray
Net Product Flow Rate	gpm	318
Bypass Flow Rate	gpm	150
Gross Influent Flow Rate	gpm	360
Anticipated Recovery		
RO System	%	80
Overall	%	88
Redundancy and Unit Quantity	-	1 x 100%%; N+0 Redundancy, (1) total units
Approximate Dimensions	Per Unit	26'-7" L x 5'-6" W x 8'-0-1/4" H
Array	-	4:2 7M

WesTech is an experienced and reliable provider of nanofiltration/reverse osmosis (NF/RO) systems including new installations, retrofit and support of existing systems, and packaged systems. Systems are designed for ease of installation, straightforward operation, and long-term reliability. WesTech systems are provided as skid-mounted, factory-tested units to minimize field assembly. Major equipment and valving are pre-configured on the skids for efficient and error-free commissioning. Controls are fully-automated and completed by in-house electrical engineers and process automation experts.

Our membrane filtration team has provided more than 100 membrane systems throughout North America with NF/RO installations in excess of 4,800 gpm As a company, WesTech has 530 employees, 140 degreed engineers, and more than 15,000 process equipment installations throughout the world. This significant experience translates into reliable, time-tested equipment.

A WesTech Reverse Osmosis System rated for 2,000 gpm capacity.

Design Information

Water Quality

Projected Water Quality*					
Description	Unit	Feed	Concentrate	Blended Product	RO Permeate
Source	-	-	-		-
Silt Density Index	-	< 5	-		-
Calcium	mg/L	34.00	169.8	16.058	0.038
Magnesium	mg/L	9.000	44.95	4.251	0.0101
Sodium	mg/L	145.0	722.7	68.68	0.543
Chloride	mg/L	268.4	1,338	127.0	0.846
Fluoride	mg/L	0.200	0.995	0.095	0.0013
Nitrate	mg/L	10.100	50.23	4.799	0.0657
Bicarbonate	mg/L	0.100	0.487	0.0566	0.0158
Carbon Dioxide	mg/L	0.0229	0.0259	0.0227	0.024
TDS	mg/L	514.8	2,567	243.7	1.583
Temperature	°C	3	3	3	3
pH	-	7.0	7.590	6.737	6.490

*Values are assumed and should be verified. Permeate water quality values are projected estimates, not guaranteed values. Water quality may be improved or hampered by changes in the water quality and fluctuations in dissolved constituent concentrations. It should be noted that the use of upstream charged polymeric flocculant aids increases risk of irreversible membrane fouling and should be discussed with WesTech, and this risk is applicable to all polymeric membranes. The presence of oil and grease in the source water should also be avoided.

The recovery of the system is preliminarily designed as 80% but may be improved or hampered by changes in the water quality and fluctuations in dissolved constituent concentrations, like TDS. The RO system has a nominal rejection rate of 95 – 99% of dissolved materials including hardness and TDS.

Process Description

Described in this proposal is the preliminary process and equipment design of a WesTech reverse osmosis membrane filtration system for the City of Moroni project. The system consists of one (1) membrane filtration unit sized to achieve a net production capacity of 168 gpm. Each unit is designed as a single-pass, two-stage system in a 4:2 7M configuration with 42 elements installed. Including the bypass flow rate of 150 gpm, the overall system recovery is targeted at 88%.

Reverse osmosis technology uses semi-permeable membranes for removal of dissolved contaminants, such as TDS, chlorides, and hardness from water. The basic principle of RO involves application of high pressure to counteract natural osmotic pressure to drive water from a more concentrated, feed solution to a pure water permeate. Dissolved impurities are removed during this process.

The process utilizes cross-flow filtration to remove dissolved contaminants from the feed stream, producing a purified water stream (permeate) and a high-solute waste stream (concentrate). Feed water quality will determine the amount of permeate capable of being recovered from feed water. Raw water from Well #2 is directly fed to the membrane system. VFD-controlled feed pumps (by others) direct the source water to a 5-µm cartridge filter for removal of larger debris. A VFD-controlled high-pressure pump boosts the feed pressure provided by the feed pumps and drive water through the membranes.

Clean-in-place (CIP) procedures are automated chemical cleaning processes used to recover membrane permeability. The automated clean-in-place procedure is conducted with either sodium hydroxide or hydrochloric acid. A CIP is initiated when normalized permeate flow decreases by ≥10%, normalized salt passage increases by ≥10%, or normalized differential pressure increases by ≥15%.

Following chemical cleaning procedures, the membrane units are flushed to remove residual chemical prior to resuming production. If desired, chemical cleaning waste can be captured and neutralized prior to discharge.

Process Design Summary

Design Summary		
Parameter	AES	SI
Number of Units and Redundancy	1 x 100%	
Array Configuration	4:2 7M; Single Pass / Two-Stage	
Membrane Element	Toray TMG20D-400	
Elements per Skid	42	
Membrane Area per Element / Diameter	400 ft^2 / 8 in	37 m^2 / 203 mm
Total Membrane Area Installed	16,800 ft^2	1,554 m^2
Design Temperature	3 °C	
Average Flux Rate	14 gfd	24 lmh
Operating Flow Rates		
System Flow Rate	360 gpm	81.8 m^3/hr
Feed Flow Rate	210 gpm	47.7 m^3/hr
Permeate Flow Rate	168 gpm	38.2 m^3/hr
Concentrate Flow Rate	42 gpm	9.5 m^3/hr
Bypass Flow Rate	150 gpm	34.1 m^3/hr
Blended Flow Rate	318 gpm	72.2 m^3/hr
Approx. Total Net Permeate Production per Day	241,920 gpd	916 m^3/day
Approx. Total Blended Product per Day	457,920 gpd	1732.8 m^3/d
Approx. Total Concentrate Volume per Day	60,480 gpd	229 m^3/day
Overall System Recovery	88 %	
Projected Feed Pressure	175 psig	

Scope of Supply

Scope of Supply – Reverse Osmosis System			
Item	Quantity	Description	Brand (or Equal)
Membrane Elements	42/unit	Spiral wound, thin-film composite, polyamide	Toray
Skid Frames	1 x 100%	Welded carbon steel, baked powder-coat	-
Manifold and Supply Piping	-	Low Pressure: Sch 80 PVC High Pressure: 316 SS	-
Element Housings	6/unit	FRP	Codeline
Feed / Transfer Pump	By Others	End-suction centrifugal	By Others
High Pressure Pump	1/unit	Multi-stage; *note that feed pressure to the high pressure pump must be 30 psi or greater*	Grundfos
Cartridge Filters and Vessels	1/unit	Stainless steel	Fil-Trek
Compressed Air System	By Others	Plant air is available for valve actuation	By Others
Instrumentation			
Conductivity Sensor	2/unit	Feed/permeate	GF Signet
ORP Sensor/Trans.	1	Combined feed	GF Signet
pH Sensor/Trans.	1	Combined feed	GF Signet
Temperature Trans.	1	Combined feed	Dwyer
Flow Meters	2/unit	Magnetic flow meter Feed / concentrate	Siemens
Pressure Instrumentation	-	Transmitters, switches, gauges	Wika
Valves / Actuators	-	Manual and actuated valves	Bray
Electrical Controls	1 Master Panel	NEMA 4, Allen-Bradley PLC	-
Tanks	By Others	Feed, Permeate HDPE with level measurement	-

Scope of Supply – Clean-in-Place System			
Item	Quantity	Description	Brand (or equal)
Skid Frames	1	Welded carbon steel, baked powder-coat	-
Manifold and Supply Piping	-	Schedule 80 PVC, HDPE	-
Recirculation Pump	1 x 100%	End-suction centrifugal	Goulds
Cartridge Filters	1 x 100%	5-micron pore size	Fil-Trek
Heater	1	18 kW	Chromalox
Chemical Metering Pumps			
Acid	1 x 100%	CIP process	ProMinent
Alkaline	1 x 100%	CIP process	ProMinent
Instrumentation			
pH Sensor/Transmitter	1	-	GF Signet
Temperature Transmitter	1	-	Dwyer
Flow Switch	1	-	IFM Efector
Pressure Instrumentation	-	Transmitters, switches, gauges	Wika, Ashcroft
Valves / Actuators	-	Manual and actuated valves	Bray
Electrical Controls	1 CIP Panel	NEMA 4, 480 V 3 ph	-
Tank	By WesTech	Off-skid; HDPE with level meas.	Norwesco

Additional Services

On-Site Technical Assistance and Training

WesTech has included on-site technical assistance during construction, pre-commissioning and start-up to ensure the equipment is installed and commissioned per WesTech and sub-supplier requirements. All service visits will be completed by certified field technicians that are qualified and have experience working with WesTech equipment.

Any additional trips that the customer may request can be purchased at the standard WesTech daily rates plus travel and living expenses.

On-Site Technical Service		
Service	Number of Trips	Number of Days
Installation and Start-Up Commissioning Assistance, Operator Training	3	15
Total Included Service	3	15

To supplement the above noted technical assistance, WesTech will provide the additional services.

- Technical support during WesTech office hours with a direct phone number to reach a qualified and involved project representative during the equipment warranty period.
- Access to a 24-hour on-call emergency support line.

Clarifications and Exceptions

General Clarifications

Terms & Conditions: This proposal, including all terms and conditions contained herein, shall become part of any resulting contract or purchase order. Changes to any terms and conditions, including but not limited to submittal and shipment days, payment terms, and escalation clause shall be negotiated at order placement, otherwise the proposal terms and conditions contained herein shall apply.

USA Tariffs and Current Trade Laws: All prices are based on current USA and North America tariffs and trade laws/agreements at time of bid. Any changes in costs due to USA Tariffs and trade laws/ agreements will be passed through to the purchaser at cost.

Exceptions

Not applicable

Commercial Proposal

Proposal Name: Moroni City
Proposal Number: 2030231
Monday, June 08, 2020

1. Bidder's Contact Information

Company Name	WesTech Engineering, Inc.
Primary Contact Name	Adrian Williams
Phone	801.265.1000
Email	name@westech-inc.com
Address: Number/Street	3665 S West Temple
Address: City, State, Zip	Salt Lake City, UT 84115

2. Budget Pricing

Currency: US Dollars

Scope of Supply

A	Reverse Osmosis System, Model ROT51B	$372,000
	Taxes (sales, use, VAT, IVA, IGV, duties, import fees, etc.)	Not Included

Prices are valid for a period not to exceed 30 days from date of proposal.

Additional Field Service

Daily Rate (Applicable Only to Field Service Not Included in Scope)	$1,200

Pricing does not include field service unless noted in scope of supply, but is available at the daily rate plus expenses. The greater of a two week notice or visa procurement time is required prior to departure date. Our field service policy can be provided upon request for more details.

3. Payment Terms

Purchase Order Acceptance and Contract Execution	10%
Submittals Provided by WesTech	15%
Release for Fabrication	35%
Notification of Ready to Ship	40%

All payments are net 30 days. Partial shipments are allowed. An approved Letter of Credit is required if Incoterms CIF, CFR, DAP, CIP, or CPT are applicable. Payment is required in full for all other Incoterms prior to international shipment. Other terms per WesTech proforma invoice. Please note that the advising bank must be named as: Wells Fargo Bank, International Department, 9000 Flair Drive, 3rd Floor, El Monte, California 91731, USA.

4. Schedule

Submittals, after Purchase Order Acceptance and Contract Execution	6 to 8 weeks
Ready to Ship, after Receipt of Final Submittal Approval	18 to 20 weeks
Estimated Weeks to Ready to Ship	24 to 28 weeks*

*Customer submittal approval is typically required to proceed with equipment fabrication and is not accounted for in the schedule above. Project schedule will be extended to account for time associated with receipt of customer submittal approval.

5. Freight

Domestic	FOB Shipping Point - Full Freight Allowed to Jobsite (FSP-FFA)	
From	Final Destination	Number of Trucks or Containers
WesTech Shops	Customer Location	Approximately one (1) flat bed truck

One-Year Warranty

WesTech equipment is backed by WesTech's reputation as a quality manufacturer, and by many years of experience in the design of reliable equipment.

Equipment manufactured or sold by WesTech Engineering, Inc., once paid for in full, is backed by the following warranty:

For the benefit of the original user, WesTech warrants all new equipment manufactured by WesTech Engineering, Inc. to be free from defects in material and workmanship, and will replace or repair, F.O.B. its factories or other location designated by it, any part or parts returned to it which WesTech's examination shall show to have failed under normal use and service by the original user within one (1) year following initial start-up, or eighteen (18) months from shipment to the purchaser, whichever occurs first.

Such repair or replacement shall be free of charge for all items except for those items such as resin, filter media and the like that are consumable and normally replaced during maintenance, with respect to which, repair or replacement shall be subject to a pro-rata charge based upon WesTech's estimate of the percentage of normal service life realized from the part. WesTech's obligation under this warranty is conditioned upon its receiving prompt notice of claimed defects, which shall in no event be later than thirty (30) days following expiration of the warranty period, and is limited to repair or replacement as aforesaid.

This warranty is expressly made by WesTech and accepted by purchaser in lieu of all other warranties, including warranties of merchantability and fitness for particular purpose, whether written, oral, express, implied, or statutory. WesTech neither assumes nor authorizes any other person to assume for it any other liability with respect to its equipment. WesTech shall not be liable for normal wear and tear, corrosion, or any contingent, incidental, or consequential damage or expense due to partial or complete inoperability of its equipment for any reason whatsoever.

This warranty shall not apply to equipment or parts thereof which have been altered or repaired outside of a WesTech factory, or damaged by improper installation, application, or maintenance, or subjected to misuse, abuse, neglect, accident, or incomplete adherence to all manufacturer’s requirements, including, but not limited to, Operations & Maintenance Manual guidelines & procedures.

This warranty applies only to equipment made or sold by WesTech Engineering, Inc.

WesTech Engineering, Inc. makes no warranty with respect to parts, accessories, or components purchased by the customer from others. The warranties which apply to such items are those offered by their respective manufacturers.

Terms & Conditions

Terms and Conditions appearing in any order based on this proposal which are inconsistent herewith shall not be binding on WesTech Engineering Inc. The sale and purchase of equipment described herein shall be governed exclusively by the foregoing proposal and the following provisions:

1. SPECIFICATIONS: WesTech Engineering Inc. is furnishing its standard equipment as outlined in the proposal and as will be covered by final approved drawings. The equipment may not be in strict compliance with the Engineer's/Owner's plans, specifications, or addenda as there may be deviations. The equipment will, however, meet the general intention of the mechanical specifications of these documents.

2. ITEMS INCLUDED: This proposal includes only the equipment specified herein and does not include erection, installation, accessories, nor associated materials such as controls, piping, etc., unless specifically listed.

3. PARTIES TO CONTRACT: WesTech Engineering Inc. is not a party to or bound by the terms of any contract between WesTech Engineering Inc.'s customer and any other party. WesTech Engineering Inc.'s undertakings are limited to those defined in the contract between WesTech Engineering Inc. and its direct customers.

4. PRICE AND DELIVERY: All selling prices quoted are subject to change without notice after 30 days from the date of this proposal unless specified otherwise. Unless otherwise stated, all prices are F.O.B. WesTech Engineering Inc. or its supplier's shipping points. All claims for damage, delay or shortage arising from such equipment shall be made by Purchaser directly against the carrier. When shipments are quoted F.O.B. job site or other designation, Purchaser shall inspect the equipment shipped, notifying WesTech Engineering Inc. of any damage or shortage within forty-eight hours of receipt, and failure to so notify WesTech Engineering Inc. shall constitute acceptance by Purchaser, relieving WesTech Engineering Inc. of any liability for shipping damages or shortages.

5. PAYMENTS: All invoices are net 30 days. Delinquencies are subject to a 1.5 percent service charge per month or the maximum permitted by law, whichever is less on all past due accounts. Pro rata payments are due as shipments are made. If shipments are delayed by the Purchaser, invoices shall be sent on the date when WesTech Engineering Inc. is prepared to make shipment and payment shall become due under standard invoicing terms. If the work to be performed hereunder is delayed by the Purchaser, payments shall be based on the purchase price and percentage of completion. Products held for the Purchaser shall be at the risk and expense of the Purchaser. Unless specifically stated otherwise, prices quoted are for equipment only. These terms are independent of and not contingent upon the time and manner in which the Purchaser receives payment from the owner.

6. PAYMENT TERMS: Credit is subject to acceptance by WesTech Engineering Inc.'s Credit Department. If the financial condition of the Purchaser at any time is such as to give WesTech Engineering Inc., in its judgment, doubt concerning the Purchaser's ability to pay, WesTech Engineering Inc. may require full or partial payment in advance or may suspend any further deliveries or continuance of the work to be performed by the WesTech Engineering Inc. until such payment has been received.

7. ESCALATION: If shipment is, for any reason, deferred by the Purchaser beyond the normal shipment date, or if material price increases are greater than 5% from proposal date to material procurement date, stated prices set forth herein are subject to escalation. The escalation shall be based upon increases in labor and material and other costs to WesTech Engineering Inc. that occur in the time period between quotation and shipment by WesTech Engineering Inc. Purchaser agrees to this potential escalation regardless of contradicting terms in the contract, except when an agreed upon escalation adder is included in the price.

(a) The total quoted revised price is based upon changes in the indices published by the United States Department of Labor, Bureau of Labor Statistics. Labor will be related to the Average Hourly Earnings indices found in the Employment and Earnings publication. Material will be related to the Metal and Metal Products Indices published in Wholesale Prices and Prices Indices.

(b) Price revision for items furnished to, and not manufactured by WesTech Engineering Inc., which exceed the above escalation calculation, will be passed along by WesTech Engineering Inc. to Purchaser based upon the actual increase in price to WesTech Engineering Inc. for the period from the date of quotation to the date of shipment by WesTech Engineering Inc. Any item that is so revised will be excluded from the index escalation calculations set forth in subparagraph (a) above.

8. APPROVAL: If approval of equipment submittals by Purchaser or others is required, a condition precedent to WesTech Engineering Inc. supplying any equipment shall be such complete approval.

9. INSTALLATION SUPERVISION: Prices quoted for equipment do not include installation supervision. WesTech Engineering Inc. recommends and will, upon request, make available, at WesTech Engineering Inc.'s then current rate, an experienced installation supervisor to act as the Purchaser's employee and agent to supervise installation of the equipment. Purchaser shall at its sole expense furnish all necessary labor equipment, and materials needed for installation.

Responsibility for proper operation of equipment, if not installed by WesTech Engineering Inc. or installed in accordance with WesTech Engineering Inc.'s instructions, and inspected and accepted in writing by WesTech Engineering Inc., rests entirely with Purchaser; and any work performed by WesTech Engineering Inc. personnel in making adjustment or changes must be paid for at WesTech Engineering Inc.'s then current per diem rates plus living and traveling expenses.

WesTech Engineering Inc. will supply the safety devices described in this proposal or shown in WesTech Engineering Inc.'s drawings furnished as part of this order but excepting these, WesTech Engineering Inc. shall not be required to supply or install any safety devices whether required by law or otherwise. The Purchaser hereby agrees to indemnify and hold harmless WesTech Engineering Inc. from any claims or losses arising due to alleged or actual insufficiency or inadequacy of the safety devices offered or supplied hereunder, whether specified by WesTech Engineering Inc. or Purchaser, and from any damage resulting from the use of the equipment supplied hereunder.

10. ACCEPTANCE OF PRODUCTS: Products will be deemed accepted without any claim by Purchaser unless written notice of non-acceptance is received by WesTech Engineering Inc. within 30 days of delivery if shipped F.O.B. point of shipment, or 48 hours of delivery if shipped F.O.B. point of destination. Such written notice shall not be considered received by WesTech Engineering Inc. unless it is accompanied by all freight bills for said shipment, with Purchaser's notations as to damages, shortages and conditions of equipment, containers, and seals. Non-accepted products are subject to the return policy stated below.

11. TAXES: Any federal, state, or local sales, use or other taxes applicable to this transaction, unless specifically included in the price, shall be for Purchaser's account.

12. TITLE: The equipment specified herein, and any replacements or substitutes therefore shall, regardless of the manner in which affixed to or used in connection with realty, remain the sole and personal property of WesTech Engineering Inc. until the full purchase price has been paid. Purchaser agrees to do all things necessary to protect and maintain WesTech Engineering Inc.'s title and interest in and to such equipment; and upon Purchaser's default, WesTech Engineering Inc. may retain as liquidated damages any and all partial payments made and shall be free to enter the premises where such equipment is located and remove the same as its property without prejudice to any further claims on account of damages or loss which WesTech Engineering Inc. may suffer from any cause.

13. INSURANCE: From date of shipment until the invoice is paid in full, Purchaser agrees to provide and maintain at its expense, but for WesTech Engineering Inc.'s benefit, adequate insurance including, but not limited to, builders risk insurance on the equipment against any loss of any nature whatsoever.

14. SHIPMENTS: Any shipment of delivery dates recited represent WesTech Engineering Inc.'s best estimate but no liability, direct or indirect, is assumed by WesTech Engineering Inc. for failure to ship or deliver on such dates.

WesTech Engineering Inc. shall have the right to make partial shipments; and invoices covering the same shall be due and payable by Purchaser in accordance with the payment terms thereof. If Purchaser defaults in any payment when due hereunder, WesTech Engineering Inc. may, without incurring any liability therefore to Purchaser or Purchaser's customers, declare all payments immediately due and payable with maximum legal interest thereon from due date of said payment, and at its option, stop all further work and shipments until all past due payments have been made, and/or require that any further deliveries be paid for prior to shipment.

If Purchaser requests postponements of shipments, the purchase price shall be due and payable upon notice from WesTech Engineering Inc. that the equipment is ready for shipment; and thereafter any storage or other charge WesTech Engineering Inc. incurs on account of the equipment shall be for the Purchaser's account.

If delivery is specified at a point other than WesTech Engineering Inc. or its supplier's shipping points, and delivery is postponed or prevented by strike, accident, embargo, or other cause beyond WesTech Engineering Inc.'s reasonable control and occurring at a location other than WesTech Engineering Inc. or its supplier's shipping points, WesTech Engineering Inc. assumes no liability in delivery delay. If Purchaser refuses such delivery, WesTech Engineering Inc. may store the equipment at Purchaser's expense. For all purposes of this agreement such tender of delivery or storage shall constitute delivery.

15. WARRANTY: WESTECH ENGINEERING INC. WARRANTS EQUIPMENT IT SUPPLIES ONLY IN ACCORDANCE WITH THE WARRANTY EXPRESSED IN THE ATTACHED COPY OF "WESTECH WARRANTY" AGAINST DEFECTS IN WORKMANSHIP AND MATERIALS WHICH IS MADE A PART HEREOF. SUCH WARRANTY IN LIEU OF ALL OTHER WARRANTIES, INCLUDING WARRANTIES OF MERCHANTABILITY AND FITNESS FOR PARTICULAR PURPOSE, WHETHER WRITTEN, ORAL, EXPRESSED, IMPLIED OR STATUTORY, WESTECH ENGINEERING INC. SHALL NOT BE LIABLE ANY CONTINGENT, INCIDENTAL, OR CONSEQUENTIAL DAMAGES FOR ANY REASON WHATSOEVER.

16. PATENTS: WesTech Engineering Inc. agrees that it will, at its own expense, defend all suits or proceedings instituted against Purchaser and pay any award of damages assessed against it in such suits or proceedings, so far as the same are based on any claim that the said equipment or any part thereof constitutes an infringement of any apparatus patent of the United States issued at the date of this Agreement, provided WesTech Engineering Inc. is given prompt notice in writing of the institution or threatened institution of any suit or proceeding and is given full control of the defense, settlement, or compromise of any such action; and Purchaser agrees to give WesTech Engineering Inc. needed information, assistance, and authority to enable WesTech Engineering Inc. so to do. In the event said equipment is held or conceded to infringe such a patent, WesTech Engineering Inc. shall have the right at its sole option and expense to a) modify the equipment to be non-infringing, b) obtain for Purchaser the license to continue using said equipment, or c) accept return of the equipment and refund to the Purchaser the purchase price thereof less a reasonable charge for the use thereof. WesTech Engineering Inc. will reimburse Purchaser for actual out-of-pocket expenses, exclusive of legal fees, incurred in preparing such information and rendering such assistance at WesTech Engineering Inc.'s request. The foregoing states the entire liability of WesTech Engineering Inc., with respect to patent infringement; and except as otherwise agreed to in writing, WesTech Engineering Inc. assumes no responsibility for process patent infringement.

17. SURFACE PREPARATION AND PAINTING: If furnished, shop primer paint is intended to serve only as minimal protective finish. WesTech Engineering Inc. will not be responsible for the condition of primed or finish painted surfaces after equipment leaves its shops. Purchasers are invited to inspect paint in shops for proper preparation and application prior to shipment. WesTech Engineering Inc. assumes no responsibility for field surface preparation or touch-up of shipping damage to paint. Painting of fasteners and other touch-up to painted surfaces will be by Purchaser's painting contractor after mechanism installation.

Motors, gear motors, and other components not manufactured by WesTech Engineering Inc. will be painted with that manufacturer's standard paint system. It is WesTech Engineering Inc.'s intention to ship major steel components as soon as fabricated, often before drive, motors, and other manufactured components. Unless Purchaser can ensure that shop primed steel shall be field painted within thirty (30) days after arrival at the job site, WesTech Engineering Inc. encourages the Purchaser to order these components without primer.

WesTech Engineering Inc.'s prices are based on paints and surface preparations as outlined in the main body of this proposal. In the event that an alternate paint system is selected, WesTech Engineering Inc. requests that Purchaser's order advise of the paint selection. WesTech Engineering Inc. will then either adjust the price as may be necessary to comply or ship the material unpainted if compliance is not possible due to application problems or environmental controls.

18. CANCELLATION, SUSPENSION, OR DELAY: After acceptance by WesTech Engineering Inc., this proposal, or Purchaser's order based on this proposal, shall be a firm agreement and is not subject to cancellation, suspension, or delay except upon payment by Purchaser of appropriate charges which shall include all costs incurred by WesTech Engineering Inc. to date of cancellation, suspension, or delay plus a reasonable profit. Additionally, all charges related to storage and/or resumption of work, at WesTech Engineering Inc.'s plant or elsewhere, shall be for Purchaser's sole account; and all risks incidental to storage shall be assumed by Purchaser.

19. FORCE MAJEURE: Neither party hereto shall be liable to the other for default or delay in delivery caused by extreme weather or other act of God, strike or other labor shortage or disturbance, fire, accident, war or civil disturbance, act of government, pandemic, delay of carriers, failure of normal sources of supply, complete or partial shutdown of plant by reason of inability to attain sufficient raw materials or power, and/or other similar contingency beyond the reasonable control of the respective parties. The time for delivery specified herein shall be extended during the continuance of such conditions, or any other cause beyond such party's reasonable control.

20. RETURN OF PRODUCTS: No products may be returned to WesTech Engineering Inc. without WesTech Engineering Inc.'s prior written permission. Said permission may be withheld by WesTech Engineering Inc. at its sole discretion.

21. BACKCHARGES: WesTech Engineering Inc. will not approve or accept backcharges for labor, materials, or other costs incurred by Purchaser or others in modification, adjustment, service, or repair of WesTech Engineering Inc.-furnished materials unless such back charge has been authorized in advance in writing by a WesTech Engineering Inc. employee, by a WesTech Engineering Inc. purchase order, or work requisition signed by WesTech Engineering Inc.

22. INDEMNIFICATION: Purchaser agrees to indemnify WesTech Engineering Inc. from all costs incurred, including but not limited to court costs and reasonable attorney fees, from enforcing any provisions of this contract, including but not limited to breach of contract or costs incurred in collecting monies owed on this contract.

23. ENTIRE AGREEMENT: This proposal expresses the entire agreement between the parties hereto superseding any prior understandings, and is not subject to modification except by a writing signed by an authorized officer of each party.

24. MOTORS AND MOTOR DRIVES: In order to avoid shipment delays of WesTech Engineering Inc. equipment, the motor drives may be sent directly to the job site for installation by the equipment installer. Minor fit-up may be required.

25. EXTENDED STORAGE: Extended storage instructions will be part of information provided to shipment. If equipment installation and start-up is delayed more than 30 days, the provisions of the storage instructions must be followed to keep WARRANTY in force.

26. LIABILITY: Professional liability insurance, including but not limited to, errors and omissions insurance, is not included. In any event, liability for errors and omissions shall be limited to the lesser of $100,000USD or the value of the particular piece of equipment (not the value of the entire order) supplied by WesTech Engineering Inc. against which a claim is sought.

27. ARBITRATION NEGOTIATION: Any controversy or claim arising out of or relating to the performance of any contract resulting from this proposal or contract issued, or the breach thereof, shall be settled by arbitration in accordance with the Construction Industry Arbitration Rules of the American Arbitration Association, and judgment upon the award rendered by the arbitrator(s) may be entered to any court having jurisdiction.

ACCEPTED BY PURCHASER

Customer Name: _____

Customer Address: _____

_____

_____

Contact Name: _____

Contact Phone: _____

Contact Email: _____

Signature: _____

Printed Name: _____

Title: _____

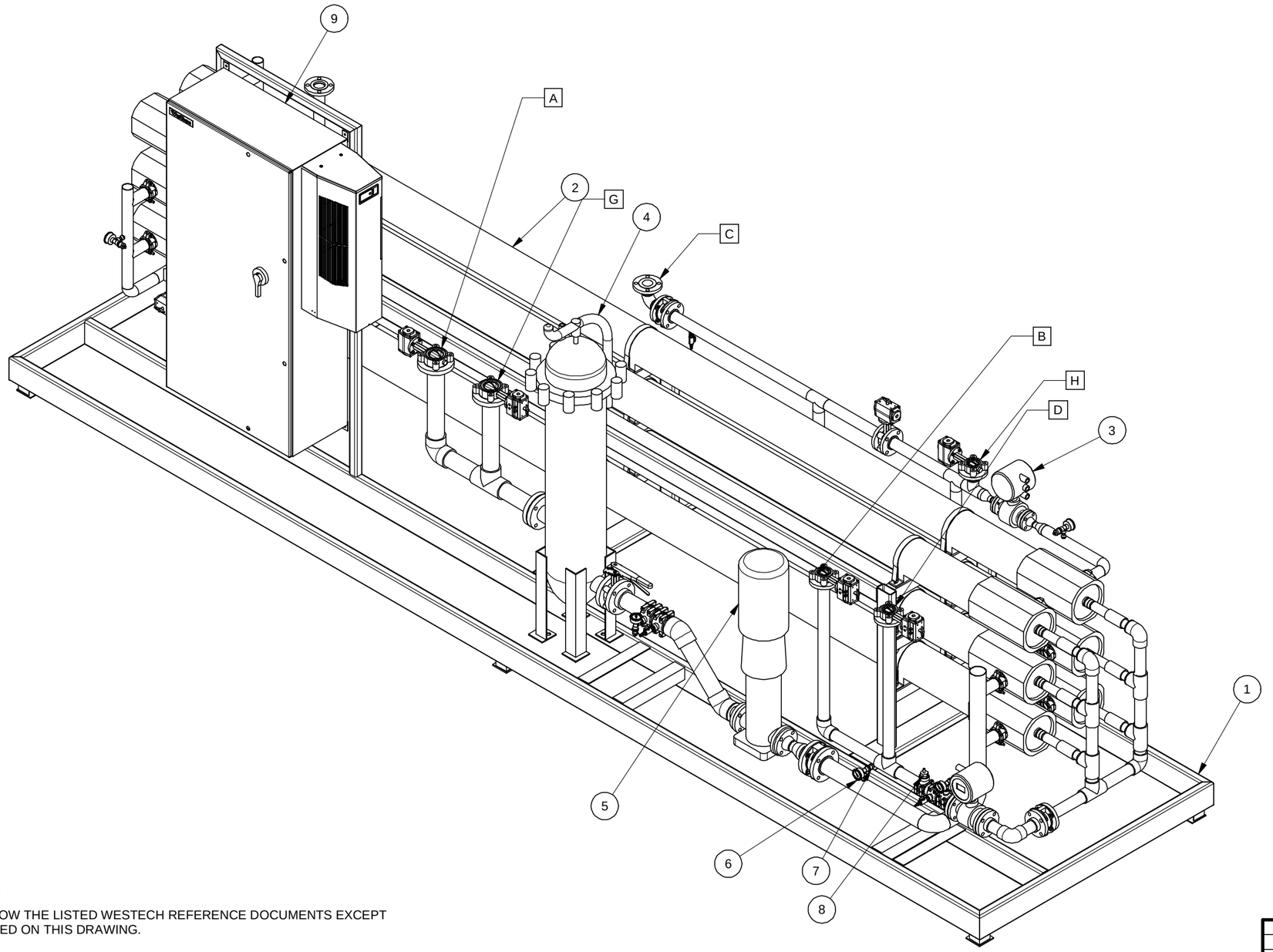
Date: _____

Supplemental Information

General Arrangement Drawings
Process & Instrumentation Diagram
Case Study

ITEM	EQUIPMENT DESCRIPTION	MAT'L
1	RO SKID	STL
2	(6) PRESSURE VESSELS, 4:2 6M	FRP
3	FLOW METERS	-
4	CARTRIDGE FILTERS	SST
5	BOOSTER PUMP	-
6	PRESSURE GAUGES	-
7	PRESSURE TRANSMITTERS	-
8	CONDUCTIVITY PROBE	-
9	CONTROL PANEL	-

CONNECTION SUMMARY			
NOZZLE	SIZE	TYPE	DESCRIPTION
A	3"	FLG	RO FEED
B	3"	FLG	RO PERMEATE
C	2"	FLG	RO CONCENTRATE
D	3"	FLG	RO WASTE
F	1/2"	FNPT	AIR SUPPLY
G	2"	FLG	CIP SUPPLY STAGE 1
H	2"	FLG	CIP RETURN STAGE 2
J	2"	FLG	CIP RETURN STAGE 1 SUPPLY STAGE 2



ISOMETRIC

NOTES:

1. FOLLOW THE LISTED WESTECH REFERENCE DOCUMENTS EXCEPT AS NOTED ON THIS DRAWING.

2. ALL FLANGE CONNECTIONS TO BE 150#.

3. SKID CONNECTIONS NOT DESIGNED TO BEAR PLANT LOADS. PLANT PIPING MUST BE PROPERLY SUPPORTED.

4. EQUIPMENT MUST BE LEVEL AFTER INSTALLATION

5. ALL VALVE AIR SUPPLY/SAMPLE/INSTRUMENTS TUBING POLYURETHANE.

REV	REVISION DESCRIPTION	ECN	DESIGNER	APPROVER	DATE	REFERENCE DOCUMENTS

WESTECH

PRELIMINARY
NOT FOR CONSTRUCTION

06/27/2018

PREPARED FOR

ENGINEER

CONTRACTOR

PO/CONTRACT NUMBER

WESTECH

TITLE **GENERAL ARRANGEMENT**
RO SKID
(6) VESSELS

DESIGNER	CHECKER	APPROVER	DATE
VO00.			

DOCUMENT NUMBER	SHEET	REV
1001	1 OF 3	-

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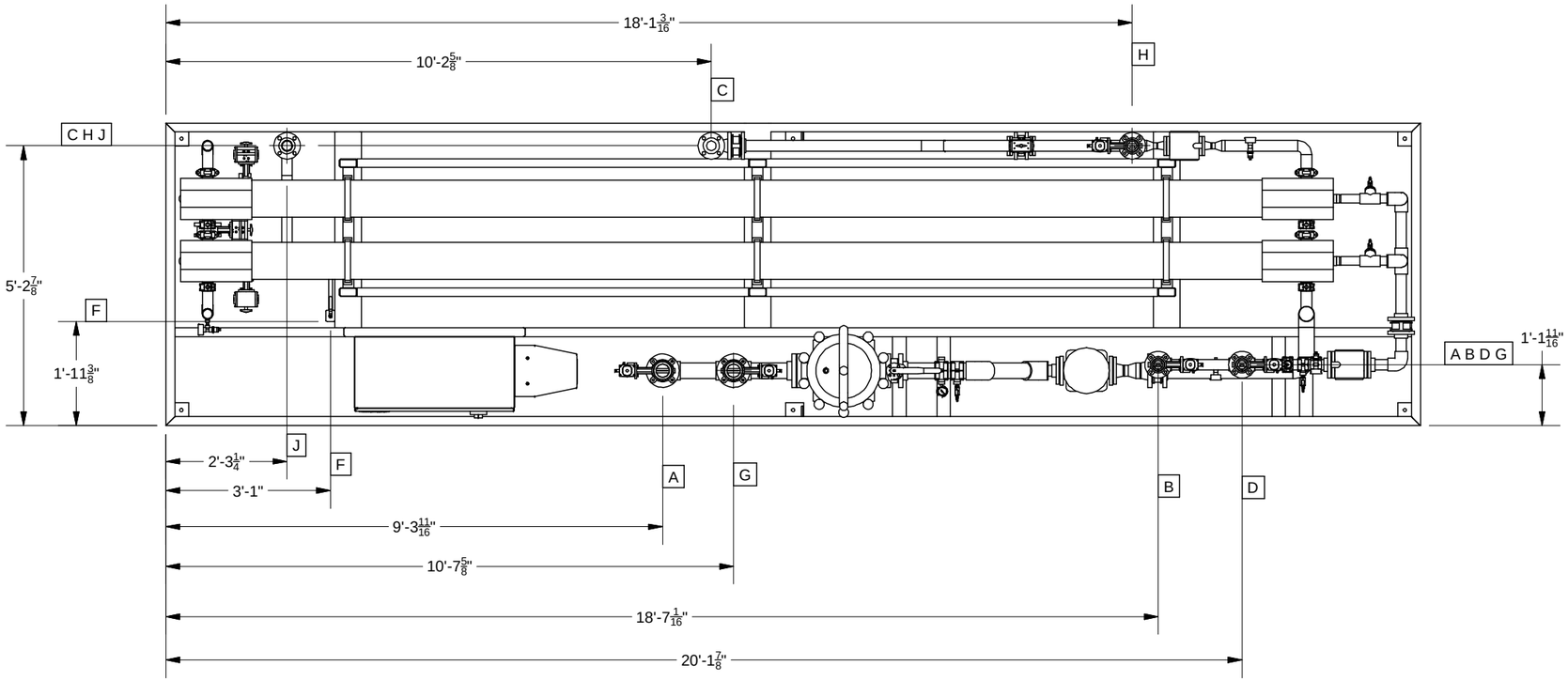
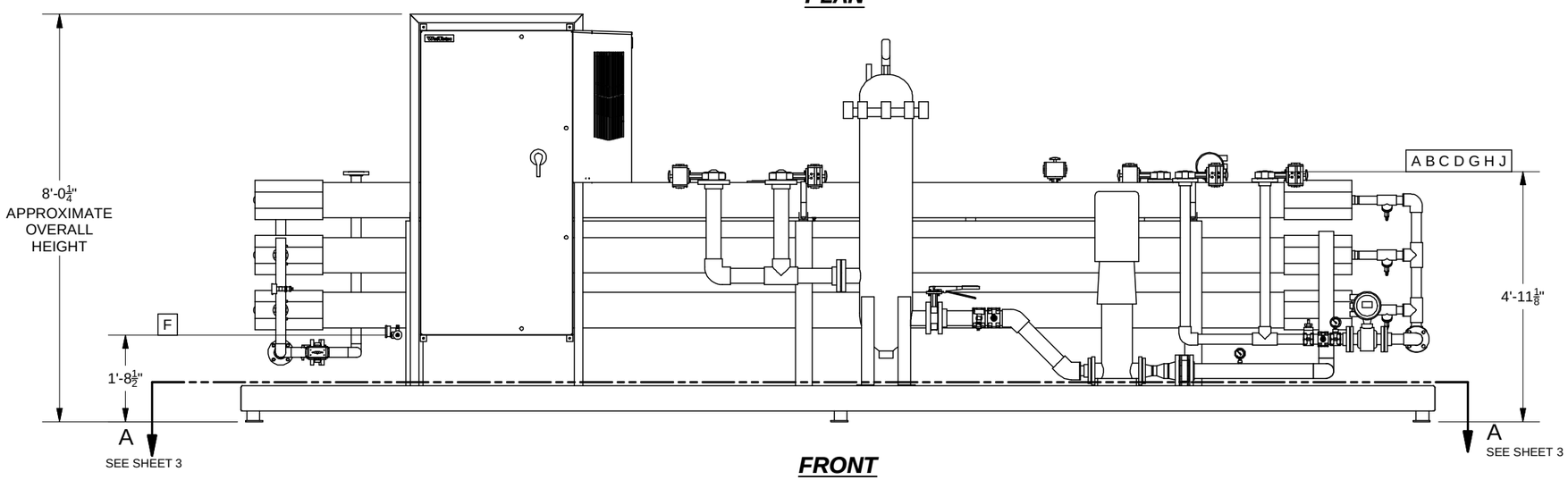


PLAN



FRONT

WESTECH

TITLE **GENERAL ARRANGEMENT**
RO SKID
(6) VESSELS

DESIGNER	CHECKER	APPROVER	DATE
VO00.			

DOCUMENT NUMBER	SHEET	REV
1001	2 OF 3	-

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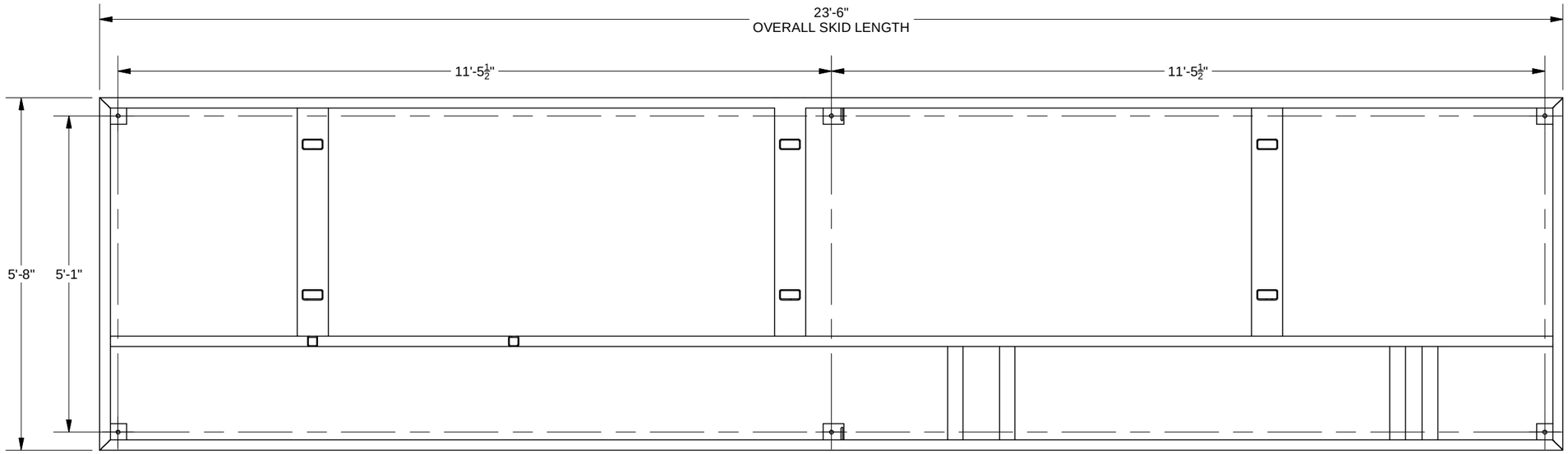


SECTION A-A
ANCHOR BOLT LAYOUT
(FROM SHEET 2)

WESTECH

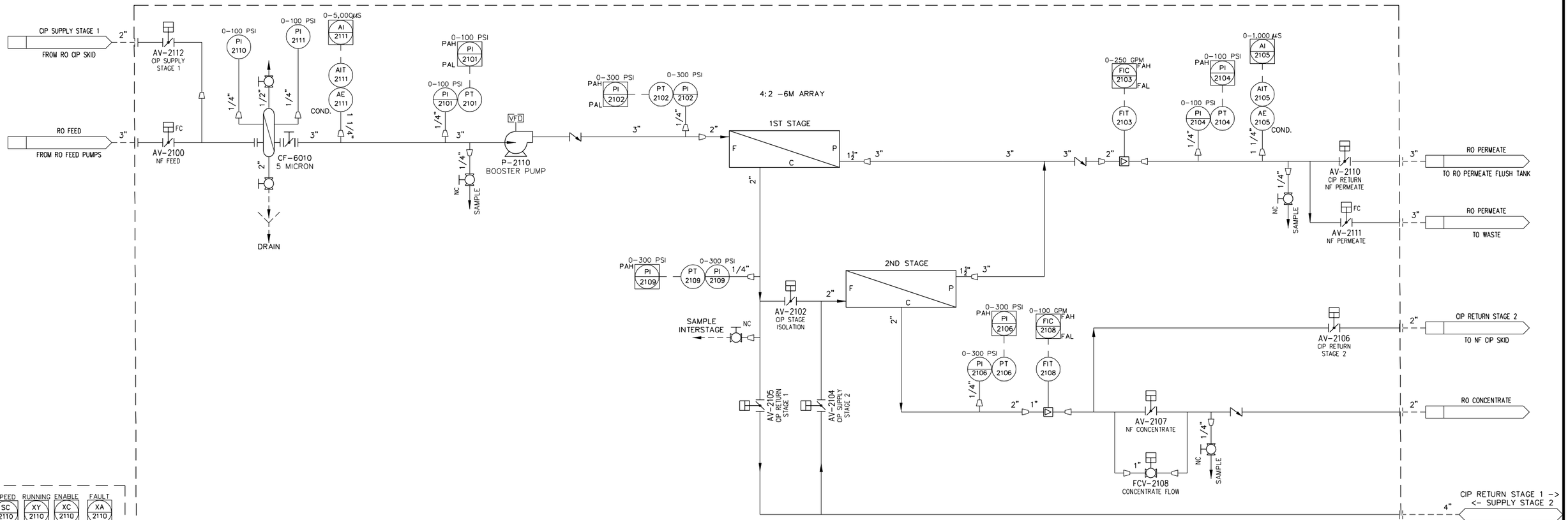
TITLE **GENERAL ARRANGEMENT**
RO SKID
(6) VESSELS

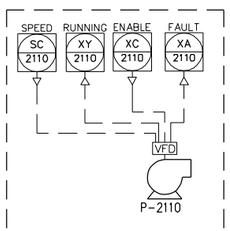
DESIGNER	CHECKER	APPROVER	DATE
VO00.			

DOCUMENT NUMBER	SHEET	REV
1001	3 OF 3	-

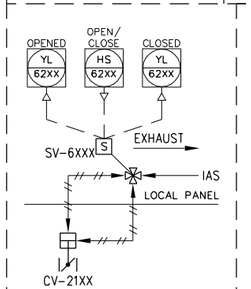
C:\vault\Design\Proposals\181\1810393\1810393-1001-GENERAL ARRANGEMENT, RO SKID, 6 VESSELS.idw

TAG	P-2110
ITEM	BOOSTER PUMP
SIZE	200 GPM @ 501 FT TDH
	40 HP
MANUF.	GRUNDFOS
MODEL	46SV-5/2



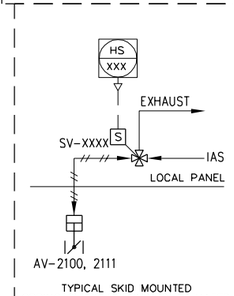


BOOSTER PUMP CONTROL DETAIL



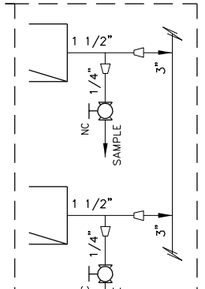
TYPICAL SKID MOUNTED PNEUMATIC ACTUATED VALVE CONTROL DETAIL

IF ELECTRICAL FAILURE: FL
IF AIR FAILURE: FI



TYPICAL SKID MOUNTED SPRING CLOSE PNEUMATIC ACTUATED VALVE CONTROL DETAIL

IF ELECTRICAL FAILURE: FC
IF AIR FAILURE: FC



VESSEL PERMEATE DETAIL

NOTES

1. FOLLOW THE LISTED WESTECH REFERENCE DOCUMENTS EXCEPT AS NOTED ON THIS DRAWING.
2. ALL VALVE AIR SUPPLY / SAMPLE / INSTRUMENT TUBING TO BE POLYURETHANE.
3. EQUIPMENT BY OTHERS / EXISTING: ----------

PRELIMINARY ONLY
NOT FOR CONSTRUCTION
JUNE, 27 2018

REV	REVISION DESCRIPTION	ECN	DESIGNER	APPROVER	DATE

REFERENCE DOCUMENTS

PREPARED FOR

ENGINEER

CONTRACTOR

CUSTOMER PO

CUSTOMER TAG NO

WESTECH

TITLE **PIPING AND INSTRUMENTATION DIAGRAM**
RO SKID
(6) VESSELS

DESIGNER	CHECKER	APPROVER	DATE
VOOO			

DOCUMENT NUMBER	SHEET	REV
1012	1 OF 1	-

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UF Handles Spring Snowmelt, Future Growth

AltaPac™ Ultrafiltration System

CASE STUDY

Location: **Dutch John, UT**
Owner: **Greendale Water Company**
Engineer: **Sunrise Engineering**
Contractor: **Ellsworth Paulsen Construction**

Problem

The Greendale Water Company services the small area in and around Flaming Gorge National Recreation Area. Their customers include the Greendale community, the Flaming Gorge resort and campground, and other seasonal businesses. Previously, water was treated from their spring water sources using small pressurized media filters. These filters required extensive maintenance, weren't supported by their manufacturer, and were challenged to produce effluent meeting drinking water standards during the spring snowmelt and subsequent high-turbidity events. In addition to these issues, the plant needed additional capacity to accommodate growth in the area.

Analysis of Alternatives

New media filtration equipment, microfiltration, and ultrafiltration were all considered for the upgrade. When choosing the best technology, Sunrise Engineering and the Greendale Water Company weighted both performance and limited operator involvement heavily. At this plant, the plant operator also serves as the county chief deputy and in several other functions, so he had minimal time to operate the plant and requested remote access from his laptop and cell phone. Full system redundancy, fast pilot deployment, and the ability to double the plant's capacity by simply adding additional modules were also of high importance.

Recommended Solution

WesTech's AltaPac™ Ultrafiltration Membrane Package System was ultimately selected for this plant upgrade for multiple reasons:

- The engineer determined that the pore size of ultrafiltration membranes would be preferable to microfiltration, since the spring snowmelt produces an extremely fine silt in the feed water which could potentially cause the microfiltration membranes to foul fast.
- The automation and remote monitoring capabilities built into the AltaPac system allowed the operator to control the plant remotely and minimized plant maintenance.

The compact and efficient design of the AltaPac limited the costs of installation and construction of the new treatment building.

WesTech®

- The AltaPac could be partially populated with modules, but the pumps and other appurtenances were sized for the full flow rate, allowing for easy expansion through installation of additional modules.
- The integral CIP skid and compact design of the AltaPac offered significant savings on building and construction costs.
- WesTech's main PLC panel could be used as the plant's Supervisory Control and Data Acquisition Systems (SCADA) system, negating the need for additional control panels.

An optional neutralization system was included with this equipment to allow for discharge of chemical solutions used during membrane cleaning.

Implementation

Following the selection of ultrafiltration as the technology of choice, WesTech competed against four other membrane suppliers in the direct bid, and was selected to provide the equipment and immediately start the state-required pilot study. The pilot study was performed for 3.5 months, and the membrane was exposed to the full range of feed turbidity. The pilot study investigated a variety of operating conditions, and WesTech assisted with a coagulant study and a disinfection byproduct formation potential study – the results of which were integrated into the plant's design. After completion of the pilot study and approval by the state, WesTech's equipment was fabricated and ready for delivery well ahead of schedule.

Results

The ultrafiltration system has been operating successfully since the start-up in January 2016. The operator and owners have been pleased with the ease of use, reliability, and high quality filtrate achieved using the AltaPac ultrafiltration system. In addition, the customer has been extremely impressed by the dedication to service and support demonstrated by all WesTech employees involved with this project. In fact, the use of ultrafiltration at the plant has been such a success that it has inspired visits by other engineers looking to overcome similar challenges.

Only half the ultrafiltration racks are populated due to current demand. The capacity of the system can be doubled quickly and inexpensively by installing additional modules. All system components are sized for the increased capacity to limit costs associated with expanding the system.

AltaPac systems are assembled and tested in WesTech facilities to ensure quality and consistency.

WESTECH®
Tel: 801.265.1000 | **westech-inc.com**

ION EXCHANGE

WESTECH

Moroni City

Utah

Engineer
Sunrise Engineering

Furnished by
Adrian Williams
awilliams@westech-inc.com

Represented by
Mike Charnholm
Goble Sampson Associates
Salt Lake City, Utah
(801) 268-8790
mcharnholm@goblesampson.com

WesTech Opportunity Number: 2030231
Thursday, June 11, 2020

Item A – Ion Exchange Vessels

Design Criteria	
Model	IEV12B
Project Flow Rate	360 gpm
Number of Softeners	3
Size of Each Softener	72” diameter x 96” straight side height
Hydraulic Loading Rate	3.0 gpm/ft^2 (4.59 gpm/ft^2 with one vessel offline)
Inlet Flow Rate to Vessels	260 gpm
Bypass Flow Rate	100 gpm (27.7% of plant flow)
Raw Total Nitrate Concentration	10.1 mg/L
Estimated Nitrate Leakage	3 mg/L
Finished Water Nitrate Concentration	< 5 mg/L
Media	Purolite A520E

Technical Description

Ion Exchange Softeners are an effective, inexpensive and low-maintenance method of reducing hardness from raw water quality. Water is induced in the top side of the vessel and passes through ion exchange resin where unwanted ions are removed. Once the resin has reached capacity it is regenerated with salt, and placed back in service.

Key Features and Benefits

- Consistent water quality with automatic regeneration controls
- Extends service life with high quality non-code constructed tanks, or ASME code tanks.
- Maximize net production while minimizing waste with high capacity Ion exchange resin
- Reduce operator attention required with automatic actuated system valves

The following budget pricing includes:

Scope includes 100 psi working pressure ASME Code pressure vessels each provided with the following: supporting legs; top side inlet connection, steel pipe overdrain; bottom center effluent connection; one brine connection; shop installed steel plate underdrain with plastic strainers; one 14 inch x 18 inch manhole in each tank top head; one coat of interior and exterior primer; and two coats of interior finish paint (above the underdrain). Plus the following shipped loose for field assembly: PVC brine distributors; face piping (prime painted on exterior); pneumatically actuated butterfly valves; compressor for valve operation, automatic air release valves and piping; graded gravel support; ion exchange resin; one automatic regeneration control panel; two inlet water meters; one brine meter; one brine pump; headloss gauge; aluminum weir board; plus freight and start-up technical direction.

Note: Any Item Not Listed Above to Be Furnished by Others.

Items Not Furnished by WesTech

- Unloading of equipment from delivering carrier, protected storage of equipment, installation, supervision of installation
- All underground and interconnecting piping, piping and fittings (not specifically listed), pipe supports, wall inserts or sleeves, Dresser or flexible couplings, hangers, valves (not specifically listed), pneumatic tubing from air compressor to filter batteries, air release piping and valves, sampling lines and sinks, small pressure water supply piping, field work of piping (i.e., drilling and tapping for instrumentation) and flow meters
- Walkways, handrails, stairways and ladders
- Finish paint and intermediate field coats, cathodic protection systems
- All chemical feeders, feed lines, start-up chemicals, chemicals, labor and procedures for the disinfection of equipment, laboratory test equipment
- Structural design, supply and installation of concrete pads, foundations, rebar, anchors, concrete, grout, sealant and sumps
- Motor control center, motor starters, disconnects, electrical wiring and conduit, connection of electrical wiring to terminals within WesTech's control panels, telemetering equipment, level controls, supports for controls, all instrumentation not specifically listed
- All pumps, operating and start-up lubricants
- All brine making equipment and tanks
- Any equipment and service not listed in this proposal

This proposal has been reviewed and is approved for issue by Rene Carson on June 11, 2020.

Budget Pricing

Proposal Name: Moroni City
Proposal Number: 2030231
Thursday, June 11, 2020

1. Bidder's Contact Information

Company Name	WesTech Engineering, Inc.
Contact Name	Adrian Williams
Phone	801.265.1000
Email	awilliams@westech-inc.com
Address: Number/Street	3665 S West Temple
Address: City, State, Zip	Salt Lake City, UT 84115

2. Pricing

Currency: US Dollars

Scope of Supply

A	Ion Exchange Vessels	$450,000
	Taxes (sales, use, VAT, IVA, IGV, duties, import fees, etc.)	Not Included

Prices are for a period not to exceed 30 days from date of proposal.

Field Service

Daily Rate	$1,200

Prices do not include field service unless noted, but it is available at the daily rate plus expenses. The customer will be charged for a minimum of three days for time at the jobsite. Travel will be billed at the daily rate. Any canceled charges due to the customer's request will be added to the invoice. The greater of visa procurement time or a two week notice is required prior to trip departure date.

3. Payment Terms

Submittals Approved	15%
Release for Fabrication	35%
Net 30 days from Shipment	50%

All payments are net 30 days. Partial shipments are allowed. Other terms per WesTech proforma invoice.

4. Schedule

Submittals, after PO receipt	6 to 8 Weeks
Customer Review Period	2 weeks
Ready to Ship, after Submittal Approval	18 to 20 weeks
Total Weeks from PO to Shipment	26 to 30 weeks

Terms & Conditions: This proposal, including all terms and conditions contained herein, shall become part of any resulting contract or purchase order. Changes to any terms and conditions, including but not limited to submittal and shipment days, payment terms, and escalation clause shall be negotiated at order placement, otherwise the proposal terms and conditions contained herein shall apply.

Freight: Prices quoted are F.O.B. shipping point with freight allowed to a readily accessible location nearest to jobsite. All claims for damage or loss in shipment shall be initiated by purchaser.

Paint: If your equipment has paint included in the price, please take note to the following. Primer paints are designed to provide only a minimal protection from the time of application (usually for a period not to exceed 30 days). Therefore, it is imperative that the finish coat be applied within 30 days of shipment on all shop primed surfaces. Without the protection of the final coatings, primer degradation may occur after this period, which in turn may require renewed surface preparation and coating. If it is impractical or impossible to coat primed surfaces within the suggested time frame, WesTech strongly recommends the supply of bare metal, with surface preparation and coating performed in the field. All field surface preparation, field paint, touch-up, and repair to shop painted surfaces are not by WesTech.

One-Year Warranty

WesTech equipment is backed by WesTech's reputation as a quality manufacturer, and by many years of experience in the design of reliable equipment.

Equipment manufactured or sold by WesTech Engineering, Inc., once paid for in full, is backed by the following warranty:

For the benefit of the original user, WesTech warrants all new equipment manufactured by WesTech Engineering, Inc. to be free from defects in material and workmanship, and will replace or repair, F.O.B. its factories or other location designated by it, any part or parts returned to it which WesTech's examination shall show to have failed under normal use and service by the original user within one (1) year following initial start-up, or eighteen (18) months from shipment to the purchaser, whichever occurs first.

Such repair or replacement shall be free of charge for all items except for those items such as resin, filter media and the like that are consumable and normally replaced during maintenance, with respect to which, repair or replacement shall be subject to a pro-rata charge based upon WesTech's estimate of the percentage of normal service life realized from the part. WesTech's obligation under this warranty is conditioned upon its receiving prompt notice of claimed defects, which shall in no event be later than thirty (30) days following expiration of the warranty period, and is limited to repair or replacement as aforesaid.

This warranty is expressly made by WesTech and accepted by purchaser in lieu of all other warranties, including warranties of merchantability and fitness for particular purpose, whether written, oral, express, implied, or statutory. WesTech neither assumes nor authorizes any other person to assume for it any other liability with respect to its equipment. WesTech shall not be liable for normal wear and tear, corrosion, or any contingent, incidental, or consequential damage or expense due to partial or complete inoperability of its equipment for any reason whatsoever.

This warranty shall not apply to equipment or parts thereof which have been altered or repaired outside of a WesTech factory, or damaged by improper installation, application, or maintenance, or subjected to misuse, abuse, neglect, accident, or incomplete adherence to all manufacturer’s requirements, including, but not limited to, Operations & Maintenance Manual guidelines & procedures.

This warranty applies only to equipment made or sold by WesTech Engineering, Inc.

WesTech Engineering, Inc. makes no warranty with respect to parts, accessories, or components purchased by the customer from others. The warranties which apply to such items are those offered by their respective manufacturers.

Terms & Conditions

Terms and Conditions appearing in any order based on this proposal which are inconsistent herewith shall not be binding on WesTech Engineering Inc. The sale and purchase of equipment described herein shall be governed exclusively by the foregoing proposal and the following provisions:

1. SPECIFICATIONS: WesTech Engineering Inc. is furnishing its standard equipment as outlined in the proposal and as will be covered by final approved drawings. The equipment may not be in strict compliance with the Engineer's/Owner's plans, specifications, or addenda as there may be deviations. The equipment will, however, meet the general intention of the mechanical specifications of these documents.

2. ITEMS INCLUDED: This proposal includes only the equipment specified herein and does not include erection, installation, accessories, nor associated materials such as controls, piping, etc., unless specifically listed.

3. PARTIES TO CONTRACT: WesTech Engineering Inc. is not a party to or bound by the terms of any contract between WesTech Engineering Inc.'s customer and any other party. WesTech Engineering Inc.'s undertakings are limited to those defined in the contract between WesTech Engineering Inc. and its direct customers.

4. PRICE AND DELIVERY: All selling prices quoted are subject to change without notice after 30 days from the date of this proposal unless specified otherwise. Unless otherwise stated, all prices are F.O.B. WesTech Engineering Inc. or its supplier's shipping points. All claims for damage, delay or shortage arising from such equipment shall be made by Purchaser directly against the carrier. When shipments are quoted F.O.B. job site or other designation, Purchaser shall inspect the equipment shipped, notifying WesTech Engineering Inc. of any damage or shortage within forty-eight hours of receipt, and failure to so notify WesTech Engineering Inc. shall constitute acceptance by Purchaser, relieving WesTech Engineering Inc. of any liability for shipping damages or shortages.

5. PAYMENTS: All invoices are net 30 days. Delinquencies are subject to a 1.5 percent service charge per month or the maximum permitted by law, whichever is less on all past due accounts. Pro rata payments are due as shipments are made. If shipments are delayed by the Purchaser, invoices shall be sent on the date when WesTech Engineering Inc. is prepared to make shipment and payment shall become due under standard invoicing terms. If the work to be performed hereunder is delayed by the Purchaser, payments shall be based on the purchase price and percentage of completion. Products held for the Purchaser shall be at the risk and expense of the Purchaser. Unless specifically stated otherwise, prices quoted are for equipment only. These terms are independent of and not contingent upon the time and manner in which the Purchaser receives payment from the owner.

6. PAYMENT TERMS: Credit is subject to acceptance by WesTech Engineering Inc.'s Credit Department. If the financial condition of the Purchaser at any time is such as to give WesTech Engineering Inc., in its judgment, doubt concerning the Purchaser's ability to pay, WesTech Engineering Inc. may require full or partial payment in advance or may suspend any further deliveries or continuance of the work to be performed by the WesTech Engineering Inc. until such payment has been received.

7. ESCALATION: If shipment is, for any reason, deferred by the Purchaser beyond the normal shipment date, or if material price increases are greater than 5% from proposal date to material procurement date, stated prices set forth herein are subject to escalation. The escalation shall be based upon increases in labor and material and other costs to WesTech Engineering Inc. that occur in the time period between quotation and shipment by WesTech Engineering Inc. Purchaser agrees to this potential escalation regardless of contradicting terms in the contract, except when an agreed upon escalation adder is included in the price.

(a) The total quoted revised price is based upon changes in the indices published by the United States Department of Labor, Bureau of Labor Statistics. Labor will be related to the Average Hourly Earnings indices found in the Employment and Earnings publication. Material will be related to the Metal and Metal Products Indices published in Wholesale Prices and Prices Indices.

(b) Price revision for items furnished to, and not manufactured by WesTech Engineering Inc., which exceed the above escalation calculation, will be passed along by WesTech Engineering Inc. to Purchaser based upon the actual increase in price to WesTech Engineering Inc. for the period from the date of quotation to the date of shipment by WesTech Engineering Inc. Any item that is so revised will be excluded from the index escalation calculations set forth in subparagraph (a) above.

8. APPROVAL: If approval of equipment submittals by Purchaser or others is required, a condition precedent to WesTech Engineering Inc. supplying any equipment shall be such complete approval.

9. INSTALLATION SUPERVISION: Prices quoted for equipment do not include installation supervision. WesTech Engineering Inc. recommends and will, upon request, make available, at WesTech Engineering Inc.'s then current rate, an experienced installation supervisor to act as the Purchaser's employee and agent to supervise installation of the equipment. Purchaser shall at its sole expense furnish all necessary labor equipment, and materials needed for installation.

Responsibility for proper operation of equipment, if not installed by WesTech Engineering Inc. or installed in accordance with WesTech Engineering Inc.'s instructions, and inspected and accepted in writing by WesTech Engineering Inc., rests entirely with Purchaser; and any work performed by WesTech Engineering Inc. personnel in making adjustment or changes must be paid for at WesTech Engineering Inc.'s then current per diem rates plus living and traveling expenses.

WesTech Engineering Inc. will supply the safety devices described in this proposal or shown in WesTech Engineering Inc.'s drawings furnished as part of this order but excepting these, WesTech Engineering Inc. shall not be required to supply or install any safety devices whether required by law or otherwise. The Purchaser hereby agrees to indemnify and hold harmless WesTech Engineering Inc. from any claims or losses arising due to alleged or actual insufficiency or inadequacy of the safety devices offered or supplied hereunder, whether specified by WesTech Engineering Inc. or Purchaser, and from any damage resulting from the use of the equipment supplied hereunder.

10. ACCEPTANCE OF PRODUCTS: Products will be deemed accepted without any claim by Purchaser unless written notice of non-acceptance is received by WesTech Engineering Inc. within 30 days of delivery if shipped F.O.B. point of shipment, or 48 hours of delivery if shipped F.O.B. point of destination. Such written notice shall not be considered received by WesTech Engineering Inc. unless it is

accompanied by all freight bills for said shipment, with Purchaser's notations as to damages, shortages and conditions of equipment, containers, and seals. Non-accepted products are subject to the return policy stated below.

11. TAXES: Any federal, state, or local sales, use or other taxes applicable to this transaction, unless specifically included in the price, shall be for Purchaser's account.

12. TITLE: The equipment specified herein, and any replacements or substitutes therefore shall, regardless of the manner in which affixed to or used in connection with realty, remain the sole and personal property of WesTech Engineering Inc. until the full purchase price has been paid. Purchaser agrees to do all things necessary to protect and maintain WesTech Engineering Inc.'s title and interest in and to such equipment; and upon Purchaser's default, WesTech Engineering Inc. may retain as liquidated damages any and all partial payments made and shall be free to enter the premises where such equipment is located and remove the same as its property without prejudice to any further claims on account of damages or loss which WesTech Engineering Inc. may suffer from any cause.

13. INSURANCE: From date of shipment until the invoice is paid in full, Purchaser agrees to provide and maintain at its expense, but for WesTech Engineering Inc.'s benefit, adequate insurance including, but not limited to, builders risk insurance on the equipment against any loss of any nature whatsoever.

14. SHIPMENTS: Any shipment of delivery dates recited represent WesTech Engineering Inc.'s best estimate but no liability, direct or indirect, is assumed by WesTech Engineering Inc. for failure to ship or deliver on such dates.

WesTech Engineering Inc. shall have the right to make partial shipments; and invoices covering the same shall be due and payable by Purchaser in accordance with the payment terms thereof. If Purchaser defaults in any payment when due hereunder, WesTech Engineering Inc. may, without incurring any liability therefore to Purchaser or Purchaser's customers, declare all payments immediately due and payable with maximum legal interest thereon from due date of said payment, and at its option, stop all further work and shipments until all past due payments have been made, and/or require that any further deliveries be paid for prior to shipment.

If Purchaser requests postponements of shipments, the purchase price shall be due and payable upon notice from WesTech Engineering Inc. that the equipment is ready for shipment; and thereafter any storage or other charge WesTech Engineering Inc. incurs on account of the equipment shall be for the Purchaser's account.

If delivery is specified at a point other than WesTech Engineering Inc. or its supplier's shipping points, and delivery is postponed or prevented by strike, accident, embargo, or other cause beyond WesTech Engineering Inc.'s reasonable control and occurring at a location other than WesTech Engineering Inc. or its supplier's shipping points, WesTech Engineering Inc. assumes no liability in delivery delay. If Purchaser refuses such delivery, WesTech Engineering Inc. may store the equipment at Purchaser's expense. For all purposes of this agreement such tender of delivery or storage shall constitute delivery.

15. WARRANTY: WESTECH ENGINEERING INC. WARRANTS EQUIPMENT IT SUPPLIES ONLY IN ACCORDANCE WITH THE WARRANTY EXPRESSED IN THE ATTACHED COPY OF "WESTECH WARRANTY" AGAINST DEFECTS IN WORKMANSHIP AND MATERIALS WHICH IS MADE A PART HEREOF. SUCH WARRANTY IN LIEU OF ALL OTHER WARRANTIES, INCLUDING WARRANTIES OF MERCHANTABILITY AND FITNESS FOR PARTICULAR PURPOSE, WHETHER WRITTEN, ORAL, EXPRESSED, IMPLIED OR STATUTORY, WESTECH ENGINEERING INC. SHALL NOT BE LIABLE ANY CONTINGENT, INCIDENTAL, OR CONSEQUENTIAL DAMAGES FOR ANY REASON WHATSOEVER.

16. PATENTS: WesTech Engineering Inc. agrees that it will, at its own expense, defend all suits or proceedings instituted against Purchaser and pay any award of damages assessed against it in such suits or proceedings, so far as the same are based on any claim that the said equipment or any part thereof constitutes an infringement of any apparatus patent of the United States issued at the date of this Agreement, provided WesTech Engineering Inc. is given prompt notice in writing of the institution or threatened institution of any suit or proceeding and is given full control of the defense, settlement, or compromise of any such action; and Purchaser agrees to give WesTech Engineering Inc. needed information, assistance, and authority to enable WesTech Engineering Inc. so to do. In the event said equipment is held or conceded to infringe such a patent, WesTech Engineering Inc. shall have the right at its sole option and expense to a) modify the equipment to be non-infringing, b) obtain for Purchaser the license to continue using said equipment, or c) accept return of the equipment and refund to the Purchaser the purchase price thereof less a reasonable charge for the use thereof. WesTech Engineering Inc. will reimburse Purchaser for actual out-of-pocket expenses, exclusive of legal fees, incurred in preparing such information and rendering such assistance at WesTech Engineering Inc.'s request. The foregoing states the entire liability of WesTech Engineering Inc., with respect to patent infringement; and except as otherwise agreed to in writing, WesTech Engineering Inc. assumes no responsibility for process patent infringement.

17. SURFACE PREPARATION AND PAINTING: If furnished, shop primer paint is intended to serve only as minimal protective finish. WesTech Engineering Inc. will not be responsible for the condition of primed or finish painted surfaces after equipment leaves its shops. Purchasers are invited to inspect paint in shops for proper preparation and application prior to shipment. WesTech Engineering Inc. assumes no responsibility for field surface preparation or touch-up of shipping damage to paint. Painting of fasteners and other touch-up to painted surfaces will be by Purchaser's painting contractor after mechanism installation.

Motors, gear motors, and other components not manufactured by WesTech Engineering Inc. will be painted with that manufacturer's standard paint system. It is WesTech Engineering Inc.'s intention to ship major steel components as soon as fabricated, often before drive, motors, and other manufactured components. Unless Purchaser can ensure that shop primed steel shall be field painted within thirty (30) days after arrival at the job site, WesTech Engineering Inc. encourages the Purchaser to order these components without primer.

WesTech Engineering Inc.'s prices are based on paints and surface preparations as outlined in the main body of this proposal. In the event that an alternate paint system is selected, WesTech Engineering Inc. requests that Purchaser's order advise of the paint selection. WesTech Engineering Inc. will then either adjust the price as may be necessary to comply or ship the material unpainted if compliance is not possible due to application problems or environmental controls.

18. CANCELLATION, SUSPENSION, OR DELAY: After acceptance by WesTech Engineering Inc., this proposal, or Purchaser's order based on this proposal, shall be a firm agreement and is not subject to cancellation, suspension, or delay except upon payment by Purchaser of appropriate charges which shall include all costs incurred by WesTech Engineering Inc. to date of cancellation, suspension, or delay plus a reasonable profit. Additionally, all charges related to storage

and/or resumption of work, at WesTech Engineering Inc.'s plant or elsewhere, shall be for Purchaser's sole account; and all risks incidental to storage shall be assumed by Purchaser.

19. RETURN OF PRODUCTS: No products may be returned to WesTech Engineering Inc. without WesTech Engineering Inc.'s prior written permission. Said permission may be withheld by WesTech Engineering Inc. at its sole discretion.

20. BACKCHARGES: WesTech Engineering Inc. will not approve or accept backcharges for labor, materials, or other costs incurred by Purchaser or others in modification, adjustment, service, or repair of WesTech Engineering Inc.-furnished materials unless such back charge has been authorized in advance in writing by a WesTech Engineering Inc. employee, by a WesTech Engineering Inc. purchase order, or work requisition signed by WesTech Engineering Inc.

21. INDEMNIFICATION: Purchaser agrees to indemnify WesTech Engineering Inc. from all costs incurred, including but not limited to court costs and reasonable attorney fees, from enforcing any provisions of this contract, including but not limited to breach of contract or costs incurred in collecting monies owed on this contract.

22. ENTIRE AGREEMENT: This proposal expresses the entire agreement between the parties hereto superseding any prior understandings, and is not subject to modification except by a writing signed by an authorized officer of each party.

23. MOTORS AND MOTOR DRIVES: In order to avoid shipment delays of WesTech Engineering Inc. equipment, the motor drives may be sent directly to the job site for installation by the equipment installer. Minor fit-up may be required.

24. EXTENDED STORAGE: Extended storage instructions will be part of information provided to shipment. If equipment installation and start-up is delayed more than 30 days, the provisions of the storage instructions must be followed to keep WARRANTY in force.

25. LIABILITY: Professional liability insurance, including but not limited to, errors and omissions insurance, is not included. In any event, liability for errors and omissions shall be limited to the lesser of $100,000USD or the value of the particular piece of equipment (not the value of the entire order) supplied by WesTech Engineering Inc. against which a claim is sought.

26. ARBITRATION NEGOTIATION: Any controversy or claim arising out of or relating to the performance of any contract resulting from this proposal or contract issued, or the breach thereof, shall be settled by arbitration in accordance with the Construction Industry Arbitration Rules of the American Arbitration Association, and judgment upon the award rendered by the arbitrator(s) may be entered to any court having jurisdiction.

ACCEPTED BY PURCHASER

Customer Name: _____

Customer Address: _____

_____

_____

Contact Name: _____

Contact Phone: _____

Contact Email: _____

Signature: _____

Printed Name: _____

Title: _____

Date: _____

ION EXCHANGE

PUROLITE

APPLICATION GUIDE

Choosing an ion exchange system for nitrate removal

Nitrate levels are coming under stricter control due to health and environmental concerns. Ion exchange technology not only effectively removes nitrate from groundwater, but also generates minimum waste volume— resulting in significant savings for total operating costs.

Purolite®

CHOOSING AN ION EXCHANGE SYSTEM FOR NITRATE REMOVAL

Inside this Application Guide you will find information on nitrate removal using ion exchange resins. For more information, please contact your local technical sales person or the Purolite office closest to you, listed on the back cover.

INTRODUCTION

Purolite is a leading manufacturer of ion exchange, catalyst, adsorbent and specialty resins. With global headquarters in the United States, Purolite is the only company that focuses 100% of its resources on the development and production of resin technology.

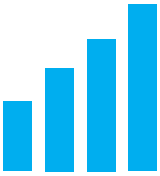
Responding to the needs of our customers, Purolite has built the largest technical sales force in the industry, the widest variety of products and five strategically located Research and Development groups. Our ISO 9001 certified manufacturing facilities in the U.S.A, Romania and Chinacombined with more than 40 sales offices in 30 countries ensure complete worldwide coverage.

PREMIER PRODUCTS

The quality and consistency of our products is fundamental to our performance. Throughout all Purolite plants, production is carefully controlled to ensure that our products meet the most stringent criteria, regardless of where they are produced.

RELIABLE SERVICE

We are technical experts and problem solvers. Reliable and knowledgeable, we understand the urgency required to keep businesses operating smoothly. Purolite employs the largest technical sales organization in the industry.



INNOVATIVE SOLUTIONS

Our continued investment in research & development means we are always perfecting and discovering innovative uses for ion exchange resins and adsorbents. We strive to make the impossible possible.

Background

Nitrate levels in water systems are under scrutiny due to potential detrimental effects on human health. Ground water is particularly susceptible to escalated nitrate levels for a number of reasons, primary of which is increased fertilizer use. In the U.S.A., states such as Nebraska, Kansas, Ohio, California and New York are significantly impacted, but the problem is expanding globally. To help reduce the impact, The U.S. Environmental Protection Agency and the World Health Organization have set maximum contaminant levels (MCL) for nitrate in drinking water to 45 and 50 mg/l as NO_3 respectively. Ion Exchange technology is recognized as an effective solution to help treatment systems comply with regulations.

The task of wading through resin options and available equipment design configurations can be challenging, even for an experienced design engineer. This document will help engineers quickly focus on the best resin and equipment choices for specific design conditions.

Ion exchange for nitrate removal

Depending on the treatment system and the chemistry of the water being treated, ion exchange waste volume typically ranges from 3% to as low as 0.2% compared with 20% – 25% for Reverse Osmosis (RO), making ion exchange technology the preferred choice for groundwater nitrate removal.

Technologies that generate minimum waste volumes are now being looked at more closely due to stricter regulations and increasing disposal costs. Waste brine is often hauled offsite for disposal, routed to an offsite evaporation pond, or it is disposed of by deep well injection to an underground aquifer.

A recent study shows that transfer costs to haul waste brine offsite for disposal can total as much as 70% – 80% of total operating costs for nitrate removal systems using ion exchange. Overall operating costs can be significantly reduced by cutting waste volume as little as 0.1%.

Achieving minimum waste volume for a nitrate removal system through ion exchange technology is dependent on the following:

- The chemistry of the water being treated
- The choice of resin
- The design selected for the ion exchange plant

Getting started

To begin, the design engineer must choose from a number of ion exchange equipment designs, which include:

- Co-flow regenerated systems
- Counter-flow regenerated systems
- Packed bed counter-flow regenerated systems
- Continuous ion exchange systems

The final design selected will determine if standard particle size resin or a specific grade of resin is needed. A water chemistry analysis and discussion of general customer requirements should also take place to further narrow the resin choices. Once complete, it will be easier to evaluate the most appropriate resin for the equipment design.

Resin choices

Nitrate removal can be accomplished with a variety of resin types:

- Nitrate selective Strong Base Anion (SBA) resin
- Type I Strong Base Anion (SBA) resin
- Higher capacity Type I Strong Base Anion (SBA) resin
- Type II Strong Base Anion (SBA) resin
- Weak Base Anion resin (patented process)

Choosing between resin types is dependent on customer-based or system-based factors such as:

- The pungent odor associated with Type I SBA resin versus odorless Type II SBA resin
- The potential of Type I and Type II resins to dump nitrate if the system is accidentally over-run
- The use of nitrate selective SBA resin when influent water sulfate is high
- The use of new higher capacity Type I SBA resin to reduce operating cost and minimize waste volume
- The need for simultaneous removal of nitrate and arsenic (nitrate selective SBA resins would not be used when designing this type of system)
- The use of a new Weak Base Anion (WBA) process to minimize waste volumes to no more than 0.2% of total water treated

Choosing the right resin

In the aforementioned list, two items are directly related to customer preference:

- The potential for odor to develop in the treated water
- The potential of the resin to dump nitrate into the treated water

Odor and potential nitrate dumping

Type I SBA resins, which are manufactured with trimethylamine to create ion exchange functionality, tend to give off a fishy amine smell that can be detected by some sensitive consumers, even at very low parts per trillion concentrations. (Purolite A600E/9149 is an example of Type I SBA resin).

Choosing an odorless resin can be important in household and small community water treatment systems. In such cases, Type I SBA resin and new higher capacity Type I SBA resin would be eliminated from consideration because of odor. Type II SBA resins that use dimethyl-ethanolamine—an odorless functional amine—were developed to address this need. (Purolite A300E is an example of a Type II SBA resin.)

If Type I and Type II SBA resins are incorrectly operated beyond safe throughput levels, or if mechanical or operator issues arise that result in improper regeneration, elevated levels of nitrate may enter the treated water system.

Nitrate initially loaded on the resins can be pushed off the resin by other anions for which these resins show a stronger affinity, such as sulfate. This is illustrated in the breakthrough curves for nitrate and sulfate shown in Figure 1 below.

Figure 1 – Nitrate breaks before arsenic for Type I or Type II SBA resin

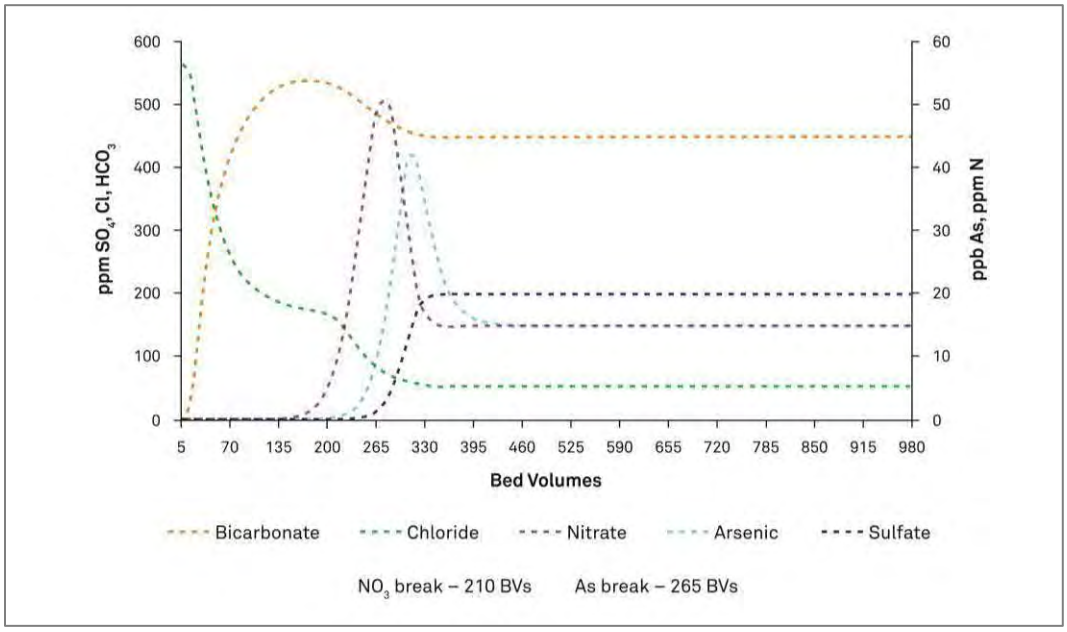
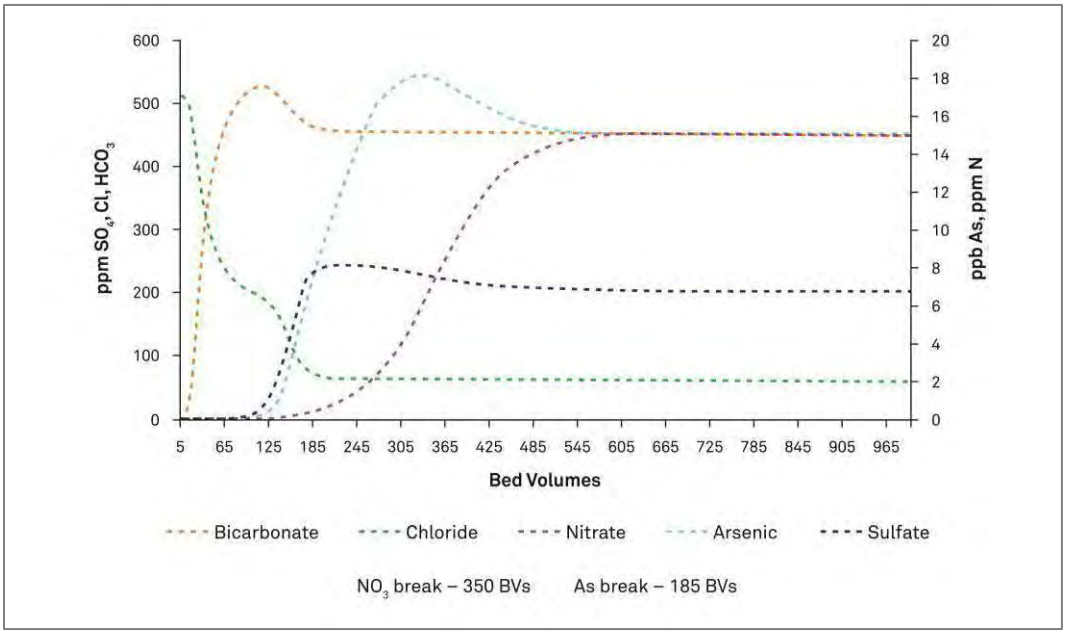


Figure 2 – Arsenic breaks before nitrate for nitrate selective resin



In typical drinking water treatment, the major competing anions are sulfate, nitrate, bicarbonate and chloride. The order of selectivity of Types 1 and 2 SBA resins under these conditions is as follows:

Sulfate > Nitrate > Chloride > Bicarbonate.

If dumping occurs, the nitrate concentration in the treated water can peak at a level higher than the influent level. This occurs only if the resin is operated far beyond the break point for nitrate. Manufacturer's recommendations for operating capacity are intended to stop the service cycle before peaking can occur, usually with an added margin of safety.

Nitrate selective resins

Nitrate selective SBA resins such as Purolite A520E were developed in part to address the potential nitrate dumping problem as well as to maintain adequate operating capacity of the resin when feed water sulfate levels are high. With nitrate selective SBA resins, the selectivity is reversed for sulfate and nitrate compared to Type I and Type II SBA resins as shown below:

Nitrate > Sulfate > Chloride > Bicarbonate.

Figure 2 shows the typical breakthrough curves for nitrate and sulfate with a nitrate selective SBA resin, showing no peaking for nitrate.

Municipal plant choices and waste minimization

For municipal plants with long distribution lines to the consumers, odor is usually not an issue. Because municipal ion exchange treatment plants usually have dedicated operators and have the resources to monitor performance more often, the potential for nitrate dumping is better controlled than in a household environment. Larger treatment plants tend to use resin that provides the lowest operating cost. Type I, Type II and nitrate selective SBA resins are popular choices.

When sulfate comprises a large fraction of the total anions present in the water to be treated, nitrate selective SBA resins are usually favored. A general industry rule-of-thumb is to consider use of nitrate selective SBA resin over Type I or Type II SBA resin when the ratio of sulfate divided by the sum of sulfate and nitrate in the feed water is greater than 60%.

This is reflected in the equation:

Sulfate / (Sulfate + Nitrate) > 60%.

To compute this ratio, express sulfate and nitrate in common units. For example, if sulfate concentration is 70 mg/l expressed as $CaCO_3$ and nitrate concentration is 40 mg/l expressed as $CaCO_3$, then

Sulfate / (Sulfate + Nitrate) = 70 / (70+40) = 0.63 or 63%.

In this case, the value is over 60% and consideration can be given to using a nitrate selective SBA resin. This rule is based on the higher price differential of nitrate selective resins over Type I or Type II SBA resins being offset by the higher operating capacity of the nitrate selective resin under high sulfate conditions. The rule, however, is somewhat outdated since cost drivers have changed over the years. Currently, the major cost driver is waste disposal, and it makes sense to choose whichever resin and equipment design yields the lowest waste volume.

A high capacity Type I SBA resin, Purolite A600E/9149, is now available and provides approximately 12% – 15% higher operating capacity over standard Type I SBA resin, which can significantly reduce waste volume.

In addition, a new patented process is available using a special weak base anion system designed to reduce waste volume to ≤ 0.2%, compared to the 1% – 3% waste volume generated with standard resin designs.[1]

If resin choice is still not clear after evaluating odor and nitrate selectivity, an economic evaluation of available nitrate removal resins should be performed. At minimum, this comparison should include the cost of resin, the cost of regenerant per volume of water treated, and the cost for waste disposal.

Table 1 below is a summary of the main criteria that should be used to select the right resin.

Special case of simultaneous removal of nitrate and arsenic

Resin choices can be narrowed down further in cases where a municipality wants to simultaneously remove additional contaminants—such as arsenic—to reduce costs and achieve compliance for both species. A number of plants across the U.S. have gone this route as both contaminants are removed in a single vessel and the same brine is used to elute both nitrate and arsenic from the resin. The simultaneous, multi-contaminant removal approach results in lower cost for salt and waste disposal as well as lower capital costs.

Note, however that nitrate selective SBA resins are not recommended for joint removal of arsenic and nitrate since the higher selectivity for nitrate over divalent anions (e.g. sulfate and arsenic) results in the earlier breakthrough of arsenic compared to nitrate from the resin during service. Since arsenic is more toxic than nitrate, it makes better sense to use a resin in which nitrate breaks before arsenic, such as with the Type I and Type II SBA resins.

Plants that use this technology successfully are highlighted on the Web site of the U.S. Environmental Protection Agency. These include plants in Vale, Oregon and the City of McCook, Nebraska, with the latter plant using special brine regenerated layered bed of resins to simultaneously remove nitrate, arsenic, uranium and total organic matter (TOCs) from the feed water.[2]

Table 1 – Summary of criteria for selecting resin to remove nitrate

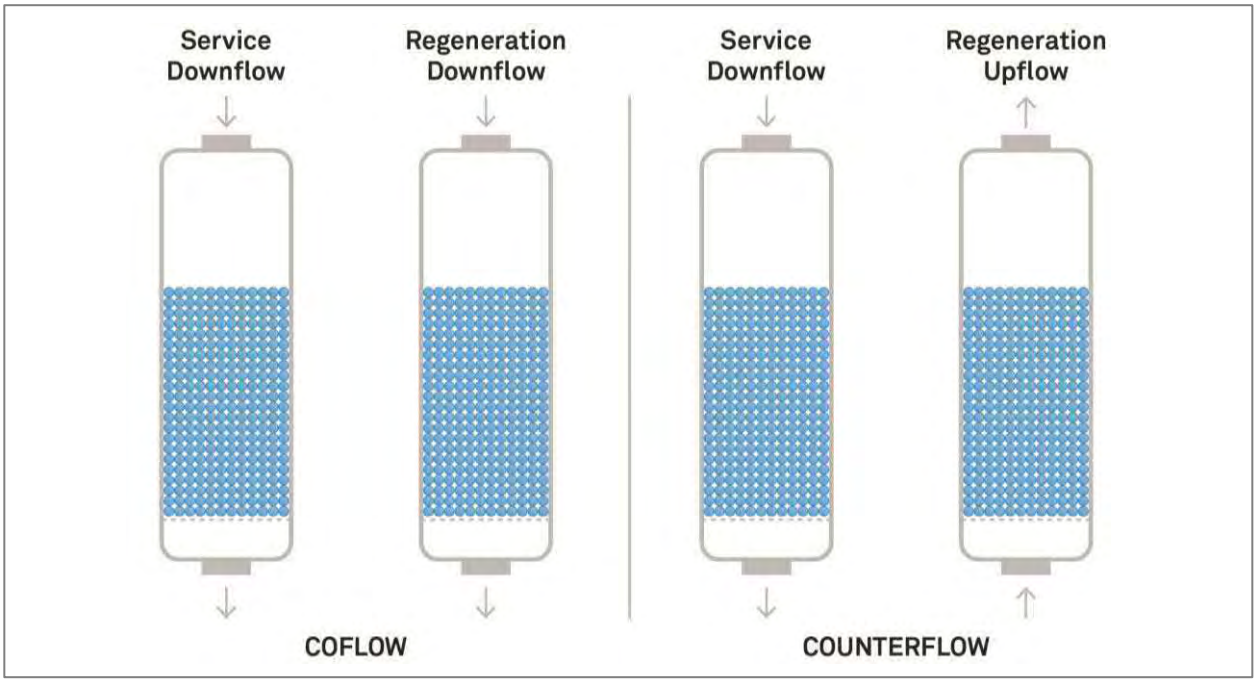
RESIN TYPE	ODORLESS	POTENTIAL FOR NITRATE DUMPING	HIGHEST CAPACITY
Nitrate selective SBA	Yes	No	No
Type I SBA	No	Yes	No
Type I higher capacity SBA	No	Yes	Yes
Type II SBA	Yes	Yes	No
Patented process with WBA	Yes	No	No

Equipment design choices

Despite higher capital costs, when waste minimization is a primary goal, equipment should include a counter-flow regenerated system—such as packed bed, air hold down or split-flow—as opposed to a co-flow regenerated system. Counter-flow regeneration also results in lower nitrate leakage, allowing for treatment of a portion of the water while bypassing the rest.

Bypassing a portion of the water around the ion exchange plant is common practice in larger plants while producing a blend of treated and untreated water that still meets the maximum allowable level in drinking water. It is well known that counter-flow regenerated systems generally produce water with lower nitrate leakage than co-flow systems. Lower nitrate leakage levels allow a greater percentage of the water to be bypassed around the treatment unit, resulting in lower overall treatment cost.

Figure 3 – Types of Regeneration Service



With co-flow regenerated systems, both the service water to be treated and the brine used for regeneration pass through the ion exchange resin bed in the same direction, generally downflow. Sulfate and nitrate tend to load on the resin bed largely at the inlet or top end, while chloride and bicarbonate load largely on the bottom or exit end of the resin bed.

When brine is applied to regenerate the bed in a co-flow mode, the brine strips sulfate and nitrate from the top of the bed and these ions are then pushed by the brine through the resin column to the bottom of the resin bed. As a result, some of the nitrate tends to exchange with and displace the less tightly bound chloride and bicarbonate ions. When the resin bed is returned to the service phase, nitrate that is bound to the lower part of the resin bed contributes to an initial elevated level of nitrate leakage in the treated water.

With counter-flow regenerated systems, feed water and brine enter and leave the resin bed in opposite directions. Nitrate loaded on the resin during service is essentially pushed back out of the bed without traversing the entire bed during regeneration.

Counter-flow regeneration is more efficient, leaving the exit end of the resin bed essentially free of nitrate ions. As a result, nitrate leakage is significantly lower compared to that from co-flow regenerated systems when the bed is returned to service.

There are several equipment design options to choose from with counter-flow systems:

- Conventional counter-flow regenerated vessels with air hold-down that keep the resin from fluidizing during the up-flow brining and rinse steps
- Split-flow designs in which 2/3 of the brine is introduced from the bottom and 1/3 through a top brine distributor
- Packed bed designs where the ion exchange vessel is packed with resin

The counter-flow and split-flow options usually allow for enough freeboard in the vessel design to periodically backwash the resin to remove suspended solids accumulated from influent water. Influent suspended solids to packed beds must be kept to a minimum, since the resin cannot be backwashed within the vessel, and would have to be taken out and backwashed in an external vessel.

Waste volumes

Below is an example of how a Type I and a Type II SBA compare to a nitrate selective SBA resin in treating typical influent water with a composition of:

1 meq/l (62 mg/l) NO_3,
1 meq/l (48 mg/l) SO_4,
2 meq/l (122 mg/l) HCO_3
1 meq/l (35.5 mg/l) as Cl

The use of the same salt dosage (120 g NaCl/l or 7.5 lb/ft^3) for either resin and comparing them in both co-flow and counter-flow regenerated designs using a 90% design factor is shown in Table 2 below.

With a MCL of 45 mg/l as NO_3 in U.S.A. (equal to 10 mg/l as N), operators usually target for 36 mg/l as NO_3 for operation control (80% of the MCL). In the above cases, a fraction of the water can be bypassed to minimize the amount that must be treated. For example, comparing Purolite A600E/9149 in co-flow versus counter-flow regeneration designs shows leakages of 10.35 and 5.53 mg/l as NO_3 respectively.

Table 2 – Comparing Type I SBA, Type II SBA and Nitrate Selective SBA resins

RESIN	TYPE	REGEN MODE	SERVICE (BV)	NO_3 LEAKAGE (mg/l)	BRINE (BV)	SLOW RINSE (BV)	FAST RINSE (BV)	TOTAL WASTE (BV)	WATER BYPASSED (%)	TOTAL WASTE AS % OF PRODUCTION
A200E	II	CF	257	10.35	1.12	1.5	5	7.62	50	1.48
A200E	II	CTF	282	5.53	1.12	3	0	4.12	54	0.67
A300E	II	CF	257	10.35	1.12	1.5	5	7.62	50	1.48
A300E	II	CTF	282	5.53	1.12	3	0	4.12	54	0.67
PFA300E	II	CF	257	10.35	1.12	1	3	5.12	50	1.00
PFA300E	II	CTF	282	5.53	1.12	2	0	3.12	54	0.51
A520E	NS	CF	272	8.15	1.12	1.5	5	7.62	52	1.34
A520E	NS	CF	250	4.35	1.12	3	0	4.12	55	0.74
PFA520E	NS	CF	272	8.15	1.12	1	3	5.10	52	0.90
PFA520E	NS	CF	250	4.35	1.12	2	0	3.12	55	0.56
A600E/9149	I	CF	293	10.35	1.12	1	3	5.12	50	0.87
A600E/9149	I	CTF	321	5.53	1.12	2	0	3.12	54	0.45

Table 3 – Impact of salt dosages on production

RESIN	SALT DOSE g/l CTF	SERVICE (BV)	NO_3 LEAKAGE (mg/l)	BRINE (BV)	TOTAL WASTE (BV)	WATER BYPASSED (%)	TOTAL WASTE AS % OF PRODUCTION	SALT & WASTE COST ($/m³ PRODUCED)
A600E/9149	120	321	5.53	1.12	3.12	54	0.45	0.140
A600E/9149	160	408	4.03	1.5	3.5	55	0.39	0.123
A600E/9149	200	438	2.52	1.87	3.87	57	0.38	0.124

As such, the following equation would be valid for calculating the percentage of water that must be treated and the percentage that must be bypassed:

62 (1-X) + 10.35X = 36 mg/l as NO_3 (the operating target) where X is the fraction of water treated.

Solving, X = 50%.

Similarly for counter-flow systems:

62 (1-X) + 5.53X = 36, So X = 54%.

The counter-flow regenerated systems will be about 50% less costly to operate versus co-flow systems when comparing the cost for disposal of waste water.

The waste volume with Purolite A600E/9149 provides the most efficient level at 0.45% of the total water produced. The impact of waste water volume on overall operating costs can be better understood by comparing the cost of haulage of the waste to an offsite disposal facility. Assuming a typical haulage cost of USD $0.1/gallon of waste ($26.42/m^3) for an ion exchange plant treating 1,000 m^3/h (6.3 mgd) of water, the total volume of waste generated per year would be as follows:

Purolite A300E, (1.48% waste – using co-flow regeneration: approximately 130,000 m^3 /year.

Purolite A600E/9149, (0.45% waste) – using counter-flow regeneration: approximately 40,000 m^3/year.

Savings = (130,000 – 40,000) x 26.42: approximately $2.4 million/year.

Higher levels of sulfate would require repeating the exercise to determine the resin that would generate the lowest waste volume.

Evaluating higher salt dosages

An evaluation of the impact of various salt dosages on overall economics can also be performed. Higher salt dosage can reduce waste volume but will increase salt cost. We recommend dosages of 120g/l (7.5 lb/ft^3), 160 g/l (10 lb/ft^3) and 200 g/l (12.5 lb/ft^3) be evaluated.

The aforementioned is based on salt, water and wastewater disposal cost of $0.10/kg, $0.1/$m^3$ and $26.42/$m^3$ ($0.1/gallon) respectively. From Table 3 above, Purolite A600E/9149 using a salt dosage of 160 g/l (or 10 lb/ft^3) is the lowest cost option.

Purolite's nitrate economic calculator

The nitrate economic calculator is an accurate and efficient design tool for ion exchange systems. Using system-specific data, Purolite experts address control conditions, compare operating costs for various resins and regeneration modes, calculate waste volumes and determine the payback period for the investment—to help our customers choose the best design option. The screen shots on the following pages represent views for water input, chemistry, performing calculations and viewing regeneration schedules.

Summary

The need for nitrate removal in drinking water is growing, but so are the regulations governing brine disposal. To be competitive, it is important to choose the right nitrate removal resin based on overall operating costs. It is imperative to consider costs for both the resin and the salt used for regeneration, as well as costs associated with waste water disposal as these can exceed all other cost components.

Figure 4 – Water chemistry and design targets

Purolite

V 1 41 10June15Exp31Dec2015

Date: 12-Dec-14
Customer: ABC Municipal
Project: New Nitrate Plant

Set all ions to: ppm as Ca CO_3

Inlet Water Chemistry:

Ca	174.500	ppm as $CaCO_3$	**HCO_3**	135.246	ppm as $CaCO_3$	**TH/T Alk**	1.77	
Mg	65.164	ppm as $CaCO_3$	**Cl**	70.282	ppm as $CaCO_3$	**Temp**	59.0	°F
Na	52.609	ppm as $CaCO_3$	**SO_4**	63.021	ppm as $CaCO_3$	**SO_4/TA**	34	%
K	3.295	ppm as $CaCO_3$	**NO_3**	41.734	ppm as $CaCO_3$	**FMA**	3.50	meq/l
NH_4	0.000	ppm as $CaCO_3$	**F**	0.000	ppm as $CaCO_3$	**FMA**	54.93	%
Ba	0.153	ppm as $CaCO_3$	**Other**	0.000	ppm as $CaCO_3$	**TOC**	1.00	ppm TOC
Sr	0.000	ppm as $CaCO_3$	**Sub-total**	6.206	meq/l			
Fe	0.000	ppm as $CaCO_3$	**SiO_2**	8.350	ppm as $CaCO_3$	**SiO_2**	4.55	%
Other	0.000	ppm as $CaCO_3$	**CO_2**	0.000	ppm as $CaCO_3$	**CO_2**	0.0	%
Total Cations	**5.914**	meq/l	Total Anions	**6.373**	meql/l	**HCO_3**	43.6	%
						Cl	22.7	%
Total Hardness	4.796					$NO_3/(SO_4+NO_3)$	39.84	%
Total Cation / TH Ratio	1.233							

Target Nitrate Leakage Breakpoint:

ppm as NO_3	**ppm as N**
36	8.13

Figure 5 – Calculations for a nitrate removal system

Purolite

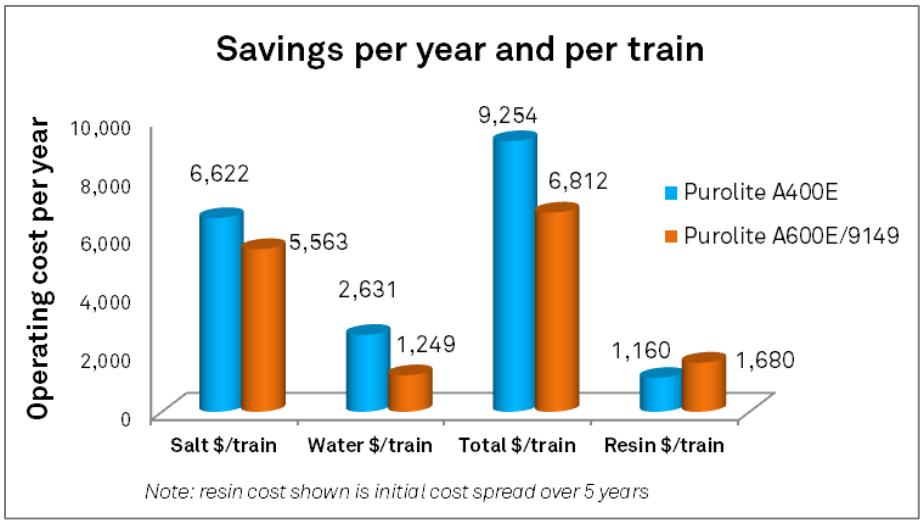
Operating Specifications			(A) Standard Purolite A400E	(B) Performance Resin Purolite A600E/9149
# Parallel Vessels Installed	1			
# of Vessels Active During Service	1			
Flow Rate/Vessel	250	US gal/min		
Total Flow Rate	250	US gal/min		
Daily Production	360,000	US gal/day		
Cycle Time		hours	12.00	12.00
Net Water treated per Cycle		US gal/cycle	72,000	59,400
			SBA	**SBA**
Product (Choose from down list) >>			A400E	A600E/9149
Gross water treated per cycle		US gal/cycle	73,496	60,256
Regenerant Mode (CF=coflow, CTF=counterflow)			CF	CTF
Regenerant Dose		lbs/ft³	5.00	4.20
Regenerant concentration		%	6.00	6.00
Leakage				
Avg. Nitrate leakage ex IX		ppm as NO_3	13.15	6.60
Avg. Nitrate leakage ex IX		ppm as N	2.97	1.49
Percent of Total Flow Treated		%	40.00	33.00
Percent Water Bypassed around IX		%	60.00	67.00
Avg. Nitrate leakage in total production		ppm as NO_3	36.31	36.85
Avg. Nitrate leakage in total production		ppm as N	8.20	8.32
Capacity				
Available Capacity		Kgrain/ft³	3.94	3.79
Design Factor			**0.85**	**0.85**
Operating Capacity		Kgrain/ft³	3.35	3.22
Ionic Load				
Resin Volume		ft³	40.00	40.00
Service Flowrate per Vessel		US gal/min	100.00	82.50
Specific Flowrate		US gpm/ft³	2.50	2.06
Ionic Load Per Train		eq	173.20	166.11
Total Ionic Load		eq	173.20	166.11
Regenerant				
Regenerant used		lbs	199.94	167.95
Regenerant used		eq	1,550.74	1,302.62
Excess regenerant		eq	1,377.54	1,136.51
Regenerant use as % of theory		%	895.35	784.18
Vessel Parameters				
Bed depth		inches	49.88	49.88
Diameter		inches	42.00	42.00
Cross-sectional area		ft²	9.62	9.62
Linear Velocity		USgpm/ft²	10.16	8.38
Pressure Drop		psi	6.33	4.86
Wastewater				
Backwash Water		US gal/ft³	14.96	0.00
Dilution Water		US gal/ft³	7.66	6.44
Slow Rinse		US gal/ft³	11.22	14.96
Fast Rinse		US gal/ft³	37.40	0.00
Backwash water volume recycled		US gal/ft³	0.00	0.00
Brine volume recycled		US gal/ft³	0.00	0.00
Rinse volume recycled		US gal/ft³	0.00	0.00
Total waste water		US gal	2,849.91	855.94

				Savings B/A	
Waste water as % of total water		%	1.58	**70%**	0.48
Mass NaCl per volume of water produced		lb/k US gal	1.11	**16%**	0.93

Figure 6 – Detailed overview of savings

Purolite		(A) Standard Resin Purolite A400E	Savings B/A	(B) Performance Resin Purolite A600E/9149
Water & Regenerant				
Waste water as % of production	%	1.58	70.0%	0.48
Mass NaCl per Volume of Water Softened	lb/kUSgal	1.111	20.5%	0.933
Total Resin cost per train	$/train	$5,799.00		$8,399.00
Water treated	kUSgal/year	52,560		43,362
Waste water volume	kUSgal/year	2,080		625
Water used for dilution	kUSgal/year	224		188
Water used for slow rinse	kUSgal/year	328		437
NaCl Use	M. Tons/year	66		56
Unit Costs				
Unit cost of waste water	$/kUSgal	1		1
Unit cost for softened water	$/kUSgal	1		1
Unit cost for NaCl	$/M. Tons NaCl	100		100
Annual Costs				
Annual NaCl cost	Per Year	$6,622.00	$1,060.00	$5,563.00
Annual water/waste water cost	Per Year	$2,631.00	$1,382.00	$1,249.00
Total regenerant & water cost	Per Train	$9,254.00	$2,442.00	$6,812.00
Payback & ROI				
Operating cost over 5 years per train	Per Train	$46,268.00	$12,209.00	$34,059.00
Return on Investment (ROI) -avg. per year	%		85	
Payback in months	months		12.8	
Savings	Per 5 Years		$9,610	

Figure 7 – Operational savings



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http://nepis.epa.gov/Adobe/PDF/P100AVF2.pdf

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P-000042-200PP-0915-R3-PCO

Calculations for Nitrate System

Date: 11-Jun-20 V 1 43 11Aug15Exp30Dec2020

Customer: Sunrise Engineering

Project: Culinary Wells in Utah

Water Chemistry & Targets for Design:

CATIONS			ANIONS			
Ca	0	ppm	HCO3	120	ppm as CaCO3	
Mg	0	ppm	Cl	0	ppm	Temp: 20°C
Na	0	ppm	SO4	48	ppm	TOC: 1 ppm TOC
K	0	ppm	NO3	45	ppm	
NH4	0	ppm	F	0.025	ppm	
Ba	0	ppm	Other	0	ppm	
Sr	0	ppm	Sub-total	3.69	meq/l	
Fe	0	ppm	SiO2	10.02	ppm	
Other	0	ppm	CO2	0	ppm	
Total Cations	0.00	meq/l	Total Anions	3.86	meql/l	

Treated Water Specifications:	Endpoint
Total Nitrate Leakage - ppm as NO3	22

Plant Design:	Units				
Design Flowrate	USgal/min	180.0	Daily Water Production	100656	USgal/day
Actual Flowrate through plant	USgal/min	360.0	Vessels Active During Service	2 out of 3 installed	
Percent of water treated	%		60	60	
Flowrate per vessel	USgal/min		108.0	108.0	

Operating Conditions:		**Standard Resin (A) A520E**	**Performance Resin (B) A600E/9149**
Cycle Time hours	hours	33.50	33.5
Net Water per Cycle	USgal/cycle	219325.8	217080.0
Sodium Chloride Dosage	lbs/ft³	10.0	10.0
Regenerant Mode(CF=coflow, CTF=counterflow)		CF	CF
Regenerant concentration	%	10	10
Avg. Nitrate leakage	ppm as NO3	21.07	21.24
Design Factor		0.85	0.85
Operating Capacity	eq/l	0.31	0.31
Vessel Design:			
Resin Volume	ft³	60	60
Specific Flowrate	USgpm/ft³	2	2
Diameter	inches	48.00	48.00
Cross-sectional Area	ft²	12.57	12.57
Linear Velocity	USgpm/ft²	8.4	8.4
Bed depth	inches	57	57
Pressure Drop	psi	5	5

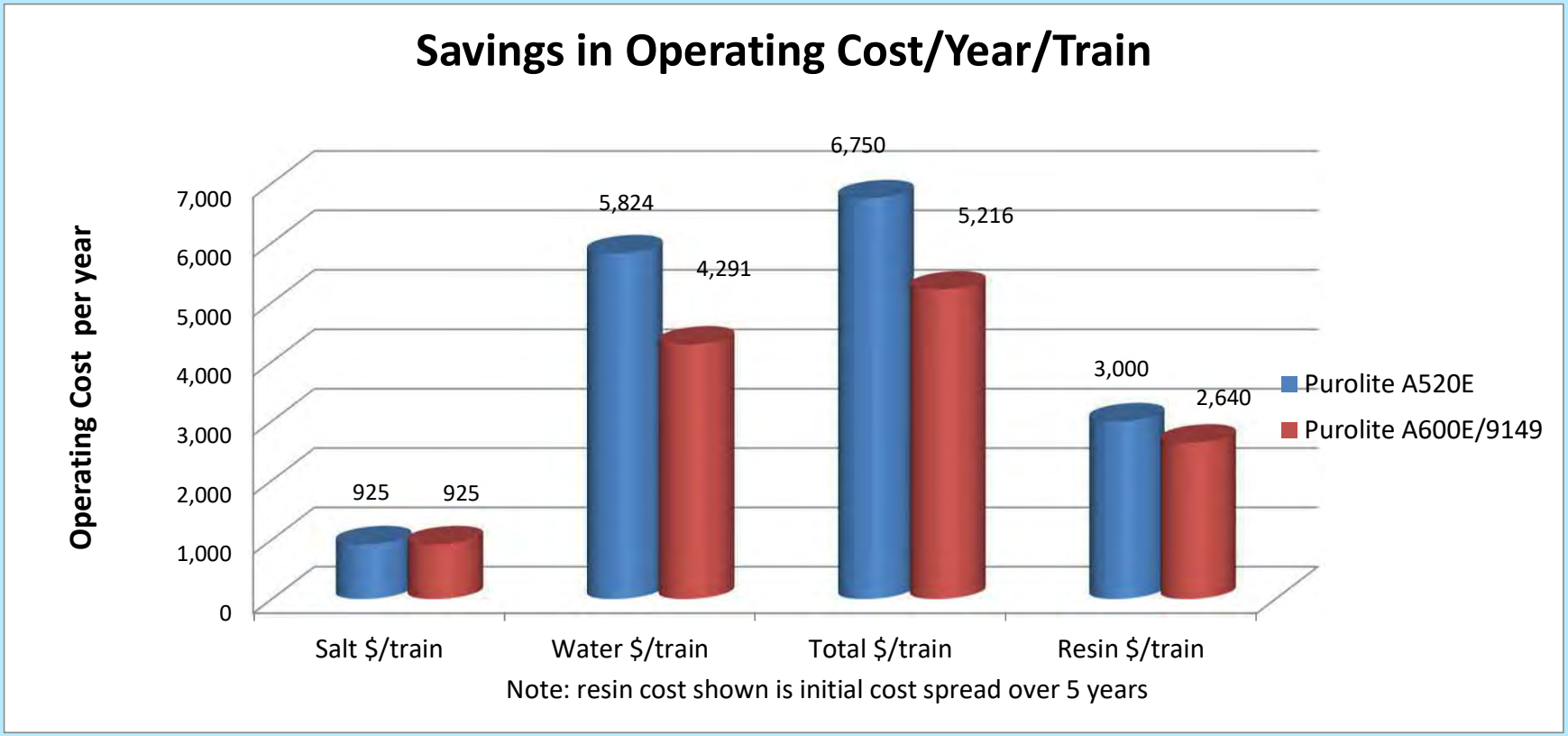
Ionic Loading:			
Ionic Load per Train	eq	534	528
Regenerant used	lbs	600	600
Regenerant used	eq	4652	4652
Excess regenerant	eq	4118	4124
Regenerant use as percent of theory	%	871	881

Waste Water:			
Backwash water	USgal/ft³	14.96	14.96
Dilution Water	USgal/ft³	7.33	7.33
Slow Rinse	USgal/ft³	11.22	7.48
Fast Rinse	USgal/ft³	37.40	22.44
Backwash water volume recycled	USgal/ft³	0.00	0.00
Brine Volume Recycled	USgal/ft³	0.00	0.00
Rinse Volume Recycled	USgal/ft³	0.00	0.00
Total Waste Water	USgal	4,254.9	3,132.8

Regeneration Schedule for Purolite A600E/9149

	Concn.	Water	Volume	Flowrate	Time
	%	Source	USgal	USgal/min	minutes
Backwash (as needed):		Raw	0.9	see graph	
Brine	10	Softened	671	15.0	44.8
Slow Rinse		Softened	449	15.0	30.0
Fast Rinse		Raw	1346.6	108.0	12.5
Total (except backwash)					87.3

Savings:		**A520E**	**Savings B/A**	**A600E/9149**
Waste water as % of production	%	0.59	26.4%	0.43
Mass NaCl per Volume of Water Softened	lb/kUSgal	3.316	20.5%	3.316
Total Resin cost per train	$/train	14998		13199
Water treated per year	kUSgal/year	7348		7348
Waste water volume	kUSgal/year	145		107
Water used for dilution	kUSgal/year	15		15
Water used for slow rinse	kUSgal/year	23		15
NaCl use per year	M. Tons/year	9		9
Unit cost of waste water	$/kUSgal	40		40
Unit cost for softened water	$/kUSgal	1		1
Unit cost for NaCl	$/M. ton NaCl	100		100
Annual NaCl cost	$/year	925	0	925
Annual water/waste water cost	$/year	5824	1534	4291
Total regenerant & water cost	$/train	6750	1534	5216
Payback and Return on Investment:				
Operating cost over 5 years per train	$/train	33749	7668	26081
Return on Investment (ROI) -avg. per year	%		-77	
Payback in months	months		-14.1	
Savings over 5 years	$		9468	



PRODUCT DATA SHEET

Purolite®
A520E

Polystyrenic Macroporous, Type I Strong Base Anion Resin, Chloride form, Potable Water Grade

PRINCIPAL APPLICATIONS

- Nitrate Removal

REGULATORY APPROVALS

- French Health Ministry Approval for Potable Water Treatment
- Kosher Certified
- Certified by the WQA to NSF/ANSI-61 Standard
- Drinking Water Inspectorate Approved for Use in Public Water Supply in the UK
- Water Regulations Advisory Scheme Approved

TYPICAL PACKAGING

- 1 ft³ Sack
- 25 L Sack
- 5 ft³ Drum (Fiber)
- 1 m³ Supersack
- 42 ft³ Supersack

TYPICAL PHYSICAL & CHEMICAL CHARACTERISTICS:

Polymer Structure	Macroporous polystyrene crosslinked with divinylbenzene
Appearance	Spherical Beads
Functional Group	Type I Quaternary Ammonium
Ionic Form	Cl^- form
Total Capacity	0.9 eq/L (19.7 Kgr/ft³) (Cl^- form)
Moisture Retention	50 - 56 % (Cl^- form)
Particle Size Range	300 - 1200 µm
< 300 µm (max.)	1 %
Uniformity Coefficient (max.)	1.7
Specific Gravity	1.07
Shipping Weight (approx.)	675 - 705 g/L (42.2 - 44.1 lb/ft³)
Temperature Limit	100 °C (212.0 °F) (Cl^- form)

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Hydraulic Characteristics

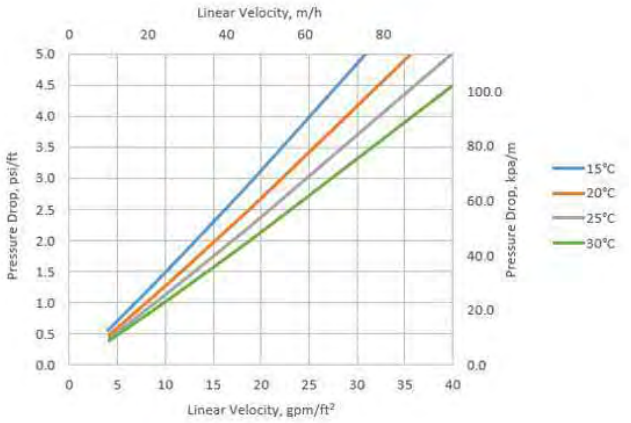
PRESSURE DROP

The pressure drop across a bed of ion exchange resin depends on the particle size distribution, bed depth, and voids volume of the exchange material, as well as on the flow rate and viscosity of the influent solution. Factors affecting any of these parameters—such as the presence of particulate matter filtered out by the bed, abnormal compressibility of the resin, or the incomplete classification of the bed—will have an adverse effect, and result in an increased head loss. Depending on the quality of the influent water, the application and the design of the plant, service flow rates may vary from 10 to 40 BV/h.

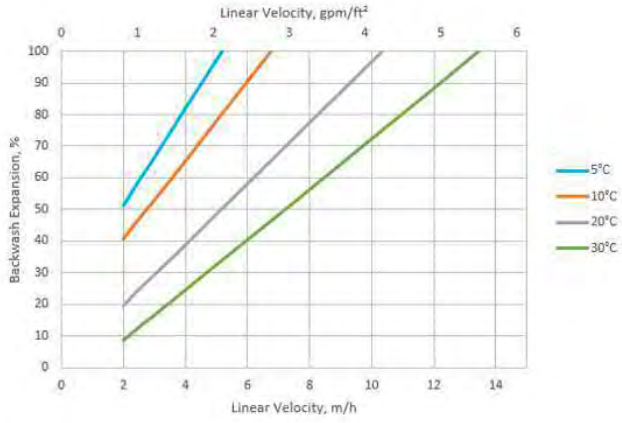
BACKWASH

During up-flow backwash, the resin bed should be expanded in volume between 50 and 70% for at least 10 to 15 minutes. This operation will free particulate matter, clear the bed of bubbles and voids, and reclassify the resin particles ensuring minimum resistance to flow. When first putting into service, approximately 30 minutes of expansion is usually sufficient to properly classify the bed. It is important to note that bed expansion increases with flow rate and decreases with influent fluid temperature. Caution must be taken to avoid loss of resin through the top of the vessel by over expansion of the bed.

PRESSURE DROP ACROSS RESIN BED



BACKWASH EXPANSION OF RESIN BED



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PRODUCT DATA SHEET

Purolite®
A600E/9149

Polystyrenic Gel, Type I Strong Base Anion Resin, Chloride form, Potable Water Grade

PRINCIPAL APPLICATIONS

- Hexavalent chromium ions removal
- Nitrate Removal
- Uranium Removal
- Sulfate Removal

ADVANTAGES

- High operating capacity
- Exceptional physical stability
- Good kinetic performance

REGULATORY APPROVALS

- Compliant with FDA Regulation 21 CFR 173.25 for Food Treatment, Ion Exchangers
- Certified by the WQA to NSF/ANSI-61 Standard
- Water Regulations Advisory Scheme Approved

TYPICAL PACKAGING

- 1 ft³ Sack
- 25 L Sack
- 5 ft³ Drum (Fiber)
- 1 m³ Supersack
- 42 ft³ Supersack

TYPICAL PHYSICAL & CHEMICAL CHARACTERISTICS:

Polymer Structure	Gel polystyrene crosslinked with divinylbenzene
Appearance	Spherical Beads
Functional Group	Type I Quaternary Ammonium
Ionic Form	Cl^- form
Total Capacity	1.6 eq/L (35.0 Kgr/ft³) (Cl^- form)
Moisture Retention	42 - 45 % (Cl^- form)
Mean Diameter	570 ± 50 µm
< 425 µm (max.)	1 %
Uniformity Coefficient (max.)	1.2
Specific Gravity	1.09
Shipping Weight (approx.)	675 - 710 g/L (42.2 - 44.4 lb/ft³)
Temperature Limit	100 °C (212.0 °F) (Cl^- form)
Temperature Limit	60 °C (140.0 °F) (OH^- form)

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BACKWASH

During up-flow backwash, the resin bed should be expanded in volume between 50 and 70% for at least 10 to 15 minutes. This operation will free particulate matter, clear the bed of bubbles and voids, and reclassify the resin particles ensuring minimum resistance to flow. When first putting into service, approximately 30 minutes of expansion is usually sufficient to properly classify the bed. It is important to note that bed expansion increases with flow rate and decreases with influent fluid temperature. Caution must be taken to avoid loss of resin through the top of the vessel by over expansion of the bed.

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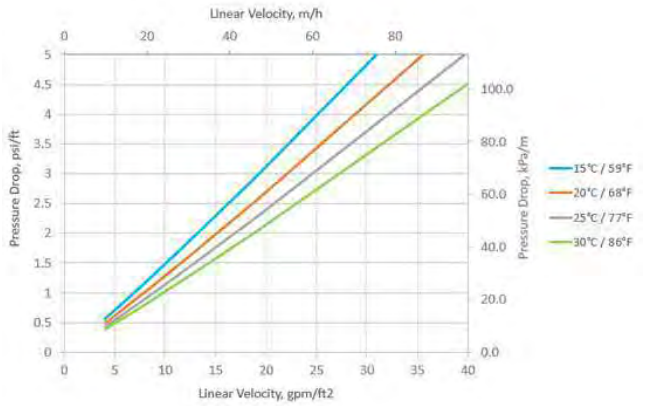

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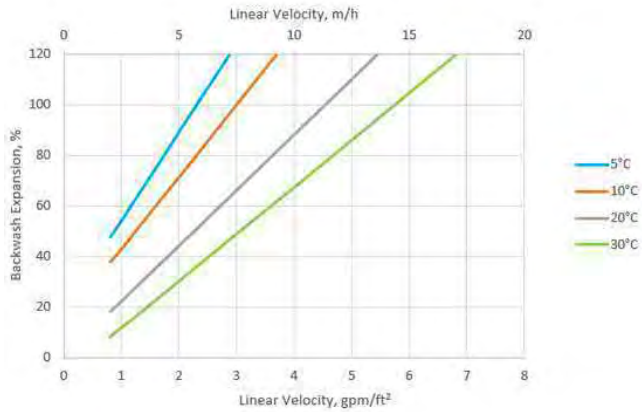

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