UTAH DEPARTMENT of ENVIRONMENTAL QUALITY
WATER QUALITY

Division of Water Quality (DWQ)
UPDES Program

UPDES Industrial Permit Application

Part X. Antidegradation Review

The objective of antidegradation rules and policies is to protect existing high quality waters and set forth a process for determining where and how much degradation is allowable for socially and/or economically important reasons. In accordance with Utah Administrative Code (UAC R317-2-3), an antidegradation review (ADR) is a permit requirement for any project that will increase the level of pollutants in waters of the state. The rule outlines requirements for both Level I and Level II ADRs, as well as public comment procedures. This review form is intended to assist the applicant and Division of Water Quality (DWQ) staff in complying with the rule but is not a substitute for the complete rule in R317-2-3.5. Additional details can be found in the *Utah Antidegradation Implementation Guidance* and relevant sections of the guidance are cited in this review form.

ADRs should be among the first steps of an application for a UPDES permit because the review helps establish treatment expectations. The level of effort and amount of information required for the ADR depends on the nature of the project and the characteristics of the receiving water. To avoid unnecessary delays in permit issuance, DWQ recommends that the process be initiated at least one year prior to the date a final approved permit is required.

DWQ will determine if the project will impair beneficial uses (Level I ADR) using information provided by the applicant and whether a Level II ADR is required. The applicant is responsible for conducting the Level II ADR. For the permit to be approved, the Level II ADR must document that all feasible measures have been undertaken to minimize pollution for socially, environmentally or economically beneficial projects resulting in an increase in pollution to waters of the state.

For permit requiring a Level II ADR, this antidegradation form must be completed and approved by DWQ before any UPDEs permit can be issued. Typically, the ADR form is completed in an iterative manner in consultation with DWQ. The applicant should first complete the statement of social, environmental and economic importance (SEEI) in Section C and determine the parameters of concern (POC) in Section D. Once the POCs' are agreed upon by DWQ, the alternatives analysis and selection of preferred alternative Section E can be conducted based on minimizing degradation resulting from discharge of the POCs. Once the applicant and DWQ agree upon the preferred alternative, the review is considered complete, and the form is submitted to DWQ.

What are the designated uses of the receiving water (R317-2-6)?

- ☒ Domestic Water Supply
- ☒ Recreation
- ☒ Aquatic Life
- ☒ Agricultural Water Supply
- ☐ Great Salt Lake

Antidegradation Category 1, 2 or 3 of receiving water (R317-2-3.2, -3.3, and -3.4): Category 3

UPDES Industrial Permit Application

Part X. Antidegradation Review ***continued***

Effluent flow reviewed: *typically, this should be the maximum daily discharge at the design capacity of the facility. Exceptions should be noted.*

Max Daily Discharge = 3,600 GPD.

What is the application for? (Check all that apply)

- ☒ A UPDES permit for a new facility, project, or outfall.
- ☐ A UPDES permit renewal with an expansion of modification of an existing wastewater treatment works.
- ☐ A UPDES permit renewal requiring limits for a pollutant not covered by the previous permit and/or an increase to existing permit limits.
- ☐ A UPDES permit renewal with no charges in facility operations.

Section B. Is a Level II ADR required?

This section of the form is intended to help applicants determine if a Level II ADR is required for specific permitted activities. In addition, the Executive Secretary may require a Level II ADR for an activity with the potential for major impact on the quality of waters of the state (R317-2-3.5a.1).

B1. The UPDES permit is new <u>or</u> is being renewed and the proposed effluent concentration and loading limits are higher than the concentration and loading limits in the previous permit and any previous antidegradation review(s).

☒ YES – (Proceed to B3 of the Form)
☐ NO – No Level II ADR is required and there is <u>no need to proceed further with the review questions. Continue to the Certification Statement and Signature page.</u>

B2. Will any pollutants use assimilative capacity of the receiving water, i.e. do the pollutant concentrations in the effluent exceed those in the receiving waters at critical conditions? For most pollutants, effluent concentrations that are higher than the ambient concentrations require an antidegradation review? For a few pollutants such as dissolved oxygen, and antidegradation review is required if the effluent concentrations are less than the ambient concentrations in the receiving water. (Section 3.3.3 of Implementation Guidance)

☐ YES – (Proceed to B4 of the Form)
☒ NO – No Level II ADR is required and there is <u>no need to proceed further with the review questions. Continue to the Certification Statement and Signature page.</u>

UPDES Industrial Permit Application

Part X. Antidegradation Review *continued*

B3. Are water quality impacts of the proposed project temporary and limited (Section 3.3.4 of Implementation Guidance)? Proposed projects that will have temporary and limited effects on water quality can be exempted form a Lev le II ADR.

☐ YES – Identify the reason used to justify this determination if B4.1 and proceed to Section G. No Level II ADR is required.

☒ NO – A Level II ADR is required (Proceed to Section C)

B3.1 Complete this question only if the applicant is requesting a Level II review exclusion for temporary and limited projects (See R317-2-3.5(b)(3) and R317-2-3.5(b)(4)). For projects requesting a temporary and limited exclusion please indicate the factor(s) used to justify this determination (check all that apply and provide details as appropriate) (Section 3.3.4 of Implementation Guidance):

☐ Water quality impacts will be temporary and related exclusively to sediment or turbidity and fish spawning will not be impaired.

Factors to be considered in determining whether water quality impacts will be temporary and limited:

a) The length of time during which water quality will be lowered:	
b) The perfect change in ambient concentrations of pollutants:	
c) Pollutants affected:	
d) Likelihood for long-term water quality benefits:	
e) Potential for any residual long-term influences on existing uses:	
f) Impairment of fish spawning, survival and development of aquatic fauna excluding fish removal efforts:	
Additional justification, as needed:	

UPDES Industrial Permit Application

Part X. Antidegradation Review *continued*

Level II ADR

Section C, D, E, and F of the form constitute the Level II ADR Review. The applicant must provide as much detail as necessary for DWQ to perform the antidegradation review. Questions are provided for the convenience of applicants; however, for more complex permits it may be more effective to provide the required information in a separate report. Applicants that prefer a separate report should record the report name here and proceed to Section G of the form.

Option Report Name: ______________________

Section C. Is the degradation from the project socially and economically necessary to accommodate important social or economic development in the area in which the waters are located? *The applicant must provide as much detail as necessary for DWQ to concur that the project is socially and economically necessary when answering the questions in the section. More information is available in Section 6.2 of the Implementation Guidance.*

C1. Describe the social and economic benefits that would be realized through the proposed project, including the number and nature of jobs created and anticipated tax revenues.

Washington County Water Conservancy District (WCWCO) owns and operates West Oam Springs pump station, Water System #27073. The West Oam Springs source has high manganese (Mn) levels that have previously created colored water events in the distribution system. These events forced WCWCO to suspend discharge to the distribution system yet continue to pump from the wet well. All of the West Dam Springs water is currently being pumped to Sand Hollow Reservoir. The source also has arsenic (As) levels near the regulated limit of 10 µg/L requiring As treatment as well. Additionally, WCWCO would like the capability to blend and treat water from the nearby Sand Hollow well field. Most of the wells have elevated As levels that require blending or treatment for culinary use. The new water treatment facility will supply clean drinking water to the WCWCO's customers. This is especially pertinent to help relieve drinking water supply strains with the rising population.

C2. Describe any environmental benefits to be realized through implementation of the proposed project.

Not applicable.

C3. Describe any social and economic losses that may result from the project, including impacts to recreation or commercial development.

None.

C4. Summarize any supporting information from the affected communities on preserving assimilative capacity to support future growth and development.

There will be limited impact to the Sand Hollow Reservoir. Only a small, additional flow into the Reservoir is anticipated from Decant Water from the new sludge drying beds. The drying beds will settle out most particles and contaminants. Additionally, the Decant water would not flow year-round, but only during period of low evaporation and high water production. It is only in place if evaporation was not sufficient to remove enough water from the drying beds, and would not be normal operation.

UTAH DEPARTMENT *of* ENVIRONMENTAL QUALITY
WATER QUALITY

Division of Water Quality (DWQ)
UPDES Program

UPDES Industrial Permit Application

Part X. Antidegradation Review ***continued***

C5. Please describe any structures or equipment associated with the project that will be placed within or adjacent to the receiving water.

An entirely new treatment building will be constructed for this project. The main treatment process involves pre-oxidation with chlorine, coagulation (ferric chloride) and pressure filtration with sand and anthracite media and air scour capabilities, followed by post-chlorination. Backwash waste flows will be pumped to a backwash clarifier. Water within the clarifier will be decanted and returned to the front of the plant. Periodically, the sludge in the tank bottom will be removed through a blowdown process and will be pumped to the drying beds for further processing. Water within the drying beds will be removed through evaporation. However, in the event that the water production exceeds the evaporation rate, decanted water will be sent to the West Dam drains, which is pumped to the Sand Hollow Reservoir. Dried sludge will be removed and hauled to a local landfill.

C6. Will the discharge potentially impact a drinking water source, e.g., Class 1C waters? Depending upon the locations of the discharge and its proximity to downstream drinking water diversions, additional treatment or more stringent effluent limits or additional monitoring, beyond that which may otherwise be required to meet minimum technology standards or in stream water quality standards, may be required by the Director in order to adequately protect public health and the environment (R317-2-3.5 d.).

☐ YES
☒ NO

Section D. Identify and rank (from increasing to decreasing potential threat to designated uses) the parameters of concern. *Parameters of concern are parameters in the effluent at concentrations greater than ambient concentrations in the receiving water. The applicant is responsible for identifying parameter concentrations in the effluent and DWQ will provide parameter concentrations for the receiving water. More information is available in Section 3.3.3 of the Implementation Guidance.*

Parameters of Concern:

Rank	**Pollutant**	**Ambient Concentration**	**Effluent Concentration**
1.	Arsenic	Not Available (NA)	NA
2.	TSS	NA	NA
3.	Iron	NA	NA
4.	Manganese	NA	NA
5.			

UPDES Industrial Permit Application

Part X. Antidegradation Review *continued*

Pollutants Evaluated that are not Considered Parameters of Concern:

Pollutant	Ambient Concentration	Effluent Concentration	Justification
1.	Nitrate	NA	NA
2.	Phosphorus	NA	NA
3.			
4.			
5.			

Section E. Alternative Analysis Requirements of Level II Antidegradation Review. *Level II ADRs require the applicant to determine whether there are feasible less-degrading alternatives to the proposed project. More information is available in Section 5.5 and 5.6 of the Implementation Guidance.*

E1. The UPDES permit is being renewed without any changes to flow or concentrations. Alternative treatment and discharge options including changes to operations and maintenance were considered and compared to the current processes. NO economically feasible treatment or discharge alternatives were identified that were not previously considered for any previous antigradation review(s).

☐ YES – (Proceed to Section F)
☒ NO or Does Not Apply (Proceed to E2)

E2. Attach as an appendix to this form a report that describes that following factors for all alternative treatment options (see 1) a technical descriptions of the treatment process, including construction costs and continued operation and maintenance expenses, 2) the mass and concentration of discharge constituents, and 3) a description of the reliability of the system, including the frequency where recurring operation and maintenance may lead to temporary increases in discharged pollutants. Most of this information is typically available from a Facility Plan, if available.

Report Name: Gunlock & Sand Hollow Water Treatment Preliminary Design Report

E3. Describe the proposed method and cost of the baseline treatment alternative. The baseline treatment alternative is the minimum treatment required to meet water quality based effluent limits (WQBEL) as determined by the preliminary or final wasteload analysis (WLC) and any secondary or categorical effluent limits.

The treatment method is as described in section C5. Water within the drying beds will be removed through evaporation. However, in the event that the water production exceeds the evaporation rate, decanted water will be sent to the West Dam drains, which eventually runs to the Sand Hollow Reservoir. Dried sludge will be removed and hauled to a local landfill.
The cost of the treatment is coupled within the $9.4 million dollar construction project.

UPDES Industrial Permit Application

Part X. Antidegradation Review ***continued***

E4. Were any of the following alternatives feasible and affordable?

Alternative	Feasible	Reason Not Feasible/Affordable
Pollutant Trading	☐ YES ☒ NO	Not Applicable
Water Recycling/Reuse	☒ YES ☐ NO	Intention
Land Application	☐ YES ☒ NO	Not Applicable
Connection to Other Facilities	☐ YES ☒ NO	Not Applicable
Upgrade to Existing Facility	☐ YES ☒ NO	Not Applicable
Total Containment	☒ YES ☐ NO	Intention
Improved O&M of Existing Systems	☐ YES ☒ NO	Not Applicable
Seasonal or Controlled Discharge	☒ YES ☐ NO	Optional
New Construction	☒ YES ☐ NO	Currently under construction
No Discharge	☒ YES ☐ NO	Intention

E5. From the applicant's perspective, what is the preferred treatment option?

The preferred treatment option is what has been designed, i.e., recycle decanted water to the front of the plant and then contain all remaining backwash waste water in the sludge drying beds. The removal of the water would be primarily through evaporation; however, a small flow may need to be decanted and discharged to avoid overburdening the drying beds.

Part X. Antidegradation Review *continued*

E6. Is the preferred option also the least polluting feasible alternative?

☒ YES ☐ NO

If No, what were less degrading feasible alternative(s)?

If No, provide a summary of the justification for not selecting the least polluting feasible alternative and if appropriate, provide a more detailed justification as an attachment.

Section F. Optional Information

F1. Does the applicant want to conduct optional public review(s) in addition to the mandatory public review? Level II ADRs are public noticed for a thirty day comment period. More information is available in Section 3.7.1 of the Implementation Guidance.

☐ YES ☒ NO

F2. Does the project include an optional mitigation plan to compensate for the proposed water quality degradation?

☐ YES ☒ NO

Report Name: ______________________________

UTAH DEPARTMENT of ENVIRONMENTAL QUALITY
WATER QUALITY

Division of Water Quality (DWQ) UPDES Program

UPDES Industrial Permit Application

Part XI. Certification Statement and Signature

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with system designed to assure that quailed personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment of knowing violations.

Corey Cram	[signature]	Assoc. Gm Mgr	4-18-20
PRINT Signatory Authority	**Signature**	**Title**	**Date**

The Division of Water Quality may request addition information.

Important: The UPDES Permit Application will not be considered complete unless you answer every question. If an item does not apply to you, enter "Not Applicable" to show that you considered the question.

The UPDES Permit Application, must be signed as follows:

1) For a corporation, a responsible corporate officer shall sign the NOT, a responsible corporate officer means:
   a. A President, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who performs similar policy- or decision-making functions for the corporation; or
   b. The manager of one or more manufacturing, production, or operating facilities, if
      i. The manager is authorized to make management decisions that govern the operation of the regulated facility, including having the explicit or implicit duty of making major capital investment recommendations, and initiating and directing other comprehensive measures to assure long term environmental compliance with environmental statutes and regulations:
      ii. The manager can ensure that the necessary systems are established or actions taken to gather complete and accurate information for permit application requirements; and
      iii. Authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures.
2) For a partnership of sole proprietorship, the general partner or the proprietor, respectively; or
3) For a municipality, state or other public agency, either a principal executive officer or ranking elected official shall sign the application; in this subsection, a principal executive officer of any agency means;
   a. The chief executive officer of the agency; or
   b. A senior executive officer having responsibility for the overall operations of a principal geographic unit or division of the agency.

Where to File the UPDES Permit Application form:

Please submit the original form with a signature in ink to the below address. Remember to retrain a copy for your records.

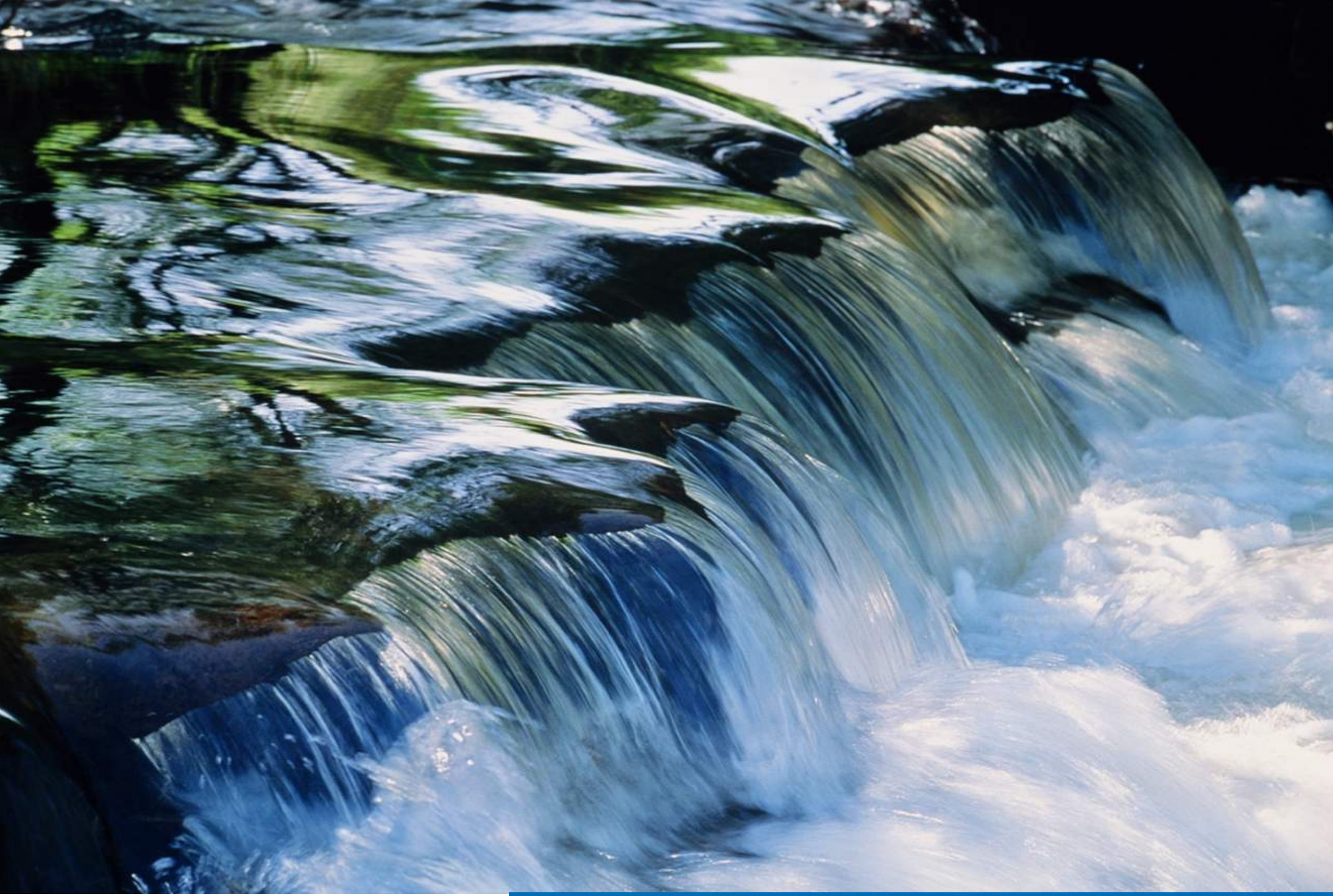
UPDES sent by mail:

Division of Water Quality
195 North 1950 West
PO Box 144870
Salt Lake City, UT 84114-4870

OFFICE USE ONLY

Date received: ____/____/____ **Received by:** ____________ **Document No:** ____________

via: ☐ Email ☐ Fax ☐ Webportal ☐ Mail ☐ Hand Delivery



City of St. George
Gunlock Water Treatment Facility Design &
Washington County Water Conservancy District
Sand Hollow Groundwater Treatment Plant
Design

Technical Memorandum 1
GUNLOCK & SAND HOLLOW WATER TREATMENT PRELIMINARY DESIGN REPORT

FINAL | December 2018

City of St. George
Gunlock Water Treatment Facility Design
&
Washington County Water Conservancy District
Sand Hollow Groundwater Treatment Plant Design

Technical Memorandum 1
GUNLOCK & SAND HOLLOW WATER TREATMENT PRELIMINARY DESIGN REPORT

FINAL | December 2018

Digitally signed by Gordon D. Thelin
Date: 2018.12.11 15:17:58-07'00'

REGISTERED PROFESSIONAL ENGINEER
No. 4860846-2202
GORDON D. THELIN
STATE OF UTAH

Contents

Technical Memorandum 1 - Gunlock & Sand Hollow Water Treatment Preliminary Design Report 1-1

1.1 Purpose 1-1

1.2 Background 1-1

1.2.1 Gunlock 1-1

1.2.2 Sand Hollow 1-2

1.3 General Site Conditions 1-2

1.3.1 Gunlock 1-2

1.3.2 Sand Hollow 1-13

1.4 Water Treatment Design Criteria 1-23

1.4.1 Gunlock 1-23

1.4.2 Sand Hollow 1-39

1.5 Building Layout 1-55

1.5.1 Gunlock 1-55

1.5.2 Sand Hollow 1-79

1.6 Electrical and Instrumentation and Controls 1-87

1.6.1 Gunlock 1-87

1.6.2 Sand Hollow 1-95

1.7 Cost Estimate 1-95

1.7.1 Gunlock 1-95

1.7.2 Sand Hollow 1-96

Appendices

Appendix A Electrical Load Study Reports

Appendix B Required Head Calculations

Tables

Table 1.1 Arsenic Values for the Gunlock Well Field 1-7

Table 1.2 Gunlock Well Field Historical Water Quality Data 1-7

Table 1.3 Sand Hollow Well Field Capacity 1-13

Table 1.4 Sand Hollow Well Field Historical Water Quality Data (2014-2015) 1-17

Table 1.5	Chlorine Technology Comparison	1-29
Table 1.6	Flash Mix Calculations	1-30
Table 1.7	Backwash Procedure	1-32
Table 1.8	Sludge Production	1-34
Table 1.9	OSHG System Design Parameters	1-48
Table 1.10	Sand Hollow Sludge Production	1-50
Table 1.11	2016 Cost Estimate for Gunlock WTF	1-96
Table 1.12	Current Cost Estimate for Gunlock WTF	1-96
Table 1.13	2016 Cost Estimate for Sand Hollow GWTP	1-97
Table 1.14	Current Cost Estimate for Sand Hollow GWTP	1-98

Figures

Figure 1.1	Gunlock Well Field Existing Conditions	1-5
Figure 1.2	Gunlock Well Field Water Network Analysis	1-9
Figure 1.3	Gunlock Water Treatment Facility Overall Site Plan	1-11
Figure 1.4	Sand Hollow Wells and Pipelines	1-15
Figure 1.5	Sand Hollow Existing Wells Water Network Analysis	1-19
Figure 1.6	Sand Hollow Groundwater Treatment Plant Overall Site Plan	1-21
Figure 1.7	Gunlock Water Treatment Facility Design Criteria	1-25
Figure 1.8	Gunlock Water Treatment Facility Process Flow Diagram	1-27
Figure 1.9	Gunlock Water Treatment Facility Hydraulic Profile	1-37
Figure 1.10	Sand Hollow Groundwater Treatment Plant Design Criteria	1-41
Figure 1.11	Sand Hollow Groundwater Treatment Plant Process Flow Diagram	1-43
Figure 1.12	Sand Hollow Groundwater Treatment Plant - Bypass Valve Vault	1-45
Figure 1.13	Sand Hollow Groundwater Treatment Plant Hydraulic Profile	1-53
Figure 1.14	Gunlock Water Treatment Facility - Upper Plan	1-57
Figure 1.15	Gunlock Water Treatment Facility - Lower Plan	1-59
Figure 1.16	Gunlock Water Treatment Facility - Section	1-61
Figure 1.17	Gunlock Water Treatment Facility - Pressure Vessel - Section 1	1-63
Figure 1.18	Gunlock Water Treatment Facility - Pressure Vessel - Section 2	1-65
Figure 1.19	Gunlock Water Treatment Facility - Pressure Vessel - Section 3	1-67
Figure 1.20	Gunlock Water Treatment Facility - Pressure Vessel - Section 4	1-69

Figure 1.21	Gunlock Water Treatment Facility - Backwash Waste Clarifiers and Pump Station - Plan	1-71
Figure 1.22	Gunlock Water Treatment Facility - Backwash Waste Clarifiers - Sections	1-73
Figure 1.23	Gunlock Water Treatment Facility - Pump Station - Sections	1-75
Figure 1.24	Gunlock Water Treatment Facility - Drying Beds - Sections	1-77
Figure 1.25	Sand Hollow Groundwater Treatment Plant - Upper Plan	1-81
Figure 1.26	Sand Hollow Groundwater Treatment Plant - Section	1-83
Figure 1.27	Sand Hollow Groundwater Treatment Plant - Backwash Waste Clarifier Tank and Pump Station - Plan	1-85
Figure 1.28	Gunlock Water Treatment Facility One-Line Diagram	1-89
Figure 1.29	Gunlock Water Treatment Facility Filter Influent P&ID	1-91
Figure 1.30	Gunlock Water Treatment Facility Filter Effluent P&ID	1-93

Abbreviations

µg/L	micrograms per liter
A	amperes
AACEI	Association for the Advancement of Cost Engineering International
AC	asphalt concrete
Alpha	Alpha Engineering
As	arsenic
As(V)	arsenate
As(III)	arsenite
BLM	Bureau of Land Management
BW	backwash
BWW	backwash waste
C/F	coagulation/filtration
Carollo	Carollo Engineers, Inc.
cfs	cubic feet per second
City	City of St. George
District	Washington County Water Conservancy District
EPA	United States Environmental Protection Agency
ES	effective size
gpm	gallons per minute
gpm/sf	gallons per minute per square foot
GWTP	Groundwater Treatment Plant
hp	horsepower
HVAC	heating, ventilation, and air conditioning
kVA	kilovolt-amperes
lbs/d	pounds per day
lbs/sf	pounds per square foot
lbs/yr	pounds per year
M	million
MCC	motor control center
MCL	maximum contaminant level
MG	million gallon
mg/L	milligrams per liter

mgd	million gallons per day
mm	millimeter
Mn	manganese
NEC	National Electrical Code
NTU	Nephelometric Turbidity Unit
O&M	Operations and Maintenance
OSHG	onsite sodium hypochlorite generating system
P&ID	process and instrumentation diagrams
PLC	Programmable Logic Controller
PP	power panel
ppb	parts per billion
ppm	parts per minute
psi	pounds per square inch
RTU	remote terminal unit
SCADA	Supervisory Control and Data Acquisition
scfm/sf	standard cubic feet per minute per square foot
SHRP	Sand Hollow Regional Pipeline
TM	technical memorandum
V	volt
VFD	variable frequency drive
WCWCD	Washington County Water Conservancy District
WTF	water treatment facility

Technical Memorandum 1

Gunlock & Sand Hollow Water Treatment Preliminary Design Report

1.1 Purpose

The purpose of this predesign report is to present the results of the predesign effort to evaluate the current hydraulic conditions of the existing Gunlock and Sand Hollow well fields, outline a potential site layout for a new arsenic water treatment facility at both sites, and recommend a treatment layout to carry forward into design. The preliminary findings are summarized in this report and prepared to facilitate review and further discussion with the City of St. George and Washington County Water Conservancy District, the two Owners of the treatment facilities.

1.2 Background

1.2.1 Gunlock

The Gunlock well field, located 15 miles northwest of the City of Saint George (City), consists of 11 wells that supply drinking water for the City and surrounding area. The City owns and operates these wells, ranging in capacity from approximately 500 to 1,600 gallons per minute (gpm). Water rights dating back to 1961 allow the Gunlock well field to produce a total flow of 18 cubic feet per second (cfs) or 13,031.4 acre-feet. The total hydraulic capacity of the existing 18-inch and 20-inch conveyance lines is 19.7 cfs.

The ground water from the Gunlock well field has arsenic (As) concentrations higher than the United States Environmental Protection Agency (USEPA) maximum contaminant level (MCL) of 10 micrograms per liter (µg/L), but otherwise is of high quality with no other constituents that require treatment for current drinking water standards.

Demand in the distribution system on the west side of the City stresses the hydraulic capacity of the Washington County Water Conservancy District (District) regional pipeline that supplies this area, since a portion of the Gunlock well field capacity is unavailable due to arsenic concerns. Implementing arsenic treatment for the Gunlock well field water supply would significantly reduce the hydraulic stresses on the St. George west side water system and would provide a reliable, long-term water supply for this area.

A new 6 million gallon per day (mgd) coagulation/filtration (C/F) pressure vessel facility located at the Upper Bureau of Land Management (BLM) site was recommended in a previous technical memorandum (TM) to treat water from the upper wells, namely wells 5, 7, 8, 9, 10 and 11 in the Gunlock well field. The treatment plant will have sufficient capacity for arsenic removal from the upper wells with the ability to blend in water from the lower wells in the future. The total capacity of the upper wells is approximately 7 mgd. The initial 6 mgd treatment plant will be equipped with a 3-mgd bypass to accommodate some of the well flow bypassing the treatment plant, if warranted, while still meeting the As standard.

The initial design will accommodate space for future treatment expansion to 12 mgd on the Upper BLM site in case future regulations or water quality create the need to treat the City's entire Gunlock well field water supply. A pipeline from the lower wells will be constructed at some future point to supply the additional 6 MGD to the future water treatment facility expansion.

1.2.2 Sand Hollow

Washington County Water Conservancy District (WCWCD) owns and operates West Dam Springs, a pump station located near the toe of the Sand Hollow Reservoir's west dam. The collective production rate of the three pumps at the pump station ranges from 1,500 gpm to 2,100 gpm, depending on the water elevation in Sand Hollow Reservoir. West Dam Springs consists of a gravel-pack collection trench running parallel to the west dam that collects groundwater in a concrete wet well that originally pumped water from the wet well to the Dixie Springs 2 million gallon (MG) tank and to other locations within the distribution system. The West Dam Springs source has high manganese (Mn) levels that have previously created colored water events in the distribution system. These events forced WCWCD to suspend discharge to the distribution system yet continue to pump from the wet well. All of the West Dam Springs water is currently being pumped to Sand Hollow Reservoir. The West Dam Springs source requires Mn treatment before it can be used again for culinary water supply. The source also has arsenic levels near the regulated limit of 10 µg/L requiring As treatment as well.

A new 3 mgd C/F pressure vessel facility, located near West Dam Springs, is recommended to treat all the water from West Dam Springs, with the capability to blend and treat water from the nearby Sand Hollow well field. The existing Sand Hollow wells range from 300 to 1,500 gpm; most of the wells have elevated As levels that require blending or treatment for culinary use. In addition, WCWCD is currently developing five additional wells (Wells 10, 11, 12, 13 and 15) in the Sand Hollow area that will range in production between 500 and 2,000 gpm. The District has requested that the Sand Hollow wells be chlorinated before the water is sent to the distribution system; therefore, the new treatment plant's chlorine system will be sized to chlorinate the treated West Dam Springs water (approximately 3 mgd) and the Sand Hollow well field water (approximately 8 mgd). The plant will be designed to accommodate additional flows from the future wells, with a buildout capacity of 6 mgd. The West Dam Springs water and Sand Hollow well field water will be blended in the new Sand Hollow Regional Pipeline (SHRP) which will originate at the treatment plant and will send blended flows to a new 4 to 5 MG storage tank. A small portion of treated, unchlorinated water will also be bypassed from entering the SHRP and sent to the Dixie Springs 2 MG storage tank. Existing West Dam Springs pumps and Sand Hollow well pumps will pump against an additional head of approximately 15 pounds per square inch (psi) associated with the pressure vessels and sand separators. This will either slightly reduce their capacity or require the pump's variable frequency drives (VFD) to operate at a higher speed.

1.3 General Site Conditions

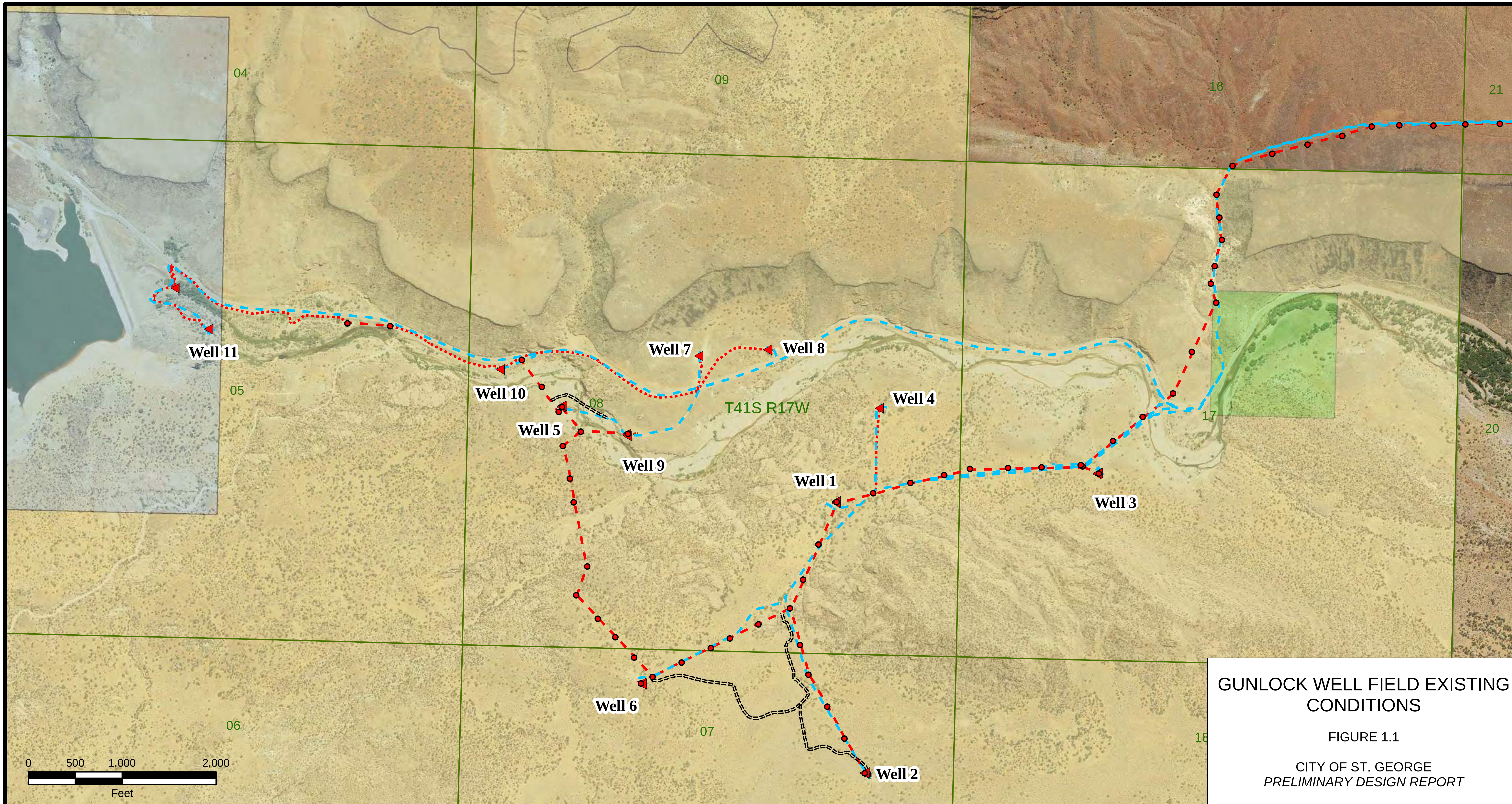
1.3.1 Gunlock

The Gunlock site was evaluated and selected as part of a preliminary engineering study performed for both the WCWCD and the City of St. George by Carollo Engineers, Inc. (Carollo) and Alpha Engineering (Alpha) in April of 2015. In that study, the Upper BLM site was selected as the site for the new arsenic treatment facility. This site is located along the east side of Gunlock Road between Well 7 and Well 8. This area is sufficiently large to accommodate current and future water treatment facilities. It is adjacent to the pipeline from the upper wells, which flows south to the interconnection with the lower wells and ultimately to the Gunlock Tank. Existing well pumps will pump against an additional head of approximately 9 psi associated with the pressure vessels. This will slightly reduce the well's capacity. The City is planning on upgrading the existing wells with larger pumps and VFDs.

1.3.1.1 Well Characteristics

Gunlock well field layout is shown in Figure 1.1 and represents the existing conditions at the well field including water and power infrastructure.

-This Page Intentionally Left Blank-



carollo

ALPHA ENGINEERING
43 South 100 East, Suite 100 • St George, Utah 84770
T: 435.628.6500 • F: 435.628.6553 • alphaengineering.com

Existing Switch
Existing Power Pole
Existing Transformer
Existing Access Road
Existing Water Line
Existing OHP Primary
Existing OHP Secondary
Existing UGP Primary
Existing UGP Secondary
Federal Land
Private Land
State Land
PLSS Section Lines
PLSS Township Lines

Figure 1.1

Gunlock Well Field Existing Conditions

Spatial Reference:	Utah State Plane NAD 83, feet
Drawn By:	JRH
Scale:	1" = 1,000'
Date:	May 2, 2016

-This Page Intentionally Left Blank-

The following tables (Table 1.1 and Table 1.2) show the water quality of the Gunlock well field.

Table 1.1 Arsenic Values for the Gunlock Well Field

Analyte	Sample Date	Well Field										
		Lower						Upper				
		1	2	3	4	5	6	7	8	9	10	11
Arsenic (µg/L)	2010-2011	27	9.7	20	26	18	16	17	18	24	18	7.0
	9/08/2015	26	9.7	21	22	20	-	20	19	24	15	7.1
	11/24/2015	26	9.5	22	20	20	-	16	18	22	13	6.8

Table 1.2 Gunlock Well Field Historical Water Quality Data

Parameter	Units	Value	Basis
Total Arsenic	ppb	25.4	Calculated composite average based on water quality data (2000)
Arsenic V	%	>99	Based on well testing analysis performed 9/03 on wells 3-5
Arsenic III	%	ND	Based on well testing analysis performed 9/03 on wells 3-5
Iron	mg/L	0.1	Average of Gunlock Well Nos. 1-9 (92'-03')
Calcium	mg/L	71.4	Average of Gunlock Well Nos. 1-9 (92'-03')
Magnesium	mg/L	14.9	Average of Gunlock Well Nos. 1-9 (92'-03')
Manganese	mg/L	<0.01	Average of Gunlock Well Nos. 1-9 (92'-03')
Sodium	mg/L	14.5	Average of Gunlock Well Nos. 1-9 (92'-03')
Sulfate	mg/L	74	Average of Gunlock Well Nos. 1-9 (92'-03')
Nitrate-N	mg/L	0.4	Average of Gunlock Well Nos. 1-9 (92'-03')
Total Silica	mg/L	21.5	Based on well testing analysis performed 9/03 on wells 3-5
Dissolved	%	>99	Based on well testing analysis performed 9/03 on wells 3-5
TOC	mg/L	0.6	Based on well testing analysis performed 9/03 on wells 3-5
Total Phosphorous-P	mg/L	0.05	Based on well testing analysis performed 9/03 on wells 3-5
Alkalinity[1]	mg/L	186	Average of Gunlock Well Nos. 1-9 (92'-03')
Fluoride	mg/L	0.3	Average of Gunlock Well Nos. 1-9 (92'-03')
Chloride	mg/L	15.8	Average of Gunlock Well Nos. 1-9 (92'-03')
Barium	mg/L	0.11	Average of Gunlock Well Nos. 1-9 (92'-03')
pH	-	7.5	Average of Gunlock Well Nos. 1-9 (92'-03')
Turbidity	NTU	0.44	Average of Gunlock Well Nos. 1-9 (92'-03')
TDS	mg/L	361	Average of Gunlock Well Nos. 1-9 (92'-03')
Conductivity	umhos/cm	976	Average of Gunlock Well Nos. 1-9 (92'-03')
Temperature	°F	55-65	Water temperature tested on Gunlock Wells Nos. 1-11 (10/03)

Notes:
(1) Expressed as $CaCO_3$.

1.3.1.2 Distribution Pipeline Conditions

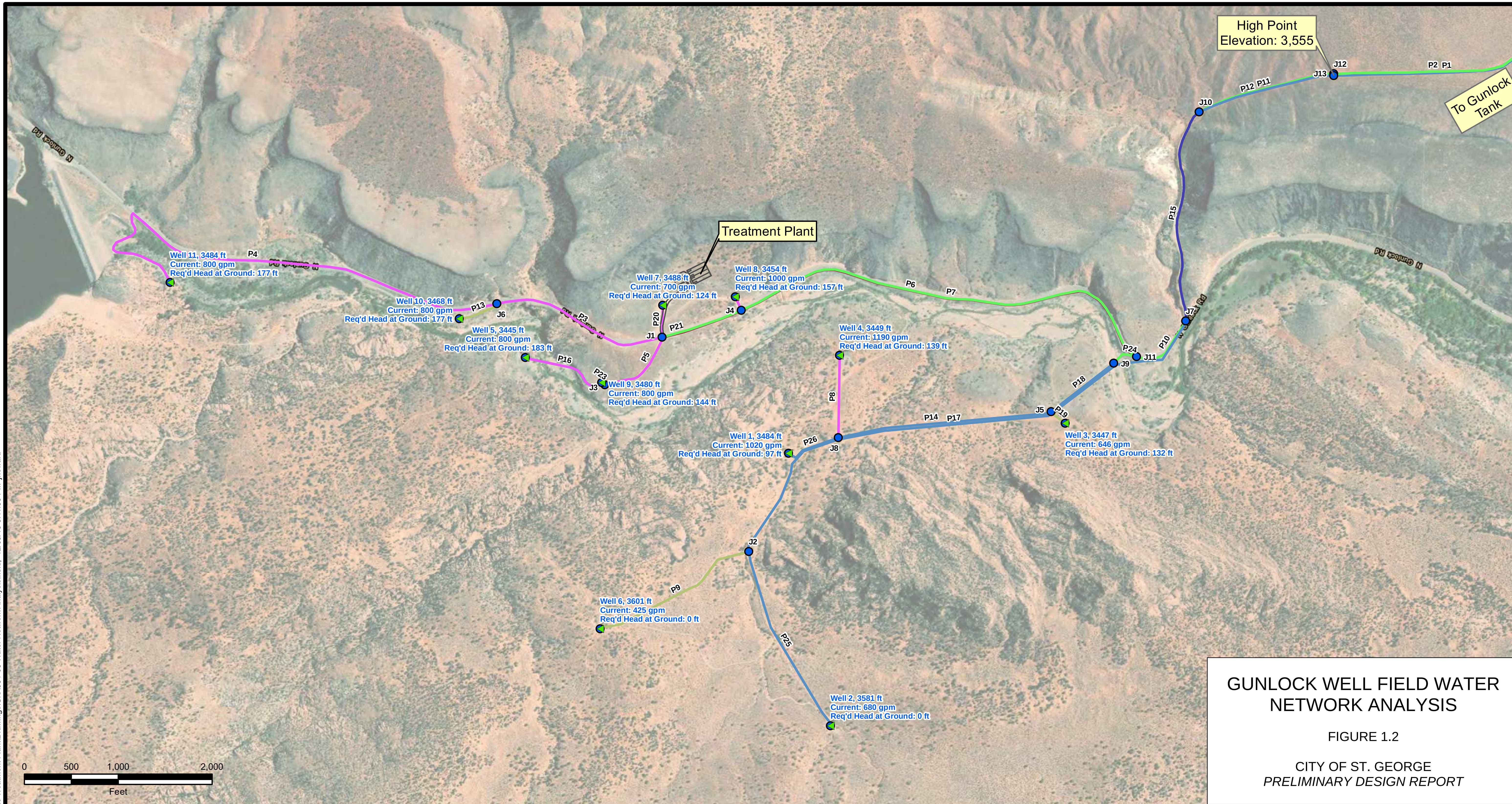
The existing 20-inch pipeline in Gunlock Road will be tapped into with a 24-inch pipe to feed the new Gunlock Water Treatment Facility (WTF). A new 24-inch pipe will return the treated water from the WTF to the existing line. Isolation valves will also be provided to direct the upper well water to the WTF and to isolate the WTF from the existing well field, if necessary. Wells 5, 7, 8, 9, 10, and 11 have a total design capacity of 4,900 gpm of which about 4,200 gpm will be sent through the treatment plant. These wells will be retrofitted by the City to provide the needed flows and head needed to reach the Gunlock Tank. Wells 1, 2, 3, 4, and 6 will mix with the treated water at the existing distribution interconnect tee. A water network analysis for the Gunlock Upper Wells is shown in Figure 1.2, which shows the ground surface elevation of the well, the existing pipe diameters, the current design pumping rate, and the required head at the ground surface to convey flow to the high point of the existing pipeline. This information provides the City with head conditions at the well with the new WTF in place and will aid the City in retrofitting the wells. Additional tables containing this information are included in the appendices of this report.

The multi-cell pressure vessel configuration uses 2,100 gpm from the filter effluent pipe to backwash one of the four cells from one filter vessel at a time. This eliminates the need for a backwash supply tank or pump station. The system is configured so that three cells can filter the design flow of 2,100 gpm, and their filtered water can backwash the fourth cell. Thus, when the WTF is operating at 2,100 gpm or higher, whether through one filter vessel or two, no supplemental water is needed from the distribution system. If the WTF is operating at less than 2,100 gpm, supplemental water from the filter effluent piping is required for backwash. This supplemental water is automatically available from the downstream transmission piping provided that the total well production entering the pipe to the Gunlock tank (either from the upper wells through the WTF, or from the lower directly into the pipe) exceeds 2,100 gpm. Since there is a high point between the wells and the Gunlock tank that prevents backflow from the tank, the filter vessels can only be backwashed when the total flow from the groundwater wells exceeds 2,100 gpm.

1.3.1.3 Site Layout

The site will include an asphaltic concrete (AC) pavement entrance road from Gunlock Road and around the WTF, as depicted in Figure 1.3. A gravel base will be placed between the asphalt paving and drying beds for easier truck access.

Yard piping will include pipelines from the filters to a backwash waste tank with decant return piping to the building and sludge piping to the drying beds. There will also be overflow pipelines, drainage pipelines, and storm drainage culverts as needed. A wastewater holding tank, with associated piping, will also be designed for sanitary waste from the treatment facility. This tank will be maintained by the City removing contents periodically via a septic type pumping truck service. The building profile and setting will meet restrictions as outlined by the BLM in the Environmental Assessment.



GUNLOCK WELL FIELD WATER NETWORK ANALYSIS

FIGURE 1.2

CITY OF ST. GEORGE
PRELIMINARY DESIGN REPORT

carollo

ALPHA ENGINEERING
43 South 100 East, Suite 100 • St George, Utah 84770
T: 435.628.6500 • F: 435.628.6553 • alphaengineering.com

▲ Existing Well
● WaterGEMS Model Junction

Existing Pipe
- 8"
- 10"
- 14"
- 18"
- 20"
- 30"

N

Figure 1.2

Water Network Analysis

Gunlock Well Field

Spatial Reference:	Utah State Plane NAD 83, feet
Drawn By:	JRH
Scale:	1 inch = 1,000 feet
Date:	December 2018

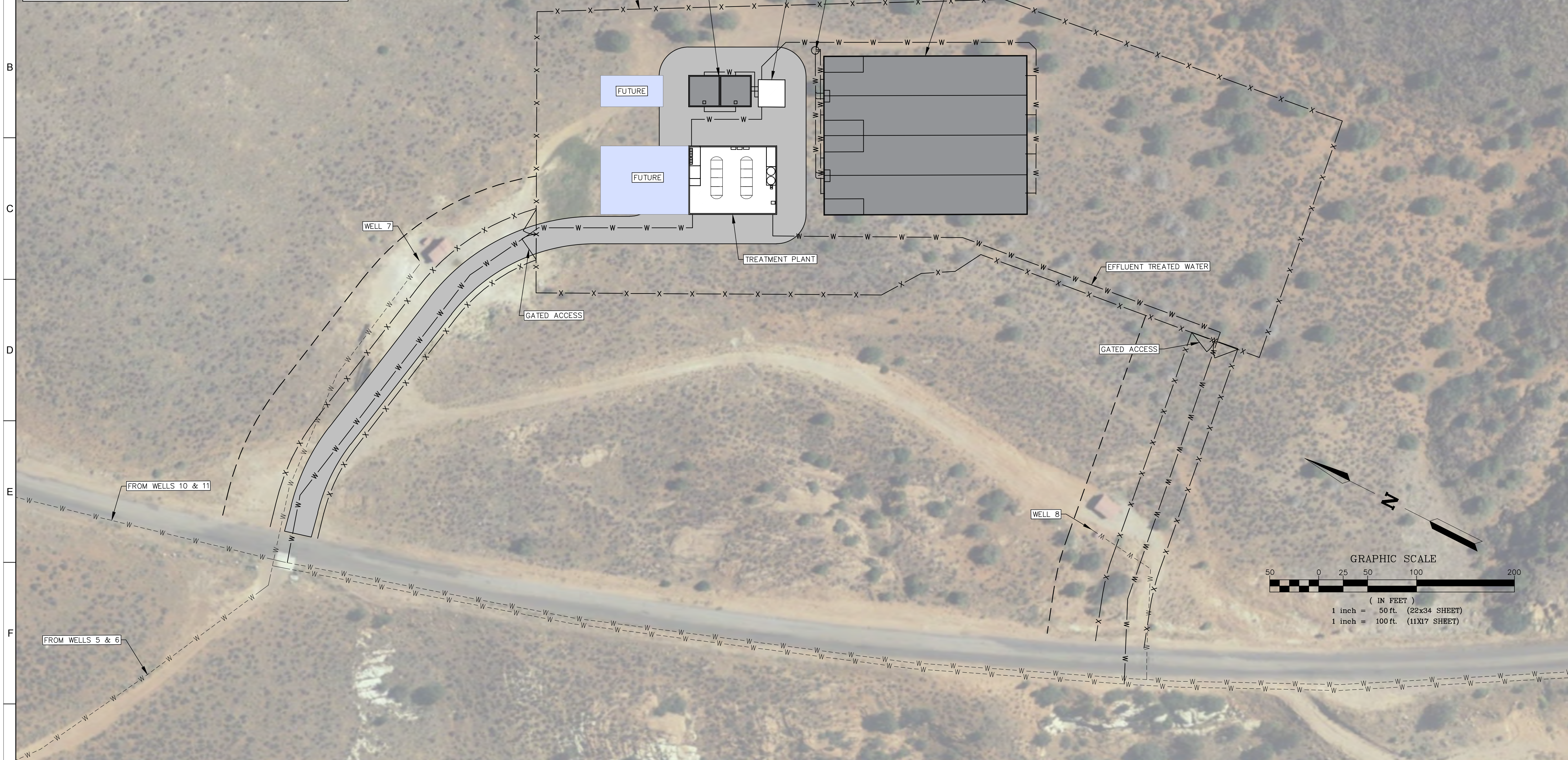
P:\331-05 City of St. George – Gunlock Arsenic Treatment Plant\Drawings\GIS\331-05 Water Network Analysis.mxd, 12/05/18 5:11:33 PM jheward

-This Page Intentionally Left Blank-

GUNLOCK WTF OVERALL SITE PLAN

FIGURE 1.3

CITY OF ST. GEORGE
PRELIMINARY DESIGN REPORT



REV	DATE	BY	DESCRIPTION

DESIGNED JRH
DRAWN JRH
CHECKED TBG
DATE DECEMBER 2018

PRELIMINARY DESIGN SUBMITTAL
NOT FOR CONSTRUCTION

carollo
ALPHA ENGINEERING
St.George THE BRIGHTER SIDE

CITY OF ST. GEORGE
GUNLOCK WATER TREATMENT FACILITY DESIGN
GENERAL
OVERALL SITE PLAN

331-06 EXH.DWG

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

JOB NO. 11185A10
DRAWING NO. 1.3
SHEET NO. SHT 1 OF 1

P:\331-05 City of St. George Gunlock Arsenic Treatment Plant\Drawings\Exhibit Drawings\331-05 EXH.dwg, 12/05/18 4:57:49 PM

-This Page Intentionally Left Blank-

1.3.2 Sand Hollow

The Sand Hollow Groundwater Treatment Plant (GWTP) site has been master planned to be located adjacent to the West Dam Springs pump station. The site is large enough to accommodate current and future water treatment facilities and is adjacent to the new Sand Hollow Regional Pipeline, which will collect groundwater from the Sand Hollow well field and the GWTP. The regional pipeline will convey groundwater to the new 4 to 5 MG Warner Valley storage tank south of the West Dam Springs area.

1.3.2.1 Well Characteristics

The Sand Hollow well field layout is shown in Figure 1.4 and represents the existing conditions at the well field.

Table 1.3 shows the capacity of the Sand Hollow well field and the water quality at each well, where wells 1, 10, 11, 12, 13, and 15 represent the future Sand Hollow wells.

Table 1.3 Sand Hollow Well Field Capacity

Well No.	Flow Rate (gpm)	Head (ft)	Avg. As (µg/L)	As Range (µg/L)	Comment
1	900	NA	8.5	1.1 - 10.7	Future Well
2	500	1,075	9.7	6.5 - 15.9	
4	205	NA	8.7	7.3 - 14.7	
5	205	NA	8.4	6.2 - 9.3	
6	237	NA	7.9	6.9 - 9.2	
8	500	390	8.9	6.4 - 21.3	
9	962	509	12.5	9.0 - 17.6	
10	2,000	NA	11	NA	Future Well
11	500	NA	10	NA	Future Well
12	1,000	NA	10	NA	Future Well
13	500	NA	10	NA	Future Well
15	500	NA	10	NA	Future Well
17	300	682	7.3	1 sample only	
18	825	395	11	1 sample only	
19	630	452	8.1	5.9 - 14	
20	800	336	14	1 sample only	
21	1,500	210	12.3	11.0 - 13.7	
22	420	202	8.2	1 sample only	
23	680	563	6.8	5.7 - 10.2	
West Dam Spring	2,100	NA	7.6	4.4 - 12.5	
Total	**15,264**				

-This Page Intentionally Left Blank-

SAND HOLLOW WELLS AND PIPELINES

FIGURE 1.4

WCWCD
PRELIMINARY DESIGN REPORT

carollo

ALPHA ENGINEERING
43 South 100 East, Suite 100 • St George, Utah 84770
T 435.628.6500 • F 435.628.6553 • alphaengineering.com

Wells - WCWCD No. (State No.)
- Existing Wells
- Proposed
- Future Wells
- Tanks
- Proposed Water
- Other

- Air/Vac Valve
- Butterfly Valve
- Blow Off Valve
- Gate Valve
- Hydrant
- PRV
- Pump
- Valve

Other, 6", 8", 10", 12", 14", 16", 18", 20", 24", 30", 60"

Sand Hollow Wells & Pipelines Exhibit
Washington County Water Conservancy District

Spatial Reference:	Utah State Plane NAD 83, feet
Drawn By:	JRH
Scale:	1 inch = 600 feet
Date:	November 2018

-This Page Intentionally Left Blank-

Historical water quality, collected 2014 to 2015, is presented in Table 1.4.

Table 1.4 Sand Hollow Well Field Historical Water Quality Data (2014-2015)

Value	Alkalinity (mg/L[1])	pH	Conductivity (µS/cm)	TDS (mg/L)	Iron (mg/L)	Manganese (mg/L)
Min	156	7.80	811	551	0.028	0.036
Average	168	8.18	906	616	0.224	0.078
Max	180	8.4	929	632	1.32	0.294

Notes:
(1) Expressed as $CaCO_3$.

1.3.2.2 Distribution Conditions

The Sand Hollow well field consists of multiple wells nearby the new Sand Hollow GWTP. In particular, Wells 10, 11, 12, 13 and 15, which are in the process of being developed, will be part of the distribution system surrounding the GWTP. As described in Section 1.2.2, the West Dam Springs pumps will be the primary water supply (up to 2,100 gpm) to the pressure vessel included in this design. The existing 30-inch pipeline will be modified to connect West Dam Springs to the GWTP. In addition, the 30-inch pipeline coming from the existing and developing wells will route through the GWTP site and then connect to the 36-inch Sand Hollow Regional Pipeline (SHRP) where the well water will normally be conveyed. The well field pipe is routed through the GWTP site to allow a portion of it to be diverted through the GWTP for treatment if desired, and to provide a convenient point of chlorination to the well water after has combined with the treated water from the GWTP.

Under normal operating conditions, all of the West Dam Springs flow will be filtered at the GWTP and the water from the surrounding Sand Hollow well field will bypass the GWTP and flow to the SHRP. If the West Dam Springs flows are less than the 2,100 gpm filtration capacity (historical data shows it can go as low as 1,500 gpm), a portion of the well water can be diverted to the GWTP for treatment if desired up to a combined treatment capacity of 2,100 gpm. Under this condition, all of the Sand Hollow wells will have to overcome the additional headloss of filtration even though only some of that water is being treated. A portion of the filtered water (700 to 1,000 gpm) from the GWTP will be diverted and pumped to the Dixie Springs 2-MG tank, via the existing 30-inch pipe, for blending and chlorination at that location. Pumping is required because the hydraulic grade in the pipe to Dixie Springs tank is higher than the hydraulic grade of the SHRP. The remaining filtered water will combine with the bypassed well water for chlorination on the GWTP site and delivery to the SHRP and the Warner Valley storage tank.

The multi-cell pressure vessel configuration uses 2,100 gpm from the filter effluent pipe to backwash one of the four cells at a time, eliminating the need for a backwash supply tank or pump station. The system is configured so that three cells can filter the design flow of 2,100 gpm, and their filtered water can backwash the fourth cell. When operating at the full 2,100 gpm rated capacity, no supplemental water is needed from the distribution system. If the GWTP is operating at less than 2,100 gpm, supplemental water from the filter effluent piping is required for backwash. This supplemental water is automatically available from the well bypass provided that combined total flow of the GWTP flow and well bypass flow exceeds 2,100 gpm. This will be the case under all but the most unusual circumstances. If the combined flow is less than 2,100 gpm, a manual bypass around the pumps to the Dixie Springs tank is provided so that supplemental water can be provided from Dixie Springs. Supplemental water is not available from the SHRP because of a high point in the pipe between the GWTP and the Warner Valley storage tank.

1.3.2.3 Site Layout

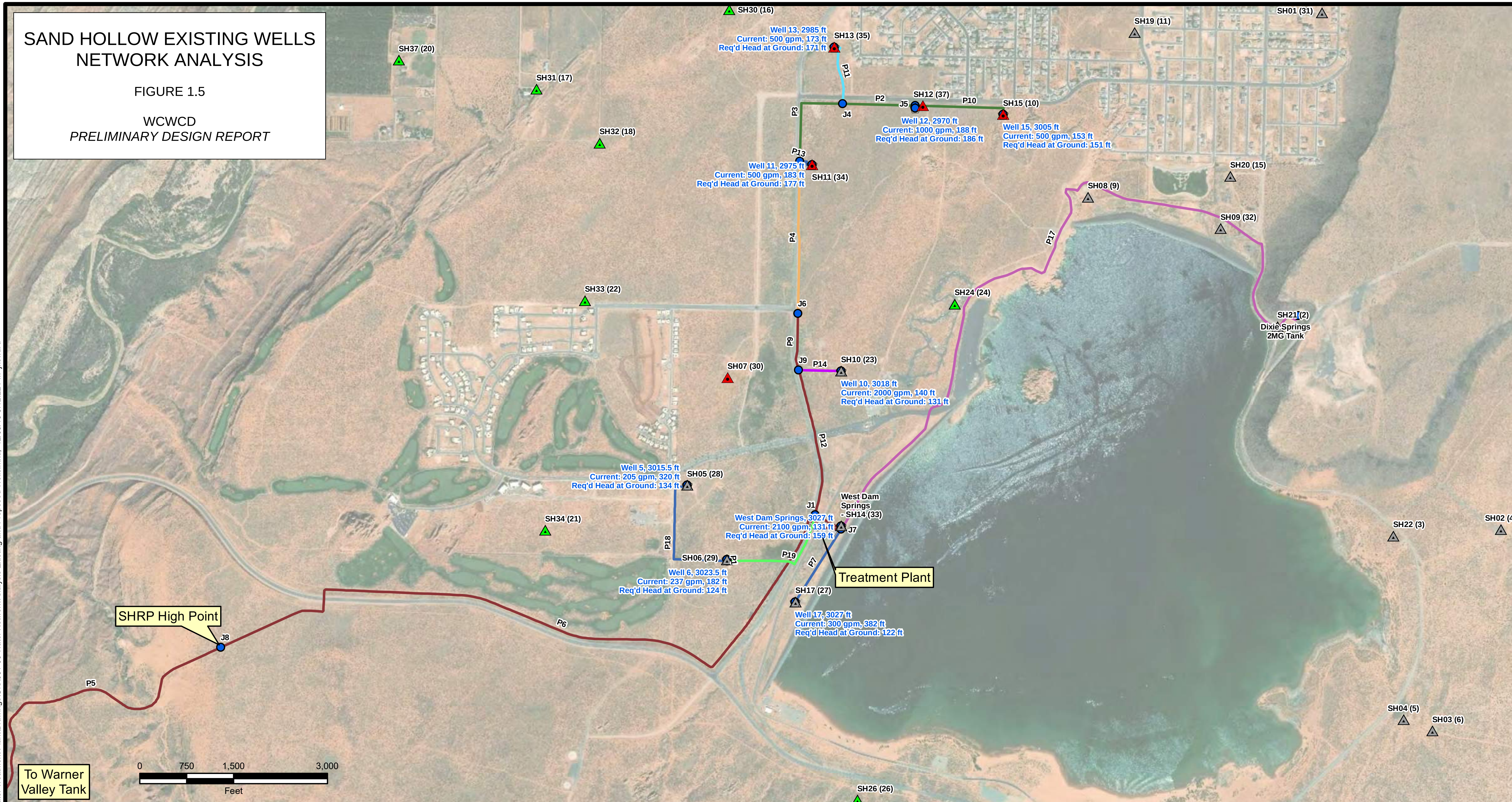
The site will include an AC pavement entrance road from Sand Hollow Road and the reservoir access road and concrete paving around the GWTP. A gravel base will be placed between the concrete paving and drying beds for easier truck access. The treatment building, concrete drying beds, backwash tanks, security fencing, and gates are depicted in Figure 1.6.

Yard piping will include lines from the filters to a backwash tank with decant return piping to the building and sludge piping to the drying beds. There will also be overflow pipelines, drainage pipelines, and culverts as needed. Waste water from the treatment plant will connect to the existing 8-inch sewer line near the site.

SAND HOLLOW EXISTING WELLS NETWORK ANALYSIS

FIGURE 1.5

WCWCD
PRELIMINARY DESIGN REPORT



Wells - WCWCD No. (State No.)

- Existing Wells
- Proposed
- Future Wells
- WaterGEMS Model Junction

Pipe

- 8"
- 10"
- 12"
- 16"
- 18"
- 20"
- 24"
- 30"

43 South 100 East, Suite 100 • St George, Utah 84770
T: 435.628.6500 • F: 435.628.6553 • alphaengineering.com

Existing and Proposed Wells Water Network Analysis
Sand Hollow Wells

Spatial Reference:	Utah State Plane NAD 83, feet
Drawn By:	JRH
Scale:	1 inch = 1,500 feet
Date:	December 2018

Figure 1.5

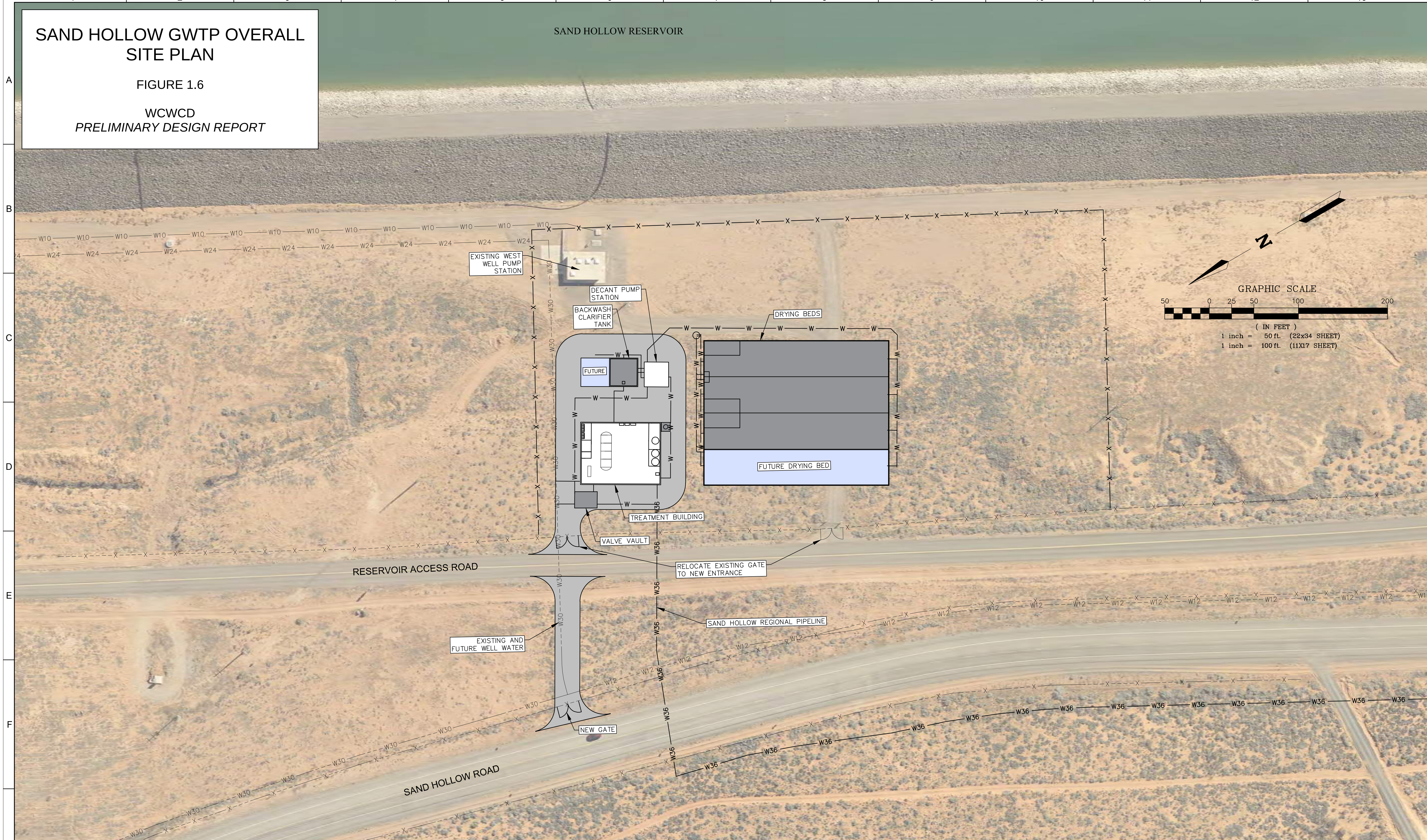
P:\331-06 WCWCD – Sand Hollow Ground Water Treatment Plant\Drawings\GIS\331-06 Water Network Analysis Existing and Proposed Wells.mxd, 12/05/18 5:12:22 PM, jheward

-This Page Intentionally Left Blank-

SAND HOLLOW GWTP OVERALL SITE PLAN

FIGURE 1.6

WCWCD
PRELIMINARY DESIGN REPORT



REV	DATE	BY	DESCRIPTION

DESIGNED JRH
DRAWN JRH
CHECKED TBG
DATE DECEMBER 2018

PRELIMINARY DESIGN SUBMITTAL
NOT FOR CONSTRUCTION

carollo
ALPHA ENGINEERING
WASHINGTON COUNTY WATER CONSERVANCY DISTRICT

WASHINGTON COUNTY WATER CONSERVANCY DISTRICT
SAND HOLLOW GROUNDWATER TREATMENT PLANT DESIGN
GENERAL
OVERALL SITE EXHIBIT

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

JOB NO. 11186A10
DRAWING NO. 1.6
SHEET NO. SHT 1 OF 1

P:\331-06 WCWCD Sand Hollow Ground Water Treatment Plant\Drawings\Exhibit Drawings\331-06 EXH.dwg, 12/05/18 5:00:02 PM

-This Page Intentionally Left Blank-

1.4 Water Treatment Design Criteria

1.4.1 Gunlock

1.4.1.1 Basis of Design

Figure 1.7 summarizes the general basis for design and equipment sizing for the Gunlock WTF. Subsequent sections provide an explanation and more detailed description for each design area. The basis of design presents two criteria. The first represents the current design and consists of two C/F pressure vessels treating up to 6 mgd of well water. The second represents the future buildout of the site which would incorporate a second pair of C/F pressure vessels and accompanying components and facilities.

The process flow diagram for the Gunlock WTF is shown in Figure 1.8, which outlays the general flow of treatment processes and equipment. The diagram represents schematically the flow path of raw groundwater through the treatment process and the proposed flow control and treatment equipment. Raw groundwater from the upper Gunlock well field enters the treatment plant in a 24-inch diameter pipe. A detailed description of each succeeding component through the treatment facility is presented below.

1.4.1.2 Bypass System

A bypass system is proposed for the WTF. A portion of the well water will be able to be routed from the incoming groundwater line around the vessels and recombined with treated water from the vessels to produce a blended water of treated and untreated groundwater still containing less than the arsenic maximum contaminant level (MCL). This blending option of treated, low-arsenic water with untreated well water will provide the capability to reduce treatment costs and extend the life of the filter media.

Generally, there is not a significant variation in groundwater quality. This allows for relatively consistent treatment wherein the process can be adjusted initially to achieve treatment objectives but then only requires monitoring and minor adjustments for a given flow rate. The proposed bypass system will be controlled by a flow control valve, which will automatically position to a particular flow or arsenic blend ratio. Multiple sample ports will be provided at different locations for sampling purposes. Raw water and treated water arsenic levels need to be measured to determine the flow split for the bypass water and treated water. There will be flow meters on the bypass line and effluent filter cells for determining flows once the valves have been adjusted.

The blending equation to determine the amount of raw water to bypass is shown in Equation 1 and Equation 2.

Equation 1 (General Equations):

$$(Q_{VL}) \times (As_{VL}) + (Q_{BY}) \times (As_{BY}) = (Q_{BL}) \times (As_{BL})$$

$$(Q_{VL}) + (Q_{BY}) = Q_{BL}$$

Where:

Q_{VL} = Flow rate for combined vessel effluent (gpm or mgd)

As_{VL} = Arsenic concentration for combined vessel effluent (µg/L)

Q_{BY} = Flow rate for bypass line (gpm or mgd)

As_{BY} = Arsenic concentration for bypass line (µg/L)

Q_{BL} = Flow rate for blended line going to the distribution system (gpm or mgd)

As_{BL} = Arsenic concentration goal for blended line going to the distribution system (µg/L)

Equation 2 (Calculation Bypass Flow Rate):

$$Q_{BY} = \frac{Q_{BL} \times (As_{BL} - As_{VL})}{(As_{BY}) \times \left(1 - {As_{VL}}/{As_{BY}}\right)}$$

If desired, all six Upper Gunlock wells could be run simultaneously at maximum capacity, producing up to 6,900 gpm, or 7 mgd. The estimated blended arsenic concentration for all six wells is approximately 24 µg/L. If the plant was receiving 7 mgd and treating to an effluent arsenic concentration less than 2 µg/L, 1.9 mgd could be bypassed and combined with an expected arsenic concentration of 8 µg/L. An example calculation is provided, which shows the input parameters needed for determining the bypass flow rate.

$$Q_{BY} = \frac{7\ MGD\ \times (8\ \mu g/L - 2 \mu g/L)}{(24 \mu g/L) \times \left(1 - {2 \mu g/L}/{24 \mu g/L}\right)}$$

$$Q_{BY} = 1.9\ MGD$$

The 14-inch bypass line is sized for 3 mgd, and recombines after filtration, but before post-chlorination.

GUNLOCK WTF DESIGN CRITERIA

FIGURE 1.7

CITY OF ST. GEORGE
PRELIMINARY DESIGN REPORT

DESCRIPTION	UNITS	CRITERIA DESIGN	CRITERIA BUILDOUT
PLANT FLOW RATE			
PROCESS DESIGN CAPACITY	MGD	6	12
MINIMUM PLANT FLOW	MGD	1	1
BYPASS FLOW CAPACITY	MGD	3	6
WELL PUMPS			
NUMBER OF WELLS	NO.	6	11
CAPCITY OF PUMPS, EA	GPM	600-1,600	
NUMBER OF VFDs	NO.	0	0
FLASH MIX			
TYPE: PUMP DIFFUSION			
NUMBER OF PUMPS	NO.	1	2
NUMBER OF VFDs	NO.	1	2
ENERGY INPUT, G	SEC^{-1}	1,000	1,000
CAPCITY OF PUMPS, EA	GPM	150	150
SIZE OF PUMPS, EA	HP	3	3
CHEMICALS			
CHLORINE			
TYPE: CHLORINE GAS			
DOSE RANGE	MG/L	0.5 - 1.5	0.5 - 1.5
ADDITION POINT	-	PLANT INFLUENT/EFFLUENT	
NUMBER OF CYLINDERS	NO.	2	4
CYLINDER SIZE, EA	LBS	150	150
DAYS OF CONNECTED STORAGE	DAYS	6	6
FERRIC CHLORIDE			
DOSE RANGE	MG/L	3.0 - 10.0	3.0 - 10.0
ADDITION POINT	-	FLASH MIX	
MAX DOSE AT PEAK FLOW	GPD	100	200
NUMBER OF TANKS	NO.	2	4
TANK SIZE, EA	GAL	1,600	1,600
DAYS OF STORAGE	DAYS	30	30
FILTRATION SYSTEM			
TYPE: HORIZONTAL PRESSURE VESSELS			
FILTER LOADING AND CAPACITY			
NUMBER OF VESSELS	NO.	2	4
NUMBER OF CELLS PER VESSEL	NO.	4	4
VESSEL DIAMETER	FT	12	12
CELL LENGTH	FT	9	9
CELL AREA	SF	108	108
TOTAL VESSEL AREA	SF	432	432
TOTAL VESSEL LENGTH	FT	36	36
NOMINAL FILTRATION RATE	GPM/SF	4.8	4.8
NOMINAL CELL CAPACITY	MGD	1	1
FILTERS OUT OF SERVICE FOR BACKWASHING	NO.	1	1
FIRM DESIGN FILTER CAPACITY (ONE WASHING)	GPM/SF	6.4	6.4
FILTER MEDIA			
TYPE: DUAL MEDIA			
ANTHRACITE DEPTH	IN	36	36
ANTHRACITE EFFECTIVE SIZE	MM	1.05	1.05
SAND DEPTH	IN	12	12
SAND EFFECTIVE SIZE	MM	0.6	0.6
L/d	-	1,380	1,380
FILTER UNDERDRAIN			
TYPE: PLATE WITH NOZZLES			
FILTER BACKWASH			
TYPE: DISTRIBUTION PRESSURE, AIR SCOUR			
MAXIMUM BACKWASH RATE	GPM/SF	20	20
FILTER DRAIN RATE/DURATION	GPM / MIN	510 / 15	510 / 15
BACKWASH STEP			
AIR EVACUATE RATE/DURATION	GPM / MIN	1,200 / 3	1,200 / 3
HIGH-RATE BW RATE/DURATION	GPM / MIN	2,160 / 5	2,160 / 5
MEDIA RESTRATIFY RATE/DURATION	GPM / MIN	1,300 / 2	1,300 / 2
TOTAL REQUIRED BW VOLUME + 1.25 SAFETY FACTOR	GAL	21,250	21,250
TOTAL BW VOLUME PRODUCED/DURATION	GAL / MIN	29,000 / 30	29,000 / 30
AIR SCOUR			
DESIGN AIR SCOUR RATE	SCFM/SF	4	4
AIR SCOUR FLOW RATE	SCFM	432	432
AIR SCOUR TIME	MIN	5	5
NUMBER OF BLOWERS	NO.	1	2
CAPACITY, EA	SCFM	500	500
SIZE, EA	HP	20	20
...NG DECANT			
	NO.	2	4
	FTXFT	30X30	30X30
	GAL	127,000	127,000
	HRS	6	6
	GPM	400	400

DESCRIPTION	UNITS	CRITERIA DESIGN	CRITERIA BUILDOUT
SOLIDS DRYING BEDS			
TYPE: RECTANGULAR, VERT. WALL, CONCRETE LINED			
NUMBER OF BEDS	NO.	4	8
DIM. OF BED (WXLXH)	FTXFTXFT	40X200X4	40X200X4
VOLUME, EA	GAL	240,000	240,000
WATER DEPTH	FT	2	2
SOLIDS LOADING RATE	LBS/SF	8	8
SOLIDS HANDLING CAPACITY, EA	LBS	55,000	55,000
TOTAL SOLIDS HANDLING CAPACITY	LBS/YR	220,000	440,000
AVG. UNIT SOLIDS PRODUCTION RATE	DRY LBS/MGAL	100	100
TOTAL AVG. ANNUAL SOLIDS PRODUCTION	DRY LBS/YR	162,000	324,000
DRYING BEDS RETURN SUBMERSIBLE PUMPS			
NUMBER (1 + 1)	NO.	2	4
CAPACITY, EA	GPM	100	100
SIZE, EA	HP	2	2
BACKWASH WASTE PUMP STATION			
TYPE: END SUCTION CENTRIFUGAL			
BACKWASH WASTE DECANT PUMPS			
NUMBER (1 + 1)	NO.	2	4
CAPACITY, EA	GPM	420	420
SIZE, EA	HP	8	8
BACKWASH WASTE SLUDGE PUMPS			
NUMBER	NO.	2	4
CAPACITY, EA	GPM	500	500
SIZE, EA	HP	8	8

REV | DATE | BY | DESCRIPTION

DESIGNED
DRAWN
CHECKED
DATE
DECEMBER 2018

PRELIMINARY DESIGN SUBMITTAL
NOT FOR CONSTRUCTION

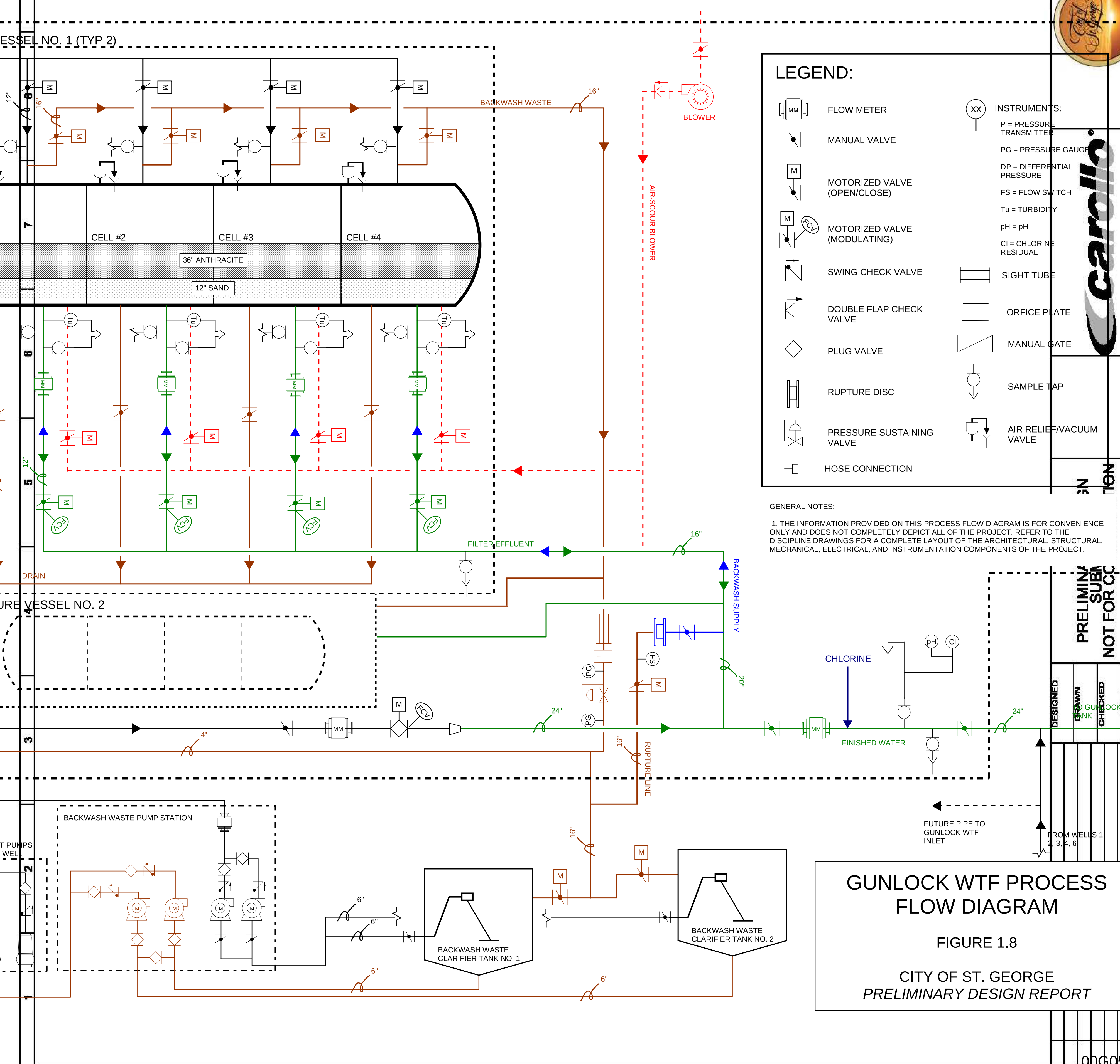
CITY OF ST. GEORGE
GUNLOCK WATER TREATMENT FACILITY DESIGN
GENERAL
DESIGN CRITERIA

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 — 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

JOB NO. 11165A10
DRAWING NO. 00G03
SHEET NO.
OF XX

PROJECT NO. 11165A10 FILE NAME: 11165a10_00G03.dgn

-This Page Intentionally Left Blank-



GENERAL NOTES:

1. THE INFORMATION PROVIDED ON THIS PROCESS FLOW DIAGRAM IS FOR CONVENIENCE ONLY AND DOES NOT COMPLETELY DEPICT ALL OF THE PROJECT. REFER TO THE DISCIPLINE DRAWINGS FOR A COMPLETE LAYOUT OF THE ARCHITECTURAL, STRUCTURAL, MECHANICAL, ELECTRICAL, AND INSTRUMENTATION COMPONENTS OF THE PROJECT.

GUNLOCK WTF PROCESS FLOW DIAGRAM

FIGURE 1.8

CITY OF ST. GEORGE

PRELIMINARY DESIGN REPORT

CITY OF ST. GEORGE
GUNLOCK WATER TREATMENT FACILITY DESIGN
GENERAL

PRELIMINARY SUBMITTAL NOT FOR CONSTRUCTION

DESIGNED | DRAWN | CHECKED | DATE DECEMBER 2018

VERIFY SCALES — BAR IS ONE INCH ON ORIGINAL DRAWING — 0 1" — IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

JOB NO. 11185A10 | DRAWING NO. 00G05 | SHEET NO. OF XX

PROJECT NO. 11185A10 FILE NAME: 11185a10_00G02.dgn

-This Page Intentionally Left Blank-

1.4.1.3 Chemical Addition and Mixing

Benchtop testing and piloting at the Gunlock Wells was conducted by Carollo from 2015 to 2016 to determine chemical dosing for arsenic removal. The study indicated that ferric chloride performed better compared to alum with optimal doses ranging from 3 to 5 mg/L. Pre-oxidizing with chlorine showed no significant benefit during piloting at the Gunlock site. However, the testing showed that the arsenic in the Gunlock well field is predominantly arsenate, or As(V), although some data showed the dominant form to be arsenite, or As(III). Therefore, the ability to pre-oxidize with chlorine is included in the design.

Chlorine Addition

Chlorine will be used to disinfect the water at two possible locations: the influent of the treatment plant, prior to flash mixing, and along the finished water pipeline, after blending. Two dosing locations are recommended in order to oxidize well water prior to the arsenic vessel media and polish or trim the chlorine residual in the treated water prior to entering the distribution system. Two chlorine addition methods were investigated for the City. These were on-site hypochlorite generation and chlorine gas. A comparison of the two technologies is shown in Table 1.5, which represents installed capacity of 6 mgd with an average flow of 3 mgd.

Table 1.5 Chlorine Technology Comparison

Category	On-Site Hypo Generation	Chlorine Gas
Average Flow (mgd)	3	3
NaOCl Conc. (%)	0.8	NA
Average Dose (mg/L)	1.0	1.0
Chlorine Consumption (lb/d)	25	25
Type of Storage	1 Day Tank	2 Gas Cylinders
Size of Storage	3,000 gal	150 lbs
Storage Time (days)	9	12
Capital Costs	$337,500	$239,360
Annual O&M Costs	$38,360	$29,355
Life Cycle Costs	$950,000	$708,000

Notes:
(1) Represents installed capacity of 6 mgd and an average flow of 3 mgd.

Due to the lower capital, Operations and Maintenance (O&M), and life cycle costs, and the City's familiarity to the technology, chlorine gas has been selected over on-site hypochlorite generation. The chlorine gas system will consist of two 150-pound chlorine gas cylinders positioned upon a cylinder weight scale. The scale provides operators an indication of chlorine spent and when to replace empty cylinders. Both cylinders are connected to chlorine gas piping that routes to wall mounted chlorinators that regulate gas flow based upon the desired feed concentration and production flow rate. The chlorinators provide a regulated gas flow to the eductors, where plant water and gas mix to create a chlorine solution that is then pumped to the injection locations. Due to the elevated safety risk of chlorine gas, the proposed chlorination room for the Gunlock WTF will be fitted with chlorine analyzers that sense the presence of chlorine gas within the room at a 1 part per million (ppm) detection limit. If the limit is exceeded, alarms will initiate shutoff valves on the chlorine cylinders. These automatic closing valves provide the secondary level of safety to the initial containment of the cylinders. The chlorination room will be equipped with heating to provide climate control for the optimal performance of the gas cylinder system. The chlorination room will also provide space to store up to 10 total 150-pound chlorine cylinders (no more than 2,500 pounds should be stored as to stay below the requirement for risk management plans per the Clean Air Act).

Flash Mix

Ferric chloride will be stored and utilized at the WTF site. Ferric chloride will be mixed into the groundwater stream via a flash mix diffusion pump. Ferric chloride storage tanks were sized for high flows (6 mgd) and max dose (10 mg/L) with a 30-day holding capacity. This equates to 500 pounds per day, or 100 gallons per day of ferric chloride, with a storage concentration of 42 percent and specific gravity of 1.45. Two double walled polyurethane tanks, sized 11 feet tall with an 8.5 feet diameter, have been selected for redundancy and space constraints to hold 1,500 gallons each.

The 3-horsepower (hp) flash mix pump was designed around the parameters in Table 1.6.

Table 1.6 Flash Mix Calculations

Description	Units	Design Condition
Conditions		
RW Flow	mgd	6
RW Diameter	in	24
Mixing Zone	Diameters	1.5
Nozzle Flow	gpm	150
Nozzle Diam	in	1.5
Absolute Viscosity	lb s/sq ft x10^{-5}	2.954
Calculated Fields		
RW Flow	gpm	4,164
Mixing Time	sec	1.0
% of flow	%	3.6%
RW Velocity	fps	3.0
Nozzle Velocity	fps	27.3
Mixing Power	hp	0.4
G	sec^{-1}	931
G x t		943
Momentum Ratio	Mixing/RW	0.33

Notes:
(1) RW Flow = mgd*694.
(2) Mixing Time = Diameter*Mixing Zone/12/velocity.
(3) % of flow = Nozzle Flow/RW Flow.
(4) RW Velocity = RW flow/448/(3.12/4*(RW diameter/12)^2).
(5) Nozzle Velocity = Nozzle flow/448/(3.12/4*(Nozzle diameter/12)^2).
(6) Mixing Power = Nozzle flow*(Nozzle Velocity^2/64/4)/3961.
(7) G = (Mixing power*550/(abs visc*0.00001)/(3.14/4*(RW diam/12)^3*Mixing Zone))^0.5.

A duty-standby pump orientation was not selected for this design to reduce footprint and costs, since flash mixing is not critical to the system. If the pump is out of service, plant staff may need to increase the coagulant dose to compensate for the lack of mixing provided by the pump. Hydraulic mixing would occur in the main header and filter inlet orifices. During these circumstances arsenic removal requirements can still be achieved.

After flash mixing, the single pipe conveying the incoming flow splits to the headers of the pressure vessels.

1.4.1.4 Pressure Vessels

The inline pressure vessels treat water in a closed system by relying on the pressure produced by the Gunlock well field pumps to deliver water to the treatment plant site, filter the water, and return the treated water, at a reduced pressure as a result of the treatment head losses, to the transmission line. The filters are contained within two steel pressure vessels, each with four independent internal compartments operating side by side to treat a total of 6 mgd at design capacity.

A 12-foot diameter vessel with 9-foot long cells (totaling 36 feet in length) was selected as the best alternative for the Gunlock and Sand Hollow facilities, targeting a nominal filter loading rate of 5 gallons per minute per square foot (gpm/sf). Each vessel has the capacity to treat flows from as low as 1 mgd and up to 3 mgd. The filters were designed to have each cell act independently, allowing for optimizing the flow control through each cell. A motorized valve will open at the inlet of each filter cell and the flow will be controlled by a flow control valve in conjunction with a flow meter at the effluent of each cell. During a backwash sequence a cell can be backwashed individually while the other three cells are in operation, instead of simultaneously backwashing the entire pressure vessel at one time, allowing for longer filter run times and better control.

The media configuration of the filters was designed based on the results of the pilot study, where 36 inches of anthracite (effective size [ES] 1.05 millimeter [mm]) over 12 inches of sand (ES 0.6 mm) performed best, based on filter run time, turbidity breakthrough and head loss, out of all the pilot filters. Therefore, this media configuration was selected for design.

Backwash Procedure

Backwashing of a cell will be initiated upon one of three setpoints. The first setpoint is head loss across the filter. As the filter media collects solids, the pressure on the upstream side of the media will increase. Each cell will be equipped with a differential pressure sensor/transmitter by which a backwash can be initiated based on an operator-adjustable setpoint. The second setpoint is turbidity of the filtrate water. As the filter media becomes loaded, eventually, particulates work through the media and register as turbidity in the filtrate. Each cell will be equipped with a turbidity meter to measure the filtered water turbidity, and when an operator-adjustable setpoint is reached (e.g., 1.0 Nephelometric Turbidity Units [NTU]), a backwash will be initiated. Finally, the third backwash setpoint is based on time (or total flow processed since the last backwash). The recommended normal operation of the filters will be for an operator to initiate a backwash once every 24 hours. The pilot study results indicated that filter run times could be as high as 30 hours. However, it is recommended that in order to achieve a consistent operation of the backwash system as well as the backwash water/sludge handling, the filters be operated with consistent backwashes every 24 hours. With lower incoming treatment flows, the filter run times could be increased beyond 24 hours however filter run times should never exceed

3 days (72 hours). Final setpoints for backwashing will be developed after startup and testing of the full-scale facilities.

A backwash (BW) is initiated by closing the filter inlet valve and opening the backwash waste valve. The pressure vessel cells are designed to pull backwash flows from the other cells still online and/or the distributions system, as needed, to achieve the backwash flow rate. If the plant is running at 3 mgd through one or two pressure vessels, the one backwashing cell will pull all the flow from the remaining online cells, resulting in no net effluent flow going to the distribution system. The filters are designed so that at the full 2,100 gpm filter design capacity can be filtered through three cells during backwash at 6.4 gpm/sf filtration rate if only one filter vessel is operating. If the WTF is producing less than 3 mgd the remaining flow will need to come from the distribution system. With the proposed configuration, the combined flow from the upper and lower wells entering the pipe to the Gunlock tank must exceed 2,100 gpm during a filter backwash. The backwash steps with corresponding flowrates and duration is shown in Table 1.7.

Table 1.7 Backwash Procedure

Step	Flowrate (gpm)	Time (min)	Volume (gal)
Filter Drain	508	15	7,614
BW 1 (Air Scour)	0	5	0
BW 2 (Air Evacuate)	1,200	3	3,600
BW 3 (High-rate BW)	2,160	5	10,800
BW 4 (Media Restratify)	1,300	2	2,600
Total	-	**30**	**21,250**
Total w/ 1.25 Safety Factor	-	**30**	**29,000**

A 20 gpm/sf high-rate backwash enables proper bed expansion during backwashing for the specified media configuration. Total backwash time is estimated at 30 minutes per cell, with a total volume of 21,250 gallons. A 1.25 safety factor was applied to ensure that the backwash water storage system will not be undersized.

A rupture disc, with a specified pressure rating, will be placed on the backwash supply line as an added safety measure. This ensures that back pressures within the pressure vessel do not exceed the vessel safety rating. If pressures are exceeded, the rupture disc will break and send the water to the backwash waste line. Flow will be detected by a flow switch and the motorized valve (normally open) will then close to prevent loss of water from the distribution system to the backwash waste system. Plant staff will receive an alert, so they can close a manual valve and isolate the rupture disc for repair/ replacement.

A filter air scour system is included for the pressure filters due to the deeper media beds (48 inches). Air scour helps break up the media via agitation and force the accumulated particles into suspension. The filter air scour system was designed at 4 standard cubic feet per minute per square foot (scfm/sf). During the backwash sequence, a motorized valve will open to the cell being backwashed allowing air to flow up through the filer media. The air scour step will occur by itself and will terminate prior to the introduction of backwash water flow to prevent media loss that can occur with simultaneous air-water wash. There will be four motorized valves per pressure vessel, one for each cell. The source of the air for the air scour will be supplied by a dedicated 20-horsepower air blower unit sized to deliver the design air scour flow rate. The air flow rate will be constant; therefore, no modulating valves are needed. A duty/standby configuration for the blowers has not been included so simplify the system and manage costs. The filter vessels can be backwashed without air scour if the blower system is unavailable, but increased backwash frequency may be required.

The backwash waste water will flow from the filters to the backwash clarification tanks through a 16-inch backwash waste line.

1.4.1.5 Solids Handling

Backwash waste water flows by gravity to one of two concrete, rectangular backwash clarification tanks. A drain pump is provided to drain each cell to the clarifications tanks as the first backwash step to prepare for air scour. A duty/standby configuration for the drain pump has not been included to simplify the system and manage costs. The filter vessels can be backwashed without air scour if the drain pump is unavailable, but increased backwash frequency may be required.

The backwash clarifier tanks will be completely enclosed, so the decant water from the tanks can be recycled back to the front of the plant and retain classification as groundwater. The operating volume of each tank is sufficient to receive one full vessel backwash (four cells). Following a backwash, the water will be stored, allowed to settle/clarify, and then processed by either decant pumping from the top of the water surface or by sludge blow-down from the bottom of the tank. The decant water will be collected by a floating decanter and then pumped to the front end of the treatment system at no greater than 10 percent of the process flow rate, or about 200 gpm per backwash tank (400 gpm total pumped from both tanks). The return line will connect with the raw groundwater line upstream of the chemical addition points. The sludge will be removed from the tank bottom through a blowdown process and pumped to the drying beds for further processing.

A decant pump wet well, with two submersible pumps, will be provided at the drying beds to facilitate sludge thickening and dewatering by collecting any water that clarifies on top of the sludge and pumping that water to an adjacent drying bed to evaporate. If approved by the Utah Department of Water Quality, the pumps in the wet well could also pump to a nearby irrigation line that is in Gunlock Road for disposal or to an on-site retention pond. Sludge will be dried via solar energy to no less than 15 percent dried solids and disposed of via land fill.

Drying Beds

The maximum solids production is based on 6 mgd flows and 10 mg/L ferric dose. The calculations are shown in Table 1.8.

Table 1.8 Sludge Production

Month	Ave Daily Flow	Monthly Flow (MG)	Average WQ and Dosages						Ave USPR (dry-lbs/month)	Solids Production dry-(lbs/month)	Cumulative Total (dry-lbs)
			Turbidity (NTU)	TOC (mg/L)	Ferric (mg/L)	PEC (mg/L)	PEA (mg/L)	PAC (mg/L)			
Jan	6.0	186	3.80	0.7	10.0	0.0	0.0	0.0	100	18,686	18,686
Feb	6.0	168	3.80	0.7	10.0	0.0	0.0	0.0	100	16,878	35,564
Mar	6.0	186	3.80	0.7	10.0	0.0	0.0	0.0	100	18,686	54,250
April	6.0	180	3.80	0.7	10.0	0.0	0.0	0.0	100	18,083	72,334
May	6.0	186	3.80	0.7	10.0	0.0	0.0	0.0	100	18,686	91,020
June	6.0	180	3.80	0.7	10.0	0.0	0.0	0.0	100	18,083	109,104
July	6.0	186	3.80	0.7	10.0	0.0	0.0	0.0	100	18,686	127,790
Aug	6.0	186	3.80	0.7	10.0	0.0	0.0	0.0	100	18,686	146,476
Sept	6.0	180	3.80	0.7	10.0	0.0	0.0	0.0	100	18,083	164,559
Oct	6.0	186	3.80	0.7	10.0	0.0	0.0	0.0	100	18,686	183,246
Nov	6.0	180	3.80	0.7	10.0	0.0	0.0	0.0	100	18,083	201,329
Dec	6.0	186	3.80	0.7	10.0	0.0	0.0	0.0	100	18,686	220,015
Ave / Total	**6.0**	**2,190**								**lbs/MG =**	**100**

Notes:
(1) TSS:NTU = 1.42.
(2) Coagulant Factor = 0.63.
(3) TOC Removal = 0.25.
(4) Turbidity values represent the max turbidity measured during the pilot study.

The solids production per year for maximum dose and flows was 220,015 pounds per year of dry solids (dry-lbs/yr) or 603 pounds per day (dry-lbs/d). Using a drying factor of 8 pounds per square foot (dry-lbs/sf) annually, the design size of the drying beds is four beds, each 40 feet wide by 200 feet long. Four beds allows for redundancy while treating sludge generated from two vessels, where one bed could be on-line (receiving clarified waste washwater), one could be decanting, one could be drying, and the last could be cleaned and ready for service. The drying beds are being designed for of 4 foot water depth to provide adequate volume of sludge drying as well as potential water storage during winter months when the regional evaporation rate is less than during the summer months. Drying sludge will accumulate in these beds to a determined depth and dryness before being emptied by earthmoving-type equipment. Disposal of the dried sludge will be via hauling to the landfill. It is anticipated that one drying bed go through at least two fill/dry cycles per year (4 lbs/sf each cycle) because thin sludge layers dry much faster than thick sludge layers.

Water decanted to the decant pump station wet well from the drying beds will be controlled with downward opening decant weir gates at the end of each bed. The weir gate will be lowered as water separates from the settling solids and will flow by gravity to the wet well equipped with two 2-horsepower submersible pumps. As water flows into the wet well, the pumps will be controlled by level instrumentation and once the level reaches a setpoint, the pumps will start and send the water to another selected drying bed, an on-site retention pond or if permitted, the irrigation line. This design flow rate is independent of the backwash return flow and therefore is a smaller pump with lower capacity than the backwash waste return pumps.

Backwash Clarifier Tanks

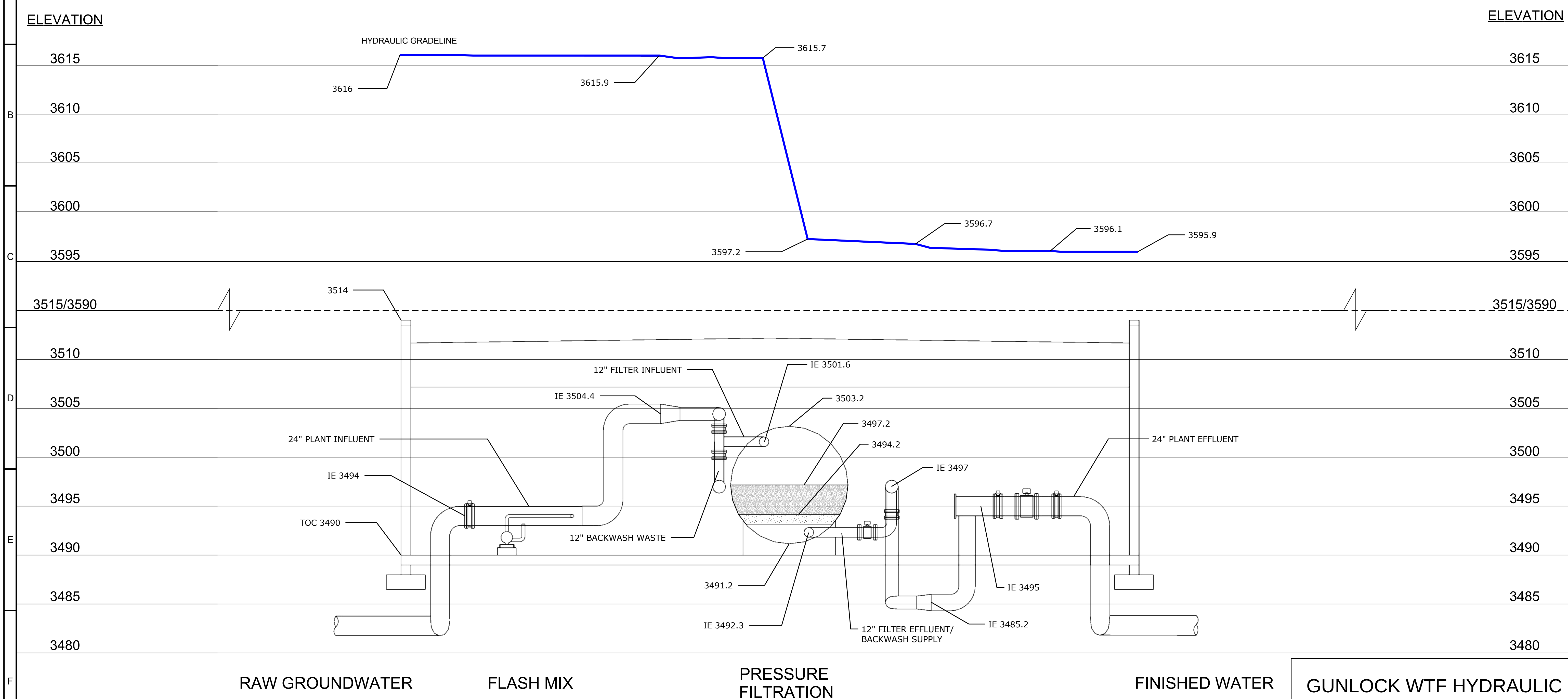
The two backwash clarifier tanks are each designed to hold four backwashes, or one entire pressure vessel backwash. Each tank is rectangular with a 30-foot length and width and approximate height of 20 feet. The tanks will have a pyramidal bottom of 30 degrees with a center hopper to collect the sludge. A 6-inch sludge line from the hopper of each tank will be routed to a pump that will send the sludge to the drying beds. The tanks will be constructed of concrete. It is proposed that the tanks will be above-grade for cost reduction of sub-grade installation. Additionally, sample ports will be installed along the lower 3 feet of the tank at 1-foot intervals so that operators can verify the depth of the sludge blanket and determine adequate blow down volume. Each tank will be equipped with a floating decanter and decant return pumps.

Normal operation of the tanks will be to send up to four cell-backwashes to each tank. This normally would be one pressure vessel backwashed per tank but could be any combination of four backwashes. It is estimated that a backwash will take approximately 30 minutes as shown in Table 1.9. For four backwashes, that time duration would be 2 hours of backwashes per tank. The normal operation would be to backwash each vessel once in a 24-hour period. The breakdown of tank operation would be as follows:

- Backwash = 2 hours.
- Tank settling = 4 hours.
- Decant = 16 to 18 hours.
- Sludge blow down = 2 hours (overlapping decant time).

1.4.1.6 Hydraulic Profile

The estimated head loss through the plant is 22 feet, flowing at 6 mgd with no cells in backwash. The largest loss is through the pressure filter, with an estimated loss of 8 psi right before a backwash (i.e., solids loaded in filter bed). The hydraulic profile through the plant is shown in Figure 1.9.



HYDRAULIC PROFILE (6 MGD)

SCALE: 1" = 10'

GUNLOCK WTF HYDRAULIC PROFILE

FIGURE 1.9

CITY OF ST. GEORGE

PRELIMINARY DESIGN REPORT

REV	DATE	BY	DESCRIPTION
			30% INTERMEDIATE DESIGN SUBMITTAL NOT FOR CONSTRUCTION

DESIGNED

DRAWN

CHECKED

DATE DECEMBER 2018

ALPHA ENGINEERING

carollo Engineers...Working Wonders With Water®

CITY OF ST. GEORGE

GUNLOCK WATER TREATMENT FACILITY DESIGN

GENERAL

HYDRAULIC PROFILE

VERIFY SCALES

BAR IS ONE INCH ON ORIGINAL DRAWING

0 1/2" 1"

IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

JOB NO. 11185A.10

DRAWING NO. 00G04

SHEET NO.

-This Page Intentionally Left Blank-

1.4.2 Sand Hollow

1.4.2.1 Basis of Design

Figure 1.10 summarizes the general basis for design and equipment sizing for the Sand Hollow GWTP, which will be owned and operated by the WCWCD. The process flow diagram for the Sand Hollow GWTP is shown in Figure 1.11. Due to the similarities between the Gunlock and the Sand Hollow sites, the Sand Hollow GWTP has been designed similarly to the Gunlock WTF, except the plant was designed around a 3-mgd capacity with a future expansion to 6 mgd. As discussed in Section 1.2.2, the West Dam Springs pump station has been found to be high in manganese, causing colored water events in the distribution system when operated. The pump station also has high arsenic levels. Therefore, both manganese and arsenic treatment are of concern at the Sand Hollow GWTP.

A pilot study at the West Dam Springs was performed by Carollo for the WCWCD in 2016 wherein it was shown that manganese levels can be reduced by approximately 90 percent by oxidizing with chlorine as sodium hypochlorite, immediately before filtration and maintaining a free chlorine residual in the filter effluent. In addition, arsenic levels can be reduced to 2 µg/L or less using a coagulant immediately before filtration. Therefore, even though the Sand Hollow GWTP is designed similar to the Gunlock WTF, which is concerned primarily with arsenic treatment, the Sand Hollow GWTP will be capable of meeting the primary goal of manganese removal and the secondary goal of arsenic removal. The other significant differences between the two designs is the chlorine treatment technology, sand separator system, and bypass vault. WCWCD has selected on-site sodium hypochlorite generation instead of chlorine gas as their preferred chlorine technology. This will be discussed in more detail in the next sections. Due to the other processes being similar to the Gunlock WTF, some treatment processes will refer to corresponding sections under the Gunlock WTF above.

1.4.2.2 Bypass System

A bypass vault is proposed for the Sand Hollow GWTP for the ground water flows coming from the Sand Hollow well field. Most, if not all, of the flow coming from the Sand Hollow well field will be routed from the incoming groundwater line around the treatment building and recombined with treated water from the vessel to produce a blended water of treated and untreated groundwater with acceptable manganese and arsenic levels. Section 1.4.1.2 describes the process for blending including an example calculation. Equipment sizing associated with the bypass system will be different than the Gunlock WTF.

As described in Section 1.3.2.2, all of the water from West Dam Springs will be treated at the Sand Hollow GWTP. If the West Dam Springs wells are not producing the required 2,100 gpm for a backwash, supplemental flows from the Sand Hollow well field will normally be available to backwash the filter cells. This will be done in one of two ways.

- A portion of the Sand Hollow well water can be treated through the GWTP. A valve vault located outside the GWTP will house a 16-inch connection line between the West Dam Springs flows and the Sand Hollow well field flows. The line will be fitted with a flow meter, flow control valve, and check valve. The 30-inch Sand Hollow well field pipeline will be equipped with a flow meter and flow control valve. If any portion of the Sand Hollow well field will be treated, all of the wells must operate to overcome the additional headloss through the GWTP and a flow control valve on the 30-inch pipe will be used to divert some of the water through the 16-inch pipe to the GWTP. The connection line to the GWTP will be sized to accommodate flows up to 3 mgd, for future expansion (adding the second pressure vessel). A check valve is placed on bypass line so untreated water from West Dam Springs cannot flow back into the Sand Hollow well field pipeline. The schematic for the bypass vault is outlined in Figure 1.11 and a mechanical plan and sections are provided in Figure 1.12.

- The second way Sand Hollow well field flows will be provided for backwash is through the 30-inch bypass line where it ties into the new Sand Hollow Regional Pipeline and joins the treated effluent line from the pressure vessel. Any well field flows bypassing the GWTP are automatically available to flow back up the effluent line to the pressure vessel for backwash supply. This will allow the WCWCD to operate the vessels at a lower production rates than the 3 mgd design rate and still be able to backwash with a 2,100 gpm flow rate.

If the combined West Dam Springs and San Hollow well field flow is less than the required 2,100 gpm, there are provisions to use water from the Dixie Springs tank to provide supplemental backwash flows as discussed in Section 1.4.2.7 (Hydraulic Profile).

DESCRIPTION	UNITS	CRITERIA	
		DESIGN	BUILDOUT
PLANT FLOW RATE			
PROCESS DESIGN CAPACITY	MGD	3	6
MINIMUM PLANT FLOW	MGD	1	1
BYPASS FLOW CAPACITY	MGD	6	6
WELL PUMPS			
NUMBER OF WELLS	NO.	15	21
CAPCITY OF PUMPS, EA	GPM	300-1,500	
NUMBER OF VFDs	NO.	3	6
FLASH MIX			
TYPE: PUMP DIFFUSION			
NUMBER OF PUMPS	NO.	1	1
NUMBER OF VFDs	NO.	1	1
ENERGY INPUT, G	SEC^{-1}	1,000	1,000
CAPCITY OF PUMPS, EA	GPM	150	150
SIZE OF PUMPS, EA	HP	3	3
CHEMICALS			
CHLORINE			
TYPE: ON-SITE GENERATION			
DOSE RANGE	MG/L	1.0 - 3.0	1.0 - 3.0
ADDITION POINT	-	PLANT INFLUENT/EFFLUENT	
SODIUM HYPOCHLORITE CONCENTRATION	%	0.8	0.8
SOLUTION STRENGTH	LBS/GAL	0.06	0.06
TANK SIZE	GAL	3,000	3,000
DAYS OF STORAGE	DAYS	9	4.5
FERRIC CHLORIDE			
DOSE RANGE	MG/L	3.0 - 10.0	3.0 - 10.0
ADDITION POINT	-	FLASH MIX	
MAX DOSE AT PEAK FLOW	GPD	50	100
NUMBER OF TANKS	NO.	1	2
TANK SIZE, EA	GAL	1,500	1,500
DAYS OF STORAGE	DAYS	30	30
FILTRATION SYSTEM			
TYPE: HORIZONTAL PRESSURE VESSELS			
FILTER LOADING AND CAPACITY			
NUMBER OF VESSELS	NO.	1	2
NUMBER OF CELLS PER VESSEL	NO.	4	4
VESSEL DIAMETER	FT	12	12
CELL LENGTH	FT	9	9
CELL AREA	SF	108	108
TOTAL VESSEL AREA	SF	432	432
TOTAL VESSEL LENGTH	FT	36	36
NOMINAL FILTRATION RATE	GPM/SF	4.8	4.8
NOMINAL CELL CAPACITY	MGD	1	1
FILTERS OUT OF SERVICE FOR BACKWASHING	NO.	1	1
FIRM DESIGN FILTER CAPACITY (ONE WASHING)	GPM/SF	6.4	6.4
FILTER MEDIA			
TYPE: DUAL MEDIA			
ANTHRACITE DEPTH	IN	36	36
ANTHRACITE EFFECTIVE SIZE	MM	1.05	1.05
SAND DEPTH	IN	12	12
SAND EFFECTIVE SIZE	MM	0.6	0.6
L/d	-	1,380	1,380
FILTER UNDERDRAIN			
TYPE: PLATE WITH NOZZLES			
FILTER BACKWASH			
TYPE: DISTRIBUTION PRESSURE, AIR SCOUR			
MAXIMUM BACKWASH RATE	GPM/SF	20	20
FILTER DRAIN RATE/DURATION	GPM / MIN	510 / 15	510 / 15
BACKWASH STEP			
AIR EVACUATE RATE/DURATION	GPM / MIN	1,200 / 3	1,200 / 3
HIGH-RATE BW RATE/DURATION	GPM / MIN	2,160 / 5	2,160 / 5
MEDIA RESTRATIFY RATE/DURATION	GPM / MIN	1,300 / 2	1,300 / 2
TOTAL REQUIRED BW VOLUME + 1.25 SAFETY FACTOR	GAL	21,250	21,250
TOTAL BW VOLUME PRODUCED/DURATION	GAL / MIN	29,000 / 30	29,000 / 30
AIR SCOUR			
DESIGN AIR SCOUR RATE	SCFM/SF	4	4
AIR SCOUR FLOW RATE	SCFM	432	432
AIR SCOUR TIME	MIN	5	5
NUMBER OF BLOWERS	NO.	1	1
CAPACITY, EA	SCFM	500	500
SIZE, EA	HP	20	20
BACKWASH WASTE CLARIFIER TANKS			
TYPE: RECTANGULAR WITH FLOATING DECANT			
	NO.	1	2
	FTXFT	30X30	30X30
	GAL	127,000	127,000
	HRS	6	6
	GPM	400	400

DESCRIPTION	UNITS	CRITERIA	
		DESIGN	BUILDOUT
SOLIDS SETTLING BASINS			
TYPE: RECTANGULAR, VERT. WALL, CONCRETE LINED			
NUMBER OF BEDS	NO.	3	4
DIM. OF BED (WXLXH)	FTXFTXFT	40X200X4	40X200X4
VOLUME, EA	GAL	240,000	240,000
WATER DEPTH	FT	2	2
SOLIDS LOADING RATE	LBS/SF	5	5
SOLIDS HANDLING CAPACITY, EA	LBS	22,667	34,000
TOTAL SOLIDS HANDLING CAPACITY	LBS/YR	68,000	136,000
AVG. UNIT SOLIDS PRODUCTION RATE	DRY LBS/MGAL	74	74
TOTAL AVG. ANNUAL SOLIDS PRODUCTION	DRY LBS/YR	81,000	162,000
DRYING BEDS RETURN SUBMERSIBLE PUMPS			
NUMBER (1 + 1)	NO.	2	2
CAPACITY, EA	GPM	100	100
SIZE, EA	HP	2	2
BACKWASH WASTE PUMP STATION			
TYPE: END SUCTION CENTRIFUGAL			
BACKWASH WASTE DECANT PUMPS			
NUMBER (1 + 1)	NO.	2	2
CAPACITY, EA	GPM	420	420
SIZE, EA	HP	5	5
BACKWASH WASTE SLUDGE PUMPS			
NUMBER	NO.	2	2
CAPACITY, EA	GPM	500	500
SIZE, EA	HP	5	5

SAND HOLLOW GWTP DESIGN CRITERIA

FIGURE 1.10

WCWCD

PRELIMINARY DESIGN REPORT

REV | DATE | BY | DESCRIPTION

DESIGNED

DRAWN

CHECKED

DATE

DECEMBER 2018

PRELIMINARY DESIGN SUBMITTAL

NOT FOR CONSTRUCTION

WASHINGTON COUNTY WATER CONSERVANCY DISTRICT

SAND HOLLOW GROUNDWATER TREATMENT PLANT DESIGN

GENERAL

DESIGN CRITERIA

VERIFY SCALES

BAR IS ONE INCH ON ORIGINAL DRAWING

0 1"

IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

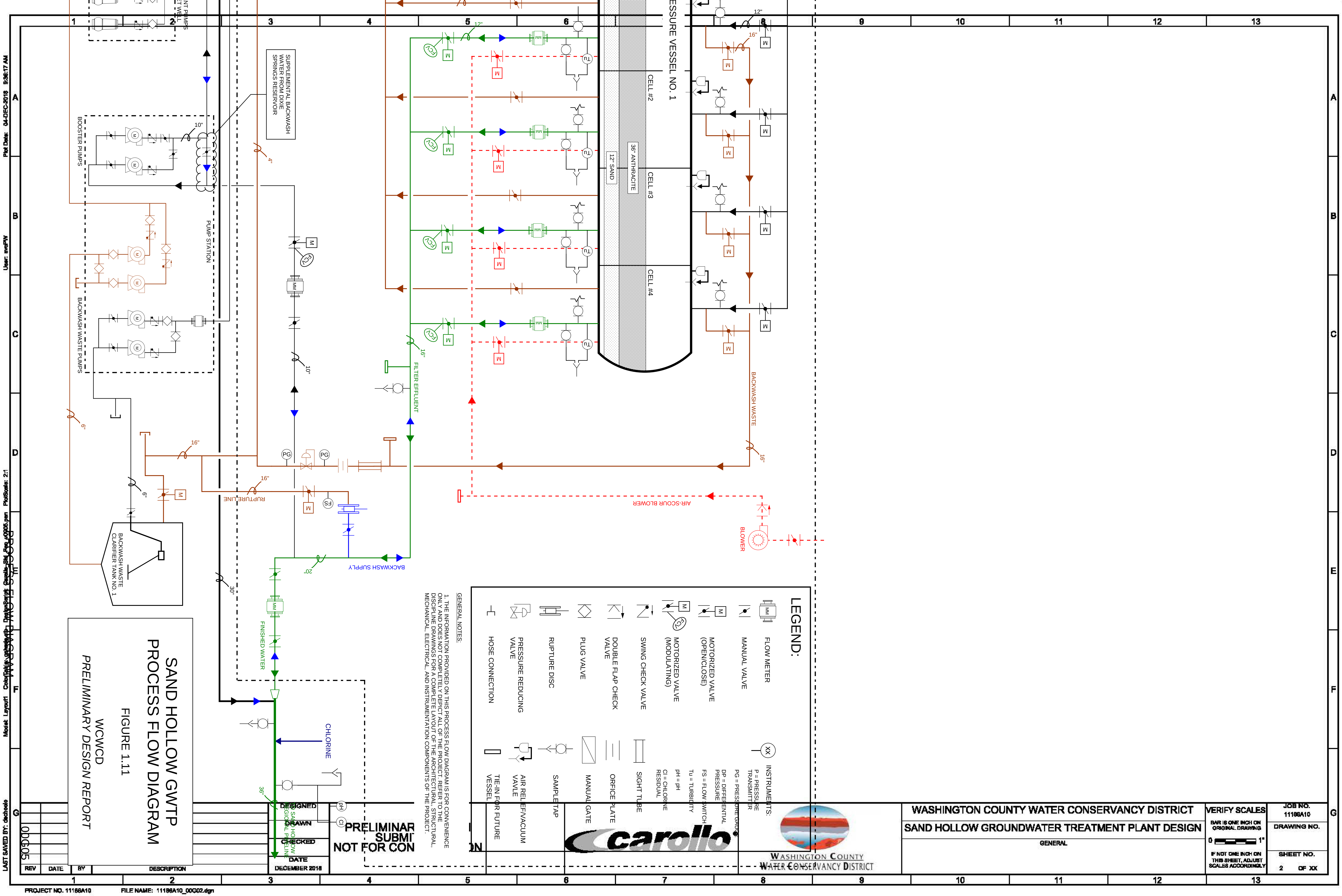
JOB NO. 11166A10

DRAWING NO. 00G03

SHEET NO. OF XX

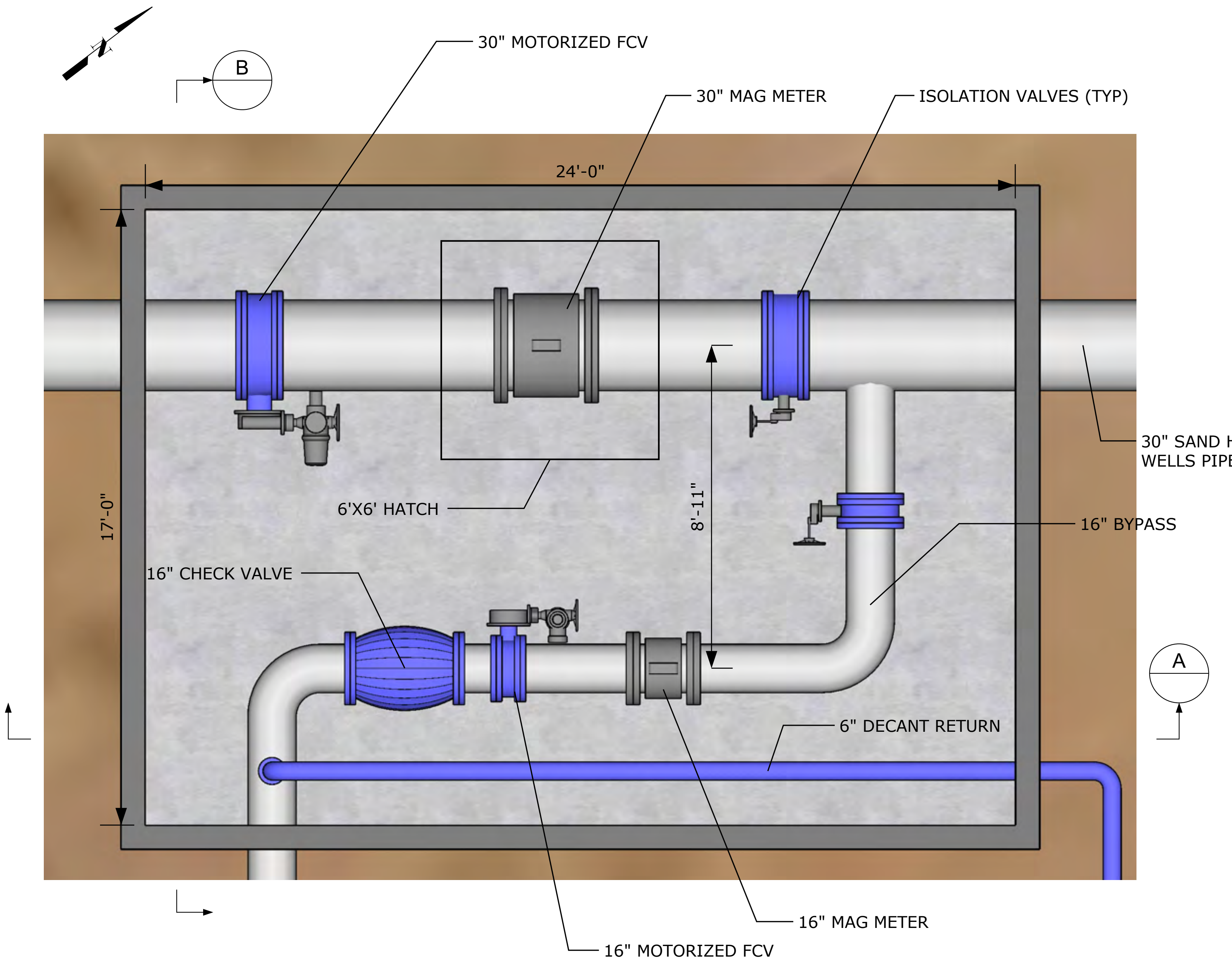
PROJECT NO. 11166A10 FILE NAME: 11166A10_00G03.dgn

-This Page Intentionally Left Blank-

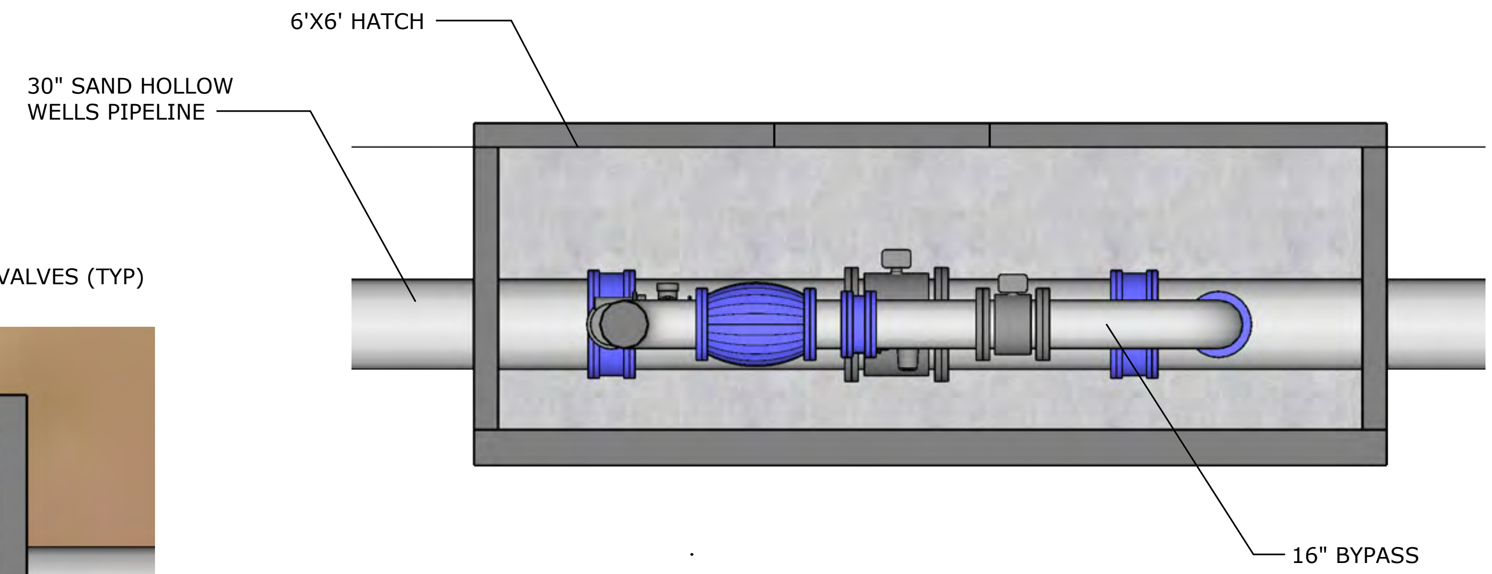


SAND HOLLOW GWTP
PROCESS FLOW DIAGRAM
FIGURE 1.11
WCWCD
PRELIMINARY DESIGN REPORT
LEGEND:
FLOW METER
MANUAL VALVE
MOTORIZED VALVE (OPEN/CLOSE)
MOTORIZED VALVE (MODULATING)
SWING CHECK VALVE
DOUBLE FLAP CHECK VALVE
PLUG VALVE
RUPTURE DISC
PRESSURE REDUCING VALVE
HOSE CONNECTION
INSTRUMENTS:
P = PRESSURE TRANSMITTER
PG = PRESSURE GAUGE
DP = DIFFERENTIAL PRESSURE
FS = FLOW SWITCH
Tu = TURBIDITY
pH = pH
Cl = CHLORINE RESIDUAL
SIGHT TUBE
ORFICE PLATE
MANUAL GATE
SAMPLE TAP
AIR RELIEF/VACUUM VAVLE
TIE-IN FOR FUTURE VESSEL
GENERAL NOTES:
1. THE INFORMATION PROVIDED ON THIS PROCESS FLOW DIAGRAM IS FOR CONVENIENCE ONLY AND DOES NOT COMPLETELY DEPICT ALL OF THE PROJECT. REFER TO THE DISCIPLINE DRAWINGS FOR A COMPLETE LAYOUT OF THE ARCHITECTURAL, STRUCTURAL, MECHANICAL, ELECTRICAL, AND INSTRUMENTATION COMPONENTS OF THE PROJECT.
PRESSURE VESSEL NO. 1
CELL #2
CELL #3
CELL #4
36" ANTHRACITE
12" SAND
FILTER EFFLUENT
BACKWASH WASTE
BACKWASH SUPPLY
AIR-SCOUR BLOWER
BLOWER
RUPTURE LINE
FINISHED WATER
CHLORINE
SUPPLEMENTAL BACKWASH WATER FROM DIXIE SPRINGS RESERVOIR
BOOSTER PUMPS
PUMP STATION
BACKWASH WASTE PUMPS
BACKWASH WASTE CLARIFIER TANK NO. 1
FCV
PG
FS
Tu
M
16"
12"
10"
6"
4"
20"
30"
36"
PRELIMINARY
NOT FOR CONSTRUCTION
DESIGNED
DRAWN
CHECKED
DATE
DECEMBER 2018
REV
DATE
BY
DESCRIPTION
00G05
WASHINGTON COUNTY WATER CONSERVANCY DISTRICT
SAND HOLLOW GROUNDWATER TREATMENT PLANT DESIGN
GENERAL
carollo
WASHINGTON COUNTY WATER CONSERVANCY DISTRICT
VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY
JOB NO.
11166A10
DRAWING NO.
SHEET NO.
2 OF XX
PROJECT NO. 11166A10
FILE NAME: 11166A10_00G02.dgn
LAST SAVED BY: dschoele

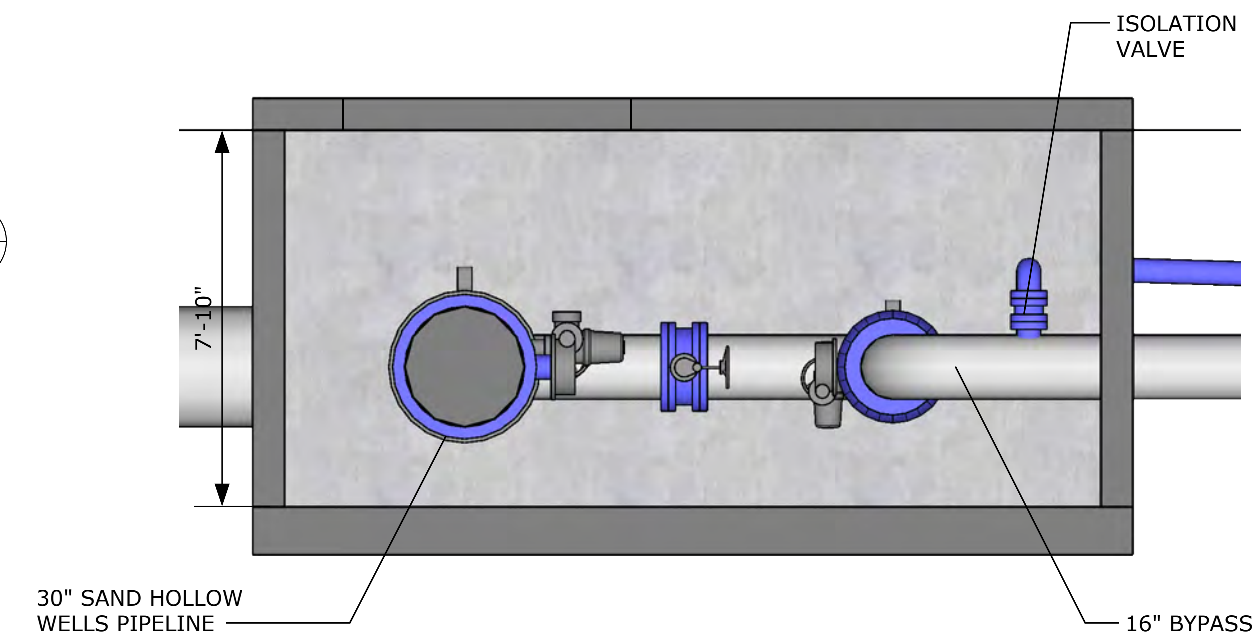
-This Page Intentionally Left Blank-



BYPASS VAULT - PLAN
SCALE: 1/4" = 1'



A BYPASS VAULT - SECTION 1
SCALE: 3/16" = 1'



B BYPASS VAULT - SECTION
SCALE: 1/4" = 1'

SAND HOLLOW GWTP - BYPASS VALVE VAULT

FIGURE 1.12

WCWCD
PRELIMINARY DESIGN REPORT

REV	DATE	BY	DESCRIPTION
			30% INTERMEDIATE DESIGN SUBMITTAL NOT FOR CONSTRUCTION

DESIGNED
DRAWN
CHECKED
DATE DECEMBER 2018

ALPHA ENGINEERING
carollo Engineers...Working Wonders With Water®
WASHINGTON COUNTY WATER CONSERVANCY DISTRICT

WASHINGTON COUNTY WATER CONSERVANCY DISTRICT
SAND HOLLOW GROUNDWATER TREATMENT PLANT DESIGN
MECHANICAL
BYPASS VAULT - PLAN AND SECTIONS

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1/2" 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

JOB NO. 11186A.10
DRAWING NO. 30M01
SHEET NO.

-This Page Intentionally Left Blank-

1.4.2.3 Sand Separators

Sand has been found in the water being pumped from the West Dam Springs pumps. Fine sand is also prevalent in the existing Sand Hollow wells. Fine sand particles that have entered the filter would be washed out during the backwash process; however larger sand particles will stay in the filter and accumulate over time. Only limited sieve analysis is available, and it indicates the potential for sand accumulation. To mitigate this issue, Carollo recommends sand separators at the plant influent to remove any sand within the West Dam Springs water. Carollo also recommends that sand separators be installed at future Sand Hollow well sites if the District plans on treating those wells at the GWTP when the second pressure vessel is installed. Sand separators work best as close to the well pump as possible and to prevent sand from dropping out in transmission pipelines.

Significant pressure losses are associated with sand separators large enough to treat 3 mgd. Therefore, it is recommended that three smaller sand separators be installed in parallel to minimize head loss through the system. Each sand separator will have a flow rate capacity of approximately 700 gpm, with a total system loss of 5 psi. This 5 psi loss is in addition to the 7 psi lost through the pressure filters.

1.4.2.4 Chemical Addition and Mixing

The pilot study performed in 2016 by Carollo determined that ferric chloride performed better compared to alum with optimal doses ranging from 3 to 5 mg/L for arsenic removal and also aided in the removal of manganese. Pre-oxidizing with chlorine was shown to be essential for oxidizing manganese for removal and aided in arsenic removal. The chorine dosage was determined to be most effective at 1.5 mg/L as sodium hypochlorite. The ability to pre-oxidize with chlorine is included in the design.

Chlorine Addition

Chlorine will be used for oxidation and disinfection at two locations: the influent of the treatment plant, prior to flash mixing, and along the finished water pipeline, after blending with the Sand Hollow well field flows. The two dosing locations are recommended in order to oxidize the manganese in the well water prior to the arsenic vessel media and polish or trim the chlorine residual in the treated and Sand Hollow well field water prior to entering the distribution system. WCWCD has selected an on-site sodium hypochlorite generating system (OSHG) for the Sand Hollow GWTP not only to supply chlorine to the pressure filter, but also for supplying chlorine to other wells within the Sand Hollow well field. As discussed above, these other wells from the Sand Hollow well field will combine with the treated water into the new Sand Hollow Regional Pipeline that begins at the Sand Hollow GWTP. The OSHG system will be sized for up to 11 mgd of water flow. OSHG technology information is shown in Table 1.9.

The OSHG system will consist of a 200 lbs/d generation system that is skid mounted containing electrolytic cells, a rectifier, brine pump, piping, valves, instrumentation, and controls. A brine storage tank and sodium hypochlorite solution storage tank will be provided. Table 1.9 provides the OSHG system design parameters.

Table 1.9 OSHG System Design Parameters

Equipment	Quantity/Size
Skid Mounted System	1
40 lbs/d electrolytic cell	5
Brine pump	1
Transformer Rectifier	1
Hydrogen Dilution Blower	1
Dual tank water softener	1
Brine storage tank	575 gal / 60" dia x 46" ht.
Hypochlorite tank	5,000 gal / 8' dia x 14' ht
Metering pump	2
Hydrogen detector	1

The OSHG system will be housed inside the treatment building but will not require a dedicated room for the equipment for climate control. The brine storage tank will be placed outside, so the process area will not be affected by salt dust during salt refill which is done by bulk delivery trucks blowing sand into the tank.

Flash Mix

Ferric chloride will be stored and utilized at the Sand Hollow GWTP site. Ferric chloride will be mixed into the groundwater stream via a flash mix diffusion pump. Ferric chloride storage tanks were sized for maximum flows (6 mgd) and maximum dose (10 mg/L) with a 30-day holding capacity. This equates to 500 pounds per day or 100 gallons per day of ferric chloride, with a storage concentration of 42 percent and specific gravity of 1.45. One double walled polyurethane tank, sized 11 feet tall with an 8.5-foot diameter, has been selected to hold 1,500 gallons. There will be space provided for the second tank to be added once the second pressure vessel is installed. See Table 1.6 for flash mix calculations and Section 1.4.1.3 for flash mix pump design.

1.4.2.5 Pressure Vessels

A single 3-mgd capacity pressure vessel will be provided for the Sand Hollow GWTP with space in the treatment building for a second 3-mgd pressure vessel in the future. The pressure vessel will be designed identical to the pressure vessels described for the Gunlock WTF under Section 1.4.1.4. A specially designed knockout wall will be provided on the east side of the building so the second 3-mgd filter can be installed at a future date and the knockout wall repaired, if it is ever needed.

Backwash Procedure

Backwash of the pressure vessel will be designed the same as the Gunlock WTF as described in Section 1.4.1.4.

1.4.2.6 Solids Handling

Backwash waste water will be processed by sending the flow to a concrete, rectangular backwash clarification tank, the same as described in Section 1.4.1.5. For Sand Hollow, one backwash clarifier tank will be constructed initially, with space for a future tank when the future filter vessel is installed.

Drying Beds

The max solids production is based on 6 mgd flows and 10 mg/L ferric dose for the ultimate build out of the site to two pressure vessels. The calculations are shown in Table 1.10. Solids production will be half of the value presented in Table 1.10 if the facility operates initially at its installed 3 mgd capacity.

Table 1.10 Sand Hollow Sludge Production

Month	Ave Daily Flow	Monthly Flow (MG)	Average WQ and Dosages						Ave USPR (lbs/month)	Solids Production (lbs/month)	Cumulative Total (lbs)
			Turbidity (NTU)	TOC (mg/L)	Ferric (mg/L)	PEC (mg/L)	PEA (mg/L)	PAC (mg/L)			
Jan	6.0	186	0.20	1.7	10.0	0.0	0.0	0.0	62	11,532	11,532
Feb	6.0	168	0.20	1.7	10.0	0.0	0.0	0.0	62	10,416	21,948
Mar	6.0	186	0.20	1.7	10.0	0.0	0.0	0.0	62	11,532	33,480
April	6.0	180	0.20	1.7	10.0	0.0	0.0	0.0	62	11,160	44,640
May	6.0	186	0.20	1.7	10.0	0.0	0.0	0.0	62	11,532	56,172
June	6.0	180	0.20	1.7	10.0	0.0	0.0	0.0	62	11,160	67,332
July	6.0	186	0.20	1.7	10.0	0.0	0.0	0.0	62	11,532	78,863
Aug	6.0	186	0.20	1.7	10.0	0.0	0.0	0.0	62	11,532	90,395
Sept	6.0	180	0.20	1.7	10.0	0.0	0.0	0.0	62	11,160	101,555
Oct	6.0	186	0.20	1.7	10.0	0.0	0.0	0.0	62	11,532	113,087
Nov	6.0	180	0.20	1.7	10.0	0.0	0.0	0.0	62	11,160	124,247
Dec	6.0	186	0.20	1.7	10.0	0.0	0.0	0.0	62	11,532	135,779
Ave / Total	**6.0**	**2,190**								**lbs/MG**	**62**

Notes:
(1) TSS:NTU = 1.42.
(2) Coagulant Factor = 0.63.
(3) TOC Removal = 0.25.

The solids production per year for maximum dose and flows was 135,779 lbs/yr or 372 lbs/d. Using a drying factor of 8 lbs/sf annually, the design size of the drying beds is four beds ultimately with the second pressure vessel installed, each 40 feet wide by 200 feet long. However, for the initial phase, only three beds will be constructed with the capability of adding the fourth drying bed in the future. The size of each bed is larger than needed for the drying of sludge, but needed for volume of backwash if future decant is available and for potential storage. The initial three beds allows for redundancy, where one bed could be on-line receiving clarified waste washwater, one could be decanting, and one could be drying. The drying beds are designed for a 4-foot water depth to provide adequate volume of sludge drying as well as potential water storage during winter months when the regional evaporation rate is less than during the summer months. Drying sludge would accumulate in these beds to a determined depth and dryness before being emptied by earthmoving-type equipment. It is anticipated that one drying bed go through at least two fill/dry cycles per year (4 lbs/sf each cycle) because thin sludge layers dry much faster than thick sludge layers. Disposal of the dried sludge will be via hauling to the landfill. Wing walls will also be placed around the drying beds to mitigate the beds from filling up with sand.

The drying beds will be designed with a decant structure as described for the Gunlock WTF to allow free water on top of drying sludge to be decanted and pumped back to the operating drying bed or an onsite retention pond.

Backwash Clarifier Tanks

A single backwash clarifier tank will be provided for the pressure vessel similar to the Gunlock WTF design. A second tank will not be needed until the second pressure vessel is installed in the future, but the site will be master planned to accommodate the second backwash clarifier tank. In the interim, if there are any maintenance issues with the decanter or the tank, the GWTP will not be able to backwash its filter vessel until the clarifier is repaired. During this time, the West Dam Springs will have to be pumped back to the Sand Hollow reservoir. The backwash clarifier tank will be designed similar to the Gunlock WTF site, as described in Section 1.4.1.5.

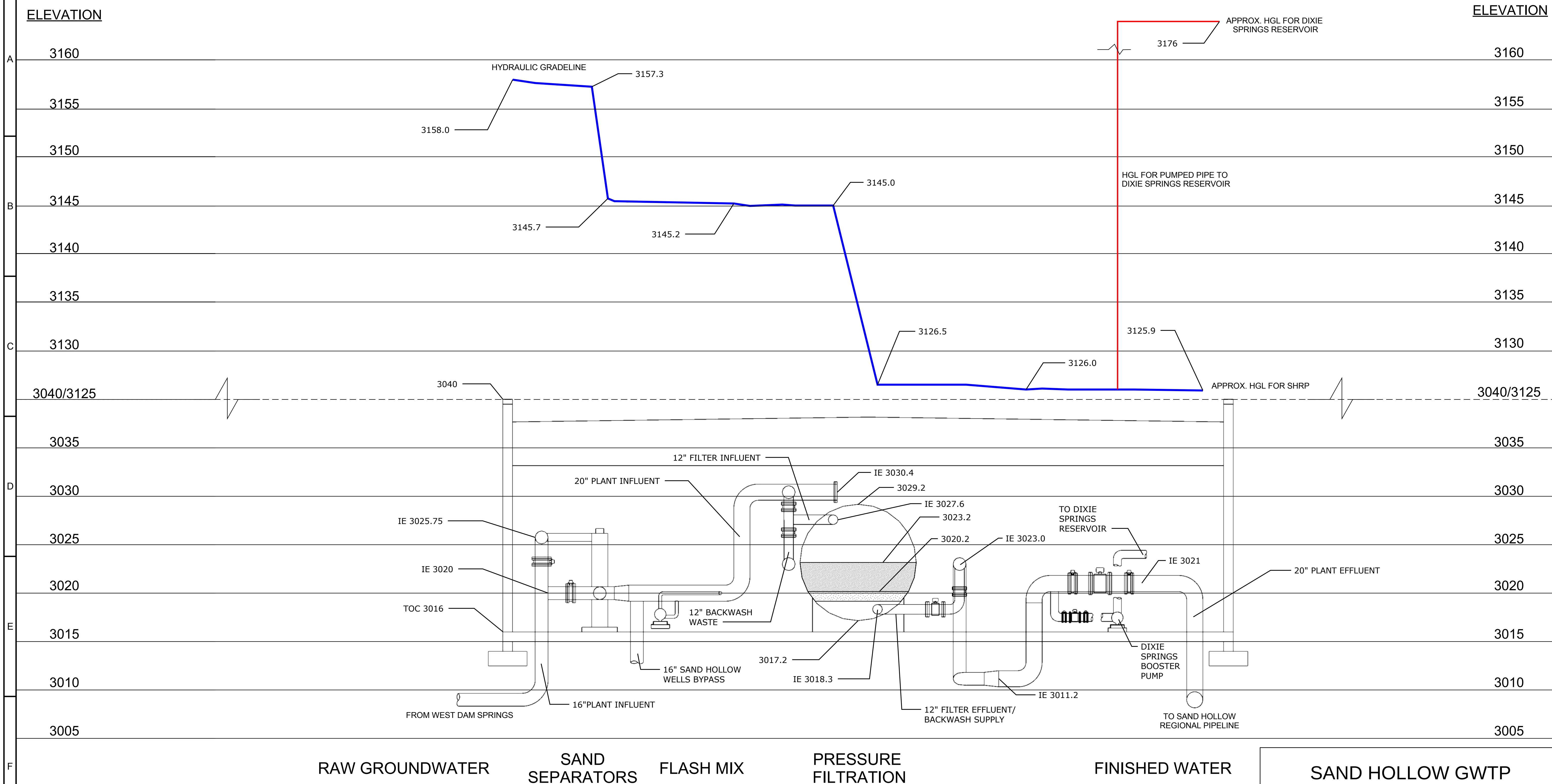
Normal operation of the tank will be to send up to four backwashes to the tank. This normally would be one pressure vessel backwash. It is estimated that a backwash will take approximately 30 minutes, as shown in Table 1.7. For four backwashes, that time duration would be 2 hours of backwashes per tank. The normal operation would be to backwash each vessel once in a 24-hour period. The breakdown of tank operation would be as follows:

- Backwash = 2 hours.
- Tank settling = 4 hours.
- Decant = 16 to 18 hours.
- Sludge blow down = 2 hours (overlapping decant time).

1.4.2.7 Hydraulic Profile

The estimated head loss through the plant is 37 feet, flowing at 3 mgd with no cells in backwash. The largest losses are through the pressure filter, with an estimated loss of 8 psi, and the sand separators, with an estimated loss of 5 psi. The hydraulic profile through the plant is shown in Figure 1.13.

The Sand Hollow GWTP and well fields ultimately deliver groundwater to two potable water destinations: the existing Dixie Springs Reservoir and the SHRP currently under design. The required hydraulic grade to deliver water to the Dixie Springs tank from the Sand Hollow GWT is approximately 50 feet higher than required to deliver to the SHRP (based on the high point in the SHRP, as currently designed). Since only a fraction of the water is delivered to the Dixie Springs tank, the operating hydraulic grade for both the plants and the wells is based on discharging to the lower SHRP. A separate pump station pumps only the required water to the higher Dixie Springs tank. This configuration, shown on both Figures 1.11 and 1.13, will save significant electricity and operating costs.



HYDRAULIC PROFILE (3 MGD)
SCALE: 1" = 10'

SAND HOLLOW GWTP HYDRAULIC PROFILE

FIGURE 1.13

WCWCD
PRELIMINARY DESIGN REPORT

REV	DATE	BY	DESCRIPTION
			30% INTERMEDIATE DESIGN SUBMITTAL NOT FOR CONSTRUCTION

DESIGNED
DRAWN
CHECKED
DATE DECEMBER 2018

ALPHA ENGINEERING
carollo Engineers...Working Wonders With Water®
WASHINGTON COUNTY WATER CONSERVANCY DISTRICT

WASHINGTON COUNTY WATER CONSERVANCY DISTRICT
SAND HOLLOW GROUNDWATER TREATMENT PLANT DESIGN
GENERAL
HYDRAULIC PROFILE

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1/2" 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

JOB NO. 11186A.10
DRAWING NO. 00G04
SHEET NO.

-This Page Intentionally Left Blank-

1.5 Building Layout

1.5.1 Gunlock

The building layout and design concepts for the Gunlock WTF are shown in Figures 1.14 through 1.20 and described below. The Backwash Waste Clarifier concepts are shown in Figures 1.21 through 1.23, and the drying bed concepts are shown in Figure 1.24. The clarifiers and drying beds are described in previous sections of this report.

1.5.1.1 Building Layout

The treatment building will be located at the Upper BLM site, as described in the site layout Section 1.3.1.3. The preferred building style is concrete, cast-in-place walls on a concrete slab. The roofing system will be a flat-roof style truss system with skylights to provide natural lighting within the buildings. A simple architectural parapet will be provided around the perimeter of the building. The overall footprint of the treatment building is 88 feet by 68 feet by 24 feet tall. Additional details and dimension are shown within the figures.

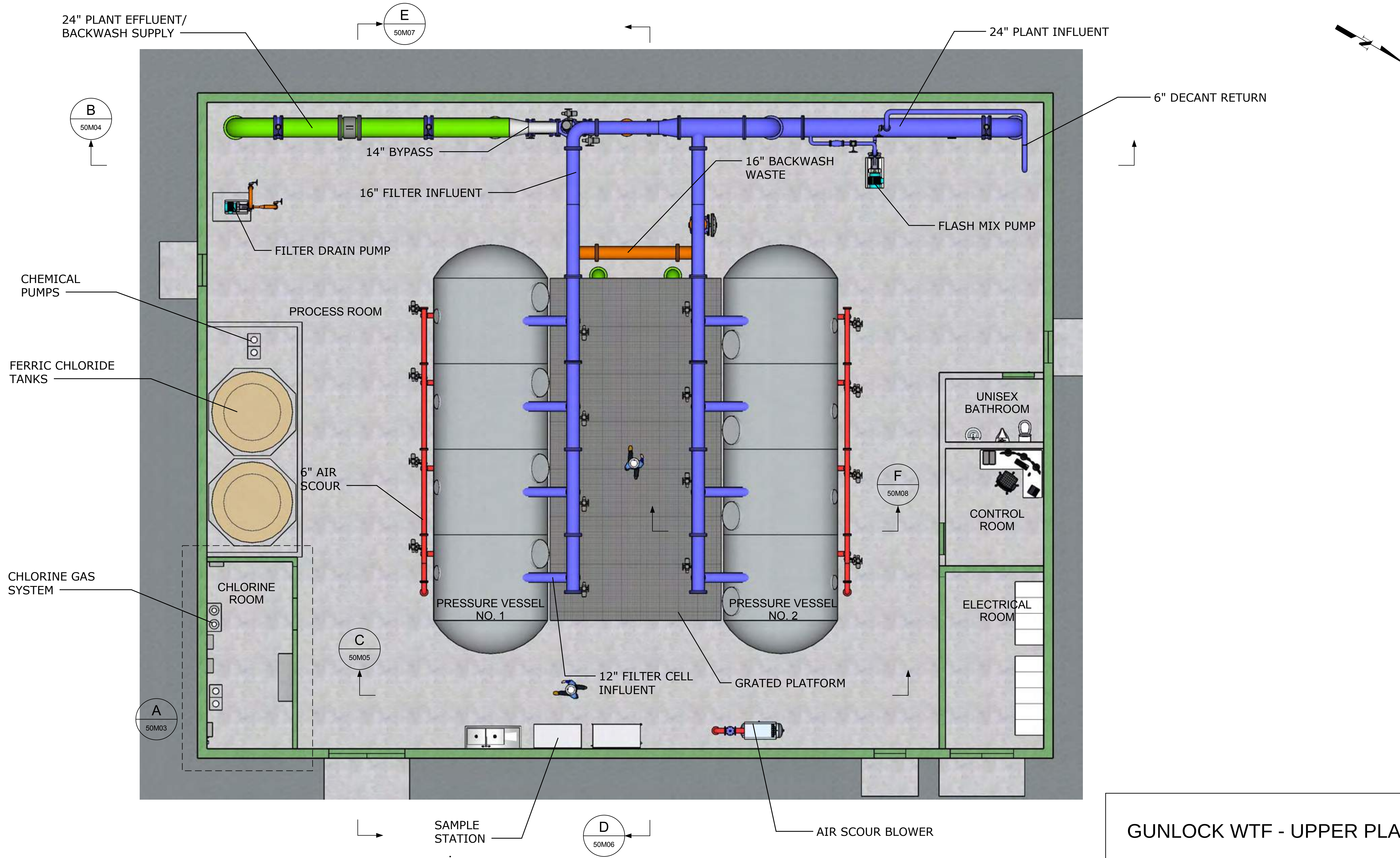
The pressure vessels, flash mix pump, air blower and ferric chloride storage tanks are located within a central process room. Four enclosed rooms will be provided within the building:

- A chlorine room with separate climate control to provide additional heating for this room, and double door access.
- A unisex restroom with toilet, sink, and single door access.
- An operator control room containing a working space for operators.
- An electrical room containing electrical gear, Programmable Logic Controller (PLC), and potential remote terminal unit (RTU) systems with double door access for facility equipment installation/removal.

A grating catwalk between the pressure vessels provides access to the upper valves and components. It is expected that the catwalk will be used infrequently and only for maintenance. The catwalk access is provided by a ladder at either end of the platform. The lower valves and components for the vessels are accessible from under the catwalk. The building provides sufficient space around the perimeter of the vessels to access and work on the pressure vessels and the accompanying piping, and move equipment with a small fork lift.

Building ingress and egress will be provided by exterior doors, including an 8-foot by 10-foot double door for large equipment. This double door provides access with better moisture and thermal protection than a typical roll-up door. Architectural features to improve aesthetics include various color selections and several building profile options (e.g., roof types and soffit/overhand). The City has requested no exterior windows, except for windows installed in doors.

-This Page Intentionally Left Blank-



TREATMENT BUILDING - UPPER PLAN

SCALE: 3/32" = 1'

GUNLOCK WTF - UPPER PLAN

FIGURE 1.14

CITY OF ST. GEORGE

PRELIMINARY DESIGN REPORT

30% INTERMEDIATE DESIGN SUBMITTAL
NOT FOR CONSTRUCTION

REV	DATE	BY	DESCRIPTION

DESIGNED
DRAWN
CHECKED
DATE
DECEMBER 2018

ALPHA ENGINEERING

carollo
Engineers...Working Wonders With Water®

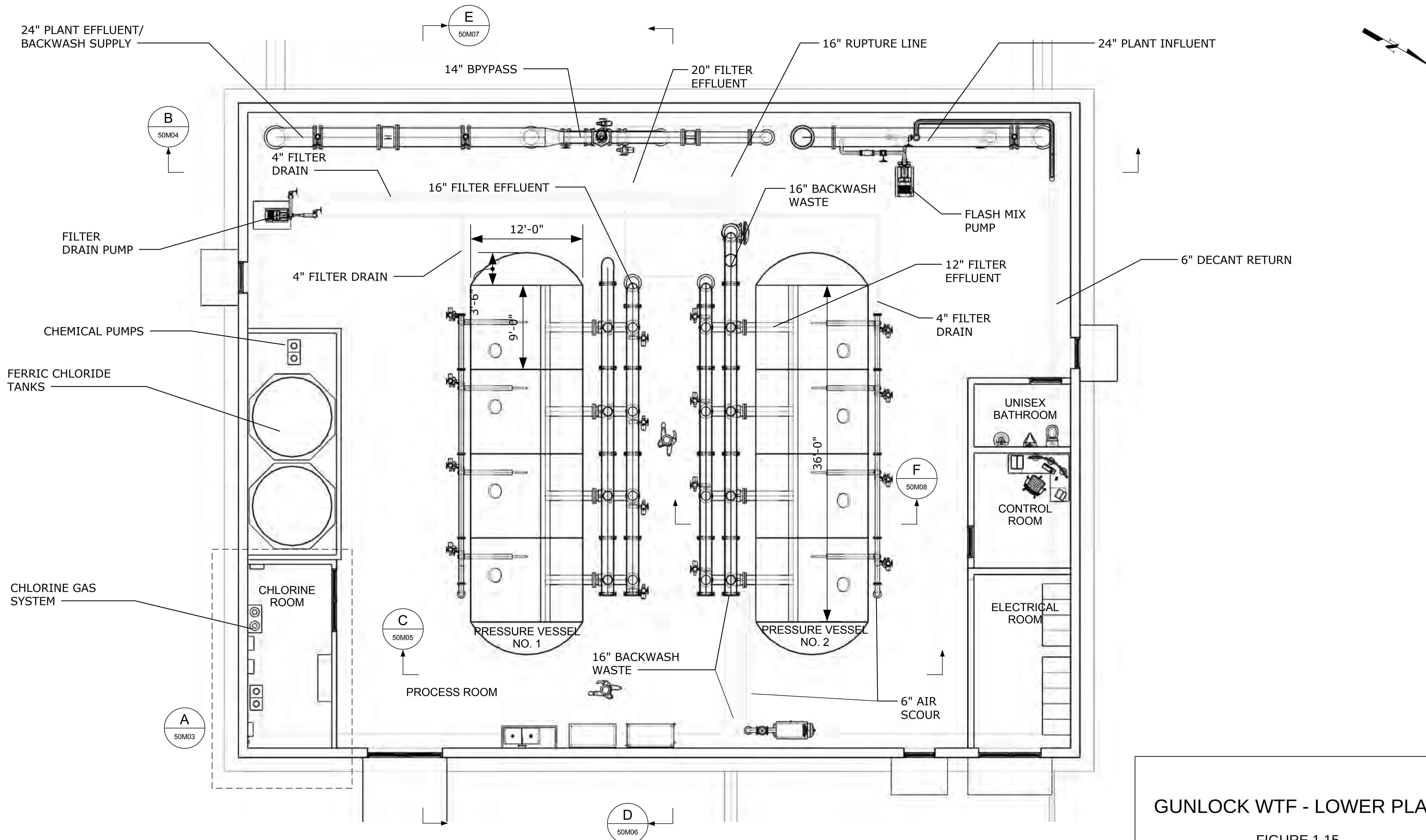
City of St. George

CITY OF ST. GEORGE
GUNLOCK WATER TREATMENT FACILITY DESIGN
MECHANICAL
TREATMENT BUILDING - UPPER PLAN

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1/2"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

JOB NO.
11185A.10
DRAWING NO.
50M02
SHEET NO.

-This Page Intentionally Left Blank-



TREATMENT BUILDING - LOWER PLAN

SCALE: 3/32" = 1'

GUNLOCK WTF - LOWER PLAN

FIGURE 1.15

CITY OF ST. GEORGE

PRELIMINARY DESIGN REPORT

REV	DATE	BY	DESCRIPTION
			30% INTERMEDIATE DESIGN SUBMITTAL NOT FOR CONSTRUCTION

DESIGNED
DRAWN
CHECKED
DATE DECEMBER 2018

ALPHA ENGINEERING

carollo Engineers...Working Wonders With Water®

CITY OF ST. GEORGE

GUNLOCK WATER TREATMENT FACILITY DESIGN

MECHANICAL

TREATMENT BUILDING - LOWER PLAN

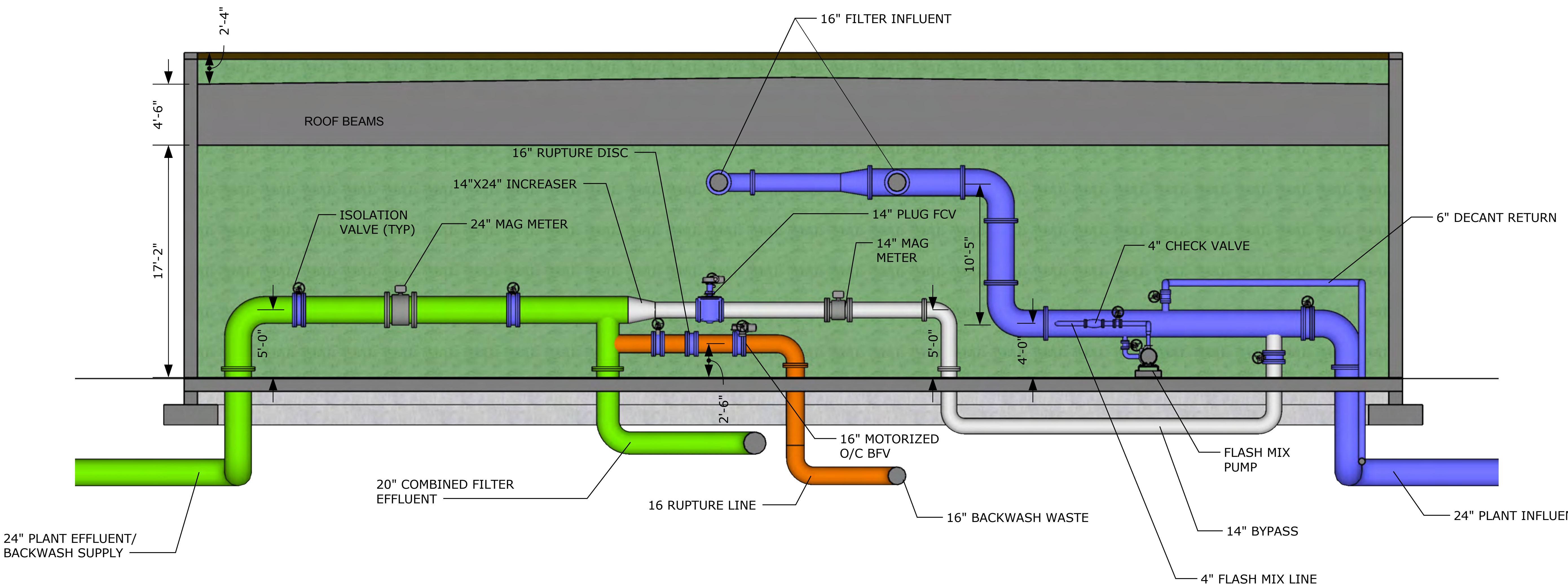
VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1/2" 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

JOB NO. 11185A.10

DRAWING NO. 50M01

SHEET NO.

-This Page Intentionally Left Blank-



B TREATMENT BUILDING - BACK WALL SECTION

SCALE: 1/8" = 1'

GUNLOCK WTF - SECTION

FIGURE 1.16

CITY OF ST. GEORGE
PRELIMINARY DESIGN REPORT

REV	DATE	BY	DESCRIPTION
			30% INTERMEDIATE DESIGN SUBMITTAL NOT FOR CONSTRUCTION

DESIGNED
DRAWN
CHECKED
DATE DECEMBER 2018

ALPHA ENGINEERING

carollo Engineers...Working Wonders With Water®

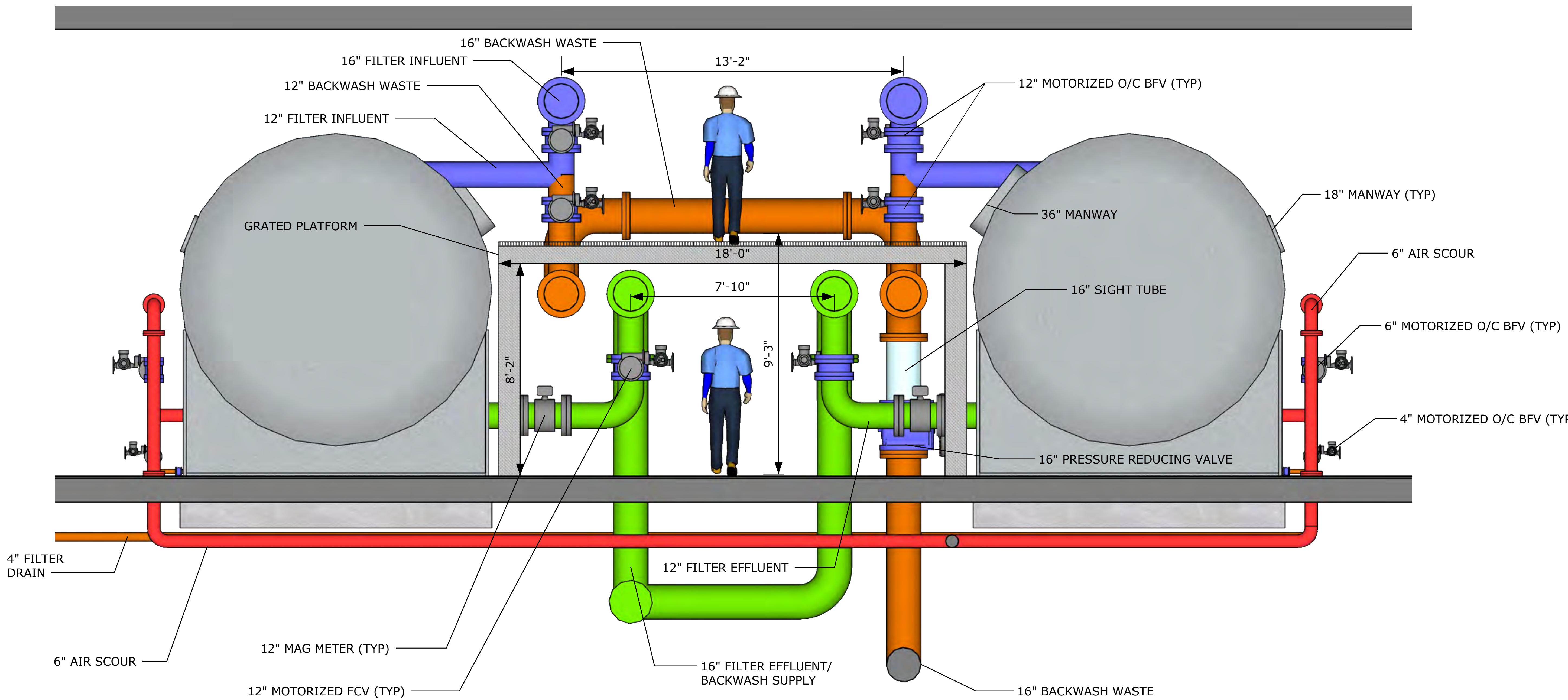
City of St. George

CITY OF ST. GEORGE
GUNLOCK WATER TREATMENT FACILITY DESIGN
MECHANICAL
TREATMENT BUILDING - SECTION

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1/2" 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

JOB NO. 11185A.10
DRAWING NO. 50M04
SHEET NO.

-This Page Intentionally Left Blank-



C TREATMENT BUILDING - PRESSURE VESSEL - SECTION 1

SCALE: 1/4" = 1'

GUNLOCK WTF - PRESSURE VESSEL - SECTION 1

FIGURE 1.17

CITY OF ST. GEORGE

PRELIMINARY DESIGN REPORT

30% INTERMEDIATE DESIGN SUBMITTAL
NOT FOR CONSTRUCTION

REV | DATE | BY | DESCRIPTION

DESIGNED
DRAWN
CHECKED
DATE DECEMBER 2018

ALPHA ENGINEERING

carollo Engineers...Working Wonders With Water®

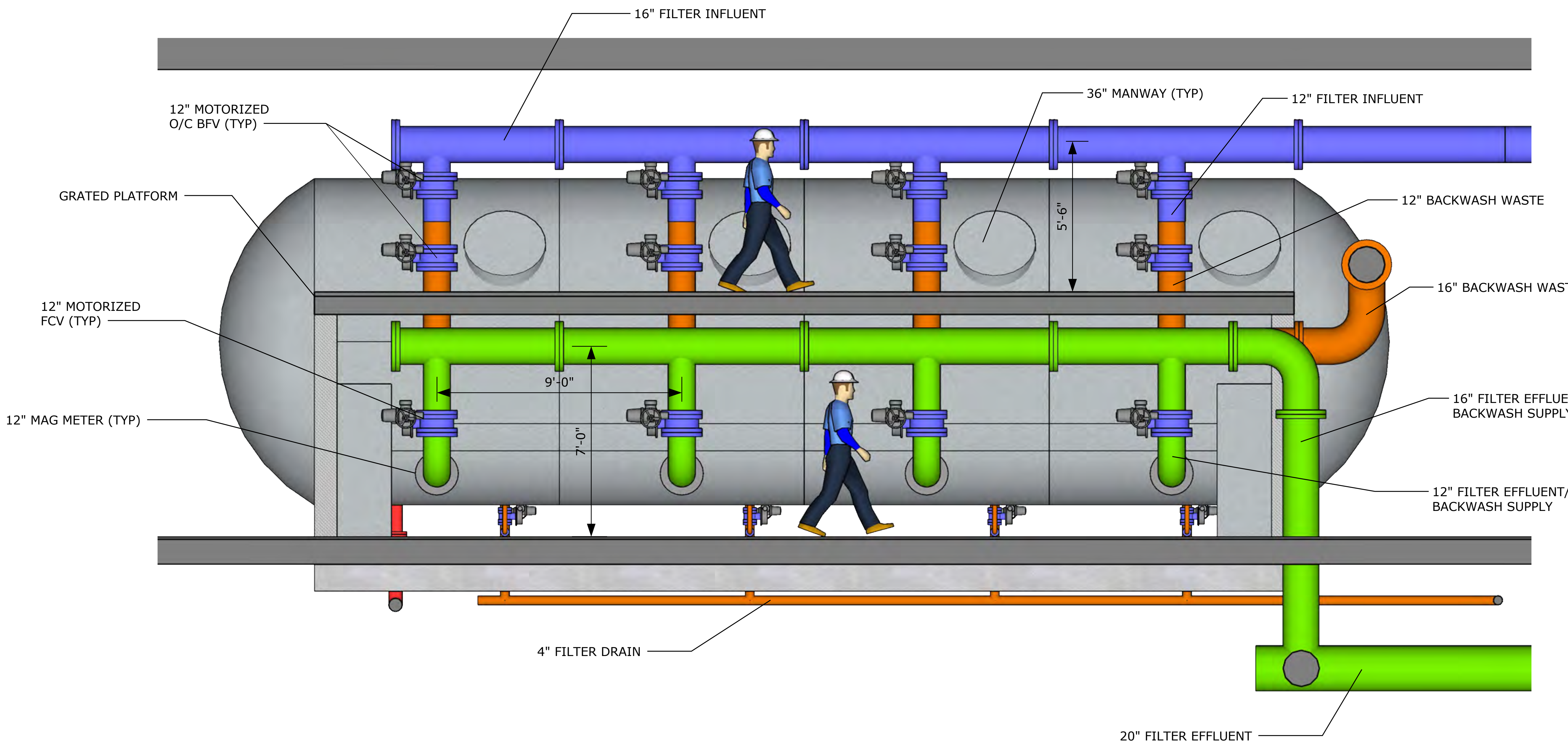
City of St. George

CITY OF ST. GEORGE
GUNLOCK WATER TREATMENT FACILITY DESIGN
MECHANICAL
TREATMENT BUILDING - PRESSURE VESSEL - SECTION 1

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1/2" 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

JOB NO. 11185A.10
DRAWING NO. 50M05
SHEET NO.

-This Page Intentionally Left Blank-



D TREATMENT BUILDING - PRESSURE VESSEL - SECTION 2

SCALE: 1/4" = 1'

GUNLOCK WTF - PRESSURE VESSEL - SECTION 2

FIGURE 1.18

CITY OF ST. GEORGE

PRELIMINARY DESIGN REPORT

30% INTERMEDIATE DESIGN SUBMITTAL
NOT FOR CONSTRUCTION

REV	DATE	BY	DESCRIPTION

DESIGNED
DRAWN
CHECKED
DATE DECEMBER 2018

ALPHA ENGINEERING

carollo Engineers...Working Wonders With Water®

City of St. George

CITY OF ST. GEORGE

GUNLOCK WATER TREATMENT FACILITY DESIGN

MECHANICAL

TREATMENT BUILDING - PRESSURE VESSEL - SECTION 2

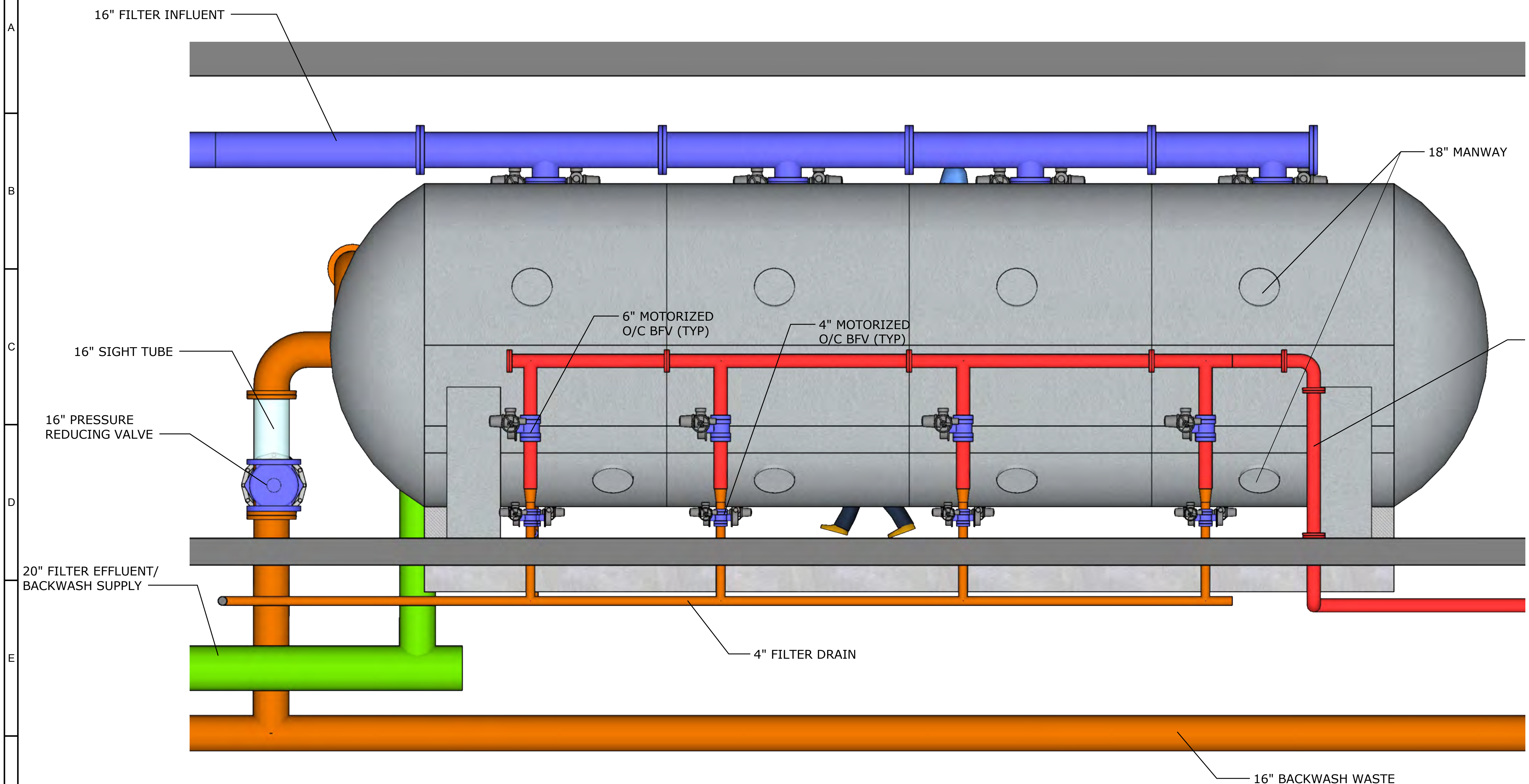
VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1/2"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

JOB NO. 11185A.10

DRAWING NO. 50M06

SHEET NO.

-This Page Intentionally Left Blank-



E TREATMENT BUILDING - PRESSURE VESSEL - SECTION 3

SCALE: 1/4" = 1'

GUNLOCK WTF - PRESSURE VESSEL - SECTION 3

FIGURE 1.19

CITY OF ST. GEORGE

PRELIMINARY DESIGN REPORT

REV	DATE	BY	DESCRIPTION
			30% INTERMEDIATE DESIGN SUBMITTAL NOT FOR CONSTRUCTION

DESIGNED

DRAWN

CHECKED

DATE DECEMBER 2018

ALPHA ENGINEERING

carollo Engineers...Working Wonders With Water®

CITY OF ST. GEORGE

GUNLOCK WATER TREATMENT FACILITY DESIGN

MECHANICAL

TREATMENT BUILDING - PRESSURE VESSEL - SECTION 3

VERIFY SCALES

BAR IS ONE INCH ON ORIGINAL DRAWING

0 1/2" 1"

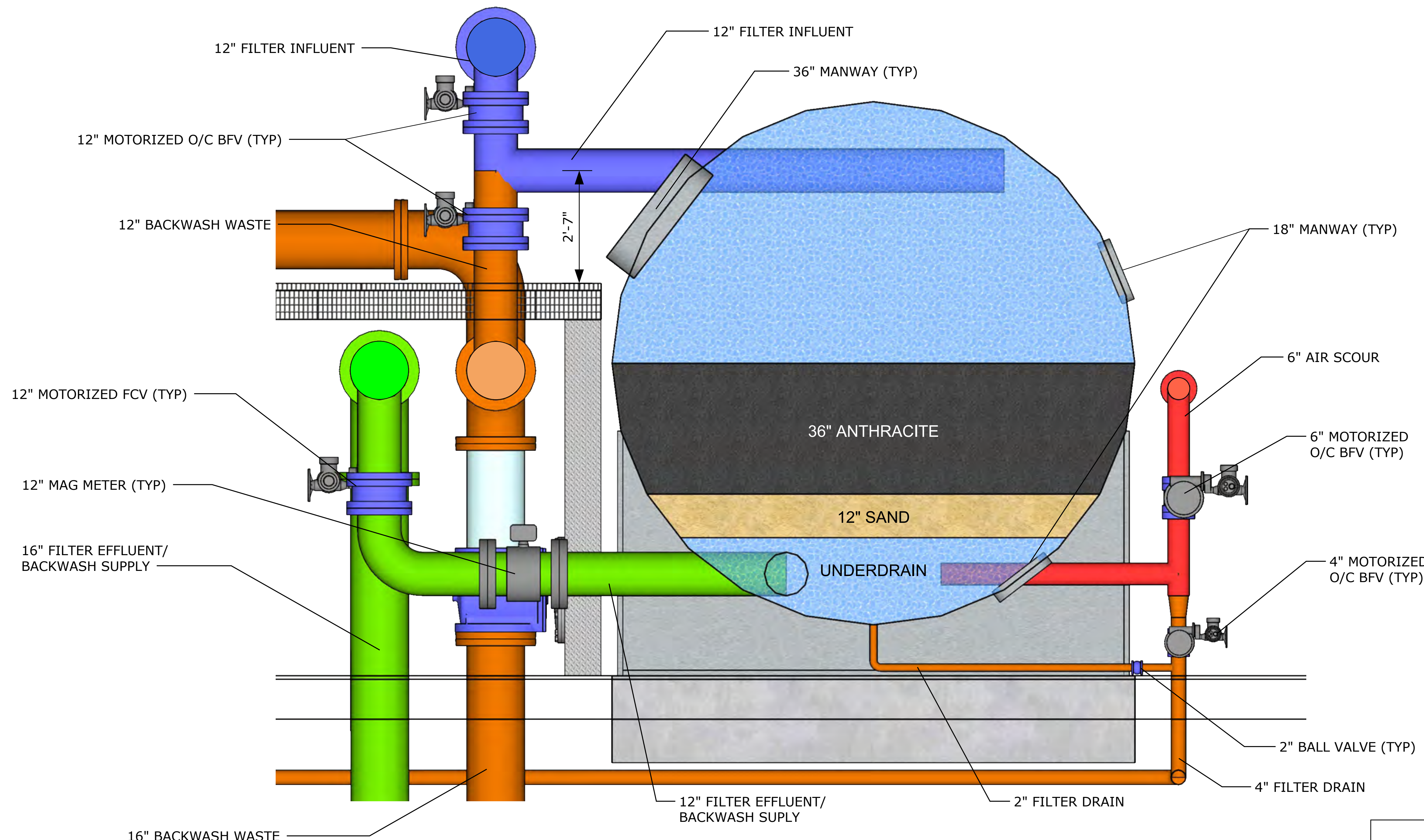
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

JOB NO. 11185A.10

DRAWING NO. 50M07

SHEET NO.

-This Page Intentionally Left Blank-



F TREATMENT BUILDING - PRESSURE VESSEL - SECTION 4

SCALE: 3/8" = 1'

GUNLOCK WTF - PRESSURE VESSEL - SECTION 4

FIGURE 1.20

CITY OF ST. GEORGE

PRELIMINARY DESIGN REPORT

30% INTERMEDIATE DESIGN SUBMITTAL
NOT FOR CONSTRUCTION

REV	DATE	BY	DESCRIPTION

DESIGNED
DRAWN
CHECKED
DATE DECEMBER 2018

ALPHA ENGINEERING

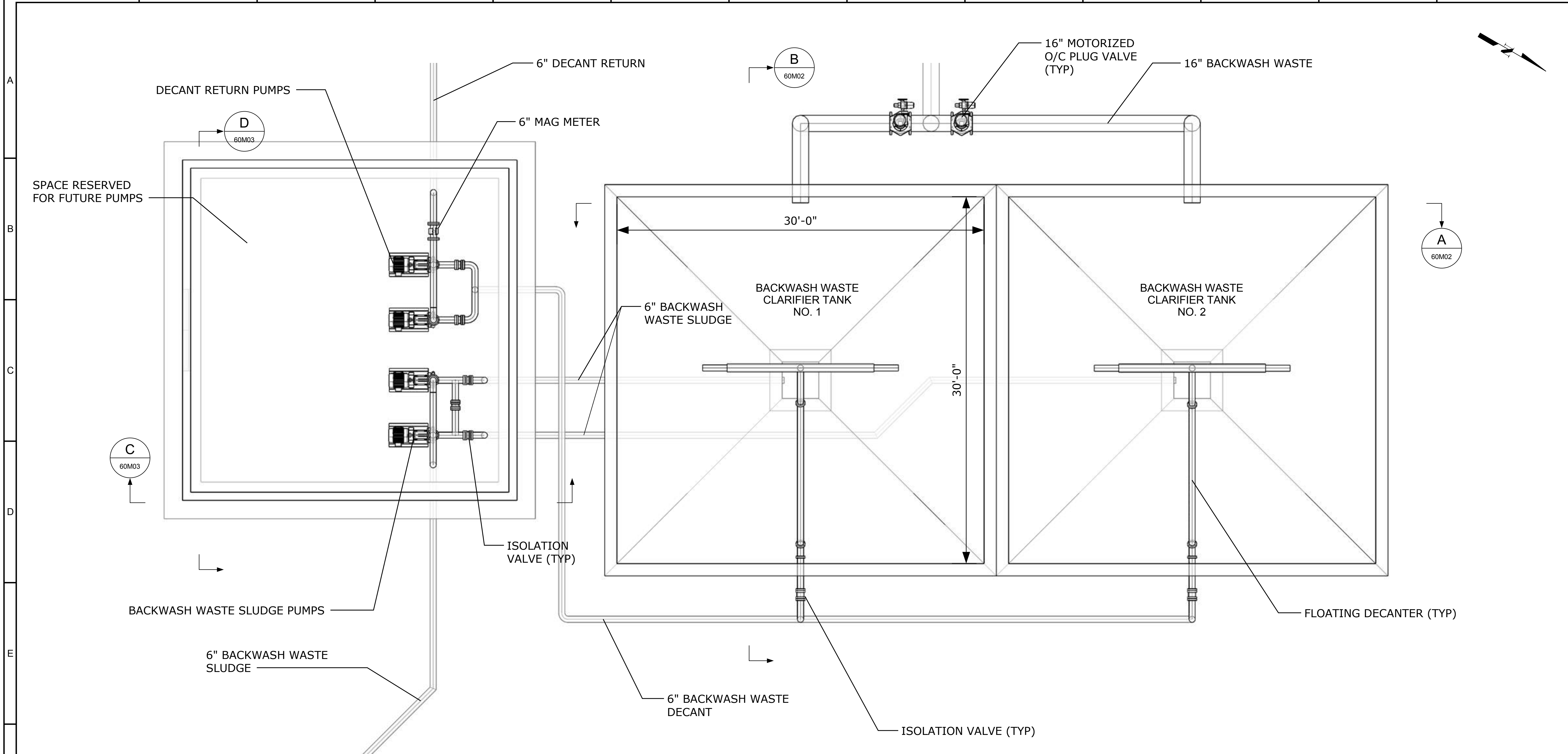
carollo
Engineers...Working Wonders With Water®

CITY OF ST. GEORGE
GUNLOCK WATER TREATMENT FACILITY DESIGN
MECHANICAL
TREATMENT BUILDING - PRESSURE VESSEL - SECTION 4

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1/2" 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

JOB NO. 11185A.10
DRAWING NO. 50M08
SHEET NO.

-This Page Intentionally Left Blank-



BWW CLARIFIER TANKS & PUMP STATION - PLAN

SCALE: 1/8" = 1'

GUNLOCK WTF - BACKWASH WASTE CLARIFIERS AND PUMP STATION - PLAN

FIGURE 1.21

CITY OF ST. GEORGE

PRELIMINARY DESIGN REPORT

REV	DATE	BY	DESCRIPTION
			30% INTERMEDIATE DESIGN SUBMITTAL NOT FOR CONSTRUCTION

DESIGNED

DRAWN

CHECKED

DATE DECEMBER 2018

ALPHA ENGINEERING

carollo Engineers...Working Wonders With Water®

CITY OF ST. GEORGE

GUNLOCK WATER TREATMENT FACILITY DESIGN

MECHANICAL

BACKWASH WASTE CLARIFIER TANKS AND PUMP STATION - PLAN

VERIFY SCALES

BAR IS ONE INCH ON ORIGINAL DRAWING

0 1/2"

IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

JOB NO. 11185A.10

DRAWING NO. 60M01

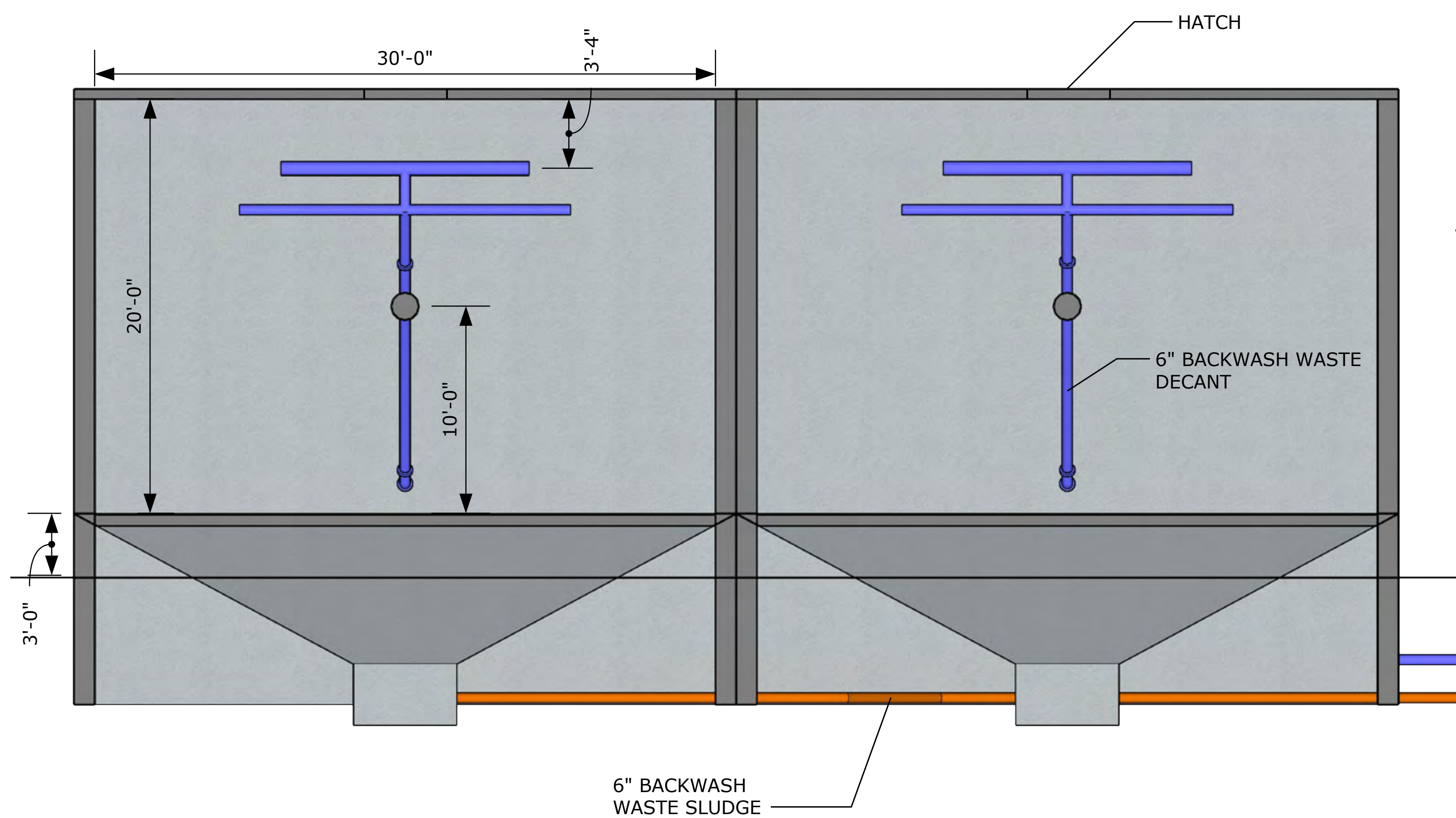
SHEET NO.

-This Page Intentionally Left Blank-

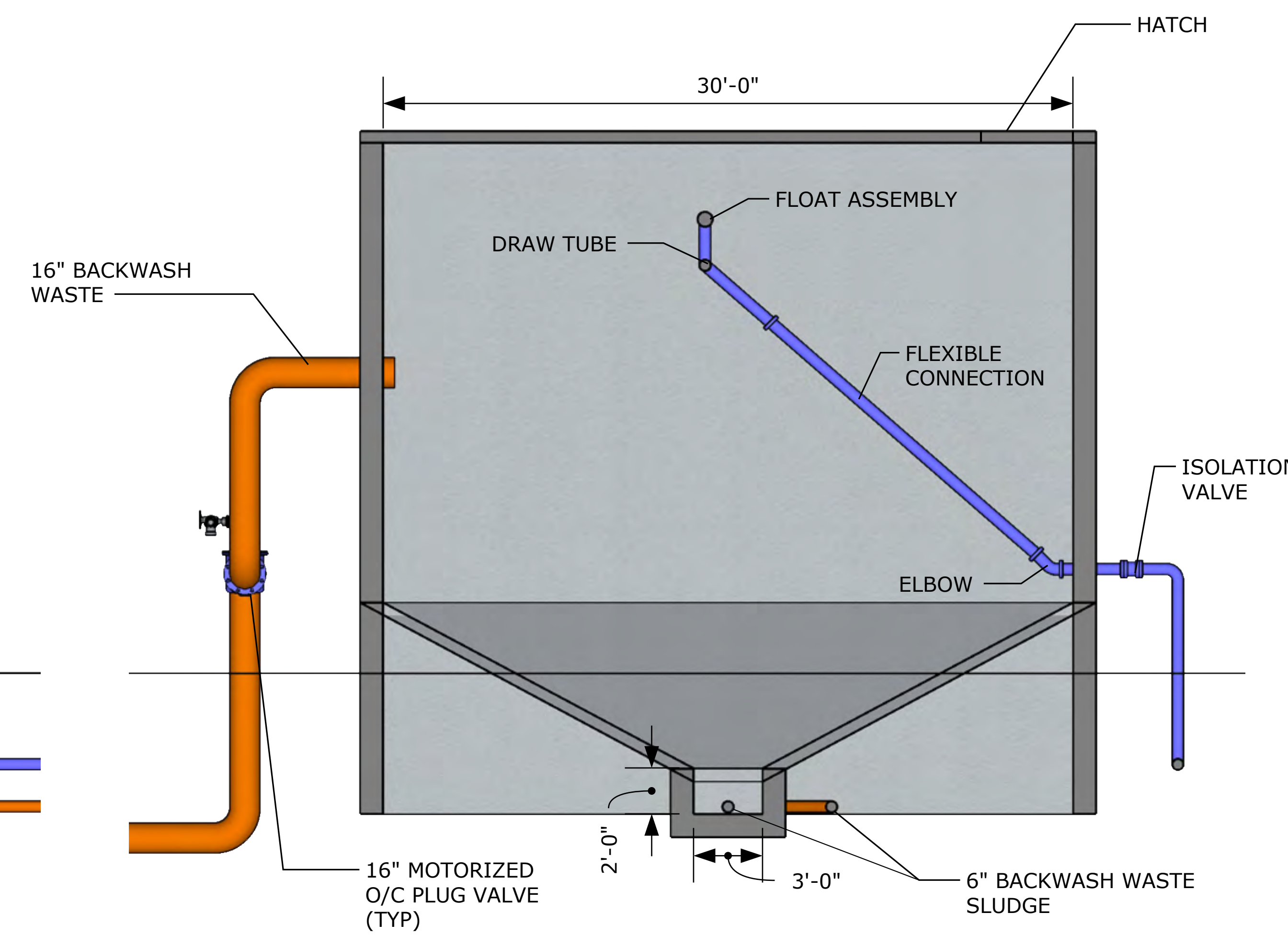
GUNLOCK WTF - BACKWASH WASTE CLARIFIERS - SECTIONS

FIGURE 1.22

CITY OF ST. GEORGE
PRELIMINARY DESIGN REPORT



(A) BWW CLARIFIER TANKS - WEST SECTION
SCALE: 1/8" = 1'



(B) BWW CLARIFIER TANKS - SOUTH SECTION
SCALE: 1/8" = 1'

REV	DATE	BY	DESCRIPTION
			30% INTERMEDIATE DESIGN SUBMITTAL NOT FOR CONSTRUCTION

DESIGNED
DRAWN
CHECKED
DATE DECEMBER 2018

ALPHA ENGINEERING
carollo *Engineers...Working Wonders With Water®*

CITY OF ST. GEORGE
GUNLOCK WATER TREATMENT FACILITY DESIGN
MECHANICAL
BACKWASH WASTE CLARIFIER TANKS - SECTIONS

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1/2" 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

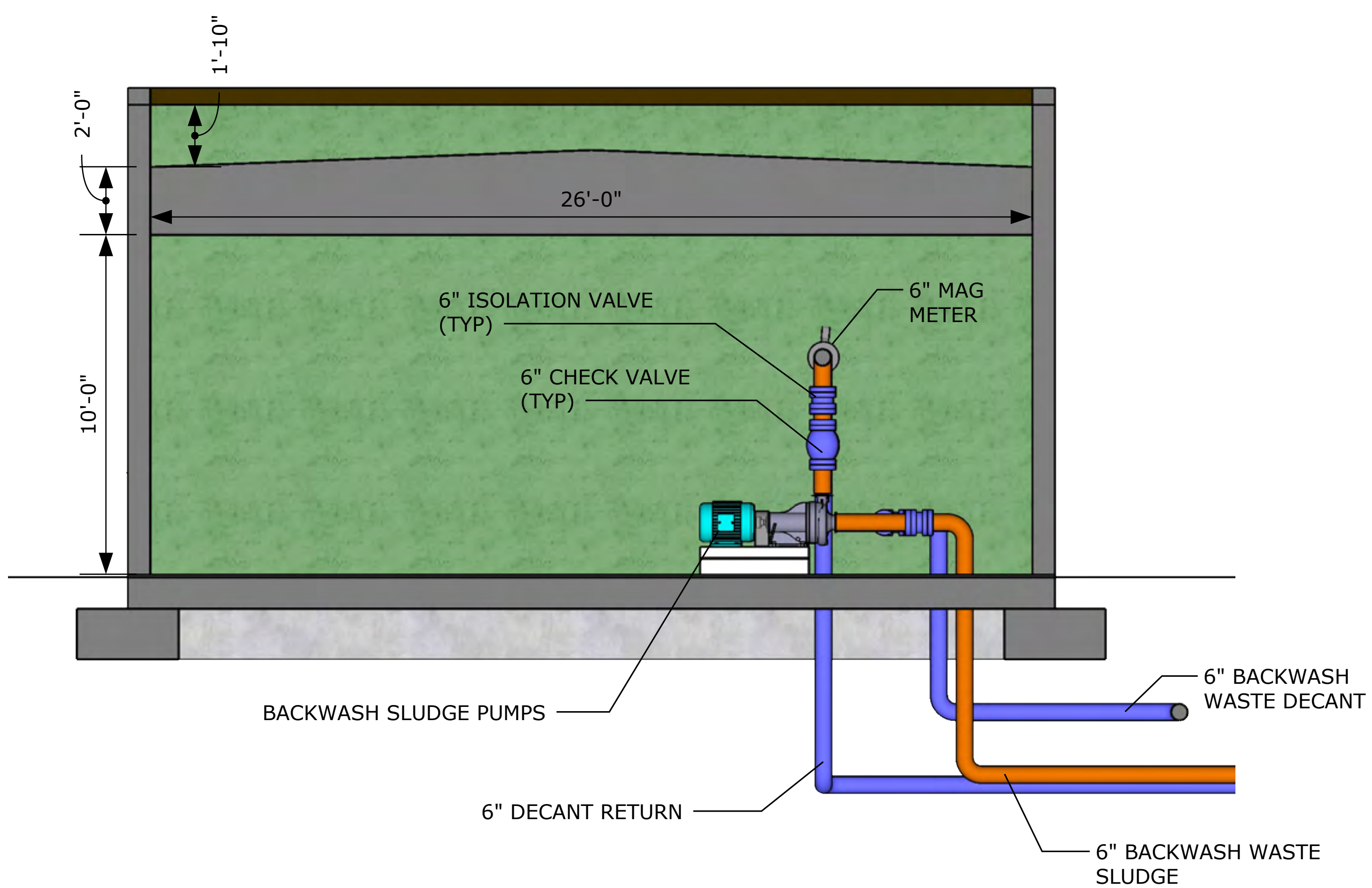
JOB NO. 11185A.10
DRAWING NO. 60M02
SHEET NO.

-This Page Intentionally Left Blank-

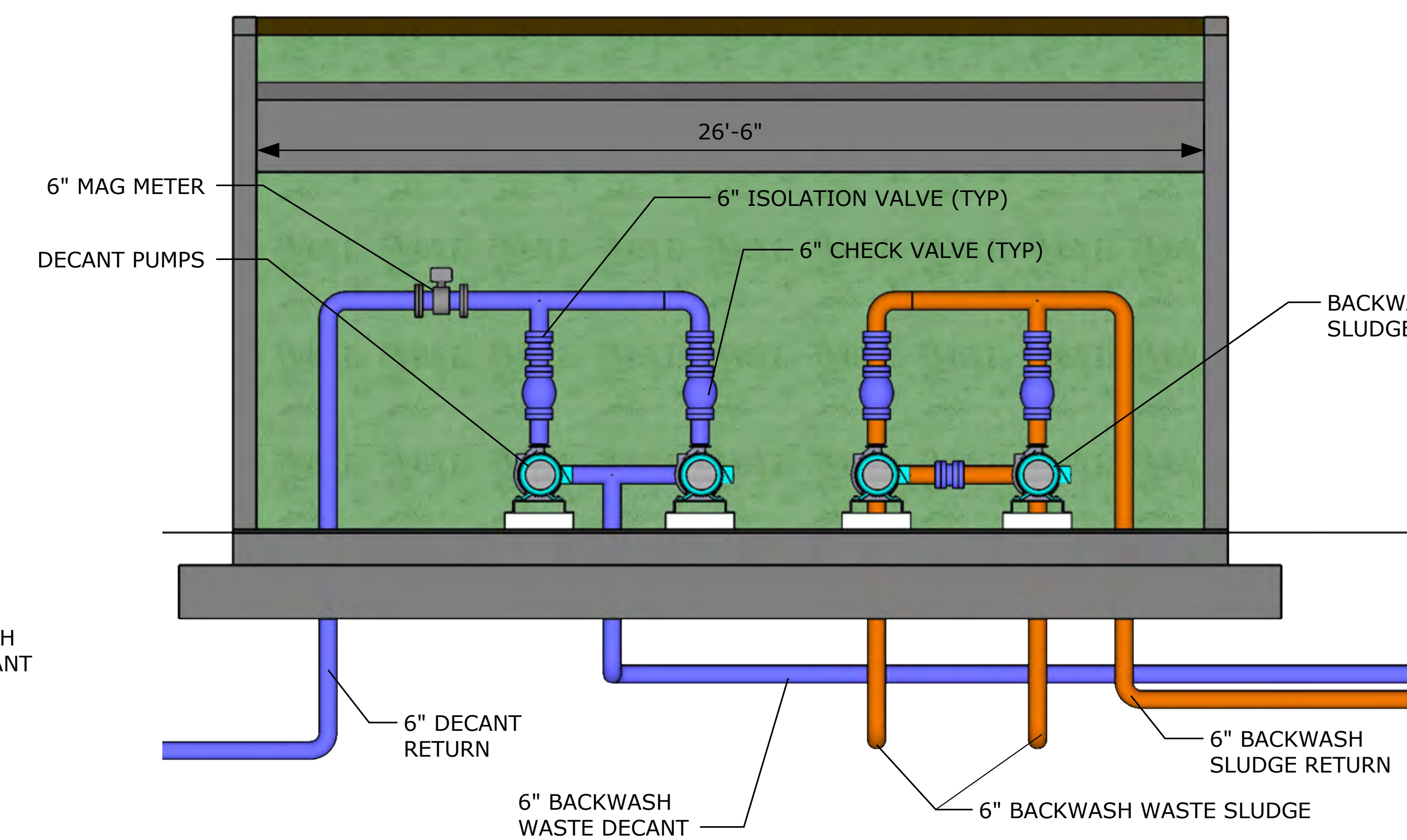
GUNLOCK WTF - PUMP STATION - SECTIONS

FIGURE 1.23

CITY OF ST. GEORGE
PRELIMINARY DESIGN REPORT



C — PUMP STATION - EAST SECTION
SCALE: 3/16" = 1'



D — PUMP STATION - SOUTH SECTION
SCALE: 3/16" = 1'

REV	DATE	BY	DESCRIPTION
			30% INTERMEDIATE DESIGN SUBMITTAL NOT FOR CONSTRUCTION

DESIGNED
DRAWN
CHECKED
DATE DECEMBER 2018

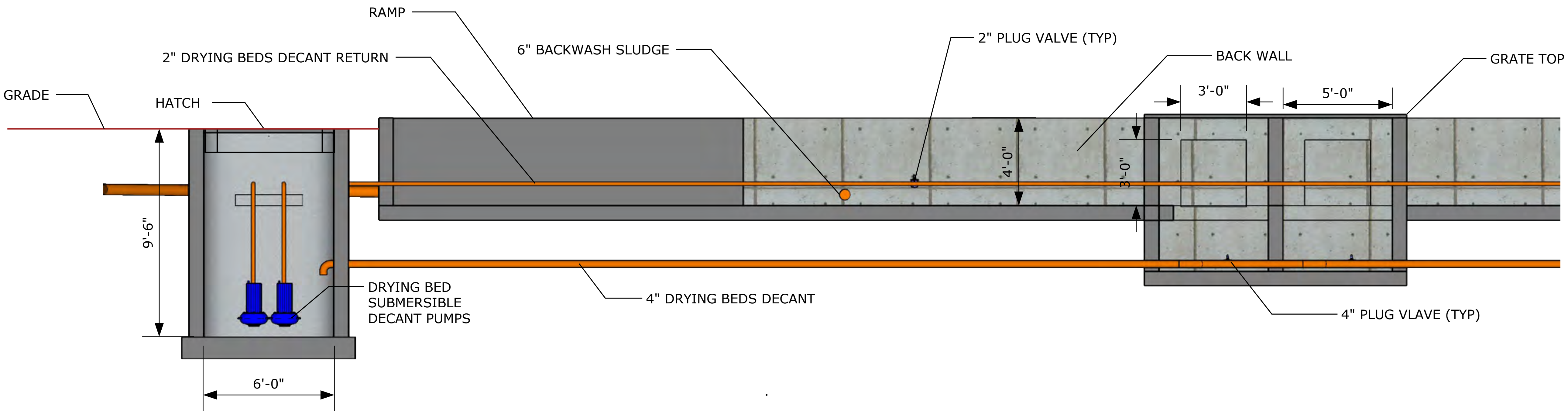
ALPHA ENGINEERING
carollo Engineers...Working Wonders With Water®

CITY OF ST. GEORGE
GUNLOCK WATER TREATMENT FACILITY DESIGN
MECHANICAL
PUMP STATION - SECTIONS

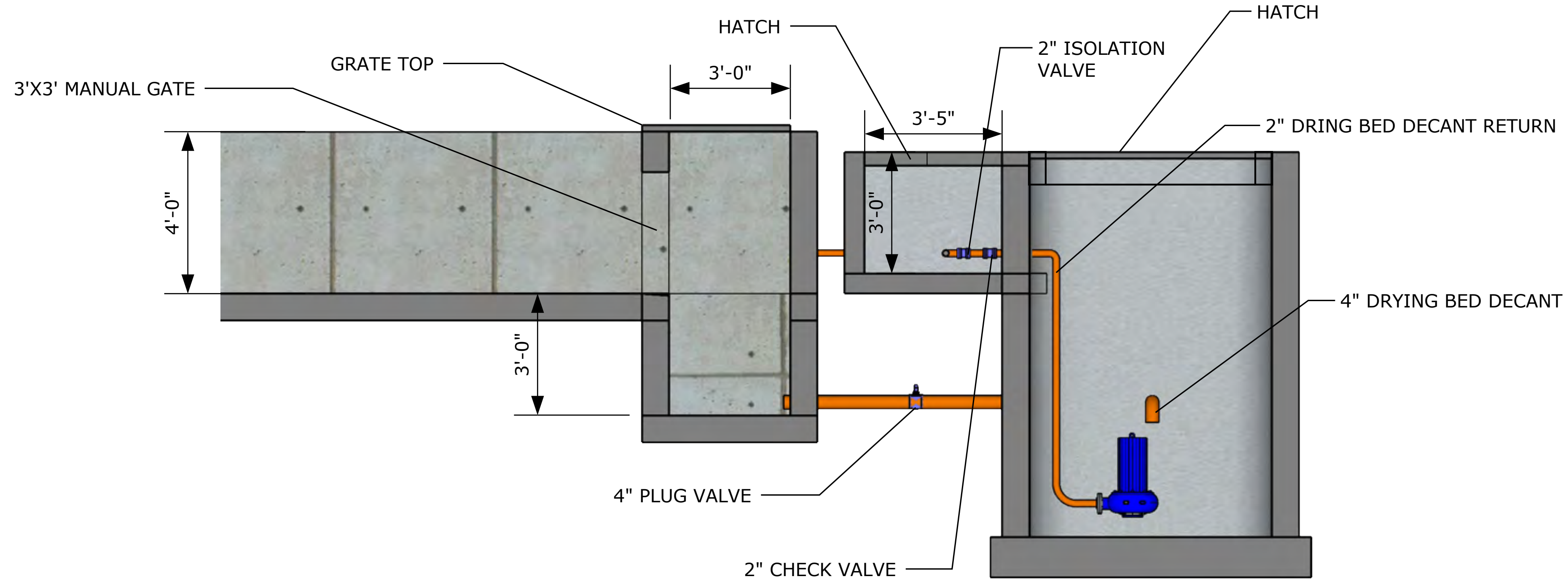
VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1/2" 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

JOB NO. 11185A.10
DRAWING NO. 60M03
SHEET NO.

-This Page Intentionally Left Blank-



A DRYING BEDS - NORTH SECTION
SCALE: 3/16" = 1'



B DRYING BEDS - EAST SECTION
SCALE: 1/4" = 1'

GUNLOCK WTF - DRYING BEDS - SECTIONS

FIGURE 1.24

CITY OF ST. GEORGE
PRELIMINARY DESIGN REPORT

REV	DATE	BY	DESCRIPTION
			30% INTERMEDIATE DESIGN SUBMITTAL NOT FOR CONSTRUCTION

DESIGNED
DRAWN
CHECKED
DATE DECEMBER 2018

ALPHA ENGINEERING

carollo
Engineers...Working Wonders With Water®

City of St. George

CITY OF ST. GEORGE
GUNLOCK WATER TREATMENT FACILITY DESIGN
MECHANICAL
DRYING BEDS - SECTIONS

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1/2"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

JOB NO. 11185A.10
DRAWING NO. 60M04
SHEET NO.

-This Page Intentionally Left Blank-

1.5.1.2 Building HVAC and Plumbing

Climate control will be provided for the treatment building. The main process area will have wall mounted evaporative cooling but no heating system. The chlorine gas room will have a ventilation fan and heaters for process requirements. The restroom, operator room, and electrical room will all have heating, ventilation, and air conditioning (HVAC) for heating and cooling.

Plumbing will be provided for the restroom sink and toilet and several hose bibb locations for wash-down water. An emergency shower/eyewash will be provided in the chlorine and ferric chloride areas. Utility water will be provided for the chlorine system with a backflow system to protect the potable water system. Floor drains will be provided around the pressure vessels and in the chemical areas. The floor drains will all be plumbed to drain to the sludge drying beds. The sanitary sewer from the restroom will be plumbed to the on-site waste water holding tank.

1.5.2 Sand Hollow

The Sand Hollow GWTP building, Backwash Waste Clarifier and drying bed concepts are similar to those at the Gunlock WTF, with few differences. Consequently, Figures 1.14 through 1.24 and Section 1.5.1 generally apply to Sand Hollow GWTF as well, except as modified herein.

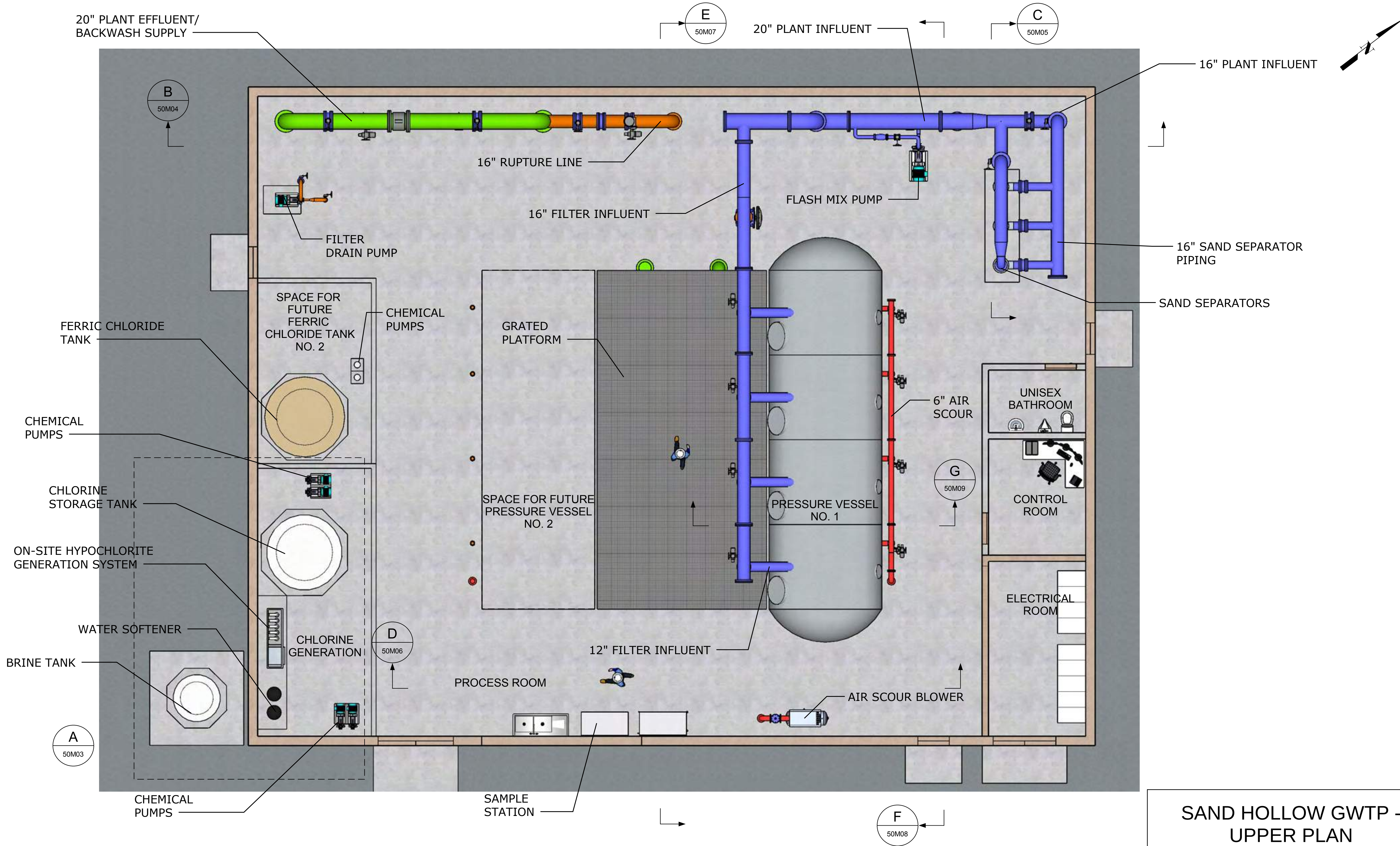
The most significant differences within the building are highlighted on Figures 1.25 and 1.26 and described below. The details for the Backwash Waste Clarifier and drying beds differ only in the number of units initially constructed - one clarifier instead of two, and three drying beds instead of four. The clarifier pump station at Sand Hollow GWTP also includes the duty and standby pumps for pumping potable water to Dixie Springs, as shown on Figure 1.27.

1.5.2.1 Building Layout

The treatment building will be located adjacent to the West Dam Springs site, as described in the site layout in Section 1.3.2.3. The Sand Hollow GWTP building layout is similar to the Gunlock WTF in all aspects except the following:

- Only one vessel will be initially constructed. The second vessel will be added as part of a future expansion in the same configuration as Gunlock WTF. Refer to Figure 1.25.
- A sand separator system is included in the corner adjacent to the flash mix pump. Refer to Figure 1.25.
- There is an on-site hypochlorite generation equipment located in the main process room, instead of a chlorine gas system located in an isolated chlorine room. The brine storage tank is located outside to minimize building footprint and facilitate bulk salt deliveries. Refer to Figure 1.25.
- The filter inlet and outlet header configuration along the wall shown in Section B for each facility is different for Sand Hollow. The primary differences are highlighted below and in Figure 1.26:
  - The filter inlet piping from West Dam Springs connects to the sand separators that can also be bypassed.
  - Bypass piping for well water that will not be filtered, along with decant return piping is provided in an exterior vault at Sand Hollow rather than internal to the building at Gunlock.
  - The Sand Hollow filter effluent piping includes a tee and flow meter to the Dixie Springs pump station.

-This Page Intentionally Left Blank-



TREATMENT BUILDING - UPPER PLAN

SCALE: 3/32" = 1'

SAND HOLLOW GWTP - UPPER PLAN

FIGURE 1.25

WCWCD

PRELIMINARY DESIGN REPORT

REV	DATE	BY	DESCRIPTION	
			30% INTERMEDIATE DESIGN SUBMITTAL NOT FOR CONSTRUCTION	DESIGNED
				DRAWN
				CHECKED
				DATE DECEMBER 2018

ALPHA ENGINEERING

carollo

Engineers...Working Wonders With Water®

WASHINGTON COUNTY WATER CONSERVANCY DISTRICT

WASHINGTON COUNTY WATER CONSERVANCY DISTRICT

SAND HOLLOW GROUNDWATER TREATMENT PLANT DESIGN

MECHANICAL

TREATMENT BUILDING - UPPER PLAN

VERIFY SCALES

BAR IS ONE INCH ON ORIGINAL DRAWING

0 1/2"

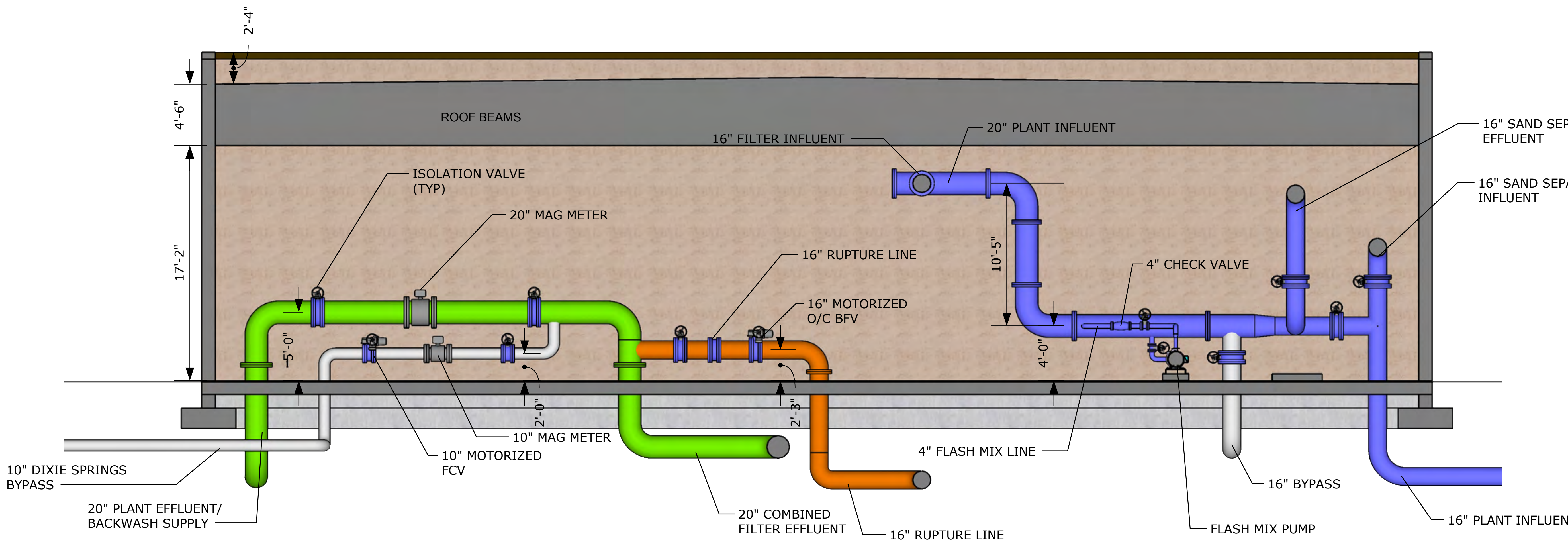
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

JOB NO. 11186A.10

DRAWING NO. 50M02

SHEET NO.

-This Page Intentionally Left Blank-



B TREATMENT BUILDING - BACK WALL SECTION

SCALE: 1/8" = 1'

SAND HOLLOW GWTP - SECTION

FIGURE 1.26

WCWCD

PRELIMINARY DESIGN REPORT

REV	DATE	BY	DESCRIPTION
			30% INTERMEDIATE DESIGN SUBMITTAL NOT FOR CONSTRUCTION

DESIGNED
DRAWN
CHECKED
DATE DECEMBER 2018

ALPHA ENGINEERING

carollo Engineers...Working Wonders With Water®

WASHINGTON COUNTY WATER CONSERVANCY DISTRICT

WASHINGTON COUNTY WATER CONSERVANCY DISTRICT

SAND HOLLOW GROUNDWATER TREATMENT PLANT DESIGN

MECHANICAL

TREATMENT BUILDING - SECTION

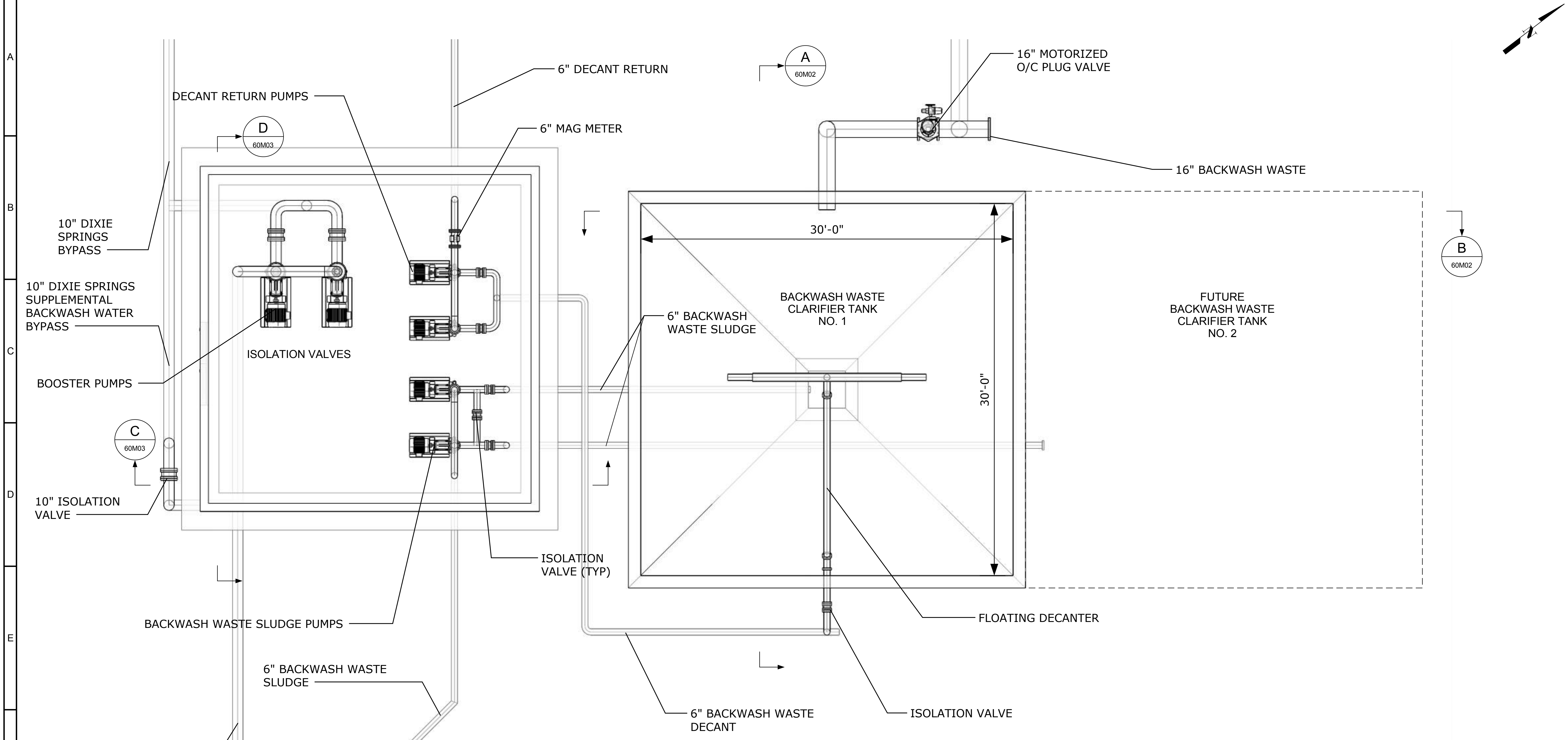
VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1/2"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

JOB NO. 11186A.10

DRAWING NO. 50M04

SHEET NO.

-This Page Intentionally Left Blank-



BWW CLARIFIER TANKS & PUMP STATION - PLAN
SCALE: 1/8" = 1'

SAND HOLLOW GWTP - BWW CLARIFIER TANK AND PUMP STATION - PLAN

FIGURE 1.27

WCWCD
PRELIMINARY DESIGN REPORT

30% INTERMEDIATE DESIGN SUBMITTAL
NOT FOR CONSTRUCTION

REV	DATE	BY	DESCRIPTION

DESIGNED
DRAWN
CHECKED
DATE DECEMBER 2018

ALPHA ENGINEERING
carollo Engineers...Working Wonders With Water®
WASHINGTON COUNTY WATER CONSERVANCY DISTRICT

WASHINGTON COUNTY WATER CONSERVANCY DISTRICT
SAND HOLLOW GROUNDWATER TREATMENT PLANT DESIGN
MECHANICAL
BACKWASH WASTE CLARIFIER TANKS AND PUMP STATION - PLAN

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1/2"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

JOB NO. 11186A.10
DRAWING NO. 60M01
SHEET NO.

-This Page Intentionally Left Blank-

1.5.2.2 Building HVAC and Plumbing

The climate control and HVAC for Sand Hollow is identical to Gunlock except:

- There is no separate HVAC system for the chlorine area because it is not in a separate room.
- The sanitary sewer from the restroom will be plumbed to the nearby existing 8-inch sanitary sewer line instead of a holding tank.

1.6 Electrical and Instrumentation and Controls

1.6.1 Gunlock

1.6.1.1 Electrical Equipment and Sizing

The Gunlock WTF will receive 480-volt (V) electrical service from a St. George Power-owned transformer. Coordination with St. George Power on exact service requirements will occur during final design. This power source is equipped with backup power generation to supply the Gunlock WTF in the event of normal power failure. Therefore, a backup or emergency power generator at the site will not be included in the design.

Appendix A contains load study data for the WTF, which is used for determining the expected sizing criteria for both motor control center (MCC) and the new transformer furnished by St. George Power. The load study in Appendix A includes the following:

- 480-volt Loads:
  - Air Scour Blower.
  - Chemical Pumps.
  - Clarifiers.
  - Flash Mix Pump.
  - Filter Drain Pump.
  - Backwash Waste (BWW) Return Pumps.
  - Decant Return Pumps.
  - Valves.
- 120-volt Loads:
  - Lighting/outlets.
  - HVAC.
  - Instrumentation.

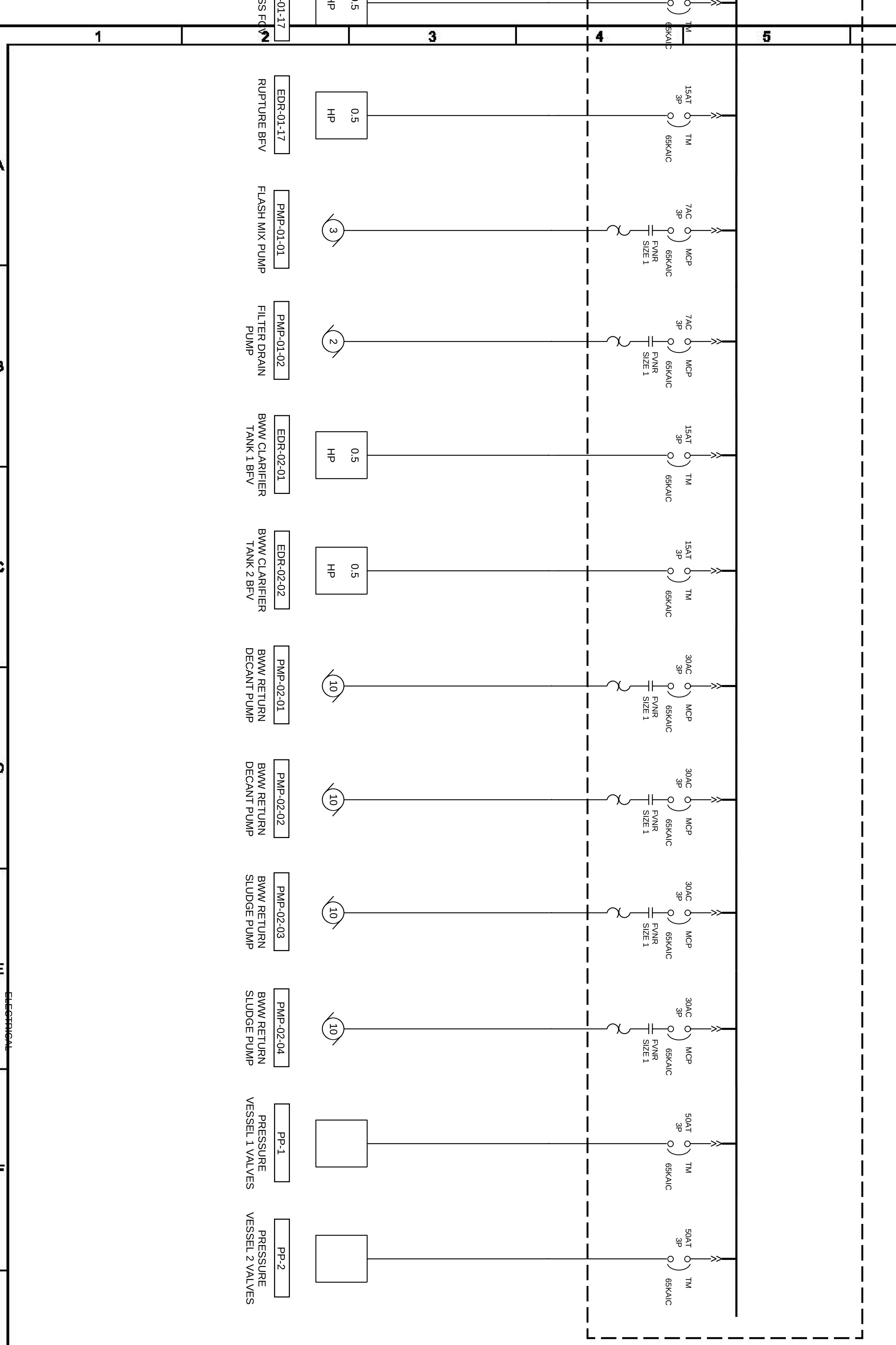
The load study calculates the amperage rating of the MCC and the transformer using three different methods: National Electrical Code (NEC) Article 215, NEC Article 430, and "Operating Loads" (the sum of the non-continuous load plus the continuous load, not including standby loads). Typically, the most conservative of the three calculations is used for equipment sizing. From the load study calculation, NEC Article 215 is the most conservative. The equipment ratings are determined by rounding up the load study calculation to the next standard size of equipment. The MCC is preliminarily sized for 450 amperes (A) and the estimated transformer size is 300 kVA. Actual equipment sizing will be determined during final design, and will be vetted with process and building loads to ensure that adequate capacity is available in the new MCC One-Line Diagram.

A preliminary power supply one-line diagram is shown in Figure 1.28 The utility transformer will be connected to a utility meter/cabinet and then an outdoor service entrance disconnect, which will feed the MCC. The MCC will serve as the main electrical distribution, as well include the starters for the pumps. The MCC will also feed two power panels (PP). Each power panel will supply power to the valves for a single pressure vessel.

1.6.1.2 Process and Instrumentation Diagram

The Gunlock WTF will have a PLC located in the electrical room, where the PLC will monitor and control the associated treatment systems. The PLC will utilize a telemetry unit to transmit the control and status to the City's remote Supervisory Control and Data Acquisition (SCADA) system.

Preliminary process and instrumentation diagrams (P&IDs) for the pressure vessels are shown in Figure 1.29 and Figure 1.30.



GUNLOCK WTF -
ONE-LINE DIAGRAM

FIGURE 1.28

CITY OF ST. GEORGE
PRELIMINARY DESIGN REPORT

REV	DATE	BY	DESCRIPTION

DESIGNED
DRAWN
CHECKED
DATE DECEMBER 2018

PRELIMINARY DESIGN SUBMITTAL
NOT FOR CONSTRUCTION

carollo

CITY OF ST. GEORGE
GUNLOCK WATER TREATMENT FACILITY DESIGN

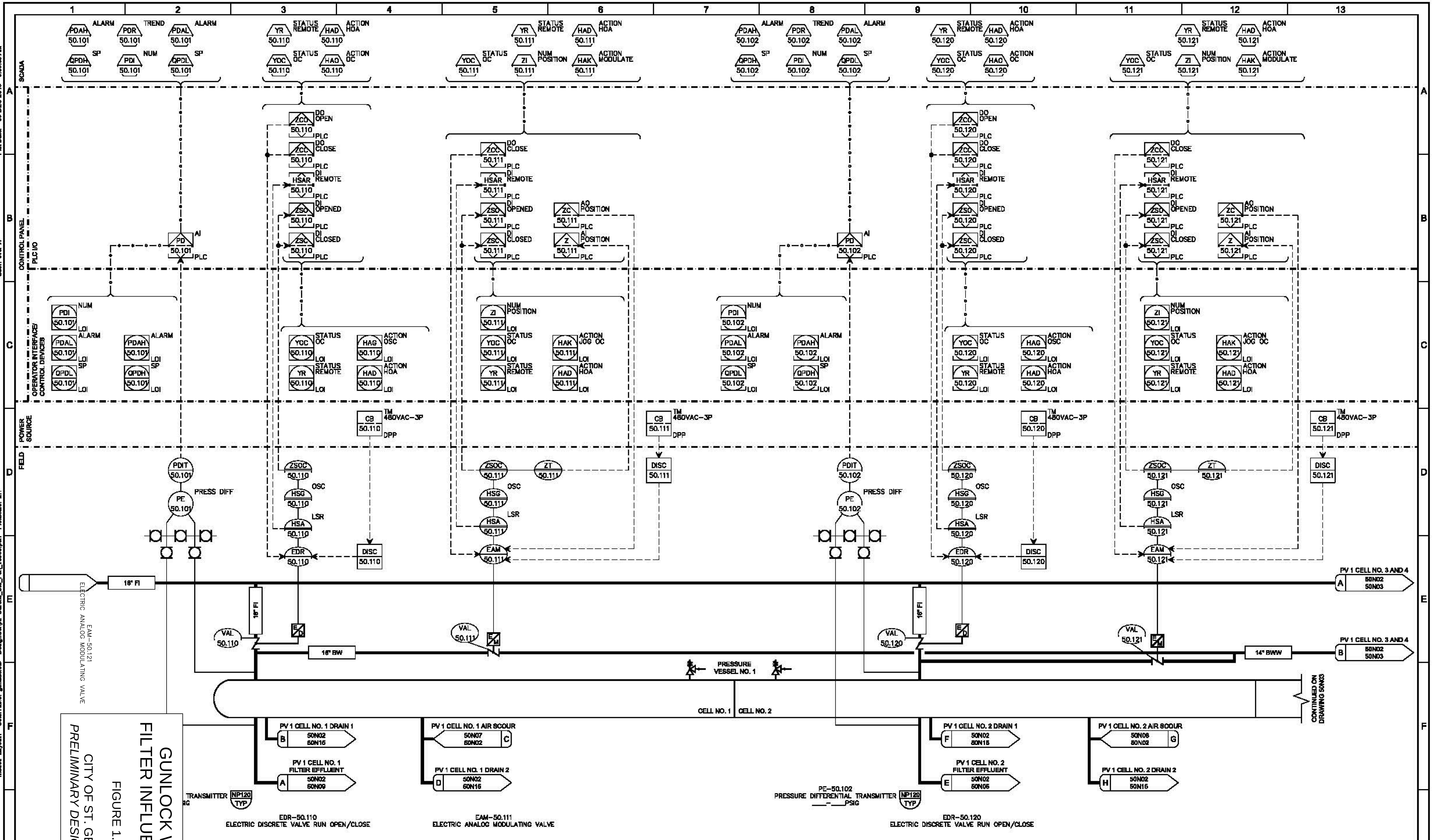
VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

JOB NO. 11165A10
DRAWING NO.
SHEET NO.
OF XX

00E01

PROJECT NO. 11165A10 FILE NAME: 11165a10_00G02.dgn

-This Page Intentionally Left Blank-



GUNLOCK WTF - FILTER INFLUENT P&ID

FIGURE 1.29

CITY OF ST. GEORGE
PRELIMINARY DESIGN REPORT

DESIGNED	GCE
DRAWN	ESW
CHECKED	
DATE	DECEMBER 2016

PRELIMINARY DESIGN SUBMITTAL
NOT FOR CONSTRUCTION

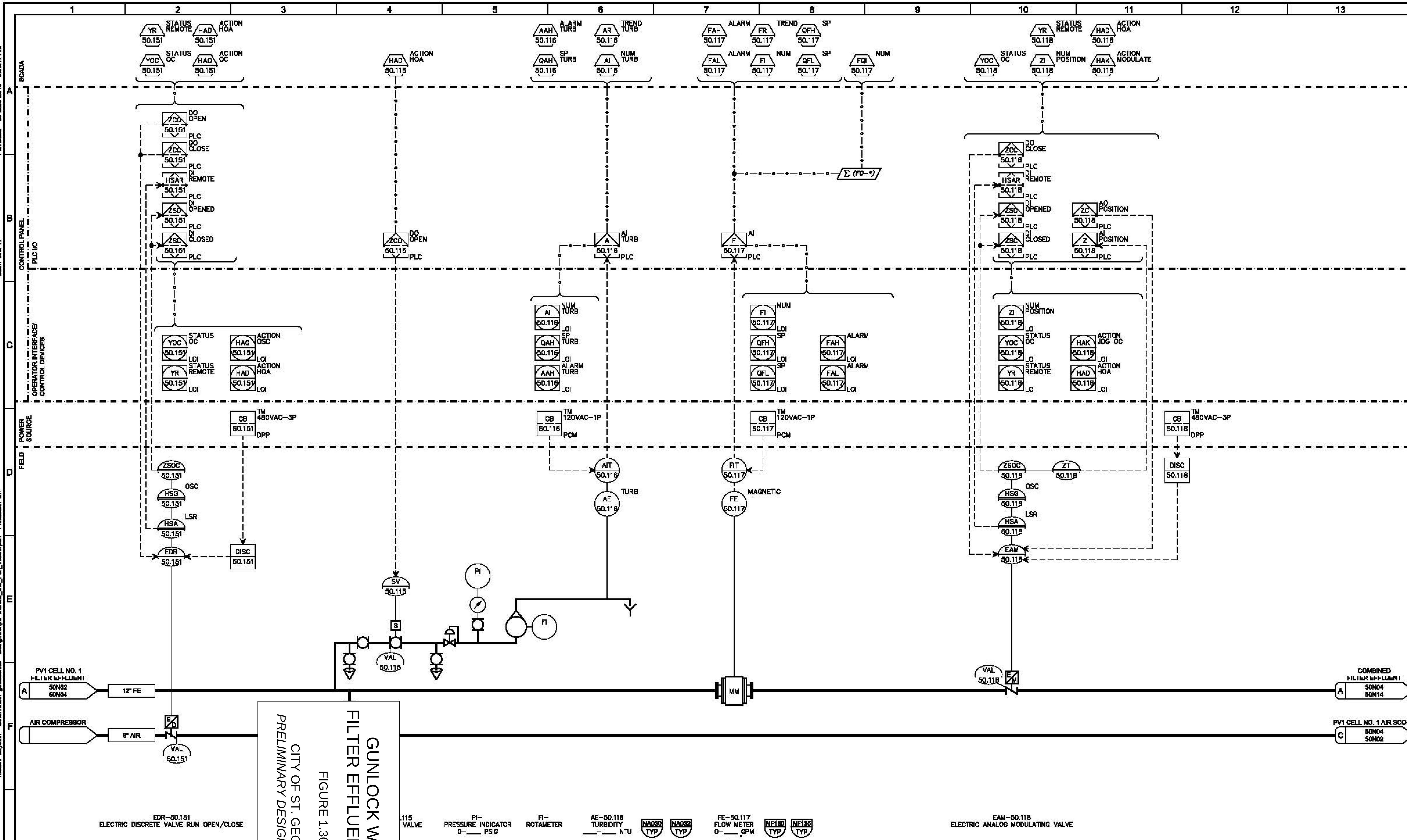
CITY OF ST. GEORGE
GUNLOCK WATER TREATMENT FACILITY DESIGN
INSTRUMENTATION
P&ID - PRESSURE FILTER NO. 1
CELLS 1 AND 2 FILTER INFLUENT

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

JOB NO. 11165A10
DRAWING NO. 50N02
SHEET NO. OF XX

PROJECT NO. 11165A10 FILE NAME: 11165A1050N002.dwg

-This Page Intentionally Left Blank-



GUNLOCK WTF - FILTER EFFLUENT P&ID

FIGURE 1.30

CITY OF ST. GEORGE

PRELIMINARY DESIGN REPORT

REV	DATE	BY	DESCRIPTION

DECEMBER 2018

...MINARY DESIGN
...SUBMITTAL
...R CONSTRUCTION

carollo

CITY OF ST. GEORGE

GUNLOCK WATER TREATMENT FACILITY DESIGN

INSTRUMENTATION

P&ID - PRESSURE FILTER NO. 1
CELL 1 FILTER EFFUENT

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 — 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

JOB NO. 11165A10

DRAWING NO. 50N04

SHEET NO. OF XX

PROJECT NO. 11165A10 FILE NAME: 11165A1050N004.dwg

-This Page Intentionally Left Blank-

1.6.2 Sand Hollow

The Sand Hollow GWTP electrical and instrumentation design criteria will be similar to the Gunlock WTF, except it will receive 480-volt (V) electrical service from Dixie Power. As a reference, refer to Figure 1.28 for the one-line diagram and Figures 1.29 and 1.30 for preliminary P&IDs. WCWCD has determined that if there was a loss of power to the Sand Hollow GWTP, the associated wells feeding the GWTP would also be without power and do not have backup power associated with them. Because no water could be pumped to the GWTP, it was decided that providing a backup power generator at the GWTP is not needed at this time. Therefore, a backup power generator will not be included in the design.

1.7 Cost Estimate

This Section provides current cost estimate for each facility and compares the current estimate with previous cost estimates provided by prior planning documents.

1.7.1 Gunlock

In September of 2016, Carollo prepared and submitted Technical Memorandum No. 2 - Gunlock Arsenic Treatment Project / Pilot Analysis to the City of St. George, which included a cost estimate for a 6-mgd inline filtration system with pressure vessels similar to what is presented in this Preliminary Design Report.

The Gunlock total estimated project cost for the 6-mgd arsenic treatment facility in the 2016 memorandum was $11.4 million (M) and included two pressure vessels with dual media filters inside a masonry building, chemical storage and metering pumps, backwash storage tanks and pumps, solar drying facilities with a decant pump station, and electrical equipment including an emergency generator. The 2016 cost estimate is shown in Table 1.11. The probable project cost estimate for the Gunlock WTF as currently proposed is $12.8 M as summarized in Table 1.12.

The $1.4 M increase in cost between the 2016 cost estimate and the current cost estimate is a result of further developed process treatment details and added. These details include such items as cast-in-place concrete building construction, larger drying beds to accommodate sludge drying and potential water storage in winter months, concrete backwash tanks versus steel backwash tanks and single-cell flow control operation of the vessels for more operational control of the vessels. A bid market allowance is included estimating that the bid climate will be positive (multiple bidders) due to the current favorable economy however still including some allowance if the bidding turnout is lower than anticipated. The overall contingency was maintained at 20 percent at this bid level but will be lowered as the 60 percent cost estimate is formulated during design.

Costs for this report were developed according to the Association for the Advancement of Cost Engineering International (AACEI) Class 4 Budget Estimate, with a level of accuracy range of approximately plus 30 percent to minus 15 percent.

Table 1.11 2016 Cost Estimate for Gunlock WTF

Item		Total
Site Civil		$1,514,000
6 mgd Treatment Building		$2,189,000
Backwash Clarifier Tanks		$597,000
Decant Pump Station		$381,000
Solids Drying Beds		$1,377,000
Electrical and I&C	@ 20%	$1,212,000
HVAC	@ 5%	$273,000
Total Direct Cost		**$7,543,000**
Contingency	@ 20%	$1,509,000
Escalation to Mid-Point	@ 3%	$272,000
Bid Market Allowance	@ 20%	**$467,000**
Total Estimated Construction Cost		**$9,791,000**
Engineering, Legal & Admin	@ 16%	$1,567,000
Total Estimated Project Cost		**$11,358,000**

Table 1.12 Current Cost Estimate for Gunlock WTF

Item		Total
Site Civil		$1,548,000
6 mgd Treatment Building		$3,515,000
Backwash Clarifier Tanks		$652,000
Decant Pump Station		$48,000
Solids Drying Beds		$603,000
Electrical and I&C	@ 20%	$1,274,000
HVAC	@ 5%	$319,000
Total Direct Cost		**$7,956,000**
Contingency	@ 20%	$1,592,000
Escalation to Mid-Point	@ 3%	$287,000
Bid Market Allowance	@12%	$1,181,000
Total Estimated Construction Cost		**$11,019,000**
Engineering, Legal & Admin	@ 16%	$1,763,000
Total Estimated Project Cost		**$12,782,000**

1.7.2 Sand Hollow

Carollo prepared and submitted to WCWCD a Project Memorandum in October of 2016 as part of the West Dam Springs Water Treatment Plant Planning Level Cost Estimate which included a cost estimate for a 3-mgd inline filtration system with pressure vessels similar to what is presented in this Preliminary Design Report. However, that estimate was based on a 3-mgd capacity and did not include infrastructure for chlorinating higher flows or for future expansion to 6 mgd.

The 2016 Sand Hollow total estimated project cost for the 3-mgd arsenic treatment facility was $6.8 M and included a single pressure vessel with dual media filters inside a smaller building , chemical storage and metering pumps, backwash storage tanks and pumps, solar drying facilities with a decant pump station, and electrical equipment including an emergency generator. All of these components were estimated around a much smaller facility with no future infrastructure included for future expansion to 6 mgd. The 2016 cost estimate is shown in Table 1.13. The probable project cost estimate for the Sand Hollow GWTP as currently proposed is $9.7 M as summarized in Table 1.14.

The $2.9 M increase in cost between the 2016 cost estimate and the current cost estimate is a result of the inclusion of infrastructure necessary to expand the groundwater treatment plant to 6 mgd in the future in addition to further developed process treatment details and added flexibility. These details include larger drying beds to accommodate sludge drying and potential water storage in winter months, sand separators, a larger sodium hypochlorite on-site generation system, concrete paving, booster pumps to pump up to 1,000 gpm of treated water to the Dixie Springs tank, and single-cell flow control operation of the vessels for more operational control of the vessels. A bid market allowance is included estimating that the bid climate will be positive (multiple bidders) due to the current favorable economy however still including some allowance if the bidding turnout is lower than anticipated. The overall contingency was maintained at 20 percent at this bid level but will be lowered as the 60 percent cost estimate is formulated during design.

Table 1.13 2016 Cost Estimate for Sand Hollow GWTP

Item		Total
Site Civil		$524,000
3 mgd Treatment Building		$1,260,000
Backwash Clarifier Tank		$321,000
Decant Pump Station		$322,000
Solids Drying Beds		$358,000
Chlorination Facility		$608,000
Mob/DeMob	@9%	$528,000
Electrical and I&C	@ 20%	$785,000
HVAC	@ 4.5%	$177,000
Total Direct Cost		**$4,883,000**
Contingency	@ 20%	$977,000
Total Estimated Construction Cost		**$5,860,000**
Engineering, Legal & Admin	@ 16%	$938,000
Total Estimated Project Cost		**$6,798,000**

Table 1.14 Current Cost Estimate for Sand Hollow GWTP

Item		Total
Site Civil		$1,255,000
3 mgd Treatment Building		$2,556,000
Backwash Clarifier Tank		$530,000
Decant Pump Station		$48,000
Solids Drying Beds		$452,000
Electrical and I&C	@ 20%	$969,000
HVAC	@ 5%	$243,000
Total Direct Cost		**$6,054,000**
Contingency	@ 25%	$1,211,000
Escalation to Mid-Point	@ 3%	$218,000
Bid Market Allowance	@ 12%	$898,000
Total Estimated Construction Cost		**$8,380,000**
Engineering, Legal & Admin	@ 16%	$1,341,000
Total Estimated Project Cost		**$9,721,000**

The Sand Hollow GWTP has a lower cost estimate than the Gunlock WTF. Gunlock is more expensive primarily because it has two filter vessels instead of one, a larger site layout, two backwash clarifier tanks instead of one, and four drying beds instead of three. These additional costs are more significant than the additional cost at Sand Hollow associated with the additional pump station for the Dixie Springs tank as well as a more complex bypass system for the Sand Hollow well field.

Appendix A

ELECTRICAL LOAD STUDY REPORTS

Carollo Engineers...Working Wonders With Water™

LOAD STUDY REPORT

RESERVOIR™

PROJECT INFORMATION

PROJECT	GUNLOCK WATER TREATMENT FACILITY DESIGN
CLIENT	CITY OF ST. GEORGE
PROJECT NUMBER	11185A10
REPORT BY	MARISSA PETTY
REPORT DATE	11/9/2018 1:23 PM

EQUIPMENT INFORMATION

TAG	MCC		
DESCRIPTION	GUNLOCK	PHASE, WIRE, KASC	3PH, 3W, 65 KAIC KASC
LOCATION	TREATMENT BUILDING	LARGEST MOTOR	15HP
VOLTAGE	480	COMMENTS	
BUS AMPS	600		

LOAD TOTALS

OPERATING KVA	OPERATING AMPS
184.2	221.6

NEC 215 EQUIPMENT SIZING

EQUIPMENT KVA	EQUIPMENT AMPS
230.3	277.0

NEC 430 EQUIPMENT SIZING

EQUIPMENT KVA	EQUIPMENT AMPS
213.6	256.9

DEFINITIONS

OPERATING = CONTINUOUS + INTERMITTENT

NEC 215 EQUIPMENT SIZING = 1.25 x CONTINUOUS + 1.0 x INTERMITTENT (BASED ON NEC ARTICLE 215)

NEC 430 EQUIPMENT SIZING = 1.25 x LARGEST MOTOR + 1.0 x ALL OTHER MOTORS + 1.25 x CONTINUOUS NON-MOTOR + 1.0 x INTERMITTENT NON-MOTOR (BASED ON NEC ARTICLE 430)

EQUIPMENT SIZING IS BASED ON THE LARGER OF NEC 215 AND NEC 430 CALCULATIONS (LARGER IS HIGHLIGHTED WHEN APPLICABLE)

Note: For 3-phase busses that feed single -phase loads, the amp summation under loads will not match the bus amps due to the difference in voltage.

Note: The values in this report are rounded from higher precision numbers. Manually summing the values shown may yield slightly varied results due to rounding error.

SUBFED EQUIPMENT

TAG	DESCRIPTION	EQUIPMENT SIZE	EQUIPMENT UNITS	STATUS	OPERATING KVA	OPERATING AMPS	BUS COMMENTS
PP-1		100.0	AMPS	NEW	14.6	17.6	
PP-2		100.0	AMPS	NEW	14.6	17.6	
				OPERATING LOAD SUBFED SUBTOTAL	29.3	35.2	

LOADS

TAG	DESCRIPTION	LOAD VALUE	LOAD UNITS	STARTING METHOD	LOAD DESIGNATION	LOAD STATUS	OPERATING KVA	OPERATING AMPS	COMMENTS
	CHEMICAL PUMPS	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
BLO-01-01	AIR SCOUR BLOWER	15	HP	FVNR	DUTY / CONTINUOUS	NEW	17.5	21.0	
BUILDING LOADS	HVAC AND LIGHTING	100	KVA		DUTY / CONTINUOUS	NEW	100.0	120.3	
EAM-01-17	BYPASS FCV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EDR-01-17	RUPTURE BFV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
PMP-01-01	FLASH MIX PUMP	3	HP	VFD-6	DUTY / CONTINUOUS	NEW	4.0	4.8	
PMP-01-02	FILTER DRAIN PUMP	2	HP	FVNR	DUTY / CONTINUOUS	NEW	2.8	3.4	
EDR-02-01	CLARIFIER 1 BFV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EDR-02-02	CLARIFIER 2 BFV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
PMP-02-01	BWW RETURN PUMP	10	HP	FVNR	DUTY / CONTINUOUS	NEW	11.6	14.0	
PMP-02-02	BWW RETURN PUMP	10	HP	FVNR	DUTY / CONTINUOUS	NEW	11.6	14.0	
PMP-02-03	BWW RETURN PUMP	10	HP	FVNR	STANDBY	NEW	11.6	14.0	

Date/Time displayed in this report reflect time in PST

Carollo Engineers...Working Wonders With Water™

LOAD STUDY REPORT

RESERVOIR™

PROJECT INFORMATION

PROJECT	GUNLOCK WATER TREATMENT FACILITY DESIGN
CLIENT	CITY OF ST. GEORGE
PROJECT NUMBER	11185A10
REPORT BY	MARISSA PETTY
REPORT DATE	11/9/2018 1:23 PM

EQUIPMENT INFORMATION

TAG	MCC		
DESCRIPTION	GUNLOCK	**PHASE, WIRE, KASC**	3PH, 3W, 65 KAIC KASC
LOCATION	TREATMENT BUILDING	**LARGEST MOTOR**	15HP
VOLTAGE	480	**COMMENTS**	
BUS AMPS	600		

LOADS

TAG	DESCRIPTION	LOAD VALUE	LOAD UNITS	STARTING METHOD	LOAD DESIGNATION	LOAD STATUS	OPERATING KVA	OPERATING AMPS	COMMENTS
PMP-02-04	DECANT RETURN PUMP	2	HP	FVNR	DUTY / CONTINUOUS	NEW	2.8	3.4	
					OPERATING LOAD SUBTOTAL		166.6	200.4	

Date/Time displayed in this report reflect time in PST

LOAD STUDY REPORT

PROJECT INFORMATION

PROJECT	GUNLOCK WATER TREATMENT FACILITY DESIGN
CLIENT	CITY OF ST. GEORGE
PROJECT NUMBER	11185A10
REPORT BY	MARISSA PETTY
REPORT DATE	11/9/2018 1:23 PM

EQUIPMENT INFORMATION

TAG	PP-1		
DESCRIPTION		PHASE, WIRE, KASC	3PH, 3W, 65 KAIC KASC
LOCATION		LARGEST MOTOR	0HP
VOLTAGE	480	COMMENTS	
BUS AMPS	100		

LOAD TOTALS

OPERATING KVA	OPERATING AMPS
14.6	17.6

NEC 215 EQUIPMENT SIZING

EQUIPMENT KVA	EQUIPMENT AMPS
18.3	22.0

NEC 430 EQUIPMENT SIZING

EQUIPMENT KVA	EQUIPMENT AMPS
14.9	17.9

DEFINITIONS

OPERATING = CONTINUOUS + INTERMITTENT

NEC 215 EQUIPMENT SIZING = 1.25 x CONTINUOUS + 1.0 x INTERMITTENT (BASED ON NEC ARTICLE 215)

NEC 430 EQUIPMENT SIZING = 1.25 x LARGEST MOTOR + 1.0 x ALL OTHER MOTORS + 1.25 x CONTINUOUS NON-MOTOR + 1.0 x INTERMITTENT NON-MOTOR (BASED ON NEC ARTICLE 430)

EQUIPMENT SIZING IS BASED ON THE LARGER OF NEC 215 AND NEC 430 CALCULATIONS (LARGER IS HIGHLIGHTED WHEN APPLICABLE)

Note: For 3-phase busses that feed single -phase loads, the amp summation under loads will not match the bus amps due to the difference in voltage.

Note: The values in this report are rounded from higher precision numbers. Manually summing the values shown may yield slightly varied results due to rounding error.

LOADS

TAG	DESCRIPTION	LOAD VALUE	LOAD UNITS	STARTING METHOD	LOAD DESIGNATION	LOAD STATUS	OPERATING KVA	OPERATING AMPS	COMMENTS
EAM-01-01	PV 1 CELL 1 FILTER EFFLUENT FCV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EAM-01-02	PV 1 CELL 2 FILTER EFFLUENT FCV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EAM-01-03	PV 1 CELL 3 FILTER EFFLUENT FCV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EAM-01-04	PV 1 CELL 4 FILTER EFFLUENT FCV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EAM-01-09	PV 1 CELL 1 BWW FCV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EAM-01-10	PV 1 CELL 2 BWW FCV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EAM-01-11	PV 1 CELL 3 BWW FCV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EAM-01-12	PV 1 CELL 4 BWW FCV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EDR-01-01	PV 1 CELL 1 FILTER INLET BFV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EDR-01-02	PV 1 CELL 2 FILTER INLET BFV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EDR-01-03	PV 1 CELL 3 FILTER INLET BFV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EDR-01-04	PV 1 CELL 4 FILTER INLET BFV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EDR-01-09	PV 1 CELL 1 AIR SCOUR INLET	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EDR-01-10	PV 1 CELL 2 AIR SCOUR INLET	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EDR-01-11	PV 1 CELL 3 AIR SCOUR INLET	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EDR-01-12	PV 1 CELL 4 AIR SCOUR INLET	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
					OPERATING LOAD SUBTOTAL		14.6	17.6	

Date/Time displayed in this report reflect time in PST

LOAD STUDY REPORT

Carollo Engineers...Working Wonders With Water™ — RESERVOIR™

PROJECT INFORMATION

PROJECT	GUNLOCK WATER TREATMENT FACILITY DESIGN
CLIENT	CITY OF ST. GEORGE
PROJECT NUMBER	11185A10
REPORT BY	MARISSA PETTY
REPORT DATE	11/9/2018 1:23 PM

EQUIPMENT INFORMATION

TAG	PP-2		
DESCRIPTION		PHASE, WIRE, KASC	3PH, 3W, 65 KAIC KASC
LOCATION		LARGEST MOTOR	0HP
VOLTAGE	480	COMMENTS	
BUS AMPS	100		

LOAD TOTALS

OPERATING KVA	OPERATING AMPS
14.6	17.6

NEC 215 EQUIPMENT SIZING

EQUIPMENT KVA	EQUIPMENT AMPS
18.3	22.0

NEC 430 EQUIPMENT SIZING

EQUIPMENT KVA	EQUIPMENT AMPS
14.9	17.9

DEFINITIONS

OPERATING = CONTINUOUS + INTERMITTENT

NEC 215 EQUIPMENT SIZING = 1.25 x CONTINUOUS + 1.0 x INTERMITTENT (BASED ON NEC ARTICLE 215)

NEC 430 EQUIPMENT SIZING = 1.25 x LARGEST MOTOR + 1.0 x ALL OTHER MOTORS + 1.25 x CONTINUOUS NON-MOTOR + 1.0 x INTERMITTENT NON-MOTOR (BASED ON NEC ARTICLE 430)

EQUIPMENT SIZING IS BASED ON THE LARGER OF NEC 215 AND NEC 430 CALCULATIONS (LARGER IS HIGHLIGHTED WHEN APPLICABLE)

Note: For 3-phase busses that feed single -phase loads, the amp summation under loads will not match the bus amps due to the difference in voltage.

Note: The values in this report are rounded from higher precision numbers. Manually summing the values shown may yield slightly varied results due to rounding error.

LOADS

TAG	DESCRIPTION	LOAD VALUE	LOAD UNITS	STARTING METHOD	LOAD DESIGNATION	LOAD STATUS	OPERATING KVA	OPERATING AMPS	COMMENTS
EAM-01-05	PV 2 CELL 1 FILTER EFFLUENT FCV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EAM-01-06	PV 2 CELL 2 FILTER EFFLUENT FCV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EAM-01-07	PV 2 CELL 3 FILTER EFFLUENT FCV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EAM-01-08	PV 2 CELL 4 FILTER EFFLUENT FCV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EAM-01-13	PV 2 CELL 1 BWW FCV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EAM-01-14	PV 2 CELL 2 BWW FCV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EAM-01-15	PV 2 CELL 3 BWW FCV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EAM-01-16	PV 2 CELL 4 BWW FCV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EDR-01-05	PV 2 CELL 1 FILTER INLET BFV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EDR-01-06	PV 2 CELL 2 FILTER INLET BFV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EDR-01-07	PV 2 CELL 3 FILTER INLET BFV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EDR-01-08	PV 2 CELL 4 FILTER INLET BFV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EDR-01-13	PV 2 CELL 1 AIR SCOUR INLET	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EDR-01-14	PV 2 CELL 2 AIR SCOUR INLET	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EDR-01-15	PV 2 CELL 3 AIR SCOUR INLET	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EDR-01-16	PV 2 CELL 4 AIR SCOUR INLET	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
					OPERATING LOAD SUBTOTAL		14.6	17.6	

Date/Time displayed in this report reflect time in PST

Engineers...Working Wonders With Water™

LOAD STUDY REPORT

PROJECT INFORMATION

PROJECT	SAND HOLLOW GROUNDWATER TREATMENT PLANT DESIGN
CLIENT	WASHINGTON COUNTY WATER CONSERVANCY DISTRICT
PROJECT NUMBER	11186A10
REPORT BY	MARISSA PETTY
REPORT DATE	11/9/2018 1:38 PM

EQUIPMENT INFORMATION

TAG	MCC		
DESCRIPTION	SAND HOLLOW	**PHASE, WIRE, KASC**	3PH, 3W, 65 KAIC KASC
LOCATION	TREATMENT BUILDING	**LARGEST MOTOR**	15HP
VOLTAGE	480	**COMMENTS**	
BUS AMPS	600		

LOAD TOTALS

OPERATING KVA	OPERATING AMPS
184.2	221.6

NEC 215 EQUIPMENT SIZING

EQUIPMENT KVA	EQUIPMENT AMPS
230.3	277.0

NEC 430 EQUIPMENT SIZING

EQUIPMENT KVA	EQUIPMENT AMPS
213.6	256.9

DEFINITIONS

OPERATING = CONTINUOUS + INTERMITTENT

NEC 215 EQUIPMENT SIZING = 1.25 x CONTINUOUS + 1.0 x INTERMITTENT (BASED ON NEC ARTICLE 215)

NEC 430 EQUIPMENT SIZING = 1.25 x LARGEST MOTOR + 1.0 x ALL OTHER MOTORS + 1.25 x CONTINUOUS NON-MOTOR + 1.0 x INTERMITTENT NON-MOTOR (BASED ON NEC ARTICLE 430)

EQUIPMENT SIZING IS BASED ON THE LARGER OF NEC 215 AND NEC 430 CALCULATIONS (LARGER IS HIGHLIGHTED WHEN APPLICABLE)

Note: For 3-phase busses that feed single -phase loads, the amp summation under loads will not match the bus amps due to the difference in voltage.

Note: The values in this report are rounded from higher precision numbers. Manually summing the values shown may yield slightly varied results due to rounding error.

SUBFED EQUIPMENT

TAG	DESCRIPTION	EQUIPMENT SIZE	EQUIPMENT UNITS	STATUS	OPERATING KVA	OPERATING AMPS	BUS COMMENTS
PP-1		100.0	AMPS	NEW	14.6	17.6	
PP-2		100.0	AMPS	NEW	14.6	17.6	
				OPERATING LOAD SUBFED SUBTOTAL	29.3	35.2	

LOADS

TAG	DESCRIPTION	LOAD VALUE	LOAD UNITS	STARTING METHOD	LOAD DESIGNATION	LOAD STATUS	OPERATING KVA	OPERATING AMPS	COMMENTS
	CHEMICAL PUMPS	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
BLO-01-01	AIR SCOUR BLOWER	15	HP	FVNR	DUTY / CONTINUOUS	NEW	17.5	21.0	
BUILDING LOADS	HVAC AND LIGHTING	100	KVA		DUTY / CONTINUOUS	NEW	100.0	120.3	
EAM-01-17	BYPASS FCV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EDR-01-17	RUPTURE BFV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
PMP-01-01	FLASH MIX PUMP	3	HP	VFD-6	DUTY / CONTINUOUS	NEW	4.0	4.8	
PMP-01-02	FILTER DRAIN PUMP	2	HP	FVNR	DUTY / CONTINUOUS	NEW	2.8	3.4	
EDR-02-01	CLARIFIER 1 BFV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EDR-02-02	CLARIFIER 2 BFV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
PMP-02-01	BWW RETURN PUMP	10	HP	FVNR	DUTY / CONTINUOUS	NEW	11.6	14.0	
PMP-02-02	BWW RETURN PUMP	10	HP	FVNR	DUTY / CONTINUOUS	NEW	11.6	14.0	

Date/Time displayed in this report reflect time in PST

Carollo Engineers...Working Wonders With Water™

LOAD STUDY REPORT

RESERVOIR™

PROJECT INFORMATION

PROJECT	SAND HOLLOW GROUNDWATER TREATMENT PLANT DESIGN
CLIENT	WASHINGTON COUNTY WATER CONSERVANCY DISTRICT
PROJECT NUMBER	11186A10
REPORT BY	MARISSA PETTY
REPORT DATE	11/9/2018 1:38 PM

EQUIPMENT INFORMATION

TAG	MCC		
DESCRIPTION	SAND HOLLOW	**PHASE, WIRE, KASC**	3PH, 3W, 65 KAIC KASC
LOCATION	TREATMENT BUILDING	**LARGEST MOTOR**	15HP
VOLTAGE	480	**COMMENTS**	
BUS AMPS	600		

LOADS

TAG	DESCRIPTION	LOAD VALUE	LOAD UNITS	STARTING METHOD	LOAD DESIGNATION	LOAD STATUS	OPERATING KVA	OPERATING AMPS	COMMENTS
PMP-02-03	BWW RETURN PUMP	10	HP	FVNR	STANDBY	NEW	11.6	14.0	
PMP-02-04	DECANT RETURN PUMP	2	HP	FVNR	DUTY / CONTINUOUS	NEW	2.8	3.4	
						OPERATING LOAD SUBTOTAL	166.6	200.4	

Date/Time displayed in this report reflect time in PST

LOAD STUDY REPORT

PROJECT INFORMATION

PROJECT	SAND HOLLOW GROUNDWATER TREATMENT PLANT DESIGN
CLIENT	WASHINGTON COUNTY WATER CONSERVANCY DISTRICT
PROJECT NUMBER	11186A10
REPORT BY	MARISSA PETTY
REPORT DATE	11/9/2018 1:38 PM

EQUIPMENT INFORMATION

TAG	PP-1		
DESCRIPTION		PHASE, WIRE, KASC	3PH, 3W, 65 KAIC KASC
LOCATION	TREATMENT BUILDING	LARGEST MOTOR	0HP
VOLTAGE	480	COMMENTS	
BUS AMPS	100		

LOAD TOTALS

OPERATING KVA	OPERATING AMPS
14.6	17.6

NEC 215 EQUIPMENT SIZING

EQUIPMENT KVA	EQUIPMENT AMPS
18.3	22.0

NEC 430 EQUIPMENT SIZING

EQUIPMENT KVA	EQUIPMENT AMPS
14.9	17.9

DEFINITIONS

OPERATING = CONTINUOUS + INTERMITTENT

NEC 215 EQUIPMENT SIZING = 1.25 x CONTINUOUS + 1.0 x INTERMITTENT (BASED ON NEC ARTICLE 215)

NEC 430 EQUIPMENT SIZING = 1.25 x LARGEST MOTOR + 1.0 x ALL OTHER MOTORS + 1.25 x CONTINUOUS NON-MOTOR + 1.0 x INTERMITTENT NON-MOTOR (BASED ON NEC ARTICLE 430)

EQUIPMENT SIZING IS BASED ON THE LARGER OF NEC 215 AND NEC 430 CALCULATIONS (LARGER IS HIGHLIGHTED WHEN APPLICABLE)

Note: For 3-phase busses that feed single -phase loads, the amp summation under loads will not match the bus amps due to the difference in voltage.

Note: The values in this report are rounded from higher precision numbers. Manually summing the values shown may yield slightly varied results due to rounding error.

LOADS

TAG	DESCRIPTION	LOAD VALUE	LOAD UNITS	STARTING METHOD	LOAD DESIGNATION	LOAD STATUS	OPERATING KVA	OPERATING AMPS	COMMENTS
EAM-01-01	PV 1 CELL 1 FILTER EFFLUENT FCV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EAM-01-02	PV 1 CELL 2 FILTER EFFLUENT FCV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EAM-01-03	PV 1 CELL 3 FILTER EFFLUENT FCV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EAM-01-04	PV 1 CELL 4 FILTER EFFLUENT FCV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EAM-01-09	PV 1 CELL 1 BWW FCV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EAM-01-10	PV 1 CELL 2 BWW FCV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EAM-01-11	PV 1 CELL 3 BWW FCV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EAM-01-12	PV 1 CELL 4 BWW FCV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EDR-01-01	PV 1 CELL 1 FILTER INLET BFV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EDR-01-02	PV 1 CELL 2 FILTER INLET BFV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EDR-01-03	PV 1 CELL 3 FILTER INLET BFV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EDR-01-04	PV 1 CELL 4 FILTER INLET BFV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EDR-01-09	PV 1 CELL 1 AIR SCOUR INLET	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EDR-01-10	PV 1 CELL 2 AIR SCOUR INLET	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EDR-01-11	PV 1 CELL 3 AIR SCOUR INLET	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EDR-01-12	PV 1 CELL 4 AIR SCOUR INLET	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
					OPERATING LOAD SUBTOTAL		14.6	17.6	

Date/Time displayed in this report reflect time in PST

Engineers...Working Wonders With Water™

LOAD STUDY REPORT

PROJECT INFORMATION

PROJECT	SAND HOLLOW GROUNDWATER TREATMENT PLANT DESIGN
CLIENT	WASHINGTON COUNTY WATER CONSERVANCY DISTRICT
PROJECT NUMBER	11186A10
REPORT BY	MARISSA PETTY
REPORT DATE	11/9/2018 1:38 PM

EQUIPMENT INFORMATION

TAG	PP-2		
DESCRIPTION		PHASE, WIRE, KASC	3PH, 3W, 65 KAIC KASC
LOCATION	TREATMENT BUILDING	LARGEST MOTOR	0HP
VOLTAGE	480	COMMENTS	
BUS AMPS	100		

LOAD TOTALS

OPERATING KVA	OPERATING AMPS
14.6	17.6

NEC 215 EQUIPMENT SIZING

EQUIPMENT KVA	EQUIPMENT AMPS
18.3	22.0

NEC 430 EQUIPMENT SIZING

EQUIPMENT KVA	EQUIPMENT AMPS
14.9	17.9

DEFINITIONS

OPERATING = CONTINUOUS + INTERMITTENT

NEC 215 EQUIPMENT SIZING = 1.25 x CONTINUOUS + 1.0 x INTERMITTENT (BASED ON NEC ARTICLE 215)

NEC 430 EQUIPMENT SIZING = 1.25 x LARGEST MOTOR + 1.0 x ALL OTHER MOTORS + 1.25 x CONTINUOUS NON-MOTOR + 1.0 x INTERMITTENT NON-MOTOR (BASED ON NEC ARTICLE 430)

EQUIPMENT SIZING IS BASED ON THE LARGER OF NEC 215 AND NEC 430 CALCULATIONS (LARGER IS HIGHLIGHTED WHEN APPLICABLE)

Note: For 3-phase busses that feed single -phase loads, the amp summation under loads will not match the bus amps due to the difference in voltage.

Note: The values in this report are rounded from higher precision numbers. Manually summing the values shown may yield slightly varied results due to rounding error.

LOADS

TAG	DESCRIPTION	LOAD VALUE	LOAD UNITS	STARTING METHOD	LOAD DESIGNATION	LOAD STATUS	OPERATING KVA	OPERATING AMPS	COMMENTS
EAM-01-05	PV 2 CELL 1 FILTER EFFLUENT FCV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EAM-01-06	PV 2 CELL 2 FILTER EFFLUENT FCV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EAM-01-07	PV 2 CELL 3 FILTER EFFLUENT FCV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EAM-01-08	PV 2 CELL 4 FILTER EFFLUENT FCV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EAM-01-13	PV 2 CELL 1 BWW FCV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EAM-01-14	PV 2 CELL 2 BWW FCV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EAM-01-15	PV 2 CELL 3 BWW FCV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EAM-01-16	PV 2 CELL 4 BWW FCV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EDR-01-05	PV 2 CELL 1 FILTER INLET BFV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EDR-01-06	PV 2 CELL 2 FILTER INLET BFV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EDR-01-07	PV 2 CELL 3 FILTER INLET BFV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EDR-01-08	PV 2 CELL 4 FILTER INLET BFV	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EDR-01-13	PV 2 CELL 1 AIR SCOUR INLET	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EDR-01-14	PV 2 CELL 2 AIR SCOUR INLET	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EDR-01-15	PV 2 CELL 3 AIR SCOUR INLET	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
EDR-01-16	PV 2 CELL 4 AIR SCOUR INLET	1/2	HP	FVNR	DUTY / CONTINUOUS	NEW	0.9	1.1	
					OPERATING LOAD SUBTOTAL		14.6	17.6	

Date/Time displayed in this report reflect time in PST

Appendix B

REQUIRED HEAD CALCULATIONS

Well 1

Friction Losses	
Pipe Label	Headloss (ft)
P26	0.2
P14	3.5
P18	2.1
P24	0.4
P10	6.8
P15	3.8
P11	6.3
Total Friction Head	23.1
Elevation Head	
Pipe Line High Point	3555
Well Ground Elevation	3484
Desired Pressure at High Point	5 psi
Total Elevation Head	73.2
Head Loss Through Treatment Plant (ft)	0
Total Req'd Head at Ground Surface of Well (ft)	97

Well 2

Friction Losses	
Pipe Label	Headloss (ft)
P25	0.4
P17	2.4
P15	3.8
P11	6.3
Total Friction Head	12.9
Elevation Head	
Pipe Line High Point	3555
Well Ground Elevation	3581
Desired Pressure at High Point	5 psi
Total Elevation Head	-23.8
Head Loss Through Treatment Plant (ft)	0
Total Req'd Head at Ground Surface of Well (ft)	0

Well 3	
Friction Losses	
Pipe Label	Headloss (ft)
P19	1.6
P18	2.1
P24	0.4
P10	6.8
P15	3.8
P11	6.3
Total Friction Head	21.0
Elevation Head	
Pipe Line High Point	3555
Well Ground Elevation	3447
Desired Pressure at High Point	5 psi
Total Elevation Head	110.2
Head Loss Through Treatment Plant (ft)	0
Total Req'd Head at Ground Surface of Well (ft)	132

Well 4	
Friction Losses	
Pipe Label	Headloss (ft)
P8	7.5
P14	3.5
P18	2.1
P24	0.4
P10	6.8
P15	3.8
P11	6.3
Total Friction Head	30.4
Elevation Head	
Pipe Line High Point	3555
Well Ground Elevation	3449
Desired Pressure at High Point	5 psi
Total Elevation Head	108.2
Head Loss Through Treatment Plant (ft)	0
Total Req'd Head at Ground Surface of Well (ft)	139

Well 5

Friction Losses	
Pipe Label	Headloss (ft)
P16	3.8
P5	12.7
P6	11.6
P10	6.8
P15	3.8
P11	6.3
Total Friction Head	45.0
Elevation Head	
Pipe Line High Point	3555
Well Ground Elevation	3445
Desired Pressure at High Point	5 psi
Total Elevation Head	112.2
Head Loss Through Treatment Plant (ft)	25
Total Req'd Head at Ground Surface of Well (ft)	183

Well 6

Friction Losses	
Pipe Label	Headloss (ft)
P9	6.9
P17	2.4
P15	3.8
P11	6.3
Total Friction Head	19.4
Elevation Head	
Pipe Line High Point	3555
Well Ground Elevation	3601
Desired Pressure at High Point	5 psi
Total Elevation Head	-43.8
Head Loss Through Treatment Plant (ft)	0
Total Req'd Head at Ground Surface of Well (ft)	0

Well 7	
Friction Losses	
Pipe Label	Headloss (ft)
P20	1.1
P6	11.6
P10	6.8
P15	3.8
P11	6.3
Total Friction Head	29.6
Elevation Head	
Pipe Line High Point	3555
Well Ground Elevation	3488
Desired Pressure at High Point	5 psi
Total Elevation Head	69.2
Head Loss Through Treatment Plant (ft)	25
Total Req'd Head at Ground Surface of Well (ft)	124

Well 8	
Friction Losses	
Pipe Label	Headloss (ft)
P22	1.0
P7	10.5
P10	6.8
P15	3.8
P11	6.3
Total Friction Head	28.4
Elevation Head	
Pipe Line High Point	3555
Well Ground Elevation	3454
Desired Pressure at High Point	5 psi
Total Elevation Head	103.2
Head Loss Through Treatment Plant (ft)	25
Total Req'd Head at Ground Surface of Well (ft)	157

Well 9	
Friction Losses	
Pipe Label	Headloss (ft)
P23	0.6
P5	12.7
P6	11.6
P10	6.8
P15	3.8
P11	6.3
Total Friction Head	41.8
Elevation Head	
Pipe Line High Point	3555
Well Ground Elevation	3480
Desired Pressure at High Point	5 psi
Total Elevation Head	77.2
Head Loss Through Treatment Plant (ft)	25
Total Req'd Head at Ground Surface of Well (ft)	144

Well 10	
Friction Losses	
Pipe Label	Headloss (ft)
P13	5.6
P3	27.9
P6	11.6
P10	6.8
P15	3.8
P11	6.3
Total Friction Head	62.0
Elevation Head	
Pipe Line High Point	3555
Well Ground Elevation	3468
Desired Pressure at High Point	5 psi
Total Elevation Head	89.2
Head Loss Through Treatment Plant (ft)	25
Total Req'd Head at Ground Surface of Well (ft)	177

Well 11	
Friction Losses	
Pipe Label	Headloss (ft)
P4	22.0
P3	27.9
P6	11.6
P10	6.8
P15	3.8
P11	6.3
Total Friction Head	78.4
Elevation Head	
Pipe Line High Point	3555
Well Ground Elevation	3484
Desired Pressure at High Point	5 psi
Total Elevation Head	73.2
Head Loss Through Treatment Plant (ft)	25
Total Req'd Head at Ground Surface of Well (ft)	177

Well 5	
Friction Losses	
Pipe Label	Headloss (ft)
P18	2.2
P19	1.1
P8	0.3
P6	11.7
Total Friction Head	15.2
Elevation Head	
Pipe Line High Point	3107
Well Ground Elevation	3015.5
Desired Pressure at High Point	5 psi
Total Elevation Head	93.7
Head Loss Through Treatment Plant (ft)	25
Total Req'd Head at Ground Surface of Well (ft)	134

Well 6	
Friction Losses	
Pipe Label	Headloss (ft)
P1	0.0
P19	1.1
P8	0.3
P6	11.7
Total Friction Head	13.1
Elevation Head	
Pipe Line High Point	3107
Well Ground Elevation	3023.5
Desired Pressure at High Point	5 psi
Total Elevation Head	85.7
Head Loss Through Treatment Plant (ft)	25
Total Req'd Head at Ground Surface of Well (ft)	124

Well 10

Friction Losses	
Pipe Label	Headloss (ft)
P14	0.9
P12	1.1
P8	0.3
P6	11.7
Total Friction Head	14.0
Elevation Head	
Pipe Line High Point	3107
Well Ground Elevation	3018
Desired Pressure at High Point	5 psi
Total Elevation Head	91.2
Head Loss Through Treatment Plant (ft)	25
Total Req'd Head at Ground Surface of Well (ft)	131

Well 11

Friction Losses	
Pipe Label	Headloss (ft)
P13	1.2
P4	2.8
P9	0.2
P12	1.1
P8	0.3
P6	11.7
Total Friction Head	17.3
Elevation Head	
Pipe Line High Point	3107
Well Ground Elevation	2975
Desired Pressure at High Point	5 psi
Total Elevation Head	134.2
Head Loss Through Treatment Plant (ft)	25
Total Req'd Head at Ground Surface of Well (ft)	177

Well 12	
Friction Losses	
Pipe Label	Headloss (ft)
P15	0.2
P2	1.5
P3	3.6
P4	2.8
P9	0.2
P12	1.1
P8	0.3
P6	11.7
Total Friction Head	21.4
Elevation Head	
Pipe Line High Point	3107
Well Ground Elevation	2970
Desired Pressure at High Point	5 psi
Total Elevation Head	139.2
Head Loss Through Treatment Plant (ft)	25
Total Req'd Head at Ground Surface of Well (ft)	186

Well 13	
Friction Losses	
Pipe Label	Headloss (ft)
P11	1.7
P3	3.6
P4	2.8
P9	0.2
P12	1.1
P8	0.3
P6	11.7
Total Friction Head	21.4
Elevation Head	
Pipe Line High Point	3107
Well Ground Elevation	2985
Desired Pressure at High Point	5 psi
Total Elevation Head	124.2
Head Loss Through Treatment Plant (ft)	25
Total Req'd Head at Ground Surface of Well (ft)	171

Well 15	
Friction Losses	
Pipe Label	Headloss (ft)
P10	0.3
P2	1.5
P3	3.6
P4	2.8
P9	0.2
P12	1.1
P8	0.3
P6	11.7
Total Friction Head	21.4
Elevation Head	
Pipe Line High Point	3107
Well Ground Elevation	3005
Desired Pressure at High Point	5 psi
Total Elevation Head	104.2
Head Loss Through Treatment Plant (ft)	25
Total Req'd Head at Ground Surface of Well (ft)	151

Well 17	
Friction Losses	
Pipe Label	Headloss (ft)
P7	2.7
P6	11.7
Total Friction Head	14.4
Elevation Head	
Pipe Line High Point	3107
Well Ground Elevation	3027
Desired Pressure at High Point	5 psi
Total Elevation Head	82.2
Head Loss Through Treatment Plant (ft)	25
Total Req'd Head at Ground Surface of Well (ft)	122

West Dam Springs to 2 MG Tank

Friction Losses	
Pipe Label	Headloss (ft)
P17	0.5
Total Friction Head	0.5
Elevation Head	
Full Tank Elevation	3158
Well Ground Elevation	3027
Desired Pressure at High Point	5 psi
Total Elevation Head	133.2
Head Loss Through Treatment Plant (ft)	25
Total Req'd Head at Ground Surface (ft)	159

West Dam Springs to SHRP

Friction Losses	
Pipe Label	Headloss (ft)
P16	0.0
P6	11.7
Total Friction Head	11.7
Elevation Head	
Pipe Line High Point	3107
Well Ground Elevation	3027
Desired Pressure at High Point	5 psi
Total Elevation Head	82.2
Head Loss Through Treatment Plant (ft)	25
Total Req'd Head at Ground Surface (ft)	119

WaterGEMS Headloss Calculations

Label	Length (ft)	Start Node	Stop Node	Diameter (inches)	Hazen Williams	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P1	11,422	J13	Gunlock Tank	18	130	3,819	4.81	48
P2	11,402	J12	Gunlock Tank	20	130	5,042	5.15	48
P3	1,896	J6	J1	10	130	1,600	6.54	27.9
P4	5,407	Well 11	J6	10	130	800	3.27	22
P5	866	J3	J1	10	130	1,600	6.54	12.7
P6	5,633	J1	J11	14	130	1,339	2.79	11.6
P7	4,744	J4	J11	20	130	3,561	3.64	10.5
P8	877	Well 4	J8	10	130	1,190	4.86	7.5
P9	1,841	Well 6	J2	8	130	425	2.71	6.9
P10	730	J11	J7	20	130	7,756	7.92	6.8
P11	1,496	J10	J12	20	130	5,042	5.15	6.3
P12	1,495	J10	J13	18	130	3,819	4.81	6.3
P13	464	Well 10	J6	8	130	800	5.11	5.6
P14	2,291	J8	J5	18	130	2,210	2.79	3.5
P15	2,313	J7	J10	30	130	8,861	4.02	3.8
P16	941	Well 5	J3	10	130	800	3.27	3.8
P17	5,772	J2	J7	18	130	1,105	1.39	2.4
P18	844	J5	J9	18	130	2,856	3.6	2.1
P19	194	Well 3	J5	8	130	646	4.12	1.6
P20	342	Well 7	J1	10	130	700	2.86	1.1
P21	893	J1	J4	20	130	2,561	2.62	1.1
P22	156	Well 8	J4	10	130	1,000	4.08	1
P23	52	Well 9	J3	8	130	800	5.11	0.6
P24	290	J9	J11	20	130	2,856	2.92	0.4
P25	2,086	Well 2	J2	18	130	680	0.86	0.4
P26	598	Well 1	J8	18	130	1,020	1.29	0.2

DWQ-2020-026049