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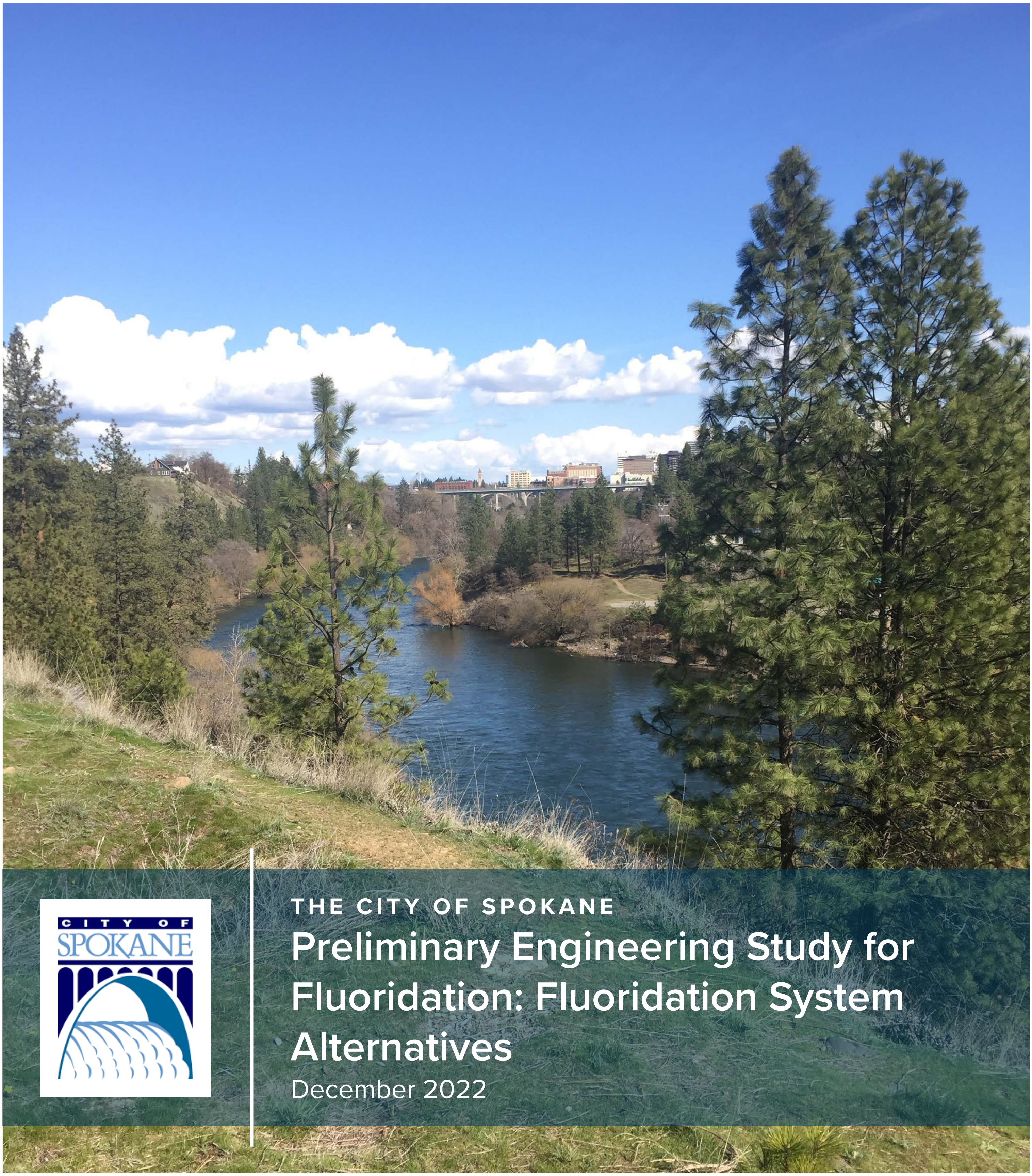

CITY OF SPOKANE

THE CITY OF SPOKANE

Preliminary Engineering Study for Fluoridation: Fluoridation System Alternatives

December 2022

Fluoridation System Alternatives

City of Spokane

December 2022

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CERTIFICATION

The technical material and data contained in this document were prepared under the supervision and direction of the undersigned, whose seal, as a professional engineer licensed to practice as such, is affixed below.

Prepared by Mike Morse, PE, Parametrix
Section 3.1.2.2

Prepared by Jacob Linke, PE, Parametrix
Sections 3.1.2.2 and 3.1.2.3

Prepared by Cameron Bui Carlson, PE, Parametrix
Sections 3.1.2.2 and 3.1.2.4

Acronyms & Abbreviations

A	
AWWA	American Water Works Assossication
C	
CDC	Centers for Disease Control
City	City of Spokane
D	
DOT	United States Department of Transportation
E	
EPA	United States Environmental Protection Agency
F	
FAA	Federal Aviation Administration
FSA	fluorosilicic acid
FTE	full-time equivalent
G	
GLUMRB	Great Lakes - Upper Mississippi River Board
H	
HVAC	heating, air conditioning, and ventilation
L	
LCCA	life cycle cost analysis
M	
MCL	Maximum Contaminant Level
mg/L	milligrams per liter
MGD	million gallons per day
MODA	multi-objective decision analysis
O	
OPCC	opinion of probable construction costs
P	
pH	Hydrogen Potiental
PLC	programable logic control
PPE	personal protective equipment
S	
SDS	safety data sheets
W	
WFI	Water Facilities Inventory
WA DOH	Washington State Department of Health

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SECTION 1

Section 1

Introduction

1.1 Purpose and Goals of this Alternatives Analysis

The City of Spokane (City) is conducting a preliminary engineering study of fluoridation implementation in the City's water system. The study is grant-funded. This Fluoridation System Alternatives Report provides an intermediate step in the development and assessment of the fluoridation implementation alternatives for the City's consideration. This Report provides input for the City to assess up to three different chemical alternatives in Task 6 of the engineering study scope, Alternatives Evaluation, and for the selection of a preferred alternative for the City to consider moving forward.

The evaluation of alternatives will be assessed through a multi-objective decision analysis (MODA) that will facilitate an objective and transparent process to select the preferred alternative based on the City's long-term goals of balancing sustainability, social responsibility, and affordability (City's Triple Bottom Line).

This Report evaluates the implementation of three fluoridation chemical alternatives: sodium fluoride, sodium fluorosilicate, and fluorosilicic acid (FSA). The defined alternatives include preliminary equipment sizing, a list of key equipment required, general process flow diagrams, general site and mechanical plan layouts based on anticipated sizes of each of the fluoridation systems and operations, maintenance, and safety considerations. A Class 5 opinion of probable construction costs (OPCC) and a concept-level 50-year life cycle cost analysis (LCCA) was developed based on equipment sizing along with operations and maintenance considerations.

1.2 Water System Overview

Fluoridation of the City's water system requires the retrofit of each of its seven existing well pump stations and a new well pump station currently under construction to add necessary fluoridation chemical feed systems. The nameplate capacities of each well station range from 15 million gallons per day (MGD) to 90 MGD. The demand on the City's water system changes greatly throughout the year, from a winter average of about 35 MGD to a summer peak of over 147 MGD, requiring careful consideration for operational effectiveness of the implemented fluoride chemical feed systems.

A detailed condition assessment of each of the well pump stations was completed in Spring 2022 and summarized in Well Facility Condition Assessment Report, September 2022. Table I-1 of the Well Facility Condition Assessment Report includes a Condition Assessment Matrix summarizing key condition assessment elements that were used for the development of the fluoridation system alternatives. The assessment determined that the future fluoridation facilities will likely need to be housed in a dedicated building. The existing well station buildings do not appear to have enough space to house a new fluoridation system. The exception is the Well Electric building, though extensive retrofits would likely be required to facilitate the new system, so the addition of a new fluoride feed facility at the Well Electric Well Station was assumed for this study.

SECTION 2

Section 2

Fluoridation System Overview

2.1 Overview of Chemical Options

Fluoridation injection systems in potable drinking water incorporate chemical addition processes that form fluoride ions in the finished water. The three common chemical injection alternatives are sodium fluoride, sodium fluorosilicate, and FSA. Sodium fluoride and sodium fluorosilicate are distributed as dry powder chemicals while FSA is distributed in liquid form. Because the facility requirements and operation and maintenance requirements are similar for both dry chemicals, and due to the severe supply chain and manufacturer limitations of sodium fluorosilicate, this Report focuses on comparing the differences between the liquid chemical and the dry chemicals. All three are further described below.

2.1.1 Sodium Fluoride

Sodium fluoride is sold as a colorless or white, odorless, low-dust granular chemical product. American Water Works Association (AWWA) Standard B701 covers its use in potable drinking water systems. Sodium fluoride has a favorable solubility characteristic: it dissolves within minutes to a near constant solubility (4 percent) at water temperatures normally experienced in potable water systems. At water temperatures typically encountered in chemical treatment equipment located in a building or from a well, a sodium fluoride solution will reach full saturation in about 5 minutes. Therefore, a saturator tank can be used to dissolve the chemical into water to create a solution for injection into the water system, meaning the chemical can be added directly to the saturator tank without precise chemical metering.

2.1.2 Sodium Fluorosilicate

Sodium fluorosilicate, also a dry fluoride product, is a white, odorless crystalline salt. American Water Works Association Standard B702 covers the use in potable drinking water systems. Like the sodium fluoride additive product, sodium fluorosilicate comes in a low-dust granular form that minimizes personnel exposure and risk of inhalation. Because sodium fluorosilicate is produced by partially neutralizing FSA, the hydrogen potential (pH) of a sodium fluorosilicate solution will range between 3.0 and 4.0.

Sodium fluorosilicate is normally fed as a dry salt to a tank sized for active mixing with a 5- to 10-minute detention. Unlike sodium fluoride, sodium fluorosilicate can take a long time to achieve full saturation, and its solubility varies with water temperature. Because sodium fluorosilicate does not become fully saturated and requires active mixing, it is unsuitable for use in saturator feed equipment (which is typically used for sodium fluoride). Hard water, lower water temperatures, and the product's crystalline character each can increase the time needed to dissolve the sodium fluorosilicate additive product to an acceptable concentration. Sodium fluorosilicate has a very slow dissolution rate as the solution approaches saturation. Up to several hours of firm mixing can be required to achieve saturation. Consequently, the preferred operating strategy is to prepare a dilute solution of less than one-half saturation.

Fluoridating with the sodium fluorosilicate additive product requires slightly larger quantities than are used with sodium fluoride. A larger dissolving tank is also required to create a chemical solution compared to the saturators that can be used for sodium fluoride.

Sodium fluorosilicate use has been declining since the 1970s and is the least used form of fluoride in municipal systems, currently.

2.1.3 Fluorosilicic Acid

An aqueous acidic solution with a pH of 1.2, FSA can range from colorless ("water-white") to a straw color. American Water Works Association Standard B703 covers the use in a potable drinking water system. Fluorosilicic acid's color comes from other substances in the solution, especially iodine and phosphoric acid. Fluorosilicic acid is a volatile acidic solution because trace amounts of hydrogen fluoride and silicon tetrafluoride gases evaporate from the liquid's surface.

The FSA additive solution is made up of about 74 percent water, with an FSA concentration ranging from 23 percent to 25 percent. The remaining one percent to three percent of the solution is made up of trace amounts of free acids: hydrogen fluoride, sulfuric acid, hydrochloric acid, phosphoric acid, and others. Shipping is a major component of FSA additive cost because three-quarters of the product volume is water. At a 25 percent concentration, FSA weighs 10.1 pounds per gallon, heavier than an equal amount of water.

2.2 Fluoridation Implementation Standards

The following industry technical standards define guidelines and recommendations for fluoridation implementation and align with Washington State Department of Health guidance. The industry technical standards that were referenced in the development of the design criteria for developing the alternatives include:

- Washington State Department of Health – Water Design Manual, June 2020 (WA DOH)
- AWWA Manual of Practice M4 – Water Fluoridation Principles and Practices (AWWA M4)
- Centers for Disease Control (CDC) and Prevention Guidelines (CDC)
- Great Lakes - Upper Mississippi River Board (GLUMRB) - often referred to as 10 States Standards

2.3 Design Criteria and Assumptions

Table 2-1 lists design criteria and assumptions which are the basis for the alternative concept-level design development used to establish a comparison between the chemical alternatives. Each assumption needs to be further evaluated and confirmed before design begins with the selected chemical alternative.

Table 2-1 | Design Criteria and Assumptions

Design Element	Assumption for Alternatives Analysis	Alternate Assumption Options	What does this assumption affect?
Chemical Storage Duration	Approximately 60 days (10 States Standards)	▪ 3 months (CDC) ▪ Match volume of delivery (AWWA M4)	Storage size/building size, chemical delivery frequency, operator chemical handling frequency
Chemical Storage Duration Demand Basis	Average daily demand when facility is operational	▪ No industry standard. ▪ Average month (Low storage) up to max month demand (High storage)	Storage size/building size, chemical delivery frequency, operator chemical handling frequency
Day Tank (liquid chemical only) Storage Duration	2 days of MDD	▪ Day tank recommended ▪ 30 hours (10 States Standards) ▪ 2 days (CDC) ▪ 3 days (AWWA M4) ▪ Note: industry standards do not specify a demand basis assumption- base day tank sizing on City preference	Day tank size, transfer pump size, operator day tank transfer frequency
Saturator (dry chemical only) Detention Time	Approx 6-ft diameter, 3.5-ft height	▪ Minimum depth of chemical 12 inches (CDC, AWWA M4) ▪ Saturator could be sized larger so that two super sacks could be dumped during one site visit	Saturator size, bulk bag unloader hopper size
Dry Chemical Storage	▪ Full hopper and one standby super sack ▪ Central storage facility	▪ Could store additional sacks onsite ▪ Saturator could be sized larger so that two super sacks could be dumped during one site visit	Building size, frequency to transport sacks
Metering Pumps	Assume two metering pumps for each well pump	▪ Depends on chemical injection point locations- to be refined during design. ▪ AWWA M4 recommends not injecting chlorine and fluoride in the same location.	Number and size of metering pumps, size of building, electrical requirements

2.4 Alternative Evaluation Criteria

Evaluation of the potential fluoridation system alternatives defined later in this Report will be done through both financial and non-financial analyses. The life-cycle cost estimates will be combined with the non-monetary analyses for an integrated alternatives analysis to support decision-making. **Table 2-2** defines non-financial criteria that were developed during the May 10, 2022 MODA Criteria Workshop. This workshop was attended by Katherine Miller (City), Loren Searl (City), Lee Odell (Murraysmith), Joe Foote (Murraysmith), Kristy Warren (Murraysmith), Aubrie Koenig (Murraysmith), Liz Kelly (Parametrix), Mark Mazzola (Parametrix), and Dana Rivera (Parametrix). The Summary of Alternatives section in this Report (**Table 4-1**) will include a summary of considerations for the City to use for scoring of the criteria during the Alternatives Workshop. Also, the Facility Summary in **Table 3-3** includes comments on criteria that are affected by the well station site.

Table 2-2 | Fluoridation Alternatives Analysis Non-Financial Criteria

Criteria No.	Criterion	Description	Weight
1	Environmental and Sustainability Impacts	Environmental impacts to the natural environment, such as those to critical areas or the aquifer, including those attributed to the supply chain, in the immediate vicinity of the facilities or the broader region. Includes impact on the city's sustainability goals.	12%
2	Neighborhood Impacts	Impacts to the built environment in the immediate neighborhood including cultural, aesthetic, historical preservation, and livability impacts such as those related to increased traffic, noise, air quality, and odors. Includes impacts during construction.	8%
3	Safety – Public	Potential public safety hazards in the immediate neighborhood as well as the broader region, including those related to increased truck traffic. Not including health impacts associated with consumption of fluoridated water. Includes hazards during construction.	25%
4	Safety – Worker	Potential worker safety hazards including chemical loading/unloading, exposure to chemicals, and other safety hazards such as slips, trips, falls, and confined space entry during facility operations and maintenance. Includes hazards during construction.	25%
5	Service Reliability	Ability to achieve desired reliability of the fluoridation system, including resiliency in extreme conditions. Consider overfeeding (which may require public notice due to termination of fluoridation) and the ability of the system to consistently achieve regulatory requirements, both near and long term. Consider outcomes at the customer tap.	15%
6	Ease of Maintenance and Operations	Relative ease of maintenance and operational activities, including training, certifications, and equipment needed, regular visits to the sites, renewal and rehabilitation needs. This criterion does not include cost, which will be included in the life cycle cost estimate, and not including worker safety, which should be considered the Safety – Worker criterion.	15%
			100%

SECTION 3

Section 3

Summary of Alternatives

3.1 Alternative Definition

For the potential fluoridation of the City's water system, three chemical alternatives as well as three chemical feed systems were reviewed. Based on initial research of the chemical availability and delivery limitations, two alternatives have been defined for evaluation.

The following is a brief description of the alternatives.

- Dry (Sodium fluoride)

  Incorporates a new structure at each of the existing well station sites, except for the Central Well Station, for a super sack bulk bag unloader and saturator tank, metering pumps, analyzers, electrical/control elements, and heating, air conditioning, and ventilation (HVAC). The Central Well Station site requires replacement of the existing electrical/chemical building to house the fluoridation equipment.

- Liquid (FSA)

  Incorporates a new structure at each of the existing well station sites, except for the Central Well Station, for bulk and day storage tanks with transfer/metering pumps, analyzers, electrical/control elements, and HVAC. The Central Well Station site requires replacement of the existing electrical/chemical building to house the fluoridation equipment.

Sodium fluorosilicate is not included as an alternative chemical for consideration, based on limitations of regional supply from vendors for bulk delivery. Additionally, bulk storage tanks/feed systems for the dry chemical option were not considered further, since chemical suppliers are not equipped to deliver sodium fluoride in bulk in the Pacific Northwest.

3.1.1 Major Equipment and Design Features – Requirements

Key equipment and design considerations for each chemical are summarized in **Table 3-1**. A concept-level equipment matrix for each well station fluoridation facility is shown in **Table 3-2**.

Table 3-1 | Key Equipment Considerations

Chemical	Dry Chemical	Liquid Chemical
Reserve Storage	30-day minimum. 1-ton super sacks or 50-lb bags. Super sacks can be stored at central location.	30-day minimum. HDPE tanks meeting ASTM 1998 standards.
Day Storage	Bags are dumped via a bulk bag unloader into a storage hopper with a vibrator to eliminate clumping or buildup	Day tank (1 to 3 days of storage) filled manually via transfer pump
Chemical Handling	Super sacks require a bulk bag unloader system with a crane and trolley. Forklift required to move super sacks. 50-lb bags can be transported on a palette and dumped into the hopper manually.	Truck pumps chemical to bulk storage.
Feed Hoppers	Volumetric and gravimetric feeder	N/A
Saturator	Saturator with radial distributor and gravel support bed. Saturator minimum bed depth > 12 inches. Preferred bed depth = 16-18 inches. 6-foot diameter, 3.5-foot depth assumed for alternatives definition.	N/A
Transference	PVC or cross-linked HDPE piping	PVC or cross-linked HDPE piping
Spill Protection	Containment required for saturator.	Entire FSA tank volume (day and bulk storage) plus an additional 10%. Containment at delivery hose building connection to catch transfer spills. Epoxy undercoat and a urethane top coat or spray-on manhole rehabilitation polyurethane to protect concrete.
Dust Control	Dust control unit and powder seal on bulk bag unloader unit	Not required, though ventilation required for acid fumes.
Building Notes	Storage should be secured in a dedicated room. Include roll-up door for forklift access.	Storage should be secured in a dedicated room. Include roll-up door for tank access.
Safety Equipment	Eyewash and shower station	Eyewash and shower station
Metering and Injection	Positive displacement metering pumps, injection quill with orifice-style mixer or pumped carrier water injection.	Positive displacement metering pumps, injection quill with orifice-style mixer or pumped carrier water injection.

Table 3-2 | Equipment by Well Station

Major Equipment	Well Electric	Parkwater	Ray	Central	Nevada/ Grace	Hoffman	Havana
Dry Chemical							
Super Sack Storage Onsite	1 in feed, 1 stored onsite						
Saturator Size	Approximately 6-ft diameter, 3.5-ft depth for all well stations. Assume tank is installed in a basement level adjacent to the bulk bag unloader						
Liquid Chemical							
Bulk Storage Onsite (gal)	4,400	4,400	2,500	2,500	5,400	750	4,400
Day Tank (gal)	250	410	160	160	410	55	250
Additional Chemical Equipment for Either Option							
Number of Metering Pumps	8	16	6	4	12	4	12
Number of Injection Points	4	8	3	2	6	2	6

3.1.2 Facility Requirements

Table 3-3 summarizes the requirements for constructing a new fluoridation facility to serve each well station including access, site impacts, building information, and electrical and controls requirements.

3.1.2.1 Permitting

As shown in **Table 3-3**, permits may include the following.

- Shoreline for Well Electric Well Station (City of Spokane)
- Conditional Use (City of Spokane, City of Spokane Valley for Havana Well Station)
- SEPA
- Historic/Architectural review for sites located in residential zones

Federal Aviation Administration (FAA) requirements for building heights will need to be considered for the Well Electric Well Station, which is near the Felts Field Airport.

The WA DOH will require a project report and description of improvements and final design documents for approval, including an updated Water Facilities Inventory (WFI). The City will also have to meet the water treatment certification requirements established by WA DOH.

3.1.2.2 General Site Requirements

As shown in **Table 3-3**, delivery truck access was evaluated for each site and incorporated into the site plans included in **Appendix A.** Driveways were sized for a 54-foot delivery truck, which would accommodate a large delivery of super sacks to multiple well stations in one trip. The proposed driveway footprints could be reduced depending on the City's desired dry chemical delivery schedule. A new driveway hardscape would likely require stormwater management facilities.

Table 3-3 | Facility Requirements Matrix

Facility Requirements Category	Well Electric	Parkwater	Ray	Central	Grace	Nevada	Hoffman	Havana
Permits	▪ Shoreline Permit. ▪ Confirm height requirements with FAA. ▪ Existing site partially within FEMA 100-year flood zone. ▪ SEPA review.	SEPA review.	▪ Conditional Use (Residential Zone). ▪ SEPA review. ▪ Historic/architectural review.	▪ Conditional Use (Residential Zone). ▪ SEPA review.	▪ No special permitting requirements. ▪ SEPA review.	▪ No special permitting requirements. ▪ SEPA review.	▪ Conditional Use (Residential Zone). ▪ SEPA review. ▪ Historic/architectural review.	▪ Permitting within City of Spokane Valley. ▪ Conditional Use (Residential Zone). ▪ SEPA review.
Access	▪ Via Waterworks St. No through access for large vehicles. Delivery route passes by several residential homes.	▪ Via E Rutter Ave. ▪ Delivery route passes by several residential homes (increased large vehicle traffic).	Passes through Residential Zones (increased large vehicle traffic).	Passes through Residential Zones for one block (increased large vehicle traffic).	Via North Foothills Drive or via the Water Department yard if added building has door(s) on its south side.	Via North Foothills Drive or via the Water Department yard if added building has door(s) on its south side.	▪ Via Hoffman Ave. ▪ Passes through Residential Zones (increased large vehicle traffic).	Passes through Residential Zones (increased large vehicle traffic).
Truck Turnaround	▪ Liquid media delivery truck (~22-ft. wheelbase) turning movement at the closed entrance gate feasible assuming delivery truck parks on westbound N Waterworks Street. ▪ Larger delivery truck (~54-ft. wheelbase) turning movement is feasible inside the site's perimeter fence within the area east of the site entrance road, south of the existing gravel road, and north of N Waterworks Street. ▪ Proposed gravel turnaround requires realignment to accommodate the turning movement and retaining wall to preserve existing police department access road.	▪ Liquid media delivery truck (~ 22-ft. wheelbase) turning movement at the west end of E Rutter Avenue is feasible within the existing 90-ft. diameter cul-de-sac. ▪ Larger delivery truck (~54-ft. wheelbase) turning movement at the west end of E Rutter Avenue is not feasible within the existing 90-ft. diameter cul-de-sac. ▪ The asphalt paved cul-de-sac with concrete curb and gutter is approximately 700 ft. west of the Parkwater well station site on E Rutter Avenue.	▪ Liquid media delivery truck (~22 ft. wheelbase) and solid media delivery truck (~54-ft. wheelbase) turning movements from southbound on S Ray Street to eastbound on E Hartson Avenue work with new pull through 30 ft. concrete driveways and new 24-ft. paved pull through with gravel shoulders. ▪ Larger vehicle turning movement is only feasible if there are no parked vehicles on the west side of S Ray Street and the south side of E Hartson Avenue. ▪ Pull through driveway to go around existing on-site tree at the NE corner of S Ray Street and E Hartson Avenue.	▪ Liquid media delivery truck (~22-ft. wheelbase) turning movement from eastbound on W Central Avenue to southbound on N Normandie Street works with wheel path tracking over the existing driveway concrete curb onto adjacent lawn, and with no parked cars on the east side of N Normandie Street. ▪ Larger delivery truck (~54-ft. wheelbase) turning movement is not feasible since wheel paths travel over W Central Avenue and N Normandie Street sidewalks, existing driveway south curb, and large swaths of on-site lawn areas.	▪ Delivery truck turn around is on site. ▪ City receives multiple deliveries at this site and sees no concern with liquid or dry bulk fluoride deliveries.	▪ Delivery truck turn around is on site. ▪ City receives multiple deliveries at this site and sees no concern with liquid or dry bulk fluoride deliveries.	Proposed driveway through site off Hoffman Ave with hammerhead truck turnaround.	▪ Liquid media delivery truck (~22 ft. wheel base) and solid media delivery truck (~54-ft. wheel base) turning movements are feasible at 30-ft. wide driveways off 6th Avenue and 7th Avenue with no site improvements required. ▪ Larger delivery truck wheel paths may track off street pavement onto gravel street shoulders adjacent to site during turning movements.

Facility Requirements Category	Well Electric	Parkwater	Ray	Central	Grace	Nevada	Hoffman	Havana
Impact to Neighborhood	Industrial zoning, little impact to neighborhood.	Industrial zoning, little impact to neighborhood.	▪ Residential neighborhood with on-street parking. ▪ Potential for delivery truck to double park to unload. ▪ Residential streets do not accommodate delivery trucks very well which results in congestion. ▪ Noise during delivery, visual impact of new building.	▪ Residential neighborhood with on-street parking. ▪ Potential for delivery truck to double park to unload. ▪ Residential streets do not accommodate delivery trucks very well which results in congestion. ▪ Noise during delivery, visual impact of new building.	Located on Water Department Site, little impact.	Located on Water Department Site, little impact.	▪ Residential neighborhood with on-street parking. ▪ Potential for delivery truck to double park to unload. ▪ Residential streets do not accommodate delivery trucks very well which results in congestion. ▪ Noise during delivery, visual impact of new building.	▪ Residential neighborhood with on-street parking. ▪ Potential for delivery truck to double park to unload. ▪ Residential streets do not accommodate delivery trucks very well which results in congestion. ▪ Noise during delivery, visual impact of new building.
Dry Chemical Building Footprint: Super Sack Option	21.5 ft x 29.5 ft =634 sf	21.5 ft x 29.5 ft =634 sf	21.5 ft x 29.5 ft = 634 sf	29.5 ft x 38.25 ft = 1,102 sf Includes space for lighting/signals infrastructure and chlorine room	31.7 ft x15 ft = 475 sf	31.7 ft x15 ft = 475 sf	21.5 ft x 29.5 ft = 634 sf	21.5 ft x 29.5 ft = 634 sf
Dry Chemical Building Height: Super Sack Option	26 ft	26 ft	26 ft	28 ft	25 ft	25 ft	26 ft	26 ft
Liquid Chemical Building Footprint	647 sf	647 sf	647 sf	1,102 sf. Includes space for lighting/signals infrastructure and chlorine room	647 sf	647 sf	729 sf	729 sf
Liquid Chemical Building Height	21 ft	21 ft	20 ft	21 ft	19 ft	19 ft	20 ft	20 ft
Architectural Style	Basic/Industrial CMU.	Basic/Industrial CMU.	Align with neighborhood/existing style (CMU with brick).	Align with neighborhood/existing style (CMU).	Basic/Industrial CMU.	Building will be located near Grace facility.	Align with neighborhood/existing style (CMU with brick).	Match proposed well facility buildings (CMU).
Tree Removal?	Yes, several small trees.	Yes, east of building.	Plan to avoid tree.	Likely No.	No.	No.	Likely No.	No.
Structural Considerations	▪ Geotech evaluation required for final design. ▪ Foundation will act as a retaining wall on steep slope.	▪ Geotech evaluation required for final design. ▪ Understand effects of new structure adjacent to existing structure.	▪ Geotech evaluation required for final design. ▪ Understand effects of new structure adjacent to existing structure.	▪ Geotech evaluation required for final design. ▪ Demo existing control building.	▪ Geotech evaluation required for final design. ▪ Understand effects of new structure adjacent to existing structure.	Building will be located near Grace facility.	Geotech evaluation required for final design. Understand effects of new structure adjacent to existing structure.	Geotech report likely available for new site.
Space Onsite for New Building?	Yes, north of Waterworks St. between access gates.	Yes, east of building.	▪ Yes, add on to existing building to the south. ▪ Do not impact community garden.	No. Demo/retrofit existing control building.	Yes, add onto Grace building.	Building will be located near Grace facility.	Yes, add on to existing building to the east.	Yes, SE of Building B.

Facility Requirements Category	Well Electric	Parkwater	Ray	Central	Grace	Nevada	Hoffman	Havana
Electrical Service Notes	▪ 120/240 1-phase power available on generator. Spare breakers on 300 A Panel P1. ▪ 2400/4160Y available on Substation Primary. ▪ As-Built load calcs not available.	▪ 120/208 3-phase power available with spare breakers on 200 A Panel A. ▪ 2400 3-phase available on Substation Primary. ▪ As-Built load calcs not available.	▪ 120/208 3-phase power available with spare breakers on 175 A Main Panelboard. ▪ 2400 3-phase available on Substation Primary. ▪ As-Built load calcs not available.	▪ 120/240 1-phase power available on 90 A Panel P3 with spare breakers and 11A demand availability. Main breaker could be increased to 125 A for 46A availability. ▪ 2400 3-phase available on Substation Primary.	▪ 120/208 3-phase power available on 100 A Station Panel (only 1 spare 20 A breaker). ▪ 4160 3-phase available on Substation Primary. ▪ As-Built load calcs not available.	▪ 120/208 3-phase power available on 200 A Station AC Panel. ▪ 2400 3-phase available on Substation Primary. ▪ As-built load calcs not available.	▪ 120/208 3-phase power available on 200 A Station Service Panel. ▪ 2400 3-phase available on Substation Primary. ▪ As-built load calcs not available.	▪ 120/208 3-phase power available on 400 A Panel A1 with spare breakers and 76 A demand availability. ▪ 4160 3-phase available on Substation Primary.
Water Service Notes	Supply from existing 12-inch distribution main that already serves the facility.	Supply from existing 6-inch service line onsite	Extend existing 1-inch service line onsite to building.	Connect into existing service to electrical/chemical building, or new service from main in the street.	Supply from existing Grace service line.	Supply from existing Grace service line.	New service line from Hoffman distribution main.	Supply from existing 6-inch service line onsite.
Fluoride Injection Yard Piping Notes	Utilidor across site to well room.	Connect directly through wall to well room.	Connect directly through wall to well room.	Parallel to Cl feed line in new utilidor.	Connect directly through wall to well room.	Utilidor through site between Nevada and fluoridation building.	Connect directly through wall to well room.	Utilidor through site Further consideration required crossing 24" transmission main and other utilities.
Estimated Electrical Load	15 kVA (65 A at 240 V 1-phase).	14 kVA (40 A at 208 V 3-phase).	30 kVA (82 A at 208 V 3-phase).	▪ 32 kVA (131 A at 240 V 1-phase). ▪ Demand exceeds existing panel capacity, according to as-built load calcs.	▪ 14 kVA (40 A at 208 V 3-phase). ▪ Demand exceeds existing panel breaker capacity.	14 kVA (40 A at 208 V 3-phase).	30 kVA (82 A at 208 V 3-phase).	▪ 30 kVA (82 A at 208 V 3-phase). ▪ Demand exceeds existing panel capacity, according to latest plan load calcs.
Control Requirements	Either connect directly to the ControlLogix MTU via Ethernet, one of the MicroLogix RTUs via hardwire, or install a new MicroLogix 1400 locally.	Either connect directly to the SLC 505 PLC (either Ethernet or hardwire), or install a new MicroLogix 1400 locally.	Either connect directly to the MicroLogix PLC via hardwire, or install a new MicroLogix 1400 locally.	Either connect directly to the MicroLogix PLC via hardwire, or install a new MicroLogix 1400 locally.	Either connect directly to the MicroLogix PLC via hardwire, or install a new MicroLogix 1400 locally.	Either connect directly to the MicroLogix PLC via hardwire, or install a new MicroLogix 1400 locally.	Either connect directly to the MicroLogix PLC via hardwire, or install a new MicroLogix 1400 locally.	Either connect directly to the MicroLogix PLC via hardwire (assuming the new PLCs are identical to most sites), or install a new MicroLogix 1400 locally.
Telemetry Requirements	MTU on site. Remote monitoring with local controls.	RTU available. Remote monitoring with local controls.	RTU available. Remote monitoring with local controls.	RTU available. Remote monitoring with local controls.	RTU available. Remote monitoring with local controls.	RTU available. Remote monitoring with local controls.	RTU available. Remote monitoring with local controls.	RTU likely available. Remote monitoring with local controls.
Station Service Voltage	120/208	120/208	120/208	120/240	120/208	120/208	120/208	120/240

Site and right-of-way improvements will be required to incorporate truck turnarounds for the Parkwater, Ray, and Central Well Stations.

Tree removal will be avoided where possible. Landscaping will likely be required for sites in residential zones such as Central, Ray, and Hoffman. Water service and electrical service will be provided to the new building and the fluoride solution injection line between the fluoride building and the well station will be installed in an accessible utilidor for future maintenance and replacement.

Most of the well station sites have plenty of space for additional yard piping. However, the Nevada and Grace Well Stations are located at the Water Department site where there are numerous fiber optic communication lines installed under the site that were not marked for the condition assessment phase of this project. These will need to be coordinated with any new yard piping on the site. Also, the Havana Well Station site will require numerous utility crossings with the proposed fluoride solution injection line which will need to be evaluated during design.

3.1.2.3 General Building Requirements

Proposed building sizes for both chemical alternatives are summarized in **Table 3-3** and are illustrated on the site plans in **Appendix A** and in the building, layout concepts in **Appendix B.** Each building construction type will align with the architectural style of the existing well station in residential zones to limit visual impact to the neighborhood. A geotechnical evaluation for each site will be required during final design, as well as design of HVAC systems. For facilities where the new fluoridation building will be attached to the existing well station building, the new building will need to be evaluated to determine if it can tie into the existing building footing or if the new structure needs a stand-alone foundation.

Due to space limitations on the Central Well Station site, the existing control building must be demolished down to the foundation and a new building constructed to accommodate the fluoridation equipment. Concept-level building layouts (liquid chemical and dry chemical) for the sites are included in **Appendix B**.

3.1.2.4 Electrical and Controls Requirements

The specific estimated electrical requirements for each well station are shown in **Table 3-3**. More electrical circuits would likely be required for the dry chemical option compared to the liquid chemical option.

The programable logic control (PLC) monitoring controls strategy between the liquid and dry options would likely differ, but this would not affect equipment cost. Further, the existing MicroLogix 1100 PLCs at the well pump stations are no longer manufactured, so replacement parts are limited. The existing City-owned MicroLogix 1100 PLCs will continue to operate, and programming can still be modified, but the 1100 hardware is not supported by the manufacturers. Replacement of the PLCs with a MicroLogix 1400 model at each station needs to be assessed further during pre-design of the preferred alternative.

3.1.2.5 Dry Chemical Facility Requirements

The new chemical building required to accommodate the dry chemical equipment would have a smaller footprint, but a larger height compared to the liquid chemical option to accommodate the bulk bag unloader equipment used to handle the chemical super sacks. It is recommended that due to the corrosive nature of the chemicals, the chemical handling equipment be located in a separate room from any electrical or controls equipment. The sodium fluoride saturator would most likely be installed below grade to avoid an excessive building height and to keep it below the bulk bag unloader so that chemical is added to the saturator via gravity. The saturator height must be sufficient to accommodate the following.

- an underdrain
- a gravel bed
- at least 12 inches of chemical, at all times
- additional chemical height after a super sack is unloaded
- saturated solution above the sodium fluoride layer
- freeboard space

The building layout sizes in **Appendix B** assume that the City's reserve chemical storage would be located offsite allowing the City to better manage stored chemicals and increase storage during peak summer demand seasons. Only one super sack would need to be stored in the building at one time. The saturator could be sized larger so that more than one super sack could be dumped into the saturator during a visit, decreasing deliveries to the sites. For well stations that are offline during the winter months, operations would plan to use all dry chemical within the bulk bag unloader before shutdown. To provide further flexibility a 50-pound bag unloading hood could be added directly to the saturator to allow operators to load small volumes of dry chemical as needed during the spring and fall operational transition periods.

3.1.2.6 Liquid Chemical Facility Requirements

The proposed building for the liquid chemical (see **Appendix B**) would likely have a larger footprint compared to the dry chemical building due to the size of the storage tanks. Both tanks (bulk and day tank) are required to have secondary containment. Some manufacturers offer double-walled tanks that have built-in containment; if these are not used containment would likely be installed below-grade. The liquid facility layouts include a day tank and a transfer pump to move the chemical from the bulk tank to the day tank. It is important that chemical fumes are vented upwards since the chemical rises and can create an unpleasant odor. It is also recommended that chemical storage and handling equipment be located in a separate room from any electrical or controls equipment due to the corrosivity of the chemical fumes.

3.2 Operations and Maintenance Considerations

This portion is a general overview of operation, maintenance, and safety considerations. This section lists common factors and/or basic procedures for each chemical.

3.2.1 Sodium Fluoride System Operation and Maintenance

A saturator or saturator-style tank would be used to create the four percent sodium fluoride solution. The saturator would be fed using a super sack loaded into the bulk bag unloader which reduces product dusting and operator exposure. To minimize dust, additive bags should be secured in the bulk bag unloader before it is opened. Operation activities includes loading super sacks and checking the sodium fluoride bed to verify a sufficient supply of product. When the bed is depleted, the operator would add another super sack of product to the bed.

The concept-level alternatives assume that each saturator is sized to hold one super sack volume of chemical above the minimum bed depth. However, the frequency of chemical deliveries to each site could be reduced with a larger saturator so that more than one super sack would be discharged into the saturator during a delivery site visit.

Maintenance should be performed regularly to ensure that all equipment is working correctly. **Table 3-4** provides a summary of typical operations and maintenance activities for sodium fluoride dry chemical injection systems.

Table 3-4 | Sodium Fluoride Recommended Operations and Maintenance Schedule

Daily/Weekly
Inspect the system
Look for leaks
Check additive solution levels
Check the solution level switch
Check hoses for air leaks
Check the pump for prime
Super sack delivery and refill feed hopper unloader
Quarterly
Remove cinders or encrustations in the saturator, pipes, and hoses
Verify a uniform flow through the additive bed
Verify water softener is in working order
Verify water strainer
Check all piping for leaks
Inspect tank level measurements (floats, gauges, etc.)
Calibrate the pump delivery rate
Rotate the additive inventory
Bi-Annually
Check the lubrication and adjustments of motor driven pumps
Check for crystalline deposits in valves, lines, hoses, and injectors
Disassemble and clean foot valves, lines, hoses, and injectors
Test the operation of vacuum breakers and anti-siphon valves
Disassemble and replace worn parts of vacuum breakers and anti-siphon valves

Annually
Thoroughly clean the saturator/tank
Disassemble and replace worn parts of metering pumps
Replace hoses, diaphragms, seals, etc. of metering pumps
Flush feed lines
Clean foot valves, suction/discharge valves, anti-siphon valves, vacuum breakers, and injection check valves

3.2.2 Liquid (FSA) Operation and Maintenance

A typical bulk FSA system includes an exterior fill port on the building for the bulk tank and then a manual transfer pump is used to convey FSA from the bulk storage tank to the day tank. Gravity feeding of day tanks from bulk tank should be avoided. Tanks should never be filled automatically, and transfer of FSA should always be monitored (10 States Standards and CDC requirements).

Table 3-5 provides a summary of typical operations and maintenance activities for FSA chemical injection systems.

Table 3-5 | FSA Recommended Operations and Maintenance Schedule

Daily
Inspect the system
Look for leaks or differences
Check additive solution levels
Check hoses for air locks
Check the pump for prime
Fill the day tank
Quarterly
Check all piping for leaks
Check gas venting for integrity
Check pipes and hoses for encrustations
Inspect tank level measurements (floats, gauges, etc.)
Calibrate the pump's delivery rate
Bi-Annually
Check the lubrication and adjustments of motor driven pumps
Check for crystalline deposits in foot valves, lines, hoses, and injectors
Disassemble and clean foot valves, lines, hoses, and injectors
Test the operation of vacuum breakers and anti-siphon valves
Disassemble and replace worn parts of vacuum breakers and anti-siphon valves
Annually
Disassemble and replace worn parts of metering pumps
Replace hoses, diaphragms, seals, etc. of metering pumps
Flush feed lines
Clean foot valves, suction/discharge valves, anti-siphon valves, vacuum breakers, and injection check valves

3.2.3 Staffing Levels

Based on the previous recommended operations and maintenance activities the following level of effort has been developed to determine requirements for full-time equivalent (FTE) operational staff needs.

Table 3-6 provides a summary of hours per day, per month, and per year. The costs associated with these staffing requirements are included in the 50-year life cycle cost analysis in **Section 3-3.**

Table 3-6 | O&M Staffing Requirements

Task	Daily	Monthly	Yearly
Both Systems			
Daily Inspection	7	210	2,520
Daily Distribution Monitoring	4	120	1,440
Preventative Maintenance		4	48
Materials Replacement Costs		4	48
Safety Costs		2	24
I&C Maintenance		2	24
Dry Chemical System Only			
Super sack Replacement	3.5*	105	1,260
Chemical Delivery		2	24
Equipment Maintenance			1,232
Total Staff Hours Per Year: Dry Chemical System			**6,620**
Staff FTE: Dry Chemical System			**3.2**
Liquid Chemical System Only			
Day Tank Fill	3.5	105	1,260
Chemical Loading		7	84
Equipment Maintenance			868
Staff Hours Per Year: Liquid Chemical System			**6,316**
Staff FTE: Liquid Chemical System			**3.0**

*Averaged over the week; super sack replacement would not need to occur every day.

3.2.4 Safety

These general recommended practices are based on the CDC's understanding of the consensus of various safety data sheets (SDS) practices. The CDC recommends that personnel in potential contact with fluoride products always wear personal protective equipment (PPE). The equipment will vary based on the task being performed. Even with a full-face shield and goggles, eye irritation is possible, especially if PPE fails. In the event of a spill, a safety shower and eye wash station should be available for immediate use. The manufacturer's SDS is the primary source of information for PPE required to handle concentrated fluoride additive product.

Exposure to single, large doses of concentrated fluoride additive product results in symptoms that vary by person. These include nonspecific symptoms: headache, sweating, excessive salivation, tearing, mucous discharges from nose and mouth, diarrhea, and generalized weakness. Potentially fatal symptoms include spasms, tetany and convulsions, weak pulse, low blood pressure, irregular heartbeats, and pulmonary edema.

In 2006, United States Environmental Protection Agency (EPA) reviewed current health effect information for the primary maximum contaminant level (MCL) of 4.0 milligrams per liter (mg/L) based on quantitative risk assessment for severe dental fluorosis, the risk for increased bone fractures as related to fluoride, and the less than crippling form of skeletal fluorosis (Stage II skeletal fluorosis). The review panel recommended updating the MCL. The EPA is conducting new research on the impacts of skeletal fluorosis, and skeletal fractures and has updated the source contributions for fluoride. The EPA may update the MCL or MCLG based on health effects in the future. The lethal dose of fluoride is currently thought to be from 2 to 8 milligrams per kilogram of body weight with lethal doses reported with levels of 16 milligrams per kilogram (mg/kg) in children and 32-64mg/kg in adults.

Use of PPE should be determined for each task based on a site-specific risk assessment. Risk assessments should consider the following.

- Using PPE
- Long gloves, coveralls, boots, apron, safety goggles, and face shield1
- Not eating or smoking in an additive storage area
- Cleaning up an additive storage area promptly after a spill
- Washing clothes and body after exposure to concentrated additive product
- Washing hands after exiting an additive product storage area
- Having a backup "buddy" when entering any additive product storage area
- Using a checklist when conducting safety and operating procedures
- Documenting checklist use
- Access to a first aid kit including a burn kit and acid neutralizer

[1] Note: Based on developed standard operating procedures (SOPs), may allow for handling of sodium fluoride that limits operators' exposure and reduce need for PPE.

- Spill control response aids should be readily accessible wherever liquid additives are handled. Spill control absorbent pillows and dams should be used for initial containment. Follow-up action to neutralize the acid with lime or caustic soda is essential.

Overfeeding of either chemical above 4 mg/L would pose a City-wide hazard for all customers of the water system; however, numerous redundant design features would be incorporated to prevent overfeed, including the following.

- Process control
- Equipment calibration
- Anti-siphon devices
- Backpressure
- Calibration columns
- Analyzer(s)
- Check valve(s)
- Flow switch(es)

3.2.5 Operator Certification

The requirements for operator certification were reviewed based on the Washington State Department of Health Purification Plant Criteria Worksheet. As noted in the worksheet, a water system with groundwater supply with only chlorination is considered a distribution system, not a water treatment facility. The addition of fluoride would result in a reclassification of water treatment certification. The City currently provides residual disinfection and at this level of treatment does not require a certified water treatment plant operator. The addition of fluoride would result in a reclassification per WAC 246-292-050 that requires a minimum operator certification of Water Treatment Plant Classification 2, WTPO 2. The City will need to designate at least one certified operator in responsible charge of the fluoridation system at this certification level.

3.3 Cost

Concept-level Class 5 capital costs (as defined by AACE International) were developed for each of the chemical alternatives and each well station. Because some elements of the alternatives design were created at a concept-level for this OPCC, the OPCC can be classified with accuracy ranges of -30 percent on the low side and +50 percent on the high side. According to AACE International, Class 5 estimates are useful for high-level screening studies such as the alternatives analysis in this Report. A concept-level 50-year LCCA was developed based on the concept alternatives defined in **Section 3.1.** All costs (see **Table 3-9**) are in August 2022 US Dollars based on information available at the time the costs were developed. Because the construction date(s) of the fluoridation systems is (are) unknown, capital costs were not escalated to a future construction year.

Final costs will depend on the following.

- actual field conditions
- actual material and labor costs
- market conditions for construction
- regulatory factors
- final project scope
- method of implementation
- schedule

Detailed workups of the costs are included in **Appendix D.** The capital OPCC unit costs were based on the Murraysmith estimating database.

The Murraysmith estimating database is stored within HCSS Heavybid Software. The estimating data based was developed from data across multiple industries and disciplines. The data base includes but is not limited to the costs from projects related to heavy civil, buildings, roads, railways, bridges, airports, dams, sewer systems, trenchless projects, tunnels, demolition, drilling and blasting operations, water systems, wastewater treatment facilities, landfills, concrete structures, under water construction projects, water filtration systems, dewatering systems, aquifer storage and recovery well construction, electrical generation facilities, electrical distribution systems, environmental protection projects, storm water management projects, and emergency response projects.

The Murraysmith database includes complete integration with RS Means, most of the United States Department of Transportation (DOT) unit cost data bases, and other national and regional costs data sources. The actual bid tab results from DOT websites are also integrated into the Heavybid system for easy comparison. These data bases together with the data form current and past projects allow Murraysmith to provide the most current cost available. Because of uncertainty with supply chains and market conditions Murraysmith does not recommend or use average unit costs, or unit cost averages that are older than 3 years.

Database inputs include labor, equipment, materials, subcontractor quotes, specialty equipment, and local contractor quotes as required. The estimates may also include costs that are derived **from first principles.** This input is updated on a quarterly basis or as required by project specific requirements. The inputs are organized by state and region within each state. This provides the most current and accurate cost data for a project within a specific region. For this OPCC, the Murraysmith data is measured against the Washington DOT information, the Spokane Washington RS Means information, and supplemented with current specialty equipment cost, or other regional data.

The OPCC costs were based on the following additional assumptions.

- Budgetary manufacturer quotes were used for the dry chemical bulk bag unloader (which includes the bag powder seal) and the liquid bulk and day storage tanks.

- Other equipment costs were based on Murraysmith's estimating data base of capital cost information.
- Site improvements were based on Murraysmith's database of capital cost information. Larger site improvements costs were used for sites with industrial or commercial zoning such as Parkwater or the Grace-Nevada site.
- Building costs were based on Murraysmith's database of capital cost information.
  - Larger building costs were used for sites located in residential zones where the architectural style would need to match the existing well station.
  - Various building sizes were developed to scale with the capacity of the well stations, see **Appendix B**.
  - Optimization of the larger building layouts may help with cost savings during preliminary design. While a square-shaped building may work best with some sites, a longer-shaped building is a more efficient use of indoor equipment space.
  - Unit building costs include HVAC, dust and gas venting/scrubbing, and safety equipment.
  - Replacement of HVAC systems due to corrosion was not evaluated and is within the contingency of a Class 5 estimate.
  - Dry chemical costs include three standalone dry chemical storage facilities. The well stations would share storage between the three facilities.
- It was assumed that the existing control building located at the Central Well Station site would be demolished to the foundation and replaced with a new facility housing existing well controls, existing chlorination equipment, and the proposed fluoridation system.
- Land or right-of-way acquisition is not expected to be required.
- Fluoride injection or water service yard piping were not included for sites where the building is not located next to the well station, since fluoride injection design will not begin until preliminary design.
- A 30 percent contingency was applied to the capital costs.

The life cycle cost analysis was based on the following assumptions and inflation projections.

- A 50-year life cycle.
- A five percent net present value discount rate was applied to the first 20 years of the LCCA; a discount rate of three percent was used for the last 30 years.

- Equipment maintenance and repairs were assumed to be two percent of capital costs each year.
- The LCCA includes estimated energy costs.
- Chemical cost budgetary quotes were obtained from two different suppliers. The highest supplier cost was used for the LCCA. See **Table 3-7**. The chemical demand estimate for each well station was based on average production in 2021 for the portion of the year a well station is typically operated (e.g., the smaller wells are typically not used in the winter).
- Labor costs were based on the FTE assumptions noted in **Table 3-2** and a labor cost of $70 per hour.
- Electrical and controls equipment were assumed to require replacement every 10 years. All other equipment, including site driveways were assumed to require replacement every 20 years.
- A 30 percent contingency was applied to the LCCA costs.
- Inflation was projected at a variable rate for the next 50 years based on current and anticipated future market conditions, as shown in **Table 3-8.**

Table 3-7 | Annual Chemical Costs

Well Station	Monthly Liquid Demand (lbs)	Monthly Dry Demand (lbs)	Number of Operating Months Per Year	Dry Cost Per Year	Liquid Cost Per Year
Well Electric	23,827	9,305	12	$ 256,900	$ 143,000
Parkwater	29,970	11,704	12	$ 323,100	$ 179,900
Nevada	14,064	5,492	8	$ 101,100	$ 56,300
Grace	11,293	4,410	8	$ 81,200	$ 45,200
Hoffman	5,950	2,324	8	$ 42,800	$ 23,900
Central	11,295	4,411	8	$ 81,200	$ 45,200
Ray	12,833	5,011	8	$ 92,300	$ 51,400
Havana	10,348	4,041	12	$ 111,600	$ 62,100
TOTAL	**119,581**	**46,699**		**$ 1,090,200**	**$ 607,000**

Table 3-8 | Assumed LCCA Inflation Rate Projections

Year Range	Annual Inflation Rate Projection
2022-2023	12.5%
2023-2024	12.0%
2024-2025	8.0%
2025-2050	5.0%
2050-2080	3.0%

Table 3-9 | Class 5 OPCC and LCCA

2022 Dollars	Dry Chemical			Liquid Chemical			% Difference Capital Cost	% Difference Operating Cost
Well Station	**Capital**	**50-Year LCCA**	**Average 50-Yr Annual Operating**	**Capital**	**50-Year LCCA**	**Average 50-Yr Annual Operating**	**Dry minus Liquid**	**Dry minus Liquid**
Well Electric	$ 1,616,000	$11,199,000	$224,000	$ 1,423,000	$ 8,772,000	$ 176,000	12%	22%
Parkwater	$ 1,865,000	$12,266,000	$246,000	$ 1,683,000	$ 9,189,000	$ 184,000	10%	25%
Ray	$ 1,332,000	$6,656,000	$134,000	$ 1,108,000	$ 5,419,000	$ 109,000	17%	19%
Central	$ 1,622,000	$6,722,000	$135,000	$ 1,328,000	$ 5,379,000	$ 108,000	18%	20%
Grace/Nevada	$ 1,616,000	$10,139,000	$203,000	$ 1,423,000	$ 8,182,000	$ 164,000	12%	19%
Hoffman	$ 1,332,000	$6,656,000	$134,000	$ 1,108,000	$ 5,419,000	$ 109,000	17%	19%
Havana	$ 1,618,000	$8,396,000	$168,000	$ 1,436,000	$ 7,100,000	$ 142,000	11%	15%
Total	$ 11,001,000	$62,034,000	$1,244,000	$ 9,509,000	$ 49,460,000	$ 992,000	14%	20%

The cost analysis shows that the two chemical alternatives are comparable in terms of capital costs. Because the liquid chemical bulk storage is located onsite, the larger well stations have more expensive liquid chemical buildings and almost match capital costs for the dry chemical option. However, the liquid chemical capital costs are lower for the smaller well stations since the building is smaller and equipment is cheaper compared to the dry system.

For all sites, the dry chemical alternative was estimated to cost about 15-25 percent more in operational costs primarily due to the cost of the chemicals.

SECTION 4

Section 4

Alternatives Assessment

4.1 Alternatives Screening

This section details a review of the evaluation criteria defined in Section 2.3 for the dry and liquid chemical options. Table 4-1 summarizes this evaluation for quick reference.

Sodium fluorosilicate was eliminated from consideration due to the limited long-term supply availability.

Table 4-1 | Alternatives MODA Screening Data

MODA Criterion	Dry Chemical	Liquid Chemical
ENVIRONMENTAL AND SUSTAINABILITY		
Impact to Aquifer	A leak would be limited to saturator smaller volume. Higher chance of chemical spill in dry form, but lower impact to aquifer (easier to clean up).	Higher potential impact with liquid spill or leak with delivery and bulk storage. Lower chance of spill.
Energy Use	Similar, additional electrical components and dust control.	Similar, additional fume ventilation required.
Impact to Critical Areas	Same, site dependent.	Same, site dependent.
Impact to City's Sustainability Goals	Higher carbon footprint due to more frequent delivery trips.	Lower carbon footprint due to fewer delivery trips.
NEIGHBORHOOD IMPACTS		
Impacts During Construction	Same, site dependent.	Same, site dependent.
Cultural Impacts	Same, site dependent.	Same, site dependent.
Aesthetic Impacts	Higher with additional building height requirements for hopper system.	Larger building, shorter height.
Historical Preservation Impacts	Same, site dependent.	Same, site dependent.
Traffic Impacts	▪ Smaller delivery vehicle. ▪ During peak demand: 2 trips per week for Parkwater, 1 trip per month for Hoffman ▪ During winter demand: 1-2 trips per week for Parkwater, 2 trips per month for Havana (smaller wells not operating) ▪ Construction traffic same.	▪ Monthly or bi-monthly chemical deliveries. ▪ Larger delivery vehicle. ▪ Construction traffic same.
Noise, Air Quality, and Odor Impacts	▪ No noticeable odor. ▪ Construction noise same.	▪ More odor potential but can be mitigated by ventilation design. ▪ Construction noise same.
SAFETY--PUBLIC		
Local Neighborhood Hazards	More delivery traffic; see above.	Less delivery traffic; see above. Potential for spills.
Hazards to Broader Region	Less with dry chemical.	Higher potential impact from spills.
SAFETY--WORKER		
Chemical Unloading/Loading	Forklift safety considerations and addressing dust filling hopper.	Truck loading containment needed for spills.
Chemical Handling/Exposure	More chemical handling with super sack delivery. Higher exposure potential with dry chemical. Chemical exposure is less hazardous to worker.	Lower chemical handling. Lower exposure potential with liquid chemical. Chemical exposure is more hazardous to worker.
Process Safety Management	Not subject to OSHA Process Safety Management	Not subject to OSHA Process Safety Management
PPE Required	Respiratory and skin exposure protection. Leather gloves, coveralls, respirator, and goggles.	Splash protection. Long gloves, coveralls, apron, boots, googles, and face shield.
Safety Equipment Required	Same.	Same.
SERVICE RELIABILITY		
Extreme Conditions Resiliency	Same.	Same.
Overfeeding Impacts	Same.	Same.
System Ability to Meet Regulatory Requirements	Same.	Same.
Outcomes at Customer Tap	Same.	Same.
Chemical Purity Consistency	Same.	Same.
Chemical Availability	Multiple manufacturers.	Multiple manufacturers.
Chemical Damage to Equipment/Facilities	Lower corrosivity. Higher potential for clogging/caking in equipment.	Higher potential with corrosive nature. Lower potential for clogging in equipment.

MODA Criterion	Dry Chemical	Liquid Chemical
EASE OF MAINTENANCE AND OPERATIONS		
Training and Certifications	Same – WTPO 2	Same – WTPO 2
FTEs needed	Based on Table 3.6, estimated 3.2 FTEs.	Based on Table 3.6, estimated 3.0 FTEs.
Ancillary Equipment Needed	Need for delivery truck and forklift, and bulk bag unloader. Requires ventilation systems with dust collection filter.	Less with just liquid chemical storage tanks. Requires ventilation system.
Number of Visits to Site Per Week	▪ Daily for equipment inspection. ▪ Super sack delivery during peak demand: 2 trips per week for Parkwater, 1 trip per month for Hoffman ▪ Super sack delivery during winter demand: 1-2 trips per week for Parkwater, 2 trips per month for Havana (smaller wells not operating)	▪ Daily for equipment inspection. ▪ Daily to fill day tank ▪ Monthly or bi-monthly chemical delivery to site
Equipment Replacement	Higher for mechanical equipment.	Lower, with higher tank life.
Equipment Cleaning	Higher with dry chemical to address chemical caking and cleaning of sa	Lower with liquid.
Other Equipment Maintenance	Additional for bulk bag unloader, ventilation filter cleaning, and water softener, beyond regular storage tanks and metering pumps maintenance.	Less with just liquid chemical storage tanks and metering pumps maintenance.
Chemical Shelf Life	Same.	Same.
Time Spent at Each Site Per Visit	▪ 30 minutes per visit for daily inspection. ▪ For super sack deliveries: Approx 1.5 hours/visit per site.	▪ 30 minutes per visit for daily inspection. ▪ 30 minutes to fill day tank ▪ 2 hours for chemical delivery

4.2 Alternatives Evaluation

4.2.1 Environmental and Sustainability Impacts

The short-term and long-term impacts of each chemical alternative include potential for contamination of the aquifer, facility energy use, impact to critical areas, and overall impact on the City's Sustainability Goals.

4.2.1.1 Chemical Considerations

Both chemicals use a similar amount of power for equipment and building operation. However, fewer delivery trips would be required for transport of the liquid chemical. A spill of the dry chemical would be easier to clean up and has less potential to infiltrate into the aquifer. A spill of the saturator tank would be more likely to reach the aquifer compared to the dry chemical as delivered. However, the saturator volume is much smaller compared to the liquid chemical bulk tanks. The liquid chemical has a higher potential for a large spill which could contaminate the aquifer; this risk would be mitigated via liquid double containment as discussed in the Alternatives Summary section.

4.2.1.2 Site Considerations

The Well Electric Well Station is located along the Spokane River, so this site has the highest potential to impact critical areas in the event of a spill.

Removal of large trees can most likely be avoided for most sites; see **Table 3-3**.

4.2.2 Neighborhood Impacts

Cultural impact, aesthetics, historical preservation, impacts during construction, and traffic were evaluated as potential impacts to the neighborhood of each well station. Noise, air quality, and odor were also considered.

4.2.2.1 Chemical Considerations

Traffic impacts depend primarily on chemical type. Because the liquid chemical is delivered in bulk it requires a larger delivery truck, though deliveries are less frequent compared to the dry chemicals. Aesthetically, the dry chemical may have more of an impact on the neighborhood due to the height requirements for the chemical hopper system, though the liquid building would likely have a larger footprint. Noise and air quality impacts would be minimal for either chemical since the equipment would be enclosed.

Sodium fluoride carries no noticeable odor, but FSA causes an unpleasant acidic odor. Proper ventilation design of the facility can direct the odor upwards. Since the fumes are lighter than air, they will rise and have a negligible effect on the local neighborhood.

4.2.2.2 Site Considerations

For historical preservation and aesthetic purposes, the architectural style of the existing well stations located in residential zones will be used for the proposed fluoridation facilities. These include the Hoffman, Ray, Central, and Havana Well Stations. These well stations would also experience a higher impact during construction compared to well stations located in commercial or industrial areas.

Due to its location on the Spokane River, the Well Electric Well Station likely has the highest potential for cultural impacts if artifacts are found or impacted during construction.

4.2.3 Safety—Public

Both local neighborhood and regional safety impacts were considered for each chemical alternative.

4.2.3.1 Chemical Considerations

The higher level of delivery traffic required for the dry chemical would pose a higher safety risk to the local neighborhood. A spill of the dry chemical is unlikely to leak into the aquifer and would not impact public safety. The liquid chemical would have a higher impact on the broader region in the event of aquifer contamination, though a small spill could be mitigated before aquifer contamination. Secondary containment is required for the liquid chemical buildings (both storage and loading area), so a large spill is unlikely. Neither chemical poses a high fire risk compared to a normal commercial building; however, if a fire should occur, fluoride additive products can release hydrogen and hydrogen fluoride gas, which requires special PPE for first responders. Under normal operating conditions, this gas is not a hazard for system operators. Further fluoride and chlorine needs to be located in separate areas with separate containment to address any potential chemical interactions.

4.2.3.2 Site Considerations

The Hoffman, Ray, Central, and Havana Well Stations are located in residential neighborhoods, so delivery, construction, and maintenance traffic would have a higher safety impact for these sites.

4.2.4 Safety—Worker

Safety impacts to the operators were considered in terms of chemical loading and unloading and chemical handling and exposure. Specific safety processes and required PPE are described in Section 3.2.4.

4.2.4.1 Chemical Considerations

Skin exposure to sodium fluoride is less hazardous than respiratory exposure, but the chemical can cause burns. Recommended PPE includes leather gloves, coveralls, a respirator, and goggles.

The chemical is delivered in a granular form which limits dust. The bulk bag unloader equipment for the dry chemical includes dust collection equipment and dust sealing features which are designed to limit worker dust exposure. Forklift and bulk bag unloader crane safety procedures may be needed to protect workers during use of chemical loading equipment.

Splash protection is the most concerning hazard for FSA; recommended PPE includes long gloves, coveralls, apron, boots, goggles, and face shield. Even with a full face shield and goggles, eye irritation is possible in proximity to FSA, especially if PPE fails. In the event of a spill, a safety shower and eye wash station should be available for immediate use. Spill containment for the liquid chemical will be required both at the chemical loading connection to the fluoridation building and around the bulk storage tank.

4.2.4.2 Site Considerations

Worker safety considerations are likely to be similar for all well stations.

4.2.5 Service Reliability

The reliability of the fluoridation system was evaluated in terms of resiliency during extreme conditions, the impact of fluoride overfeeding, the system's ability to meet regulatory requirements, outcomes at the customer's tap, consistency in chemical purity, chemical availability, and potential chemical damage to equipment or facilities.

4.2.5.1 Chemical Considerations

Sodium fluoride and FSA are both produced by multiple manufacturers; however, there are a limited number of manufacturers who produce sodium fluorosilicate and supply is limited and unreliable. Because a long gap in chemical availability would result in an extended outage of the fluoridation system, sodium fluorosilicate was eliminated from the chemical alternatives evaluation. The liquid chemical has a higher potential to damage equipment and facilities due to its corrosive nature but is unlikely to cause an outage of the system if equipment is maintained properly.

Overfeeding impacts, resiliency under extreme conditions, ability to meet regulatory requirements, the outcomes at customer taps, and the consistency of chemical purity are unlikely to vary between chemical types.

4.2.5.2 Site Considerations

Service reliability is unlikely to vary between sites.

4.2.6 Ease of Maintenance and Operations

4.2.6.1 Chemical Considerations

The liquid chemical equipment will likely require less maintenance compared to the dry chemical, though the daily filling of the day tank and inspection of the feed equipment is required. For the dry chemical, multiple deliveries of the chemical super sack are required every week or month, depending on the time of year, whereas the liquid chemical would be delivered less frequently. For each operator to visit the site, more time would need to be spent at the site unloading the dry chemical. Chemical shelf life does not vary between chemicals. The dry chemical would require the largest and most expensive ancillary equipment including a City delivery truck and forklift.

Additionally, for either chemical, an operator with a WTPO 2 certification is required, which is not currently held by any of the City's staff.

4.2.6.2 Site Considerations

The Parkwater Well Station is the highest producing well station in the system, so it would require the most frequent operator visits and delivery of the dry chemical (multiple times per week). Since the dry chemical super sacks would likely be stored in bulk at the Water Department warehouse on E North Foothills Drive, dry chemical loading for the Nevada and Grace Well Stations would be simpler and would likely not require a delivery truck. For the facilities that are typically not operated during the low-use season, chemical deliveries, day tank operation, and daily inspection would not be needed between October and March unless the off-season wells are turned on. These well stations are Grace, Nevada, Central, Hoffman, and Ray.

SECTION 5

Section 5

Assessment Summary

Table 5-1 summarizes key considerations for each chemical alternative (dry chemical: sodium fluoride; liquid chemical: FSA) as discussed in this Report.

Table 5-1 | Key Alternatives Considerations

Alternative Criterion	Dry Chemical	Liquid Chemical
Cost: Capital (2022 Dollars)	$11.00M	$9.51M
Cost: Annual Operational (2022 Dollars)	$1.24M	$0.99M
ENVIRONMENTAL AND SUSTAINABILITY	▪ Higher carbon footprint ▪ Lower impact of spill ▪ Higher risk of spill	▪ Lower carbon footprint ▪ Higher impact of spill ▪ Lower risk of spill
NEIGHBORHOOD IMPACTS	▪ Higher building with smaller footprint. ▪ More frequent traffic (1-4 trips per month per site), but smaller delivery vehicle. ▪ No noticeable odor.	▪ Larger building, but shorter height. ▪ Less frequent traffic (monthly or bi-monthly) but larger delivery vehicle. ▪ Odor can be mitigated.
SAFETY--PUBLIC	▪ More delivery traffic. ▪ Less potential for chemical spills.	▪ Less delivery traffic. ▪ Higher potential for spills.
SAFETY--WORKER	▪ Respiratory exposure, respirator required. ▪ Some skin protection required but less compared to liquid chemical. ▪ More chemical handling; higher risk of exposure. ▪ Exposure is less hazardous to worker. ▪ Smaller containment required. ▪ Forklift safety considerations.	▪ Splash protection required. ▪ More PPE required. ▪ Less chemical handling; lower risk of exposure. ▪ Exposure is more hazardous to worker. ▪ Larger containment required.
SERVICE RELIABILITY	▪ Less potential to damage facilities. ▪ More chance of clogging/caking in equipment.	▪ Corrosivity may damage facilities. ▪ Lower change of clogging in equipment.
EASE OF MAINTENANCE AND OPERATIONS	▪ Deliveries are more frequent but require less time per delivery. ▪ No daily operation of facilities other than inspection. ▪ More equipment maintenance required. ▪ Forklift required. ▪ Estimate 3.2 FTEs.	▪ Less frequent deliveries, but more time required per delivery. ▪ Daily transfer pump operation required. ▪ Less equipment maintenance required. ▪ Estimate 3.0 FTEs.

The information in this section will be used to “score” the liquid and dry chemical options against the City’s MODA criteria as part of Task 6 of this engineering study on fluoridation of the City’s system. Task 6 includes City selection of a chemical alternative, and a preliminary design will be completed for the selected alternative in early 2023.

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APPENDICES

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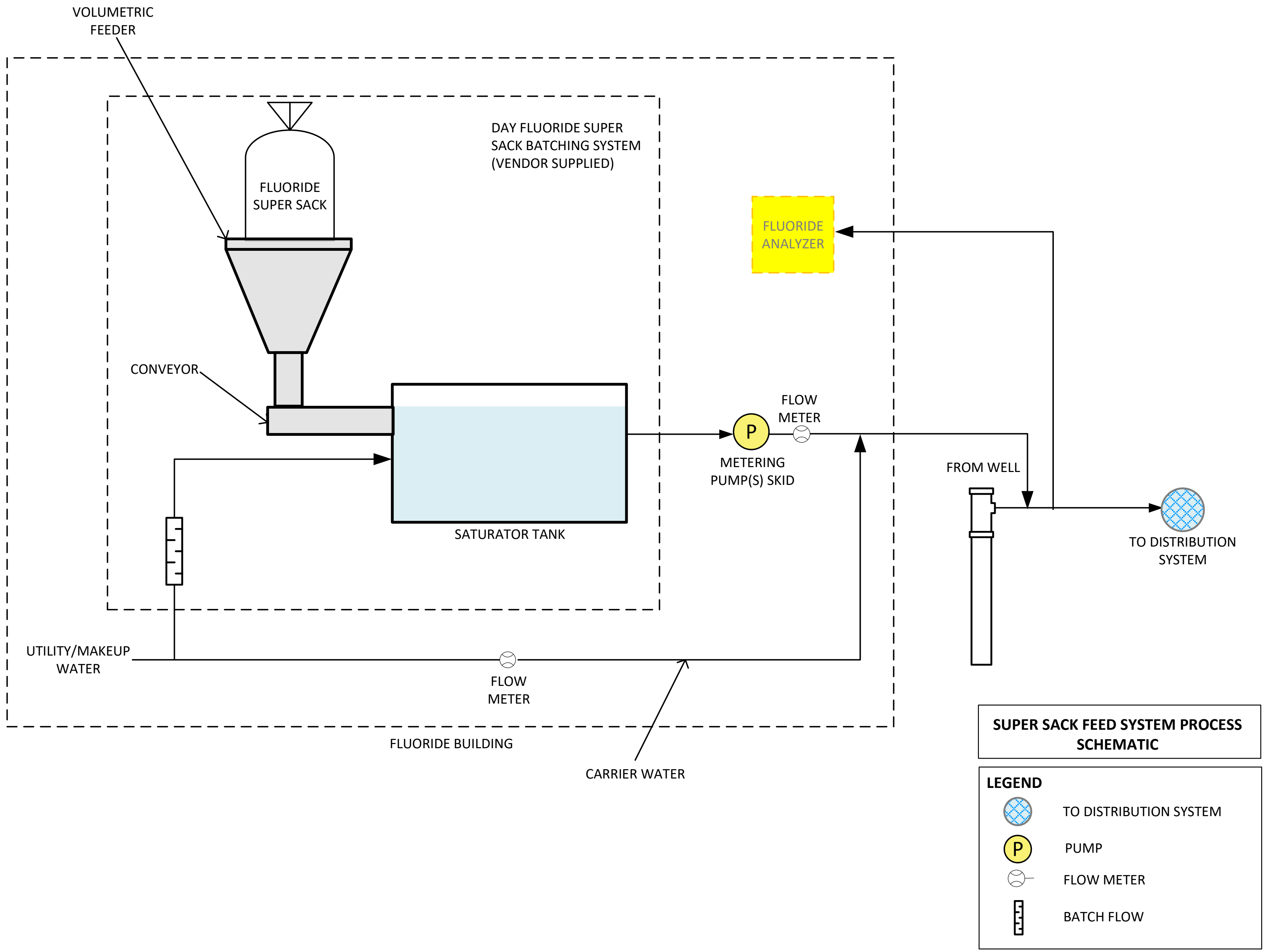
APPENDIX A
PROCESS FLOW DIAGRAMS



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SPOKANE FLUORIDATION STUDY

DRY CHEMICAL PROCESS FLOW DIAGRAM

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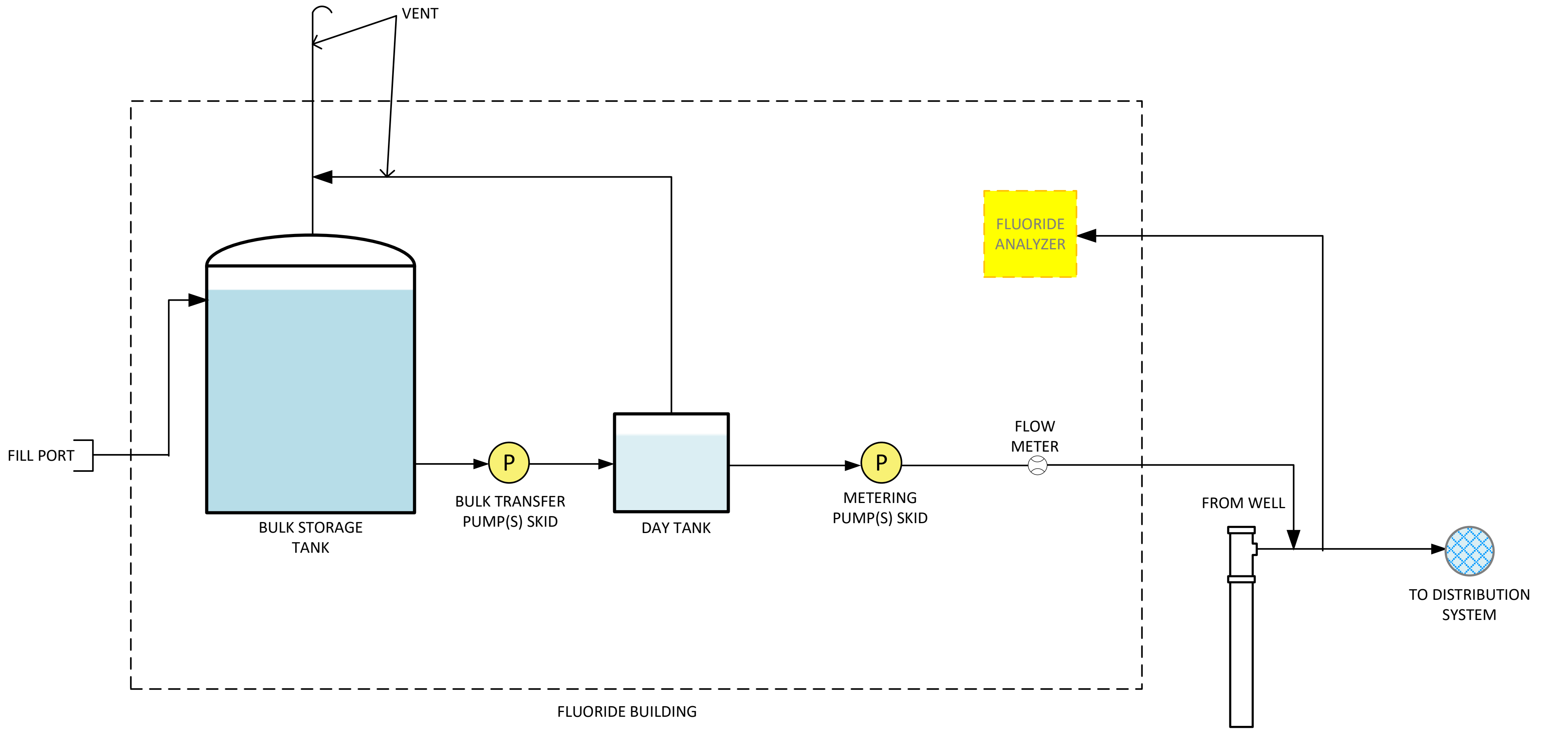

BUILK LIQUID FEED SYSTEM PROCESS SCHEMATIC

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- P PUMP/ MOTOR
- FLOW METER

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LIQUID CHEMICAL PROCESS FLOW DIAGRAM

DRAFT

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APPENDIX B
PRELIMINARY SITE PLANS

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LEGEND

- M — FLOW METER
- CL — CHLORINE ANALYZER
- ● — CHLORINE INJECTION POINT
- ▲ — SAMPLE POINT FOR CHLORINE MONITOR ANALYSIS
- ○ — APPROX LOCATION OF WELL PUMP
- —F— CHEMICAL SOLUTION LINE
- —W— PROPOSED WATER SERVICE LINE
- —E— PROPOSED ELECTRICAL SERVICE LINE

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PLAN

SCALE: 1"=20'

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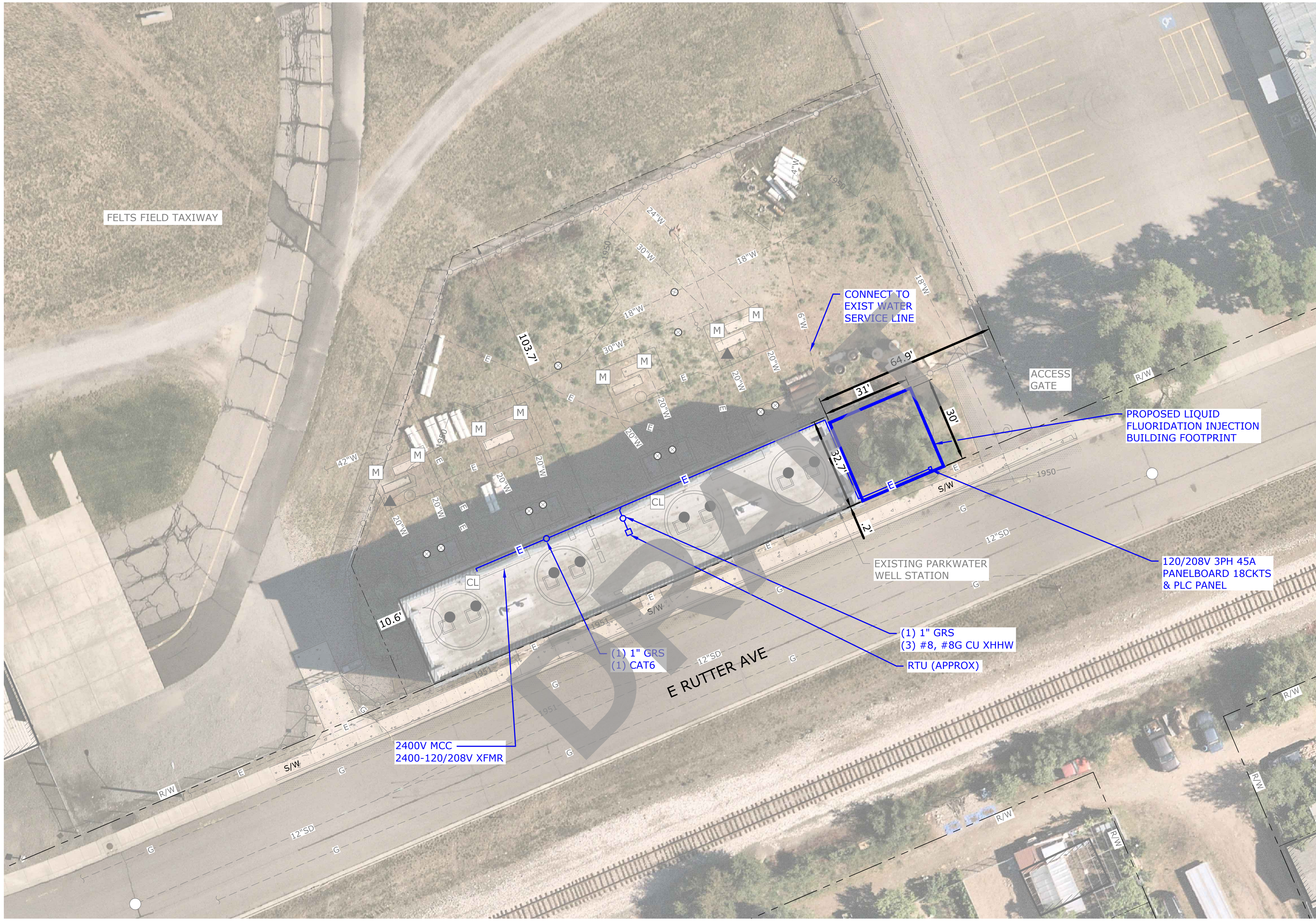
WELL ELECTRIC WELL STATION SITE PLAN

DRAFT

PROJECT NO.:	22-3386	SCALE:	AS SHOWN	DATE:	SEPTEMBER 2022

LEGEND

- M — FLOW METER
- CL — CHLORINE ANALYZER
- ● — CHLORINE INJECTION POINT
- ▲ — SAMPLE POINT FOR CHLORINE MONITOR ANALYSIS
- ○ — APPROX LOCATION OF WELL PUMP
- —E— PROPOSED ELECTRICAL SERVICE LINE



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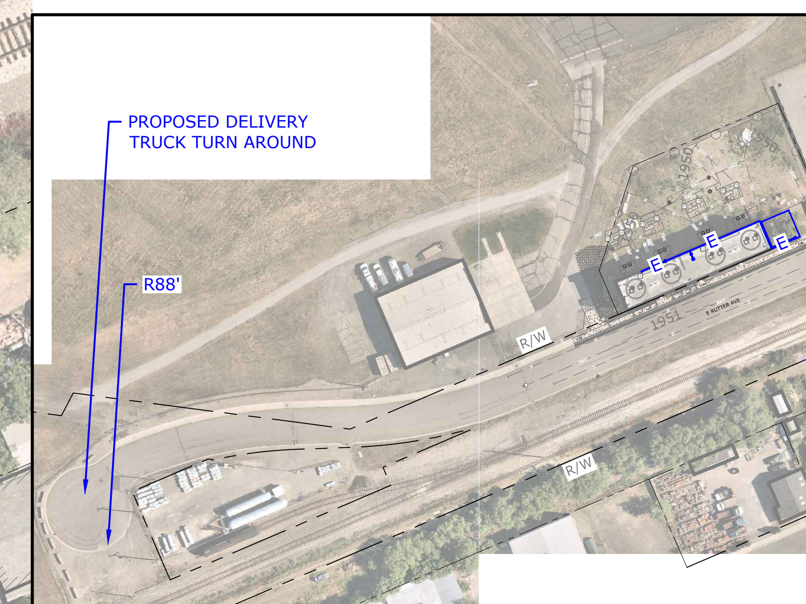

VICINITY MAP
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PARKWATER WELL STATION SITE PLAN

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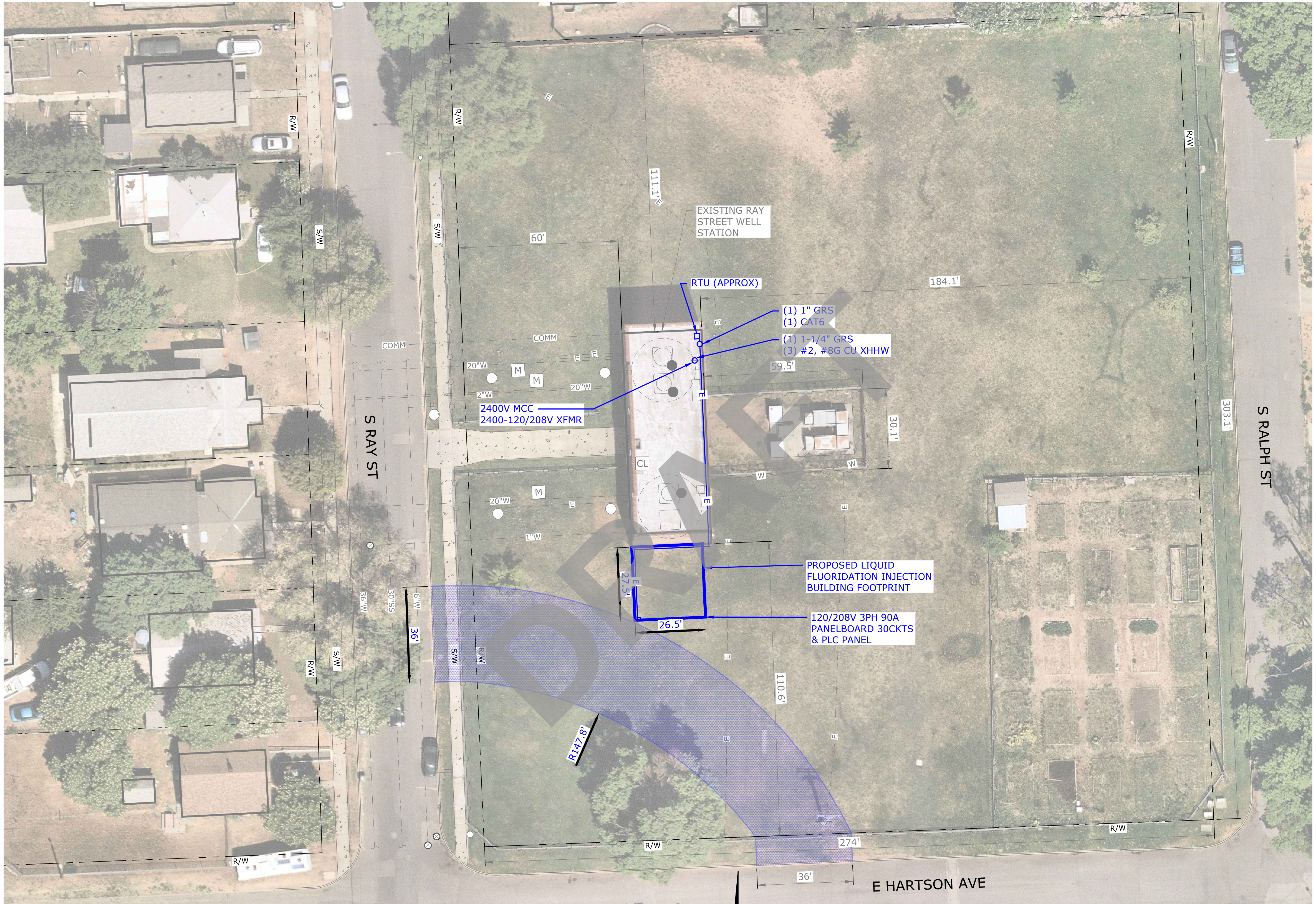

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- M — FLOW METER
- CL — CHLORINE ANALYZER
- ● — CHLORINE INJECTION POINT
- ▲ — SAMPLE POINT FOR CHLORINE MONITOR ANALYSIS
- ○ — APPROX LOCATION OF WELL PUMP
- —E— — PROPOSED ELECTRICAL SERVICE LINE

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RAY STREET
WELL STATION SITE PLAN

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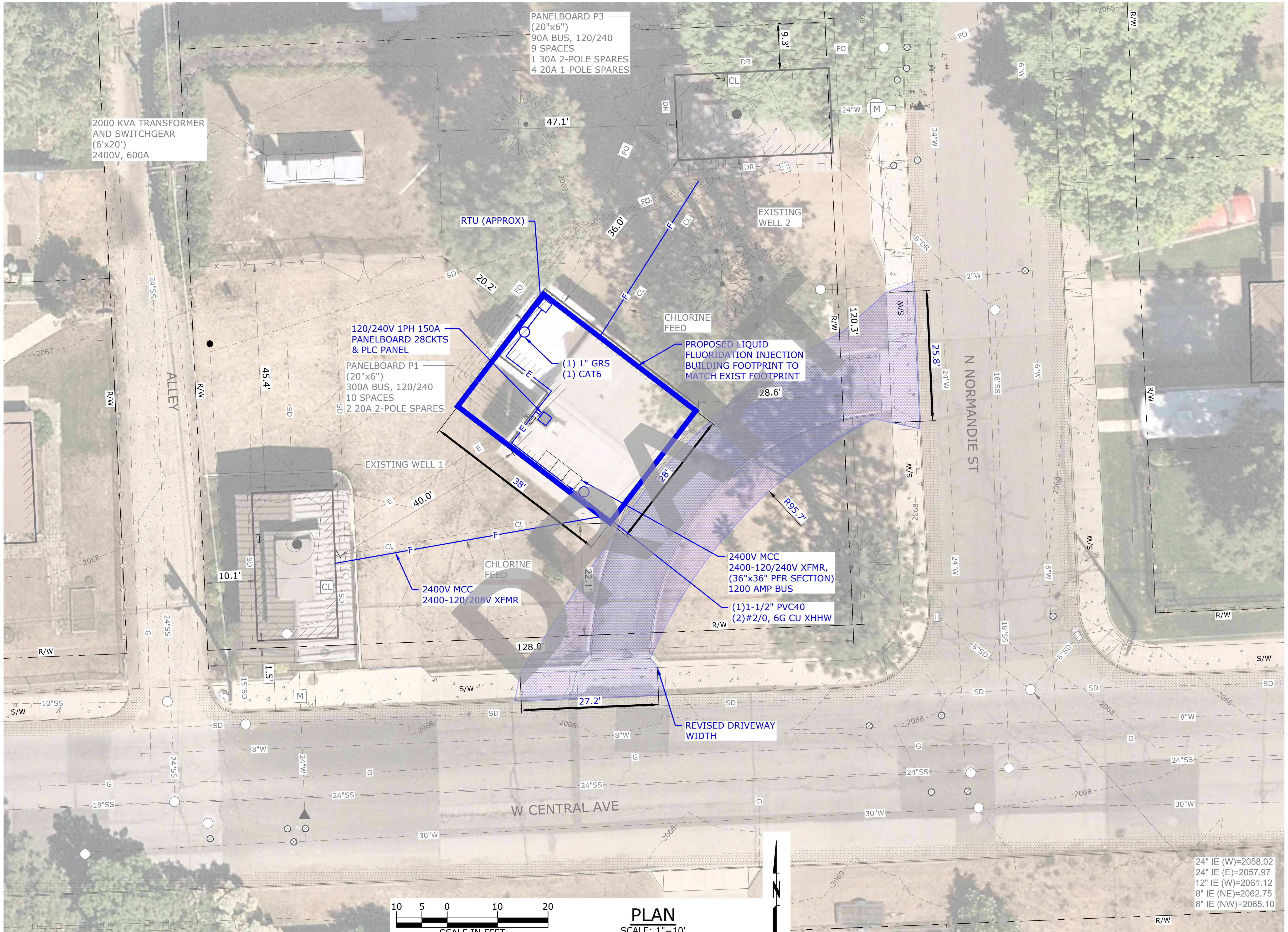

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PLAN
SCALE: 1"=10'

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●	CHLORINE INJECTION POINT
▲	SAMPLE POINT FOR CHLORINE MONITOR ANALYSIS
○	APPROX LOCATION OF WELL PUMP
—F—	CHEMICAL SOLUTION LINE
—E—	PROPOSED ELECTRICAL SERVICE LINE

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CENTRAL AVE WELL STATION SITE PLAN

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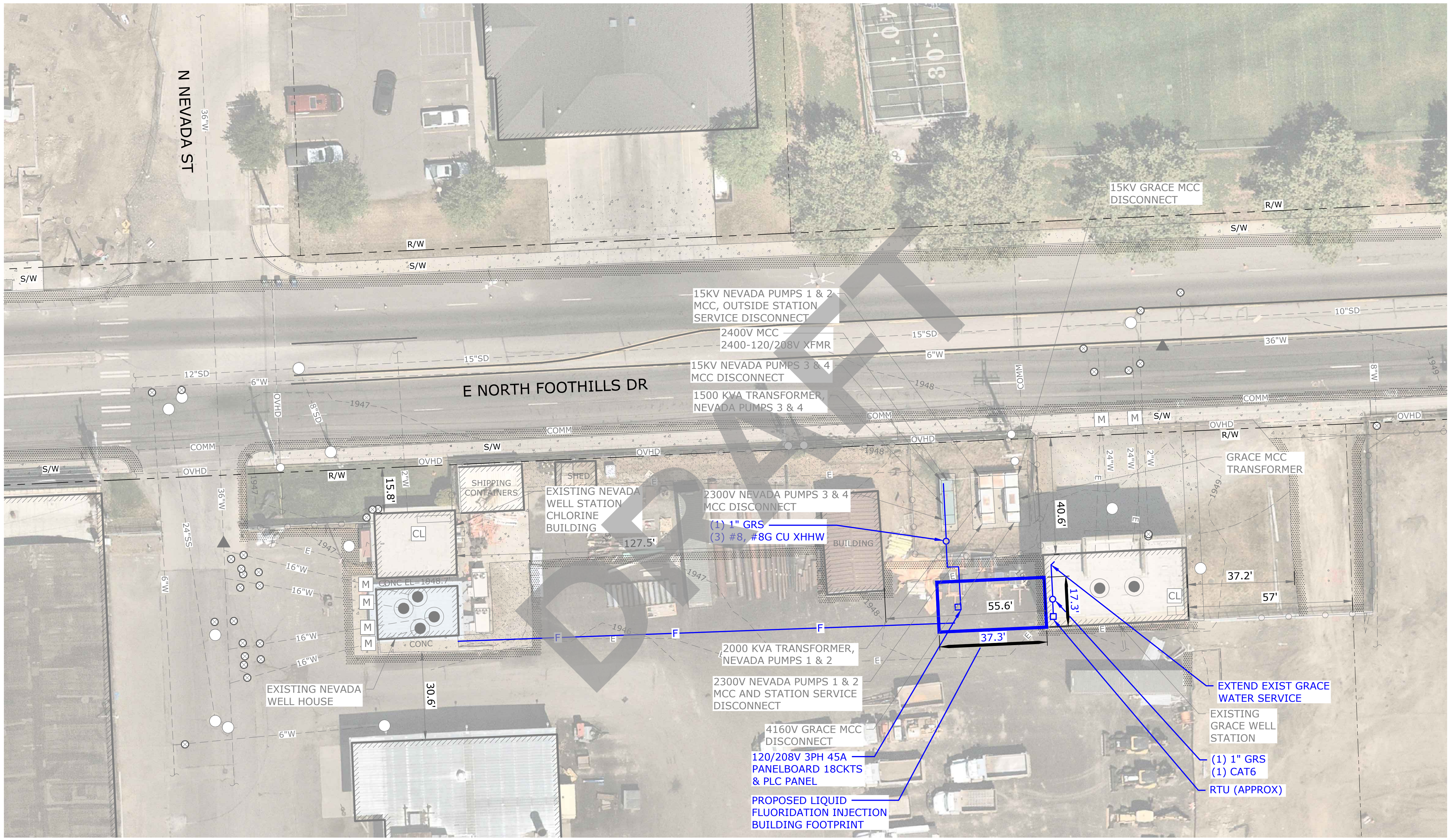
CL	CHLORINE ANALYZER
●	CHLORINE INJECTION POINT
▲	SAMPLE POINT FOR CHLORINE MONITOR ANALYSIS
○	APPROX LOCATION OF WELL PUMP
—F—	CHEMICAL SOLUTION LINE
—E—	PROPOSED ELECTRICAL SERVICE LINE



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GRACE AND NEVADA WELL STATION SITE PLAN

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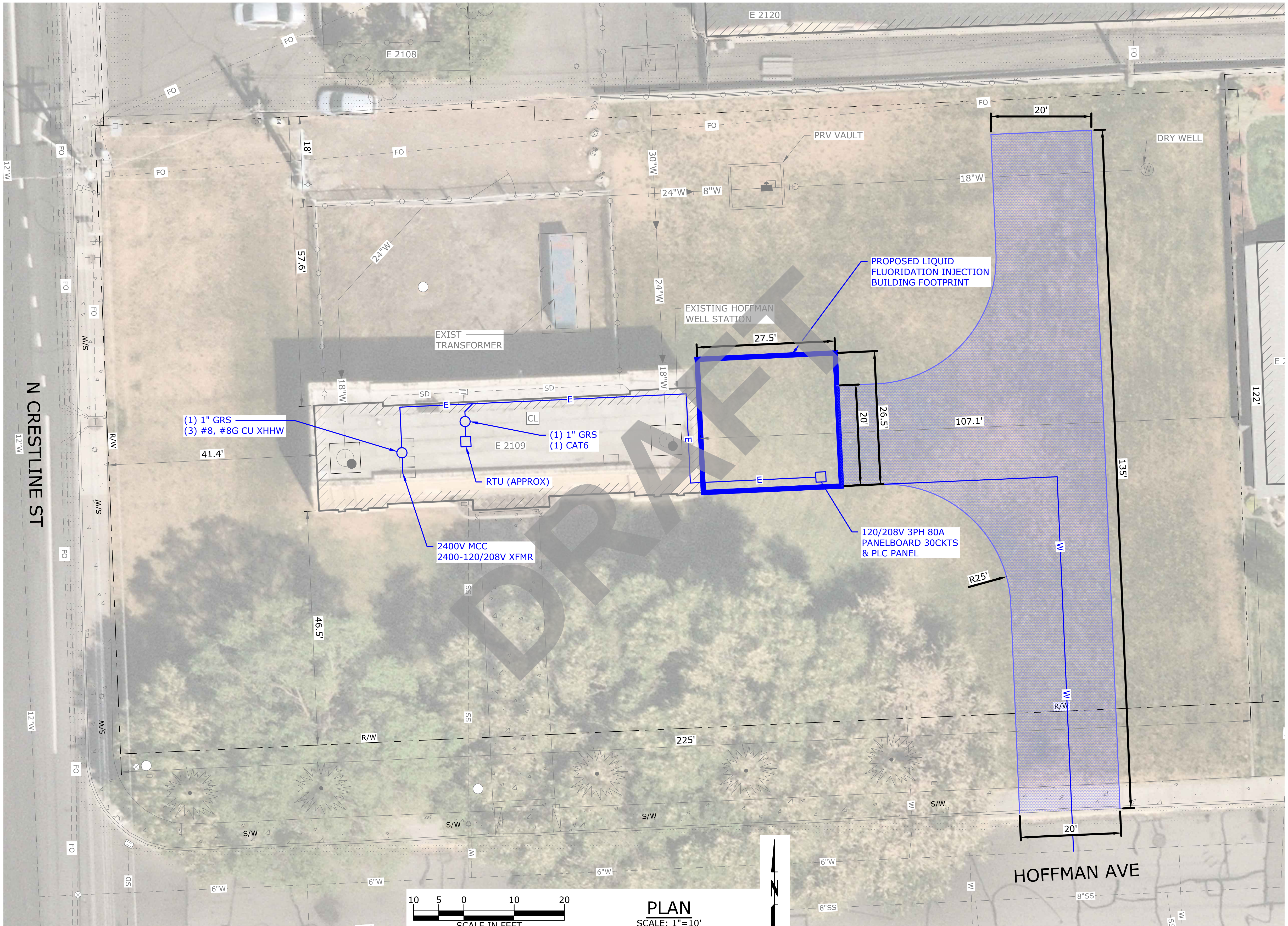

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●	CHLORINE INJECTION POINT
▲	SAMPLE POINT FOR CHLORINE MONITOR ANALYSIS
○	APPROX LOCATION OF WELL PUMP
—W—	PROPOSED WATER SERVICE LINE
—E—	PROPOSED ELECTRICAL SERVICE LINE

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HOFFMAN WELL STATION SITE PLAN

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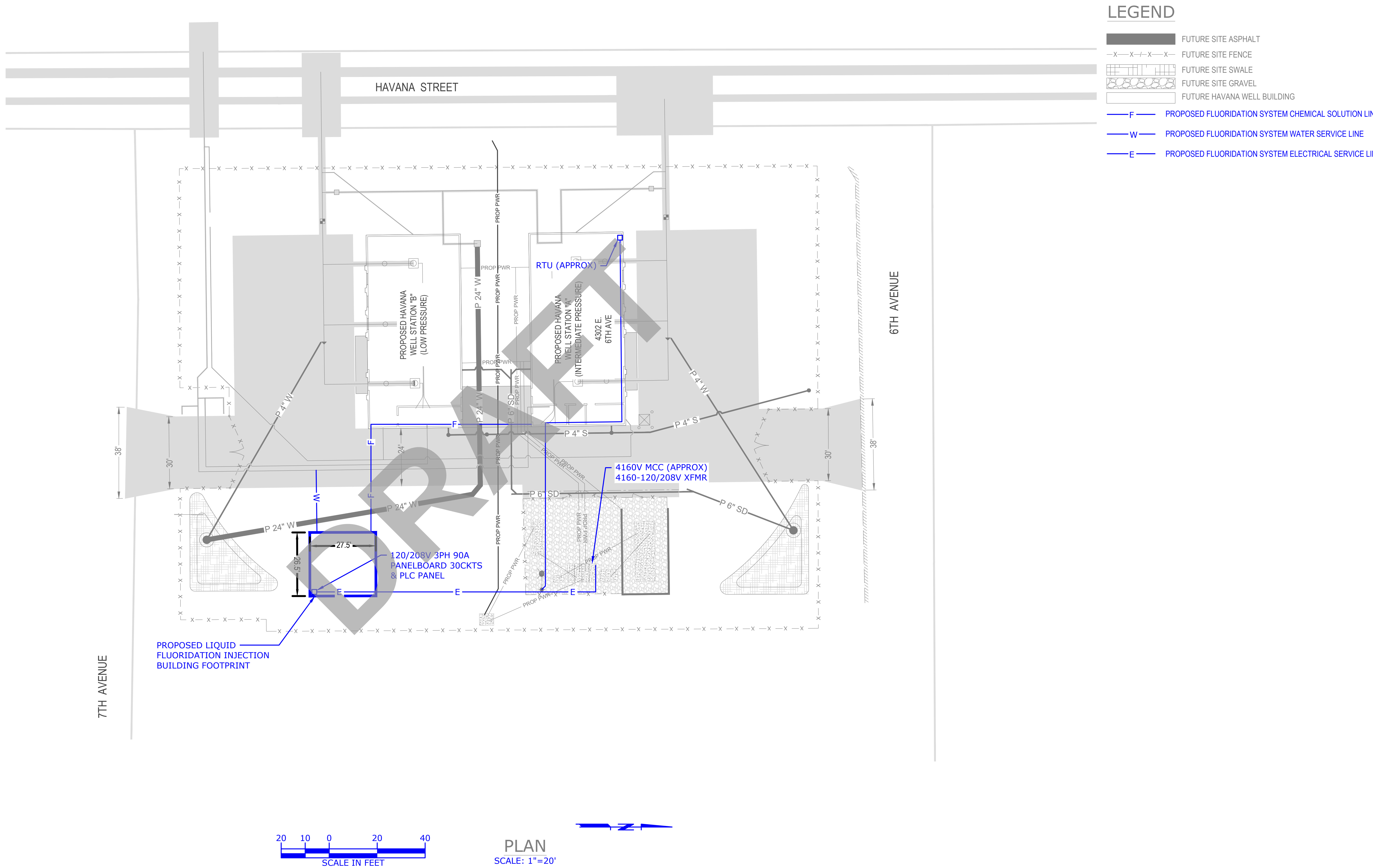

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HAVANA WELL STATION SITE PLAN

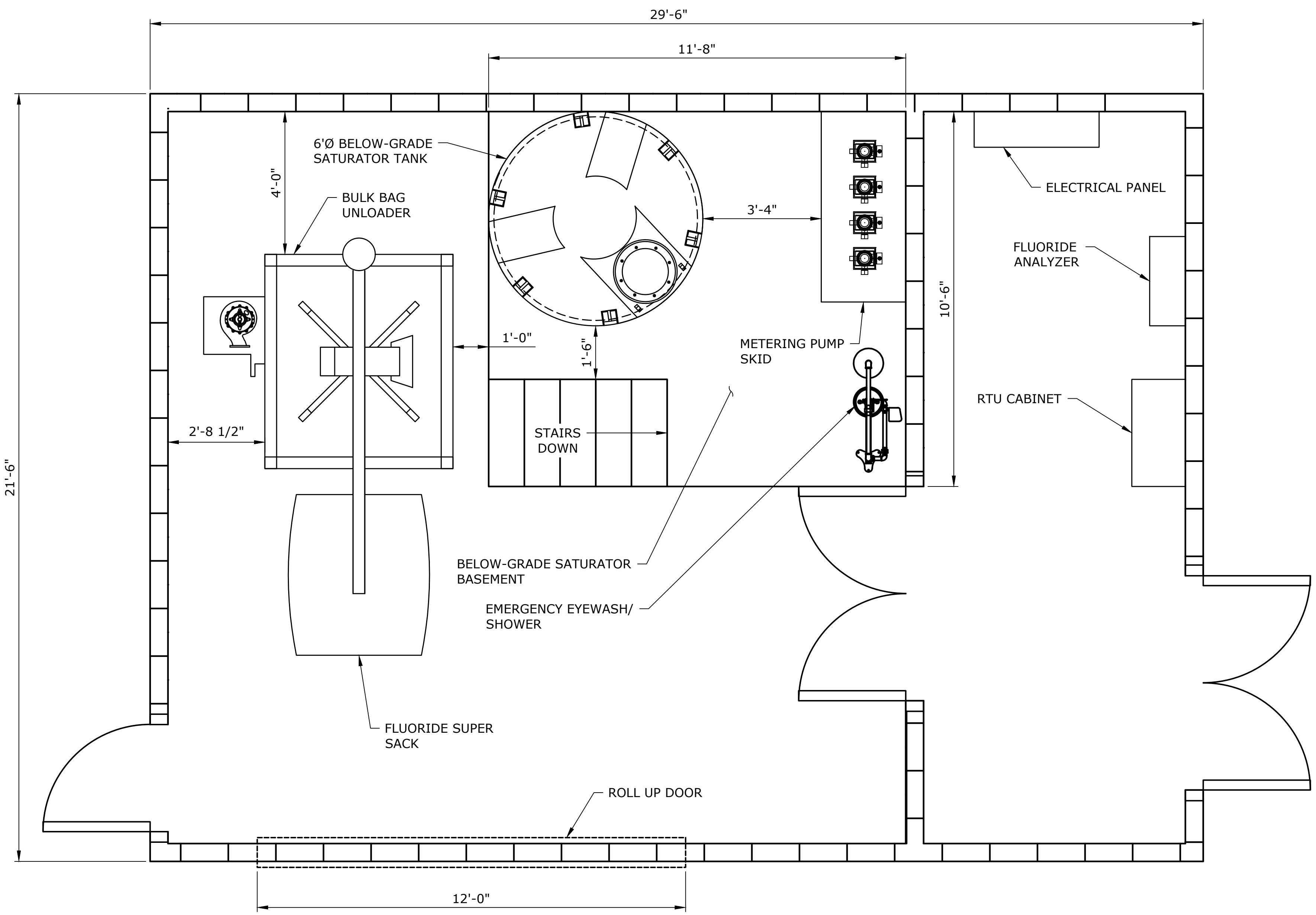
PROJECT NO.: 22-3386 | SCALE: AS SHOWN | DATE: SEPTEMBER 2022

APPENDIX C
PRELIMINARY BUILDING LAYOUTS

NOTES:

1. ALL ROOMS TO HAVE HVAC EQUIPMENT TO BE INSTALLED.

2. ESTIMATED BUILDING HEIGHT: 26'



PLAN
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PARKWATER/RAY/HOFFMAN/HAVANA
SUPER SACK FEED SYSTEM
MECHANICAL LAYOUT

PROJECT NO.: 22-3386 | SCALE: AS SHOWN | DATE: JULY 2022

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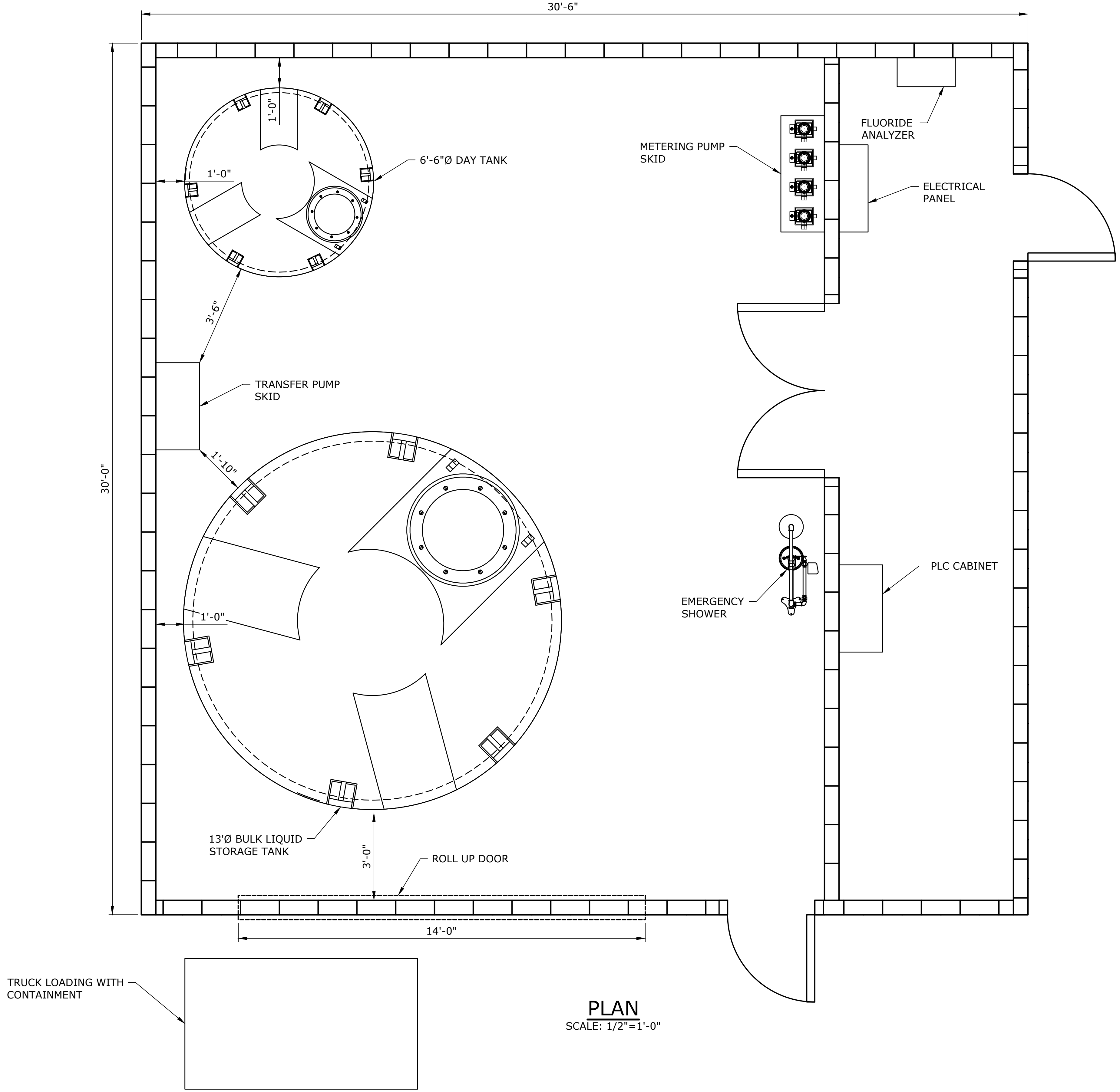

PLAN
SCALE: 1/2"=1'-0"

NOTES:

1. ALL ROOMS TO HAVE HVAC EQUIPMENT TO BE INSTALLED.

2. ESTIMATED BUILDING HEIGHT: 21'

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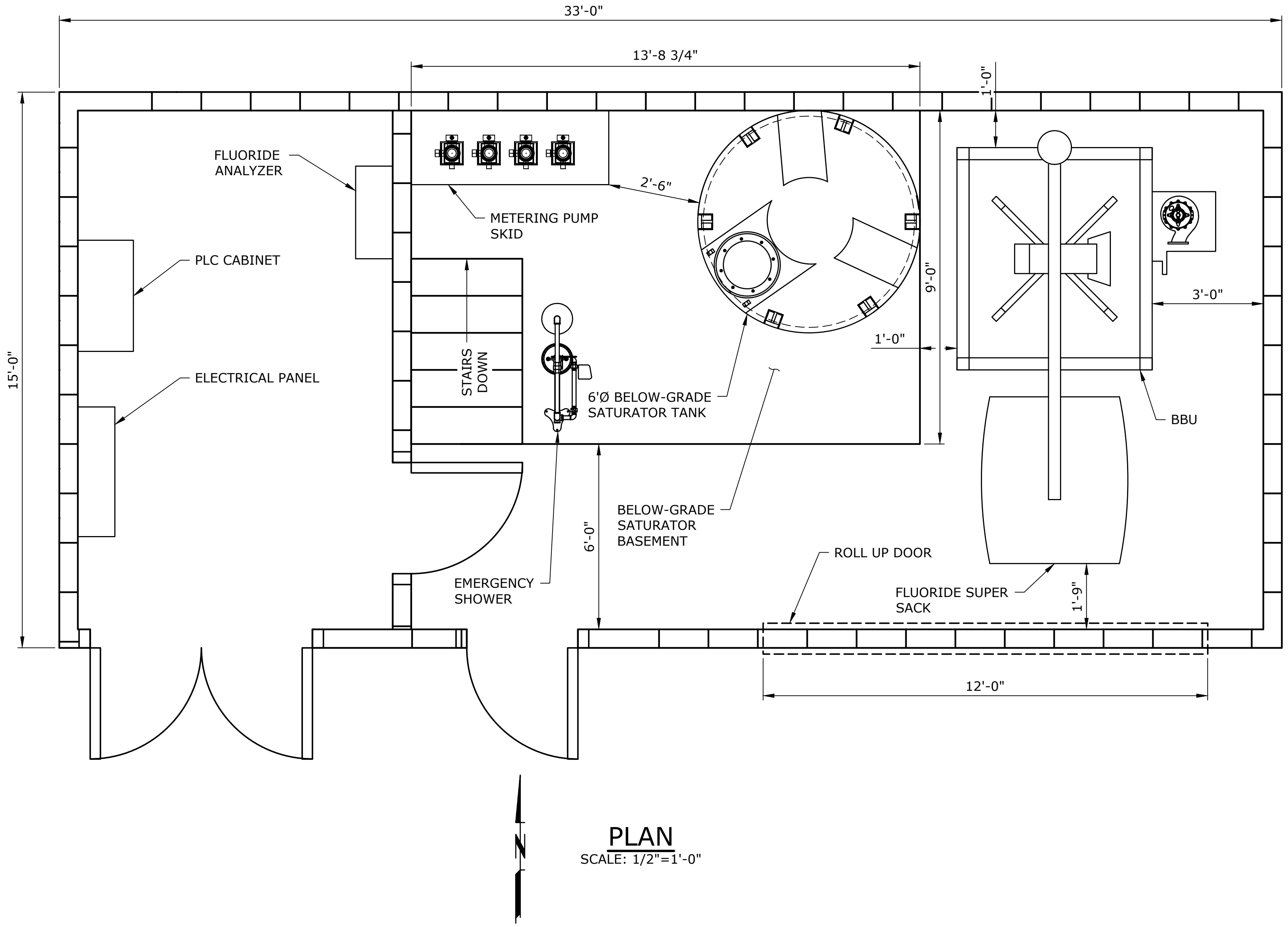
WELL ELECTRIC/PARKWATER/HAVANA
LIQUID FEED SYSTEM
MECHANICAL LAYOUT

PROJECT NO.: 22-3386	SCALE: AS SHOWN	DATE: JULY 2022

NOTES:

1. ALL ROOMS TO HAVE HVAC EQUIPMENT TO BE INSTALLED.

2. ESTIMATED BUILDING HEIGHT: 25'



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SPOKANE FLUORIDATION STUDY

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NEVADA/GRACE/WELL ELECTRIC
SUPER SACK FEED SYSTEM
MECHANICAL LAYOUT

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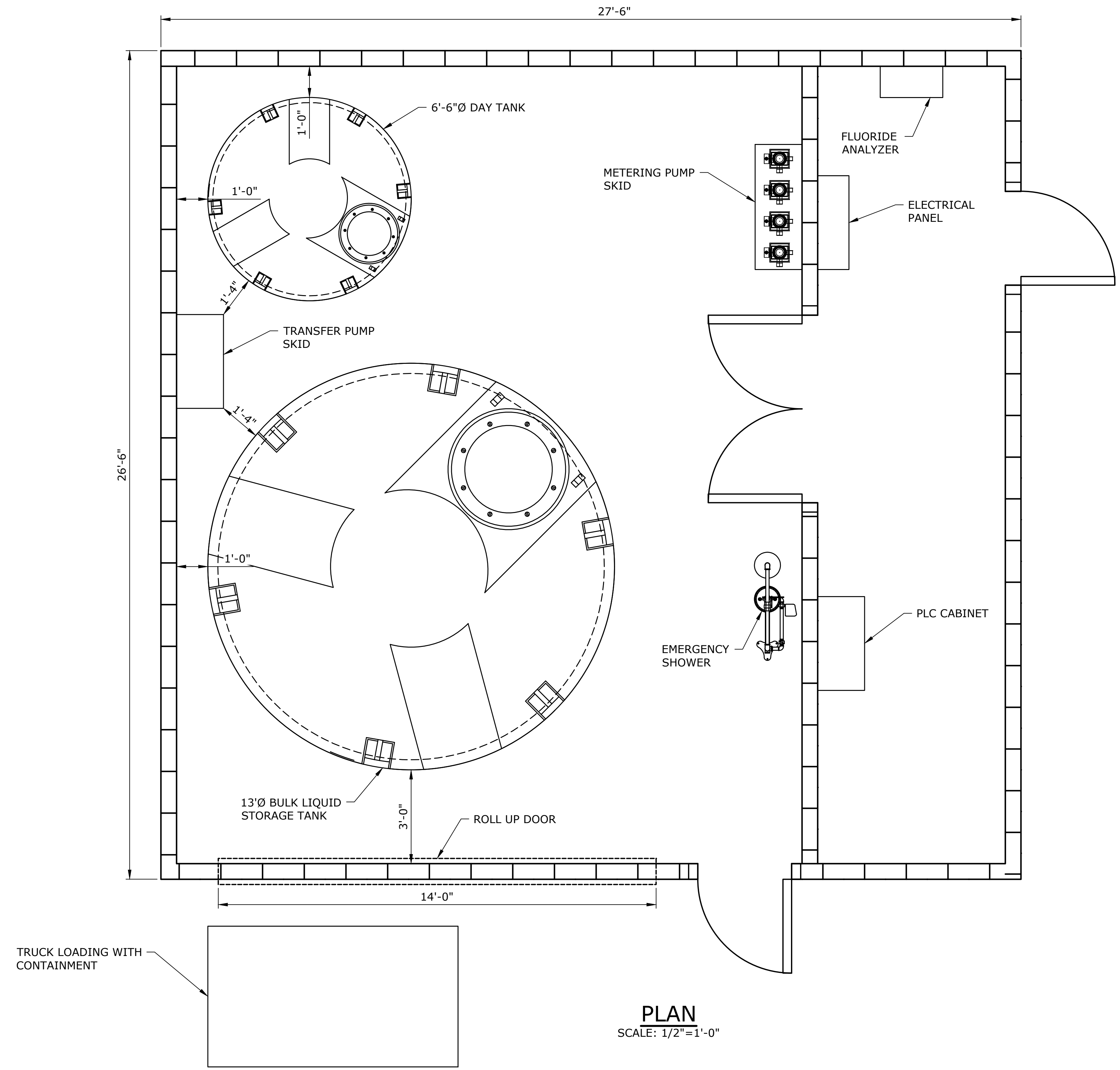

PLAN

SCALE: 1/2"=1'-0"

NOTES:

1. ALL ROOMS TO HAVE HVAC EQUIPMENT TO BE INSTALLED.

2. ESTIMATED BUILDING HEIGHT: 20'

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SPOKANE FLUORIDATION STUDY

RAY/HOFFMAN STREET
LIQUID FEED SYSTEM
MECHANICAL LAYOUT

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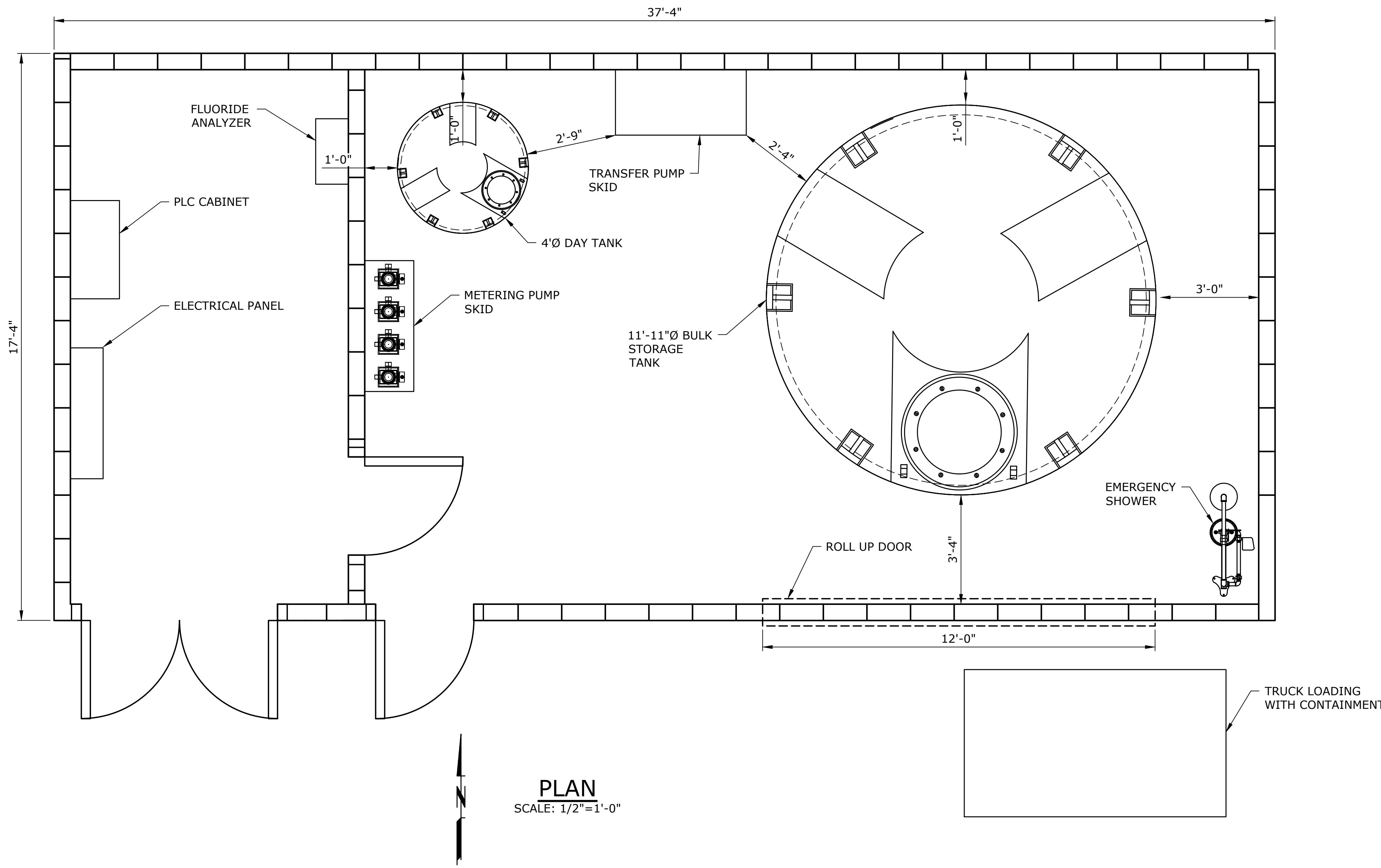
NOTES:

1. ALL ROOMS TO HAVE HVAC EQUIPMENT TO BE INSTALLED.

2. ESTIMATED BUILDING HEIGHT: 19'



PLAN
SCALE: 1/2"=1'-0"

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SPOKANE FLUORIDATION STUDY

DRAFT

NEVADA/GRACE
LIQUID FEED SYSTEM
MECHANICAL LAYOUT

PROJECT NO.:	22-3386	SCALE:	AS SHOWN	DATE:	JULY 2022

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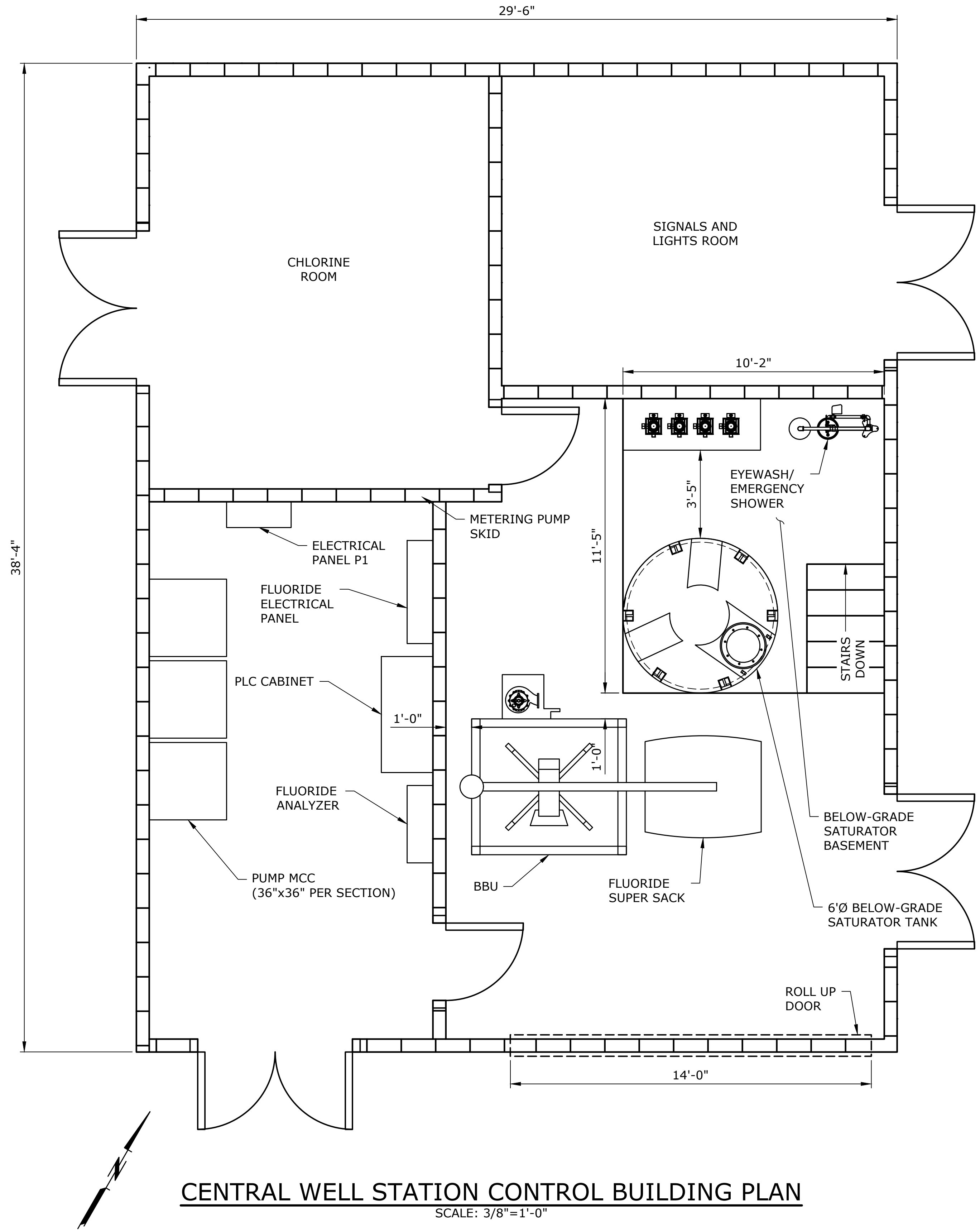
NOTES:

1. ALL ROOMS TO HAVE HVAC EQUIPMENT TO BE INSTALLED.

2. ESTIMATED BUILDING HEIGHT: 28'



CENTRAL WELL STATION CONTROL BUILDING PLAN

SCALE: 3/8"=1'-0"

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NOTICE

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SPOKANE FLUORIDATION STUDY

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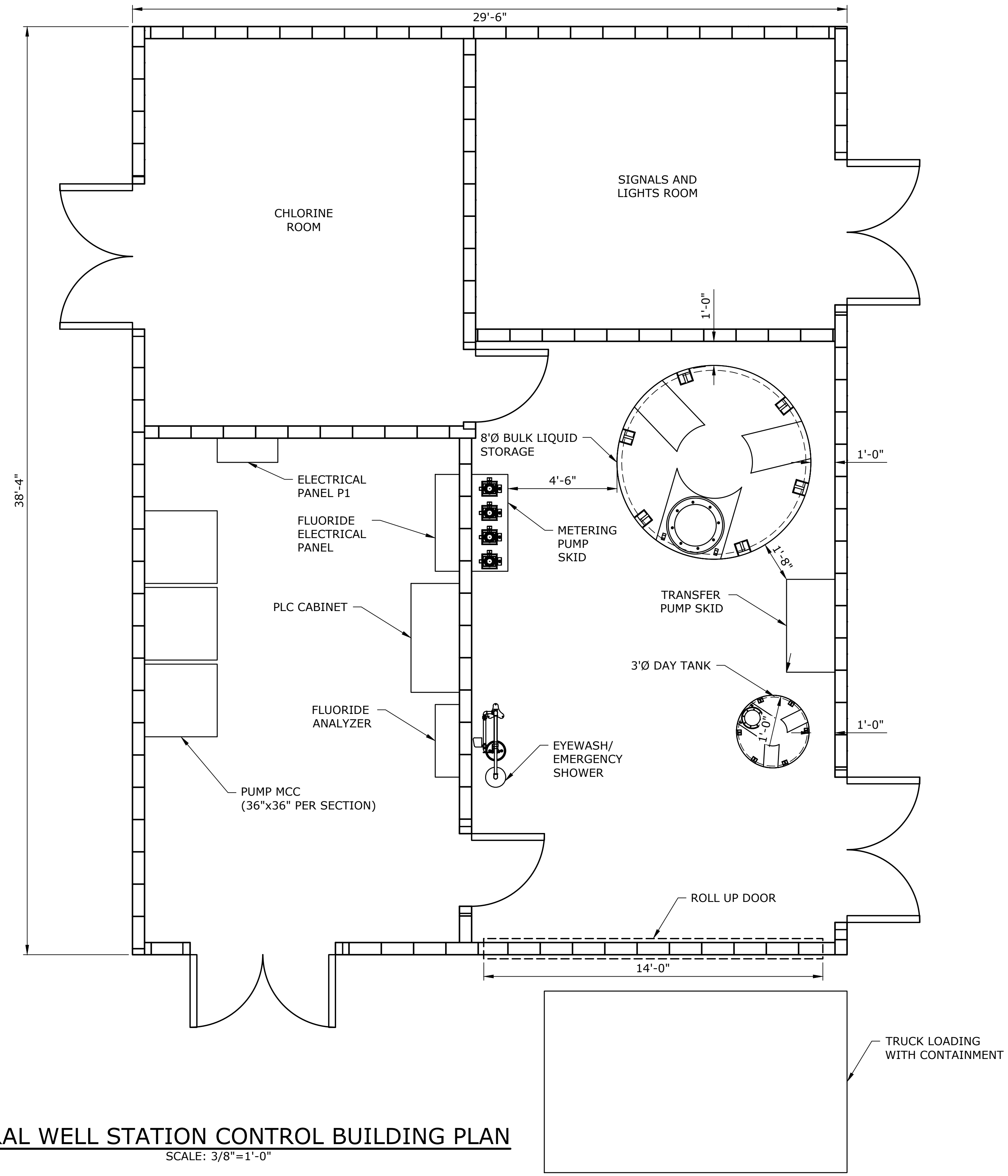
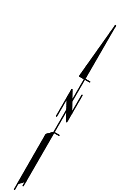
CENTRAL
SUPER SACK FEED SYSTEM
MECHANICAL LAYOUT

PROJECT NO.: 22-3386 | SCALE: AS SHOWN | DATE: JULY 2022





CENTRAL WELL STATION CONTROL BUILDING PLAN

SCALE: 3/8"=1'-0"

NOTES:

1. ALL ROOMS TO HAVE HVAC EQUIPMENT TO BE INSTALLED.

2. ESTIMATED BUILDING HEIGHT: 21'

NO.	DATE	BY	REVISION

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IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

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EJJ DRAWN

KLW CHECKED

PRELIMINARY ONLY
DO NOT USE FOR CONSTRUCTION

JULY 2022

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CITY OF SPOKANE

SPOKANE FLUORIDATION STUDY

DRAFT

CENTRAL
LIQUID FEED SYSTEM
MECHANICAL LAYOUT

PROJECT NO.: 22-3386 | SCALE: AS SHOWN | DATE: JULY 2022

APPENDIX D
CLASS 5 OPCC AND 50-YEAR LCCA

Fluoridation Costs (2022 Dollars)			Dry Chemical			Liquid Chemical			% Difference Capital	% Difference LCCA
Well Station	Type of Building/Site	Size of Building	Capital	50-Year LCCA	Average 50-Yr Annual Operating	Capital	50-Year LCCA	Average 50-Yr Annual Operating	Dry minus Liquid	Dry minus Liquid
Well Electric	Industrial	Large	$ 1,616,000	$ 11,199,000	$ 224,000	$ 1,423,000	$ 8,772,000	$ 176,000	12%	22%
Parkwater	Industrial	Large	$ 1,865,000	$ 12,266,000	$ 246,000	$ 1,683,000	$ 9,189,000	$ 184,000	10%	25%
Ray	Match Existing Architectural Style	Small	$ 1,332,000	$ 6,656,000	$ 134,000	$ 1,108,000	$ 5,419,000	$ 109,000	17%	19%
Central Ave	Match Existing Architectural Style	Existing building size	$ 1,622,000	$ 6,722,000	$ 135,000	$ 1,328,000	$ 5,379,000	$ 108,000	18%	20%
Grace/Nevada	Industrial	Long and skinny	$ 1,616,000	$ 10,139,000	$ 203,000	$ 1,423,000	$ 8,182,000	$ 164,000	12%	19%
Hoffman	Match Existing Architectural Style	Small	$ 1,332,000	$ 6,656,000	$ 134,000	$ 1,108,000	$ 5,419,000	$ 109,000	17%	19%
Havana	Match Existing Architectural Style	Large	$ 1,618,000	$ 8,396,000	$ 168,000	$ 1,436,000	$ 7,100,000	$ 142,000	11%	15%
Total			$ 11,001,000	$ 62,034,000	$ 1,244,000	$ 9,509,000	$ 49,460,000	$ 992,000	14%	20%

MURRAYSMITH’s construction cost estimate (“estimate”) is in dollars valued as of the date of this estimate. This estimate is an opinion of probable cost based on information available at the time of its development. F

- actual field conditions.
- actual material and labor costs.
- market conditions for construction.
- regulatory factors.
- final project scope.
- method of implementation.
- schedule (time to completion? time of commencement? Speed of execution?), and
- other variables.
-

This estimate is based on our perception, which is based on experience and research, yet nevertheless, an assessment, of current conditions at the project location. This estimate reflects our professional opinion of current costs and is subject to change as the project design evolves. MURRAYSMITH has no control over, nor can it forecast variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means, and methods of executing the work, or of determining prices, of the impact of competitive bidding or market conditions, practices, or bidding strategies. MURRAYSMITH neither warrants nor guarantees that proposals, bids, or actual construction costs will reflect the costs presented, which are for illustrative purposes only.

*This is the master sheet- cells affect other sheets

Parkwater

Orange: 5% discount rate, Net Present value

	Large Liquid Building	Concept Level Cost, 2022 Dollars	LCCA Cost (2022 Dollars)	2023	2024	2025	2030	2040	2050	2060	2070	2080
				12.5%	12.0%	8.0%	25.0%	50.0%	50.0%	30.0%	30.0%	30.0%
	Capital Cost			1 year	2 years	3 years	4 years	10 years	20 Years	30 Years	40 Years	50 Years
1	Electrical Equipment	$ 71,000.00	$ 510,573.05	$ 8,875.00	$ 8,520.00	$ 5,680.00	$ 17,750.00	$ 106,500.00	$ 106,500.00	$ 92,300.00	$ 92,300.00	$ 92,300.00
2	PLC MicroLogic 1400	$ 45,000.00	$ 323,602.64	$ 5,625.00	$ 5,400.00	$ 3,600.00	$ 11,250.00	$ 67,500.00	$ 67,500.00	$ 58,500.00	$ 58,500.00	$ 58,500.00
3	Metering Pump Skid	$ 480,000.00	$ 1,922,773.93	$ 60,000.00	$ 57,600.00	$ 38,400.00	$ 120,000.00	$ 240,000.00	$ 720,000.00	$ 144,000.00	$ 624,000.00	$ -
4	Bulk Storage Tank	$ 30,000.00	$ 120,173.37	$ 3,750.00	$ 3,600.00	$ 2,400.00	$ 7,500.00	$ 15,000.00	$ 45,000.00	$ 9,000.00	$ 39,000.00	$ -
5	Day Storage Tank	$ 20,000.00	$ 80,115.58	$ 2,500.00	$ 2,400.00	$ 1,600.00	$ 5,000.00	$ 10,000.00	$ 30,000.00	$ 6,000.00	$ 26,000.00	$ -
6	Roll up Door	$ 10,000.00	$ 40,057.79	$ 1,250.00	$ 1,200.00	$ 800.00	$ 2,500.00	$ 5,000.00	$ 15,000.00	$ 3,000.00	$ 13,000.00	$ -
7	Man Door	$ 8,000.00	$ 32,046.23	$ 1,000.00	$ 960.00	$ 640.00	$ 2,000.00	$ 4,000.00	$ 12,000.00	$ 2,400.00	$ 10,400.00	$ -
8	Fluoride Analyzer	$ 20,000.00	$ 143,823.39	$ 2,500.00	$ 2,400.00	$ 1,600.00	$ 5,000.00	$ 30,000.00	$ 30,000.00	$ 26,000.00	$ 26,000.00	$ 26,000.00
9	Backflow Preventer	$ 6,000.00	$ 24,034.67	$ 750.00	$ 720.00	$ 480.00	$ 1,500.00	$ 3,000.00	$ 9,000.00	$ 1,800.00	$ 7,800.00	$ -
10	Transfer Pump Skid	$ 30,000.00	$ 120,173.37	$ 3,750.00	$ 3,600.00	$ 2,400.00	$ 7,500.00	$ 15,000.00	$ 45,000.00	$ 9,000.00	$ 39,000.00	$ -
11	Secondary Containment	$ 50,000.00	$ -									
12	Building 915 sf @ $300	$ 274,500.00	$ -									
13	Site Improvements	$ 250,000.00	$ 1,001,444.75	$ 31,250.00	$ 30,000.00	$ 20,000.00	$ 62,500.00	$ 125,000.00	$ 375,000.00	$ 75,000.00	$ 325,000.00	$ -
	Subtotal Capital Cost	$ 1,294,500.00										
	Contingency 30%	$ 388,350.00										
	Total Capital Cost	**$ 1,682,850.00**										
	Operating Cost											
		Cost Per Year										
1	Maintenance	$ 25,890.00	$ 282,940.71	$ 29,126.25	$ 28,996.80	$ 27,961.20	$ 32,362.50	$ 38,835.00	$ 38,835.00	$ 33,657.00	$ 33,657.00	$ 33,657.00
2	Replace Equipment	See above	$ 4,318,818.77	See above	See above	See above	See above	See above	See above	See above	See above	See above
3	Operation of Equipment	$ 63,160.00	$ 690,248.57	$ 71,055.00	$ 70,739.20	$ 68,212.80	$ 78,950.00	$ 94,740.00	$ 94,740.00	$ 82,108.00	$ 82,108.00	$ 82,108.00
4	Power Cost	$ 1,126.46	$ 12,310.56	$ 1,267.26	$ 1,261.63	$ 1,216.57	$ 1,408.07	$ 1,689.68	$ 1,689.68	$ 1,464.39	$ 1,464.39	$ 1,464.39
5	Chemical Cost	$ 161,392.97	$ 1,763,794.61	$ 181,567.09	$ 180,760.13	$ 174,304.41	$ 201,741.21	$ 242,089.46	$ 242,089.46	$ 209,810.86	$ 209,810.86	$ 209,810.86
	Subtotal Operating Cost		$ 7,068,113.23									
	Operating Contingency 30%	$ -	$ 2,120,433.97									
	Total 50-year Operating Cost		**$ 9,188,547.20**									
	Total Capital and Operating	**$ 10,871,397.20**										
	Average Yearly Operating (2022 Dollars)		**$ 183,770.94**	$ 375,139.36	$ 369,160.96	$ 321,333.78	$ 104,919.86	$ 95,951.91	$ 179,351.91	$ 72,038.33	$ 155,438.33	$ 47,018.33

Hoffman, Ray

Orange: 5% discount rate, Net Present value

	Small Liquid Building	**Concept Level Cost**	**LCCA Cost**	**2023**	**2024**	**2025**	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**
	Capital Cost			12.5%	12%	8%	4 years 25%	10 years 50%	20 Years 50%	30 Years 30.0%	40 Years 30.0%	50 Years 30.0%
1	Electrical Equipment	$ 71,000.00	$ 544,382.57	$ 8,875.00	$ 8,520.00	$ 5,680.00	$ 17,750.00	$ 106,500.00	$ 142,000.00	$ 92,300.00	$ 92,300.00	$ 92,300.00
2	PLC MicroLogic 1400	$ 45,000.00	$ 345,031.21	$ 5,625.00	$ 5,400.00	$ 3,600.00	$ 11,250.00	$ 67,500.00	$ 90,000.00	$ 58,500.00	$ 58,500.00	$ 58,500.00
3	Metering Pump Skid	$ 120,000.00	$ 537,836.34	$ 15,000.00	$ 14,400.00	$ 9,600.00	$ 30,000.00	$ 60,000.00	$ 240,000.00	$ 36,000.00	$ 156,000.00	$ -
4	Bulk Storage Tank	$ 30,000.00	$ 134,459.08	$ 3,750.00	$ 3,600.00	$ 2,400.00	$ 7,500.00	$ 15,000.00	$ 60,000.00	$ 9,000.00	$ 39,000.00	$ -
5	Day Storage Tank	$ 20,000.00	$ 89,639.39	$ 2,500.00	$ 2,400.00	$ 1,600.00	$ 5,000.00	$ 10,000.00	$ 40,000.00	$ 6,000.00	$ 26,000.00	$ -
6	Roll up Door	$ 10,000.00	$ 44,819.69	$ 1,250.00	$ 1,200.00	$ 800.00	$ 2,500.00	$ 5,000.00	$ 20,000.00	$ 3,000.00	$ 13,000.00	$ -
7	Man Door	$ 8,000.00	$ 35,855.76	$ 1,000.00	$ 960.00	$ 640.00	$ 2,000.00	$ 4,000.00	$ 16,000.00	$ 2,400.00	$ 10,400.00	$ -
8	Fluoride Analyzer	$ 20,000.00	$ 153,347.20	$ 2,500.00	$ 2,400.00	$ 1,600.00	$ 5,000.00	$ 30,000.00	$ 40,000.00	$ 26,000.00	$ 26,000.00	$ 26,000.00
9	Backflow Preventer	$ 6,000.00	$ 26,891.82	$ 750.00	$ 720.00	$ 480.00	$ 1,500.00	$ 3,000.00	$ 12,000.00	$ 1,800.00	$ 7,800.00	$ -
10	Transfer Pump Skid	$ 30,000.00	$ 134,459.08	$ 3,750.00	$ 3,600.00	$ 2,400.00	$ 7,500.00	$ 15,000.00	$ 60,000.00	$ 9,000.00	$ 39,000.00	$ -
11	Secondary Containment	$ 50,000.00	$ -									
12	Building 729 sf @ $400	$ 291,600.00	$ -									
13	Site Improvements	$ 150,000.00	$ 672,295.42	$ 18,750.00	$ 18,000.00	$ 12,000.00	$ 37,500.00	$ 75,000.00	$ 300,000.00	$ 45,000.00	$ 195,000.00	$ -
	Subtotal Capital Cost	$ 851,600.00										
	Contingency 30%	$ 255,480.00										
	Total Capital Cost	**$ 1,107,080.00**										
	Operating Cost	Cost Per Year										
1	Maintenance	$ 17,032.00	$ 186,135.43	$ 19,161.00	$ 19,075.84	$ 18,394.56	$ 21,290.00	$ 25,548.00	$ 25,548.00	$ 22,141.60	$ 22,141.60	$ 22,141.60
2	Replace Equipment	See above	$ 2,719,017.57	See above	See above	See above	See above	See above	See above	See above	See above	See above
3	Operation of Equipment	$ 63,160.00	$ 690,248.57	$ 71,055.00	$ 70,739.20	$ 68,212.80	$ 78,950.00	$ 94,740.00	$ 94,740.00	$ 82,108.00	$ 82,108.00	$ 82,108.00
4	Power Cost	$ 1,047.55	$ 11,448.23	$ 1,178.49	$ 1,173.26	$ 1,131.35	$ 1,309.44	$ 1,571.33	$ 1,571.33	$ 1,361.82	$ 1,361.82	$ 1,361.82
5	Chemical Cost	$ 51,331.55	$ 560,980.50	$ 57,747.99	$ 57,491.33	$ 55,438.07	$ 64,164.44	$ 76,997.32	$ 76,997.32	$ 66,731.01	$ 66,731.01	$ 66,731.01
	Subtotal Operating Cost		$ 4,167,830.30									
	Operating Contingency 30%		$ 1,250,349.09									
	Total 50-year Operating Cost		**$ 5,418,179.39**									
	Total Capital and Operating	**$ 6,525,259.39**										
	Average Yearly Operating (2022 Dollars)		**$ 108,363.59**									

*This is the master sheet- cells affect other sheets

Havana

Orange: 5% discount rate, Net Present value

	Large Liquid Building- Havana (Residential)	**Concept Level Cost, 2022 Dollars**	**LCCA Cost (2022 Dollars)**	**2023**	**2024**	**2025**	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**
	Capital Cost			12.5%	12%	8%	20% 4 years	50% 10 Years	100% 20 Years	30.0% 30 Years	30.0% 40 Years	30.0% 50 Years
1	Electrical Equipment	$ 71,000.00	$ 541,001.62	$ 8,875.00	$ 8,520.00	$ 5,680.00	$ 14,200.00	$ 106,500.00	$ 142,000.00	$ 92,300.00	$ 92,300.00	$ 92,300.00
2	PLC MicroLogic 1400	$ 45,000.00	$ 342,888.35	$ 5,625.00	$ 5,400.00	$ 3,600.00	$ 9,000.00	$ 67,500.00	$ 90,000.00	$ 58,500.00	$ 58,500.00	$ 58,500.00
3	Metering Pump Skid	$ 360,000.00	$ 1,596,366.16	$ 45,000.00	$ 43,200.00	$ 28,800.00	$ 72,000.00	$ 180,000.00	$ 720,000.00	$ 108,000.00	$ 468,000.00	$ -
4	Bulk Storage Tank	$ 30,000.00	$ 133,030.51	$ 3,750.00	$ 3,600.00	$ 2,400.00	$ 6,000.00	$ 15,000.00	$ 60,000.00	$ 9,000.00	$ 39,000.00	$ -
5	Day Storage Tank	$ 20,000.00	$ 88,687.01	$ 2,500.00	$ 2,400.00	$ 1,600.00	$ 4,000.00	$ 10,000.00	$ 40,000.00	$ 6,000.00	$ 26,000.00	$ -
6	Roll up Door	$ 10,000.00	$ 44,343.50	$ 1,250.00	$ 1,200.00	$ 800.00	$ 2,000.00	$ 5,000.00	$ 20,000.00	$ 3,000.00	$ 13,000.00	$ -
7	Man Door	$ 8,000.00	$ 35,474.80	$ 1,000.00	$ 960.00	$ 640.00	$ 1,600.00	$ 4,000.00	$ 16,000.00	$ 2,400.00	$ 10,400.00	$ -
8	Fluoride Analyzer	$ 20,000.00	$ 152,394.82	$ 2,500.00	$ 2,400.00	$ 1,600.00	$ 4,000.00	$ 30,000.00	$ 40,000.00	$ 26,000.00	$ 26,000.00	$ 26,000.00
9	Backflow Preventer	$ 6,000.00	$ 26,606.10	$ 750.00	$ 720.00	$ 480.00	$ 1,200.00	$ 3,000.00	$ 12,000.00	$ 1,800.00	$ 7,800.00	$ -
10	Transfer Pump Skid	$ 30,000.00	$ 133,030.51	$ 3,750.00	$ 3,600.00	$ 2,400.00	$ 6,000.00	$ 15,000.00	$ 60,000.00	$ 9,000.00	$ 39,000.00	$ -
11	Secondary Containment	$ 50,000.00	$ -									
12	Building 915 sf @ $400	$ 366,000.00	$ -									
13	Site Improvements	$ 150,000.00	$ 665,152.57	$ 18,750.00	$ 18,000.00	$ 12,000.00	$ 30,000.00	$ 75,000.00	$ 300,000.00	$ 45,000.00	$ 195,000.00	$ -
	Subtotal Capital Cost	$ 1,166,000.00										
	Contingency 30%	$ 349,800.00										
	Total Capital Cost	**$ 1,515,800.00**										
	Operating Cost											
		Cost Per Year										
1	Maintenance	$ 23,320.00	$ 264,848.57	$ 26,235.00	$ 26,118.40	$ 25,185.60	$ 27,984.00	$ 34,980.00	$ 46,640.00	$ 30,316.00	$ 30,316.00	$ 30,316.00
2	Replace Equipment	See above	$ 3,758,975.96	See above	See above	See above	See above	See above	See above	See above	See above	See above
3	Operation of Equipment	$ 63,160.00	$ 717,317.14	$ 71,055.00	$ 70,739.20	$ 68,212.80	$ 75,792.00	$ 94,740.00	$ 126,320.00	$ 82,108.00	$ 82,108.00	$ 82,108.00
4	Power Cost	$ 1,341.07	$ 15,230.75	$ 1,508.71	$ 1,502.00	$ 1,448.36	$ 1,609.29	$ 2,011.61	$ 2,682.14	$ 1,743.39	$ 1,743.39	$ 1,743.39
5	Chemical Cost	$ 62,088.71	$ 705,150.35	$ 69,849.80	$ 69,539.36	$ 67,055.81	$ 74,506.45	$ 93,133.07	$ 124,177.42	$ 80,715.32	$ 80,715.32	$ 80,715.32
	Subtotal Operating Cost		$ 5,461,522.78									
	Operating Contingency 30%	$ -	$ 1,638,456.83									
	Total 50-year Operating Cost		**$ 7,099,979.61**									
	Total Capital and Operating	**$ 8,615,779.61**										
	Average Yearly Operating (2022 Dollars)		**$ 141,999.59**									

Parkwater

Orange: 5% discount rate, Net Present Value

	Dry Building	Concept Level Cost	LCCA Cost	2023	2024	2025	2030	2040	2050	2060	2070	2080
	Capital Cost			12.5%	12%	8%	25% 4 years	50% 10 years	50% 20 Years	30.0% 30 Years	30.0% 40 Years	30.0% 50 Years
1	Electrical Equipment	$55,000.00	$ 421,704.81	$ 6,875.00	$ 6,600.00	$ 4,400.00	$ 13,750.00	$ 82,500.00	$ 110,000.00	$ 71,500.00	$ 71,500.00	$ 71,500.00
2	PLC MicroLogic 1400	$45,000.00	$ 345,031.21	$ 5,625.00	$ 5,400.00	$ 3,600.00	$ 11,250.00	$ 67,500.00	$ 90,000.00	$ 58,500.00	$ 58,500.00	$ 58,500.00
3	Metering Pump Skid (about 2-8 pumps per facility, will follow up with table showing number of pumps for each facility)	$ 480,000.00	$ 2,151,345.35	$ 60,000.00	$ 57,600.00	$ 38,400.00	$ 120,000.00	$ 240,000.00	$ 960,000.00	$ 144,000.00	$ 624,000.00	$ -
4	Backflow Preventer	$ 6,000.00	$ 26,891.82	$ 750.00	$ 720.00	$ 480.00	$ 1,500.00	$ 3,000.00	$ 12,000.00	$ 1,800.00	$ 7,800.00	$ -
5	Man Door	$ 8,000.00	$ 35,855.76	$ 1,000.00	$ 960.00	$ 640.00	$ 2,000.00	$ 4,000.00	$ 16,000.00	$ 2,400.00	$ 10,400.00	$ -
6	Roll up Door	$ 10,000.00	$ 44,819.69	$ 1,250.00	$ 1,200.00	$ 800.00	$ 2,500.00	$ 5,000.00	$ 20,000.00	$ 3,000.00	$ 13,000.00	$ -
7	Fluoride Analyzer	$ 20,000.00	$ 153,347.20	$ 2,500.00	$ 2,400.00	$ 1,600.00	$ 5,000.00	$ 30,000.00	$ 40,000.00	$ 26,000.00	$ 26,000.00	$ 26,000.00
8	Water Softener	$ 2,500.00	$ 19,168.40	$ 312.50	$ 300.00	$ 200.00	$ 625.00	$ 3,750.00	$ 5,000.00	$ 3,250.00	$ 3,250.00	$ 3,250.00
9	BBU (includes refill feeder, weigh feeder, model 810 BBU, saturator, volumetric feeder, control panel)	$ 200,000.00	$ 896,393.90	$ 25,000.00	$ 24,000.00	$ 16,000.00	$ 50,000.00	$ 100,000.00	$ 400,000.00	$ 60,000.00	$ 260,000.00	$ -
10	Saturator Basement	$ 50,000.00	$ -									
11	Building 635 sf @ $300	$ 190,500.00	$ -									
12	Storage Warehouse Space	$ 117,000.00	$ -									
13	Site Improvements	$ 250,000.00	$ 1,120,492.37	$ 31,250.00	$ 30,000.00	$ 20,000.00	$ 62,500.00	$ 125,000.00	$ 500,000.00	$ 75,000.00	$ 325,000.00	$ -
	Subtotal Capital Cost	$1,434,000.00										
	Contingency 30%	$ 430,200.00										
	Total Capital Cost	**$ 1,864,200.00**										
	Operating Cost	Cost Per Year										
1	Maintenance	$ 28,680.00	$ 313,431.43	$ 32,265.00	$ 32,121.60	$ 30,974.40	$ 35,850.00	$ 43,020.00	$ 43,020.00	$ 37,284.00	$ 37,284.00	$ 37,284.00
2	Replace Equipment	See above	$ 5,215,050.51	See above	See above	See above	See above	See above	See above	See above	See above	See above
3	Operation of Equipment	$ 66,200.00	$ 723,471.43	$ 74,475.00	$ 74,144.00	$ 71,496.00	$ 82,750.00	$ 99,300.00	$ 99,300.00	$ 86,060.00	$ 86,060.00	$ 86,060.00
4	Power Cost	$ 1,335.38	$ 14,593.78	$ 1,502.30	$ 1,495.62	$ 1,442.21	$ 1,669.22	$ 2,003.07	$ 2,003.07	$ 1,735.99	$ 1,735.99	$ 1,735.99
5	Chemical Cost	$ 289,924.82	$ 3,168,464.08	$ 326,165.42	$ 324,715.80	$ 313,118.80	$ 362,406.02	$ 434,887.23	$ 434,887.23	$ 376,902.26	$ 376,902.26	$ 376,902.26
	Subtotal Operating Cost		$ 9,435,011.23									
	Operating Contingency 30%		$ 2,830,503.37									
	Total 50-year Operating Cost		**$ 12,265,514.59**									
	Total Capital and Operating	**$ 14,129,714.59**										
	Average Yearly Operating (2022 Dollars)		**$ 245,310.29**									

Hoffman, Ray

Orange: 5% discount rate, Net Present Value

	Dry Building	Concept Level Cost	LCCA Cost	2023	2024	2025	2030	2040	2050	2060	2070	2080
	Capital Cost			12.5%	12%	8%	25% 4 years	50% 10 years	50% 20 Years	30.0% 30 Years	30.0% 40 Years	30.0% 50 Years
1	Electrical Equipment	$55,000.00	$ 421,704.81	$ 6,875.00	$ 6,600.00	$ 4,400.00	$ 13,750.00	$ 82,500.00	$ 110,000.00	$ 71,500.00	$ 71,500.00	$ 71,500.00
2	PLC MicroLogic 1400	$45,000.00	$ 345,031.21	$ 5,625.00	$ 5,400.00	$ 3,600.00	$ 11,250.00	$ 67,500.00	$ 90,000.00	$ 58,500.00	$ 58,500.00	$ 58,500.00
3	Metering Pump Skid (about 2-8 pumps per facility, will follow up with table showing number of pumps for each facility)	$ 120,000.00	$ 537,836.34	$ 15,000.00	$ 14,400.00	$ 9,600.00	$ 30,000.00	$ 60,000.00	$ 240,000.00	$ 36,000.00	$ 156,000.00	$ -
4	Backflow Preventer	$ 6,000.00	$ 26,891.82	$ 750.00	$ 720.00	$ 480.00	$ 1,500.00	$ 3,000.00	$ 12,000.00	$ 1,800.00	$ 7,800.00	$ -
5	Man Door	$ 8,000.00	$ 35,855.76	$ 1,000.00	$ 960.00	$ 640.00	$ 2,000.00	$ 4,000.00	$ 16,000.00	$ 2,400.00	$ 10,400.00	$ -
6	Roll up Door	$ 10,000.00	$ 44,819.69	$ 1,250.00	$ 1,200.00	$ 800.00	$ 2,500.00	$ 5,000.00	$ 20,000.00	$ 3,000.00	$ 13,000.00	$ -
7	Fluoride Analyzer	$ 20,000.00	$ 153,347.20	$ 2,500.00	$ 2,400.00	$ 1,600.00	$ 5,000.00	$ 30,000.00	$ 40,000.00	$ 26,000.00	$ 26,000.00	$ 26,000.00
8	Water Softener	$ 2,500.00	$ 19,168.40	$ 312.50	$ 300.00	$ 200.00	$ 625.00	$ 3,750.00	$ 5,000.00	$ 3,250.00	$ 3,250.00	$ 3,250.00
9	BBU (includes refill feeder, weigh feeder, model 810 BBU, saturator, volumetric feeder, control panel)	$ 200,000.00	$ 896,393.90	$ 25,000.00	$ 24,000.00	$ 16,000.00	$ 50,000.00	$ 100,000.00	$ 400,000.00	$ 60,000.00	$ 260,000.00	$ -
10	Saturator Basement	$ 50,000.00	$ -									
11	Building 635 sf @ $400	$ 254,000.00	$ -									
12	Storage Warehouse Space	$ 104,000.00	$ -									
13	Site Improvements	$ 150,000.00	$ 672,295.42	$ 18,750.00	$ 18,000.00	$ 12,000.00	$ 37,500.00	$ 75,000.00	$ 300,000.00	$ 45,000.00	$ 195,000.00	$ -
	Subtotal Capital Cost	$ 1,024,500.00										
	Contingency 30%	$ 307,350.00										
	Total Capital Cost	**$ 1,331,850.00**										
	Operating Cost	Cost Per Year										
1	Maintenance	$ 20,490.00	$ 223,926.43	$ 23,051.25	$ 22,948.80	$ 22,129.20	$ 25,612.50	$ 30,735.00	$ 30,735.00	$ 26,637.00	$ 26,637.00	$ 26,637.00
2	Replace Equipment	See above	$ 3,153,344.54	See above	See above	See above	See above	See above	See above	See above	See above	See above
3	Operation of Equipment	$ 66,200.00	$ 723,471.43	$ 74,475.00	$ 74,144.00	$ 71,496.00	$ 82,750.00	$ 99,300.00	$ 99,300.00	$ 86,060.00	$ 86,060.00	$ 86,060.00
4	Power Cost	$ 1,050.50	$ 11,480.41	$ 1,181.81	$ 1,176.55	$ 1,134.54	$ 1,313.12	$ 1,575.74	$ 1,575.74	$ 1,365.64	$ 1,365.64	$ 1,365.64
5	Chemical Cost	$ 92,211.51	$ 1,007,740.10	$ 103,737.95	$ 103,276.89	$ 99,588.43	$ 115,264.39	$ 138,317.27	$ 138,317.27	$ 119,874.97	$ 119,874.97	$ 119,874.97
	Subtotal Operating Cost		$ 5,119,962.91									
	Operating Contingency 30%		$ 1,535,988.87									
	Total 50-year Operating Cost		**$ 6,655,951.79**									
	Total Capital and Operating	**$ 7,987,801.79**										
	Average Yearly Operating (2022 Dollars)		**$ 133,119.04**									

Havana

Orange: 5% discount rate, Net Present Value

	Dry Building	Concept Level Cost	LCCA Cost	2023	2024	2025	2030	2040	2050	2060	2070	2080
	Capital Cost			12.5%	12%	8%	25% 4 years	50% 10 years	50% 20 Years	30.0% 30 Years	30.0% 40 Years	30.0% 50 Years
1	Electrical Equipment	$55,000.00	$ 421,704.81	$ 6,875.00	$ 6,600.00	$ 4,400.00	$ 13,750.00	$ 82,500.00	$ 110,000.00	$ 71,500.00	$ 71,500.00	$ 71,500.00
2	PLC MicroLogic 1400	$45,000.00	$ 345,031.21	$ 5,625.00	$ 5,400.00	$ 3,600.00	$ 11,250.00	$ 67,500.00	$ 90,000.00	$ 58,500.00	$ 58,500.00	$ 58,500.00
3	Metering Pump Skid (about 2-8 pumps per facility, will follow up with table showing number of pumps for each facility)	$ 360,000.00	$ 1,613,509.02	$ 45,000.00	$ 43,200.00	$ 28,800.00	$ 90,000.00	$ 180,000.00	$ 720,000.00	$ 108,000.00	$ 468,000.00	$ -
4	Backflow Preventer	$ 6,000.00	$ 26,891.82	$ 750.00	$ 720.00	$ 480.00	$ 1,500.00	$ 3,000.00	$ 12,000.00	$ 1,800.00	$ 7,800.00	$ -
5	Man Door	$ 8,000.00	$ 35,855.76	$ 1,000.00	$ 960.00	$ 640.00	$ 2,000.00	$ 4,000.00	$ 16,000.00	$ 2,400.00	$ 10,400.00	$ -
6	Roll up Door	$ 10,000.00	$ 44,819.69	$ 1,250.00	$ 1,200.00	$ 800.00	$ 2,500.00	$ 5,000.00	$ 20,000.00	$ 3,000.00	$ 13,000.00	$ -
7	Fluoride Analyzer	$ 20,000.00	$ 153,347.20	$ 2,500.00	$ 2,400.00	$ 1,600.00	$ 5,000.00	$ 30,000.00	$ 40,000.00	$ 26,000.00	$ 26,000.00	$ 26,000.00
8	Water Softener	$ 2,500.00	$ 19,168.40	$ 312.50	$ 300.00	$ 200.00	$ 625.00	$ 3,750.00	$ 5,000.00	$ 3,250.00	$ 3,250.00	$ 3,250.00
9	BBU (includes refill feeder, weigh feeder, model 810 BBU, saturator, volumetric feeder, control panel)	$ 200,000.00	$ 896,393.90	$ 25,000.00	$ 24,000.00	$ 16,000.00	$ 50,000.00	$ 100,000.00	$ 400,000.00	$ 60,000.00	$ 260,000.00	$ -
10	Saturator Basement	$ 50,000.00	$ -									
11	Building 635 sf @ $400	$ 254,000.00	$ -									
12	Storage Warehouse Space	$ 84,000.00	$ -									
13	Site Improvements	$ 150,000.00	$ 672,295.42	$ 18,750.00	$ 18,000.00	$ 12,000.00	$ 37,500.00	$ 75,000.00	$ 300,000.00	$ 45,000.00	$ 195,000.00	$ -
	Subtotal Capital Cost	$ 1,244,500.00										
	Contingency 30%	$ 373,350.00										
	Total Capital Cost	**$ 1,617,850.00**										
	Operating Cost	Cost Per Year										
1	Maintenance	$ 24,890.00	$ 272,012.14	$ 28,001.25	$ 27,876.80	$ 26,881.20	$ 31,112.50	$ 37,335.00	$ 37,335.00	$ 32,357.00	$ 32,357.00	$ 32,357.00
2	Replace Equipment	See above	$ 4,229,017.22	See above	See above	See above	See above	See above	See above	See above	See above	See above
3	Operation of Equipment	$ 66,200.00	$ 723,471.43	$ 74,475.00	$ 74,144.00	$ 71,496.00	$ 82,750.00	$ 99,300.00	$ 99,300.00	$ 86,060.00	$ 86,060.00	$ 86,060.00
4	Power Cost	$ 1,365.86	$ 14,926.84	$ 1,536.59	$ 1,529.76	$ 1,475.12	$ 1,707.32	$ 2,048.78	$ 2,048.78	$ 1,775.61	$ 1,775.61	$ 1,775.61
5	Chemical Cost	$ 111,535.58	$ 1,218,924.51	$ 125,477.52	$ 124,919.85	$ 120,458.42	$ 139,419.47	$ 167,303.36	$ 167,303.36	$ 144,996.25	$ 144,996.25	$ 144,996.25
	Subtotal Operating Cost		$ 6,458,352.15									
	Operating Contingency 30%		$ 1,937,505.64									
	Total 50-year Operating Cost		**$ 8,395,857.79**									
	Total Capital and Operating	**$ 10,013,707.79**										
	Average Yearly Operating (2022 Dollars)		**$ 167,917.16**									

Central

Orange: 5% discount rate, Net Present value

	Central Ave Liquid Building	Concept Level Cost	LCCA Cost	2023	2024	2025	2030	2040	2050	2060	2070	2080
	Capital Cost			12.5%	12%	8%	25% 4 years	50% 10 years	50% 20 Years	30.0% 30 Years	30.0% 40 Years	30.0% 50 Years
1	Electrical Equipment	$ 71,000.00	$ 544,382.57	$ 8,875.00	$ 8,520.00	$ 5,680.00	$ 17,750.00	$ 106,500.00	$ 142,000.00	$ 92,300.00	$ 92,300.00	$ 92,300.00
2	PLC MicroLogic 1400	$ 45,000.00	$ 345,031.21	$ 5,625.00	$ 5,400.00	$ 3,600.00	$ 11,250.00	$ 67,500.00	$ 90,000.00	$ 58,500.00	$ 58,500.00	$ 58,500.00
3	Metering Pump Skid	$ 120,000.00	$ 537,836.34	$ 15,000.00	$ 14,400.00	$ 9,600.00	$ 30,000.00	$ 60,000.00	$ 240,000.00	$ 36,000.00	$ 156,000.00	$ -
4	Bulk Storage Tank	$ 30,000.00	$ 134,459.08	$ 3,750.00	$ 3,600.00	$ 2,400.00	$ 7,500.00	$ 15,000.00	$ 60,000.00	$ 9,000.00	$ 39,000.00	$ -
5	Day Storage Tank	$ 20,000.00	$ 89,639.39	$ 2,500.00	$ 2,400.00	$ 1,600.00	$ 5,000.00	$ 10,000.00	$ 40,000.00	$ 6,000.00	$ 26,000.00	$ -
6	Roll up Door	$ 10,000.00	$ 44,819.69	$ 1,250.00	$ 1,200.00	$ 800.00	$ 2,500.00	$ 5,000.00	$ 20,000.00	$ 3,000.00	$ 13,000.00	$ -
7	Man Door	$ 8,000.00	$ 35,855.76	$ 1,000.00	$ 960.00	$ 640.00	$ 2,000.00	$ 4,000.00	$ 16,000.00	$ 2,400.00	$ 10,400.00	$ -
8	Fluoride Analyzer	$ 20,000.00	$ 153,347.20	$ 2,500.00	$ 2,400.00	$ 1,600.00	$ 5,000.00	$ 30,000.00	$ 40,000.00	$ 26,000.00	$ 26,000.00	$ 26,000.00
9	Backflow Preventer	$ 6,000.00	$ 26,891.82	$ 750.00	$ 720.00	$ 480.00	$ 1,500.00	$ 3,000.00	$ 12,000.00	$ 1,800.00	$ 7,800.00	$ -
10	Transfer Pump Skid	$ 30,000.00	$ 134,459.08	$ 3,750.00	$ 3,600.00	$ 2,400.00	$ 7,500.00	$ 15,000.00	$ 60,000.00	$ 9,000.00	$ 39,000.00	$ -
11	Secondary Containment	$ 50,000.00	$ -									
12	Building 1102 sf @ $400	$ 440,800.00	$ -									
13	Demo Existing Building	$ 20,000.00	$ -									
14	Site Improvements	$ 150,000.00	$ 672,295.42	$ 18,750.00	$ 18,000.00	$ 12,000.00	$ 37,500.00	$ 75,000.00	$ 300,000.00	$ 45,000.00	$ 195,000.00	$ -
	Subtotal Capital Cost	$ 1,020,800.00										
	Contingency 30%	$ 306,240.00										
	Total Capital Cost	**$ 1,327,040.00**										
	Operating Cost	Cost Per Year										
1	Maintenance	$ 20,416.00	$ 223,117.71	$ 22,968.00	$ 22,865.92	$ 22,049.28	$ 25,520.00	$ 30,624.00	$ 30,624.00	$ 26,540.80	$ 26,540.80	$ 26,540.80
2	Replace Equipment	See above	$ 2,719,017.57	See above	See above	See above	See above	See above	See above	See above	See above	See above
3	Operation of Equipment	$ 63,160.00	$ 690,248.57	$ 71,055.00	$ 70,739.20	$ 68,212.80	$ 78,950.00	$ 94,740.00	$ 94,740.00	$ 82,108.00	$ 82,108.00	$ 82,108.00
4	Power Cost	$ 1,059.06	$ 11,574.05	$ 1,191.45	$ 1,186.15	$ 1,143.79	$ 1,323.83	$ 1,588.60	$ 1,588.60	$ 1,376.78	$ 1,376.78	$ 1,376.78
5	Chemical Cost	$ 45,178.16	$ 493,732.79	$ 50,825.43	$ 50,599.54	$ 48,792.42	$ 56,472.71	$ 67,767.25	$ 67,767.25	$ 58,731.61	$ 58,731.61	$ 58,731.61
	Subtotal Operating Cost		$ 4,137,690.70									
	Operating Contingency 30%		$ 1,241,307.21									
	Total 50-year Operating Cost		**$ 5,378,997.91**									
	Total Capital and Operating	**$ 6,706,037.91**										
	Average Yearly Operating (2022 Dollars)		**$ 107,579.96**									

Central

Orange: 5% discount rate, Net Present Value

	Central Ave Dry Building	Concept Level Cost	LCCA Cost	2023	2024	2025	2030	2040	2050	2060	2070	2080
	Capital Cost			12.5%	12%	8%	25% 4 years	50% 10 years	50% 20 Years	30.0% 30 Years	30.0% 40 Years	30.0% 50 Years
1	Electrical Equipment	$ 71,000.00	$ 544,382.57	$ 8,875.00	$ 8,520.00	$ 5,680.00	$ 17,750.00	$ 106,500.00	$ 142,000.00	$ 92,300.00	$ 92,300.00	$ 92,300.00
2	PLC MicroLogic 1400	$45,000.00	$ 345,031.21	$ 5,625.00	$ 5,400.00	$ 3,600.00	$ 11,250.00	$ 67,500.00	$ 90,000.00	$ 58,500.00	$ 58,500.00	$ 58,500.00
3	Metering Pump Skid (about 2-8 pumps per facility, will follow up with table showing number of pumps for each facility)	$ 120,000.00	$ 537,836.34	$ 15,000.00	$ 14,400.00	$ 9,600.00	$ 30,000.00	$ 60,000.00	$ 240,000.00	$ 36,000.00	$ 156,000.00	$ -
4	Backflow Preventer	$ 6,000.00	$ 26,891.82	$ 750.00	$ 720.00	$ 480.00	$ 1,500.00	$ 3,000.00	$ 12,000.00	$ 1,800.00	$ 7,800.00	$ -
5	Man Door	$ 8,000.00	$ 35,855.76	$ 1,000.00	$ 960.00	$ 640.00	$ 2,000.00	$ 4,000.00	$ 16,000.00	$ 2,400.00	$ 10,400.00	$ -
6	Roll up Door	$ 10,000.00	$ 44,819.69	$ 1,250.00	$ 1,200.00	$ 800.00	$ 2,500.00	$ 5,000.00	$ 20,000.00	$ 3,000.00	$ 13,000.00	$ -
7	Fluoride Analyzer	$ 20,000.00	$ 153,347.20	$ 2,500.00	$ 2,400.00	$ 1,600.00	$ 5,000.00	$ 30,000.00	$ 40,000.00	$ 26,000.00	$ 26,000.00	$ 26,000.00
8	Water Softener	$ 2,500.00	$ 19,168.40	$ 312.50	$ 300.00	$ 200.00	$ 625.00	$ 3,750.00	$ 5,000.00	$ 3,250.00	$ 3,250.00	$ 3,250.00
9	BBU (includes refill feeder, weigh feeder, model 810 BBU, saturator, volumetric feeder, control panel)	$ 200,000.00	$ 896,393.90	$ 25,000.00	$ 24,000.00	$ 16,000.00	$ 50,000.00	$ 100,000.00	$ 400,000.00	$ 60,000.00	$ 260,000.00	$ -
10	Saturator Basement	$ 50,000.00	$ -									
11	Building 1102 sf @ $400	$ 440,800.00	$ -									
12	Demo Existing Building	$ 20,000.00	$ -									
13	Storage Warehouse Space	$ 104,000.00	$ -									
14	Site Improvements	$ 150,000.00	$ 672,295.42	$ 18,750.00	$ 18,000.00	$ 12,000.00	$ 37,500.00	$ 75,000.00	$ 300,000.00	$ 45,000.00	$ 195,000.00	$ -
	Subtotal Capital Cost	$ 1,247,300.00										
	Contingency 30%	$ 374,190.00										
	Total Capital Cost	**$ 1,621,490.00**										
	Operating Cost	Cost Per Year										
1	Maintenance	$ 24,946.00	$ 272,624.14	$ 28,064.25	$ 27,939.52	$ 26,941.68	$ 31,182.50	$ 37,419.00	$ 37,419.00	$ 32,429.80	$ 32,429.80	$ 32,429.80
2	Replace Equipment	See above	$ 3,276,022.31	See above	See above	See above	See above	See above	See above	See above	See above	See above
3	Operation of Equipment	$ 66,200.00	$ 723,471.43	$ 74,475.00	$ 74,144.00	$ 71,496.00	$ 82,750.00	$ 99,300.00	$ 99,300.00	$ 86,060.00	$ 86,060.00	$ 86,060.00
4	Power Cost	$ 1,067.74	$ 11,668.91	$ 1,201.21	$ 1,195.87	$ 1,153.16	$ 1,334.68	$ 1,601.62	$ 1,601.62	$ 1,388.07	$ 1,388.07	$ 1,388.07
5	Chemical Cost	$ 81,157.63	$ 886,936.95	$ 91,302.33	$ 90,896.55	$ 87,650.24	$ 101,447.04	$ 121,736.44	$ 121,736.44	$ 105,504.92	$ 105,504.92	$ 105,504.92
	Subtotal Operating Cost		$ 5,170,723.74									
	Operating Contingency 30%		$ 1,551,217.12									
	Total 50-year Operating Cost		**$ 6,721,940.87**									
	Total Capital and Operating	**$ 8,343,430.87**										
	Average Yearly Operating (2022 Dollars)		**$ 134,438.82**									

Nevada AND Grace (One Building)

Orange: 5% discount rate, Net Present value

	Nevada/Grace Liquid Buildling	Concept Level Cost	LCCA Cost	2023	2024	2025	2030	2040	2050	2060	2070	2080
	Capital Cost			12.5%	12%	8%	25% 4 years	50% 10 years	50% 20 Years	30.0% 30 Years	30.0% 40 Years	30.0% 50 Years
1	Electrical Equipment	$ 71,000.00	$ 544,382.57	$ 8,875.00	$ 8,520.00	$ 5,680.00	$ 17,750.00	$ 106,500.00	$ 142,000.00	$ 92,300.00	$ 92,300.00	$ 92,300.00
2	PLC MicroLogic 1400	$ 45,000.00	$ 345,031.21	$ 5,625.00	$ 5,400.00	$ 3,600.00	$ 11,250.00	$ 67,500.00	$ 90,000.00	$ 58,500.00	$ 58,500.00	$ 58,500.00
3	Metering Pump Skid	$ 360,000.00	$ 1,613,509.02	$ 45,000.00	$ 43,200.00	$ 28,800.00	$ 90,000.00	$ 180,000.00	$ 720,000.00	$ 108,000.00	$ 468,000.00	$ -
4	Bulk Storage Tank	$ 30,000.00	$ 134,459.08	$ 3,750.00	$ 3,600.00	$ 2,400.00	$ 7,500.00	$ 15,000.00	$ 60,000.00	$ 9,000.00	$ 39,000.00	$ -
5	Day Storage Tank	$ 20,000.00	$ 89,639.39	$ 2,500.00	$ 2,400.00	$ 1,600.00	$ 5,000.00	$ 10,000.00	$ 40,000.00	$ 6,000.00	$ 26,000.00	$ -
6	Roll up Door	$ 10,000.00	$ 44,819.69	$ 1,250.00	$ 1,200.00	$ 800.00	$ 2,500.00	$ 5,000.00	$ 20,000.00	$ 3,000.00	$ 13,000.00	$ -
7	Man Door	$ 8,000.00	$ 35,855.76	$ 1,000.00	$ 960.00	$ 640.00	$ 2,000.00	$ 4,000.00	$ 16,000.00	$ 2,400.00	$ 10,400.00	$ -
8	Fluoride Analyzer	$ 20,000.00	$ 153,347.20	$ 2,500.00	$ 2,400.00	$ 1,600.00	$ 5,000.00	$ 30,000.00	$ 40,000.00	$ 26,000.00	$ 26,000.00	$ 26,000.00
9	Backflow Preventer	$ 6,000.00	$ 26,891.82	$ 750.00	$ 720.00	$ 480.00	$ 1,500.00	$ 3,000.00	$ 12,000.00	$ 1,800.00	$ 7,800.00	$ -
10	Transfer Pump Skid	$ 30,000.00	$ 134,459.08	$ 3,750.00	$ 3,600.00	$ 2,400.00	$ 7,500.00	$ 15,000.00	$ 60,000.00	$ 9,000.00	$ 39,000.00	$ -
11	Secondary Containment	$ 50,000.00	$ -									
12	Building 647 sf @ $300	$ 194,100.00	$ -									
13	Site Improvements	$ 250,000.00	$ 1,120,492.37	$ 31,250.00	$ 30,000.00	$ 20,000.00	$ 62,500.00	$ 125,000.00	$ 500,000.00	$ 75,000.00	$ 325,000.00	$ -
	Subtotal Capital Cost	$ 1,094,100.00										
	Contingency 30%	$ 328,230.00										
	Total Capital Cost	**$ 1,422,330.00**										
	Operating Cost	Cost Per Year										
1	Maintenance	$ 21,882.00	$ 239,139.00	$ 24,617.25	$ 24,507.84	$ 23,632.56	$ 27,352.50	$ 32,823.00	$ 32,823.00	$ 28,446.60	$ 28,446.60	$ 28,446.60
2	Replace Equipment	See above	$ 4,242,887.19	See above	See above	See above	See above	See above	See above	See above	See above	See above
3	Operation of Equipment	$ 63,160.00	$ 690,248.57	$ 71,055.00	$ 70,739.20	$ 68,212.80	$ 78,950.00	$ 94,740.00	$ 94,740.00	$ 82,108.00	$ 82,108.00	$ 82,108.00
4	Power Cost	$ 1,153.04	$ 12,601.13	$ 1,297.18	$ 1,291.41	$ 1,245.29	$ 1,441.31	$ 1,729.57	$ 1,729.57	$ 1,498.96	$ 1,498.96	$ 1,498.96
5	Chemical Cost	$ 101,429.37	$ 1,108,478.16	$ 114,108.05	$ 113,600.90	$ 109,543.72	$ 126,786.72	$ 152,144.06	$ 152,144.06	$ 131,858.19	$ 131,858.19	$ 131,858.19
	Subtotal Operating Cost		$ 6,293,354.05									
	Operating Contingency 30%		$ 1,888,006.22									
	Total 50-year Operating Cost		**$ 8,181,360.27**									
	Total Capital and Operating	**$ 9,603,690.27**										
	Average Yearly Operating (2022 Dollars)		**$ 163,627.21**									

Well Electric

Orange: 5% discount rate, Net Present value

	Well Electric Liquid Buildling	Concept Level Cost	LCCA Cost	2023	2024	2025	2030	2040	2050	2060	2070	2080
				12.5%	12%	8%	25% 4 years	50% 10 years	50% 20 Years	30.0% 30 Years	30.0% 40 Years	30.0% 50 Years
	Capital Cost											
1	Electrical Equipment	$ 71,000.00	$ 544,382.57	$ 8,875.00	$ 8,520.00	$ 5,680.00	$ 17,750.00	$ 106,500.00	$ 142,000.00	$ 92,300.00	$ 92,300.00	$ 92,300.00
2	PLC MicroLogic 1400	$ 45,000.00	$ 345,031.21	$ 5,625.00	$ 5,400.00	$ 3,600.00	$ 11,250.00	$ 67,500.00	$ 90,000.00	$ 58,500.00	$ 58,500.00	$ 58,500.00
3	Metering Pump Skid	$ 360,000.00	$ 1,613,509.02	$ 45,000.00	$ 43,200.00	$ 28,800.00	$ 90,000.00	$ 180,000.00	$ 720,000.00	$ 108,000.00	$ 468,000.00	$ -
4	Bulk Storage Tank	$ 30,000.00	$ 134,459.08	$ 3,750.00	$ 3,600.00	$ 2,400.00	$ 7,500.00	$ 15,000.00	$ 60,000.00	$ 9,000.00	$ 39,000.00	$ -
5	Day Storage Tank	$ 20,000.00	$ 89,639.39	$ 2,500.00	$ 2,400.00	$ 1,600.00	$ 5,000.00	$ 10,000.00	$ 40,000.00	$ 6,000.00	$ 26,000.00	$ -
6	Roll up Door	$ 10,000.00	$ 44,819.69	$ 1,250.00	$ 1,200.00	$ 800.00	$ 2,500.00	$ 5,000.00	$ 20,000.00	$ 3,000.00	$ 13,000.00	$ -
7	Man Door	$ 8,000.00	$ 35,855.76	$ 1,000.00	$ 960.00	$ 640.00	$ 2,000.00	$ 4,000.00	$ 16,000.00	$ 2,400.00	$ 10,400.00	$ -
8	Fluoride Analyzer	$ 20,000.00	$ 153,347.20	$ 2,500.00	$ 2,400.00	$ 1,600.00	$ 5,000.00	$ 30,000.00	$ 40,000.00	$ 26,000.00	$ 26,000.00	$ 26,000.00
9	Backflow Preventer	$ 6,000.00	$ 26,891.82	$ 750.00	$ 720.00	$ 480.00	$ 1,500.00	$ 3,000.00	$ 12,000.00	$ 1,800.00	$ 7,800.00	$ -
10	Transfer Pump Skid	$ 30,000.00	$ 134,459.08	$ 3,750.00	$ 3,600.00	$ 2,400.00	$ 7,500.00	$ 15,000.00	$ 60,000.00	$ 9,000.00	$ 39,000.00	$ -
11	Secondary Containment	$ 50,000.00	$ -									
12	Building 647 sf @ $300	$ 194,100.00	$ -									
13	Site Improvements	$ 250,000.00	$ 1,120,492.37	$ 31,250.00	$ 30,000.00	$ 20,000.00	$ 62,500.00	$ 125,000.00	$ 500,000.00	$ 75,000.00	$ 325,000.00	$ -
	Subtotal Capital Cost	$ 1,094,100.00										
	Contingency 30%	$ 328,230.00										
	Total Capital Cost	**$ 1,422,330.00**										
	Operating Cost	Cost Per Year										
1	Maintenance	$ 21,882.00	$ 239,139.00	$ 24,617.25	$ 24,507.84	$ 23,632.56	$ 27,352.50	$ 32,823.00	$ 32,823.00	$ 28,446.60	$ 28,446.60	$ 28,446.60
2	Replace Equipment	See above	$ 4,242,887.19	See above	See above	See above	See above	See above	See above	See above	See above	See above
3	Operation of Equipment	$ 63,160.00	$ 690,248.57	$ 71,055.00	$ 70,739.20	$ 68,212.80	$ 78,950.00	$ 94,740.00	$ 94,740.00	$ 82,108.00	$ 82,108.00	$ 82,108.00
4	Power Cost	$ 1,126.46	$ 12,310.56	$ 1,267.26	$ 1,261.63	$ 1,216.57	$ 1,408.07	$ 1,689.68	$ 1,689.68	$ 1,464.39	$ 1,464.39	$ 1,464.39
5	Chemical Cost	$ 142,963.25	$ 1,562,384.08	$ 160,833.66	$ 160,118.84	$ 154,400.31	$ 178,704.06	$ 214,444.87	$ 214,444.87	$ 185,852.22	$ 185,852.22	$ 185,852.22
	Subtotal Operating Cost		$ 6,746,969.41									
	Operating Contingency 30%		$ 2,024,090.82									
	Total 50-year Operating Cost		**$ 8,771,060.23**									
	Total Capital and Operating	**$ 10,193,390.23**										
	Average Yearly Operating (2022 Dollars)		**$ 175,421.20**									

Nevada AND Grace (One Building)

Orange: 5% discount rate, Net Present Value

	Nevada/Grace Dry Building	Concept Level Cost	LCCA Cost	2023	2024	2025	2030	2040	2050	2060	2070	2080
	Capital Cost			12.5%	12%	8%	4 years 25%	10 years 50%	20 Years 50%	30 Years 30.0%	40 Years 30.0%	50 Years 30.0%
1	Electrical Equipment	$ 71,000.00	$ 544,382.57	$ 8,875.00	$ 8,520.00	$ 5,680.00	$ 17,750.00	$ 106,500.00	$ 142,000.00	$ 92,300.00	$ 92,300.00	$ 92,300.00
2	PLC MicroLogic 1400	$45,000.00	$ 345,031.21	$ 5,625.00	$ 5,400.00	$ 3,600.00	$ 11,250.00	$ 67,500.00	$ 90,000.00	$ 58,500.00	$ 58,500.00	$ 58,500.00
3	Metering Pump Skid (about 2-8 pumps per facility, will follow up with table showing number of pumps for each facility)	$ 360,000.00	$ 1,613,509.02	$ 45,000.00	$ 43,200.00	$ 28,800.00	$ 90,000.00	$ 180,000.00	$ 720,000.00	$ 108,000.00	$ 468,000.00	$ -
4	Backflow Preventer	$ 6,000.00	$ 26,891.82	$ 750.00	$ 720.00	$ 480.00	$ 1,500.00	$ 3,000.00	$ 12,000.00	$ 1,800.00	$ 7,800.00	$ -
5	Man Door	$ 8,000.00	$ 35,855.76	$ 1,000.00	$ 960.00	$ 640.00	$ 2,000.00	$ 4,000.00	$ 16,000.00	$ 2,400.00	$ 10,400.00	$ -
6	Roll up Door	$ 10,000.00	$ 44,819.69	$ 1,250.00	$ 1,200.00	$ 800.00	$ 2,500.00	$ 5,000.00	$ 20,000.00	$ 3,000.00	$ 13,000.00	$ -
7	Fluoride Analyzer	$ 20,000.00	$ 153,347.20	$ 2,500.00	$ 2,400.00	$ 1,600.00	$ 5,000.00	$ 30,000.00	$ 40,000.00	$ 26,000.00	$ 26,000.00	$ 26,000.00
8	Water Softener	$ 2,500.00	$ 19,168.40	$ 312.50	$ 300.00	$ 200.00	$ 625.00	$ 3,750.00	$ 5,000.00	$ 3,250.00	$ 3,250.00	$ 3,250.00
9	BBU (includes refill feeder, weigh feeder, model 810 BBU, saturator, volumetric feeder, control panel)	$ 200,000.00	$ 896,393.90	$ 25,000.00	$ 24,000.00	$ 16,000.00	$ 50,000.00	$ 100,000.00	$ 400,000.00	$ 60,000.00	$ 260,000.00	$ -
10	Saturator Basement	$ 50,000.00	$ -									
11	Building 475 SF @ $300	$ 142,500.00	$ -									
12	Storage Warehouse Space	$ 78,000.00	$ -									
13	Site Improvements	$ 250,000.00	$ 1,120,492.37	$ 31,250.00	$ 30,000.00	$ 20,000.00	$ 62,500.00	$ 125,000.00	$ 500,000.00	$ 75,000.00	$ 325,000.00	$ -
	Subtotal Capital Cost	$ 1,243,000.00										
	Contingency 30%	$ 372,900.00										
	Total Capital Cost	**$ 1,615,900.00**										
	Operating Cost	Cost Per Year										
1	Maintenance	$ 24,860.00	$ 271,684.29	$ 27,967.50	$ 27,843.20	$ 26,848.80	$ 31,075.00	$ 37,290.00	$ 37,290.00	$ 32,318.00	$ 32,318.00	$ 32,318.00
2	Replace Equipment	See above	$ 4,799,891.93	See above	See above	See above	See above	See above	See above	See above	See above	See above
3	Operation of Equipment	$ 66,200.00	$ 723,471.43	$ 74,475.00	$ 74,144.00	$ 71,496.00	$ 82,750.00	$ 99,300.00	$ 99,300.00	$ 86,060.00	$ 86,060.00	$ 86,060.00
4	Power Cost	$ 1,164.46	$ 12,725.83	$ 1,310.01	$ 1,304.19	$ 1,257.61	$ 1,455.57	$ 1,746.68	$ 1,746.68	$ 1,513.79	$ 1,513.79	$ 1,513.79
5	Chemical Cost	$ 182,206.77	$ 1,991,259.75	$ 204,982.62	$ 204,071.59	$ 196,783.32	$ 227,758.47	$ 273,310.16	$ 273,310.16	$ 236,868.81	$ 236,868.81	$ 236,868.81
	Subtotal Operating Cost		$ 7,799,033.23									
	Operating Contingency 30%		$ 2,339,709.97									
	Total 50-year Operating Cost		**$ 10,138,743.20**									
	Total Capital and Operating	**$ 11,754,643.20**										
	Average Yearly Operating (2022 Dollars)		**$ 202,774.86**									

Well Electric

Orange: 5% discount rate, Net Present Value

	Well Electric Dry Building	Concept Level Cost	LCCA Cost	2023	2024	2025	2030	2040	2050	2060	2070	2080
	Capital Cost			12.5%	12%	8%	4 years 25%	10 years 50%	20 Years 50%	30 Years 30.0%	40 Years 30.0%	50 Years 30.0%
1	Electrical Equipment	$ 71,000.00	$ 544,382.57	$ 8,875.00	$ 8,520.00	$ 5,680.00	$ 17,750.00	$ 106,500.00	$ 142,000.00	$ 92,300.00	$ 92,300.00	$ 92,300.00
2	PLC MicroLogic 1400	$45,000.00	$ 345,031.21	$ 5,625.00	$ 5,400.00	$ 3,600.00	$ 11,250.00	$ 67,500.00	$ 90,000.00	$ 58,500.00	$ 58,500.00	$ 58,500.00
3	Metering Pump Skid (about 2-8 pumps per facility, will follow up with table showing number of pumps for each facility)	$ 360,000.00	$ 1,613,509.02	$ 45,000.00	$ 43,200.00	$ 28,800.00	$ 90,000.00	$ 180,000.00	$ 720,000.00	$ 108,000.00	$ 468,000.00	$ -
4	Backflow Preventer	$ 6,000.00	$ 26,891.82	$ 750.00	$ 720.00	$ 480.00	$ 1,500.00	$ 3,000.00	$ 12,000.00	$ 1,800.00	$ 7,800.00	$ -
5	Man Door	$ 8,000.00	$ 35,855.76	$ 1,000.00	$ 960.00	$ 640.00	$ 2,000.00	$ 4,000.00	$ 16,000.00	$ 2,400.00	$ 10,400.00	$ -
6	Roll up Door	$ 10,000.00	$ 44,819.69	$ 1,250.00	$ 1,200.00	$ 800.00	$ 2,500.00	$ 5,000.00	$ 20,000.00	$ 3,000.00	$ 13,000.00	$ -
7	Fluoride Analyzer	$ 20,000.00	$ 153,347.20	$ 2,500.00	$ 2,400.00	$ 1,600.00	$ 5,000.00	$ 30,000.00	$ 40,000.00	$ 26,000.00	$ 26,000.00	$ 26,000.00
8	Water Softener	$ 2,500.00	$ 19,168.40	$ 312.50	$ 300.00	$ 200.00	$ 625.00	$ 3,750.00	$ 5,000.00	$ 3,250.00	$ 3,250.00	$ 3,250.00
9	BBU (includes refill feeder, weigh feeder, model 810 BBU, saturator, volumetric feeder, control panel)	$ 200,000.00	$ 896,393.90	$ 25,000.00	$ 24,000.00	$ 16,000.00	$ 50,000.00	$ 100,000.00	$ 400,000.00	$ 60,000.00	$ 260,000.00	$ -
10	Saturator Basement	$ 50,000.00	$ -									
11	Building 475 SF @ $300	$ 142,500.00	$ -									
12	Storage Warehouse Space	$ 78,000.00	$ -									
13	Site Improvements	$ 250,000.00	$ 1,120,492.37	$ 31,250.00	$ 30,000.00	$ 20,000.00	$ 62,500.00	$ 125,000.00	$ 500,000.00	$ 75,000.00	$ 325,000.00	$ -
	Subtotal Capital Cost	$ 1,243,000.00										
	Contingency 30%	$ 372,900.00										
	Total Capital Cost	**$ 1,615,900.00**										
	Operating Cost	Cost Per Year										
1	Maintenance	$ 24,860.00	$ 271,684.29	$ 27,967.50	$ 27,843.20	$ 26,848.80	$ 31,075.00	$ 37,290.00	$ 37,290.00	$ 32,318.00	$ 32,318.00	$ 32,318.00
2	Replace Equipment	See above	$ 4,799,891.93	See above	See above	See above	See above	See above	See above	See above	See above	See above
3	Operation of Equipment	$ 66,200.00	$ 723,471.43	$ 74,475.00	$ 74,144.00	$ 71,496.00	$ 82,750.00	$ 99,300.00	$ 99,300.00	$ 86,060.00	$ 86,060.00	$ 86,060.00
4	Power Cost	$ 1,168.74	$ 12,772.68	$ 1,314.83	$ 1,308.99	$ 1,262.24	$ 1,460.93	$ 1,753.11	$ 1,753.11	$ 1,519.36	$ 1,519.36	$ 1,519.36
5	Chemical Cost	$ 256,817.84	$ 2,806,652.09	$ 288,920.07	$ 287,635.98	$ 277,363.27	$ 321,022.30	$ 385,226.76	$ 385,226.76	$ 333,863.19	$ 333,863.19	$ 333,863.19
	Subtotal Operating Cost		$ 8,614,472.42									
	Operating Contingency 30%		$ 2,584,341.73									
	Total 50-year Operating Cost		**$ 11,198,814.14**									
	Total Capital and Operating	**$ 12,814,714.14**										
	Average Yearly Operating (2022 Dollars)		**$ 223,976.28**									