Appendix C
Vendor Packages

V3-5

Kaiser Mead Water Treatment System Specifications 03-25-2020

Contents

Section 1. General Description

1.0 Extraction Wells – Wetlands

Customer will install five extraction wells for water removal from the local aquifer. Water is pumped through the Water Treatment building for flow measurement and manual control. A flow-indicating transmitter mounted in a prefabricated pipe section will send 4-20mA signal to the United Rentals control PLC. Flow rate can be monitored on screen, as well as at the transmitter. The anticipated flow rate is entered by the operator at the HMI control panel. If flow falls below an adjustable rate (deviation value) indicating a pumping problem, the PLC will indicate an alarm condition.

Extraction well piping includes a pneumatically actuated fail close ball valve controlled by the United Rentals control PLC. The pneumatically actuated valve is closed when power is off, treatment system is off, e-stop is activated, or wetland lift station indicates a general alarm condition. Additionally, manual valves in the pipeline allow for maintenance services, sample collection and by-pass of the wetland system.

1.1 Electrocoagulation Treatment

Water will enter United Rental's electrocoagulation system from a wetlands process for cyanide destruction. Water entering the equalization tank is monitored for conductivity. Water in the equalization tank will be monitored for pH and adjusted by United Rentals's pH system. Calcium chloride will be dosed into the equalization tank to assist in water treatment for the removal of fluoride. Conductivity is monitored in the equalization tank. Once water reaches desired state it will be pumped by United Rentals's equipment into and through the United Rentals Hi-Flo Electrocoagulation nominal 50 GPM treatment package with a maximum hydraulic flow rate of 75 gpm.

The electrocoagulation unit, controls, tanks, and additional equipment will be housed inside a building for climate control. The building shall maintain the temperature greater than 40 degrees and provide air exchanging (100 CFM) for exhausting hydrogen production during the EC process.

A polish step is included for final filtration. Water discharged from the clarifier will flow through multi-media filtration and bag filters, for polishing, before leaving the system.

1.2 Water Delivery to United Rentals Treatment System

United Rentals system will control an equalization vessel. The EQ vessel must be agitated to prevent stratification either by density or by temperature. A pH controller will adjust pH in the equalization vessel if required. The maximum operating temperature for the building and liquids used in the treatment system is 104F. Note operating system at an abnormally high or abnormally low pH or temperature will cause damage to treatment system and cause undesired results. United Rentals will bring water to the reactor using appropriately sized pump(s) whose speed is controlled by the United Rentals system. The water in the equalization vessel will contain no free oil.

1.2.1 Entering United Rentals System

A flow-indicating transmitter mounted in a prefabricated pipe section ahead of the Hi-Flo unit will send 4-20mA signal to the United Rentals control PLC. Flow rate can be monitored on screen, as well as at the transmitter.

Flow is to be adjusted by the operator at the controls using a 4-20ma output and displayed in gpm. If flow falls below an adjustable rate indicating a pumping problem, the PLC will shut down the system and indicate the fault.

Normally, the pumped flow rate is not proportionally controlled by the EQ tank water level. The pumped flow rate is a constant flow rate set by the operator. A program modification will be implemented to allow the operator to input a minimum flow rate and maximum flow rate for the treatment system as well as the tank level associated with the minimum and maximum flow rate. For example, this modification will allow the system to automatically increase the flow rate for a short period following a media filter backwash event and thus remove the backwash water from the EQ tank. Treatment flow rate would return to the steady state condition once the additional water is removed from the EQ tank.

In a scenario where flow rate from the wetlands decreases and pumped flow rate from the EC system is not changed, the EQ tank level will drop and reach an EC stop level condition. The EC stop level condition will place the EC system in standby mode. Once the EQ tank level increases to an EC start level condition, the EC system will automatically resume treatment. Operator can input the EC start and EC stop levels through the HMI.

In a scenario when the flow rate from the wetlands increases and pumped flow rate from the EC system is not changed, the EQ tank level will rise and reach a High level condition. The High level condition will close the pneumatic valve on the feed line from the lift station; the EC system will continue to treat water. Once the EQ tank level decreases and returns to a normal operating level, the pneumatic valve will automatically open and continue to move water from the lift station to the EQ tank. Operator can input the EC start and EC stop levels through the HMI.

Flow rate is recorded through the HMI. Operator can view the graphical representation of the flow rates with time.

Reactor inlet flow control includes a pneumatically actuated butterfly valve controlled by the EC unit's PLC. Additionally, manual valves in the pipeline allow for maintenance services.

Section 2: System Scope of Supply

The EC Treatment System to be furnished is specified to operate as a nominal 50 GPM system. Hydraulically, the system can operate in a 50-75 GPM flow range. All components required for the complete reaction shall be furnished. Replacement of sacrificial plates is the responsibility of the customer.

2.1 United Rentals Hi-Flo Electrocoagulation Treatment Package

The 50 GPM reactor cell will consist of the following, Tandem United Rentals Hi-Flo Reactor Package of this description:

2.1.1 Hi-Flo Reactors

Wastewater delivered by the centrifugal pump will enter the United Rentals Hi-Flo Treatment Reactor, RX- 1, with a removable Reactor Treatment Cartridge.

The United Rentals Electrocoagulation Hi-Flo® Dual-Tandem Reactor Cell System by Kaselco employs electrolysis-based technology that does not require the use of chemical precipitants to remove suspended and dissolved solids from solution. The electrochemical process facilitates the settling of suspended particle and drives chemical reactions between constituents in the water.

The control system for the Electrocoagulation has the following features:

- Provide for automatic control of reactor cell electrode current in response to routine variations in waste stream characteristics.
- Provide the capability for on-site modification of electrode configuration when required to accommodate substantial and ongoing changes in waste stream characteristics.
- Provide the capability for the system operator to adjust power settings as necessary to optimize treatment efficiency.
- Provide for automatic control of reactor cell polarity to optimize the consumption rate of electrode plate material.
- Provide the capability to manually control surge current at operator discretion to allow periodic purging of accumulated surface impurities from electrode plates to optimize performance.
- Provide electrode cartridge configuration with segmented intermediate plates and designed to accommodate replacement of electrode plates on-site by facility personnel using locally sourced materials.
- Provide for manual cleaning of electrode plates without disassembly of the reactor cells when necessary to accommodate waste streams generating excessively high solids content.

Wastewater delivered by the pump will enter a Hi-Flo Treatment Reactor, RX-1, with a removable Reactor Treatment Cartridge. Wastewater enters the bottom of this vessel through an inlet and up through the vertically arranged steel plates in the first Reactor Cartridge. Treated water overflows the top of the cartridge and enters the second chamber of the Treatment Reactor Vessel through internal piping in the vessel. Treated water overflow from RX-2 then proceeds to the post EC tank. The reactors are open to the atmosphere.

Reactor vessels can be upgraded, with a change order, with plastic covers to contain off-gasses and removed using an air ventilation system.

To eliminate the possibility of reactor treatment plates shorting in the event of a large piece of rust or scale sloughing off of a reactor plate, each Reactor Treatment Vessel has a deep sump. This allows even the largest pieces of scale to fall to the bottom, below the treatment plate pack, eliminating the possibility of shorting out reactor sections.

The steel and aluminum plates are sacrificial. The iron from the steel plates and aluminum in the aluminum plates is slowly driven off and into the water. Under the influence of the electrical field, the iron an aluminum atoms engage in a series of electrochemical reactions, their final act being the reaction with pollutants such as dissolved metals and emulsions in the wastewater causing them to be insoluble so they can be settled out in a solids separation system.

To remove heavy particles of rust or scale that may slough off of the treatment plates and that are not entrained in the water stream, a sub-system called “Scale Purge” is occasionally energized to remove heavy solids from the bottom of the treatment reactor. The cycle time is adjustable and the PLC manages this cycle. The cycle time for scale purge is set by the operator based on needs for this specific installation. The scale system provided will include the two air-operated valves, the AODD pump, and the interconnecting plumbing. The scale purge system requires no chemicals.

The scale purge cycle can be manually engaged to remove water from the reactor vessel for maintenance and inspection activities.

2.1.2 Treatment Power

Power is applied to select plates through a copper buss system. The copper buss bar is connected to power plates, and connects to the positive and negative posts on the rectifiers, which supply the treatment power.

Two rectifiers provide treatment power through the buss to the reactor. Typically, power supply to the rectifier is 480VAC, 60Hz, 3-phase power. The rectifier’s continuous duty rated output is 2,000 Amps at 48VDC with reversing polarity. Polarity reversal time is adjusted in the PLC program by the operator. Amperage is the primary controlled treatment power parameter. The operator can adjust power within a range to ensure treatment, and to save electrical energy cost and treatment plates if the water can be treated adequately with less power. Voltage automatically “floats” depending on the conductivity of the wastewater.

Reactor Power Monitor: If reactor treatment power supply voltage drops below an adjustable voltage, the PLC shuts down the reactor package and indicates treatment power failure on the control panel.

2.1.3 Solids Separation

Step 1: The normal flow will be a single pass through the EC reactor into an open top Post-EC Tank. Treated water is pumped using a Post-EC pump to the Defoam Tank or to the EQ Tank using the Post-EC Recycle valve. Operations and controls for the Post-EC Tank, Post-EC Pumps, and Post-EC Recycle valve.

Post-EC Tank

- This system has a single open top Post EC tank.
- The tank is equipped with a LSH, LSL, and LIT.
- The HMI indicates an alarm and the HiFlo system enters standby mode if the level exceeds a high level setting or if the high level switch floats. This alarm remains enabled in all modes of the treatment system (i.e., standby, off, etc.).
- The system resumes treatment when high level clears.
- The level transmitter is used for starting, stopping and controlling the speed of the Post EC pumps, as described below.

Post-EC Pump and Valve (ACV-0409)

- Profinet communication between PLC and VFD drives
- Two pumps operate as a redundant pair
    - One pump runs at a time
    - Each time the system starts a pump, it chooses the one that was not used last if that pump is available.
    - The backup pump is started whenever the primary pump becomes unavailable (i.e., fails to run or is put in MANUAL/OFF).
    - The primary / backup pumps are swapped when the primary has run for a long time (the setting is configurable through the HMI).
- Pump starts when system is in service and Post-EC tank level is above a “start pump” setting.
- Pump stops when tank level is below a “stop pump” level. In Standby, the pump continues to run until the tank level is low.
- The pump speed is modulated in proportion to tank level. The HMI allows the operator to adjust
    - Pump minimum speed
    - Pump maximum speed

  - Level corresponding to minimum speed (same as the level for starting the pump)
  - Level corresponding to maximum speed (an alarm is posted if the tank reaches this HI LEVEL setting).
- Post-EC valve opens whenever Post-EC pump runs.
- Post-EC pump will not run in auto if the valve is not available.
- System will **not** run if the Post-EC pump or valve is not available.

Post-EC Recycle Valve (ACV-0414)

- When the associated discrete output is energized, the valve directs flow to the equalization tank (i.e., water is directed away from the solids treatment system).
- Valve solenoid is not energized when the system is treating, except for these cases:
  - Solenoid is energized for a period of time following EC start-up.
  - Solenoid is energized for a period of time following polarity reversal
- The valve may be manually controlled via the HMI
- The EC system is allowed to treat when the valve is in manual, directing flow either way.

The de-foam tank drives the electrolysis bubbles from the solids, allowing them to settle. The tank will be equipped with an agitator and aeration. A downcomer in the de-foam tank will ensure that only the heavier, de-gassed solids exit. A mixer and aeration disc is provided in package costs for solids separation.

Sulfuric acid is dosed into the Defoam tank to control the pH range. The pH is monitored on the HMI. The PLC will control the chemical metering pump in an “On/Off” operation. The sulfuric acid dosing rate is manually set by the operator. Two pumps operate as a redundant pair; one pump runs at a time.

Defoam pH adjustment

- A packaged system measures pH.
- The packaged system provides 4-20mA signals for pH. These will be recorded by the HMI.
- The HMI will provide alarms for high and low pH. All settings may be adjusted by the operator.
- The system provides the following alarm and process control transition points for pH, presented from high to low pH:
  - High-high pH alarm. Stop sending water to ECs if condition persists for set amount of time.
  - High alarm: present alarm
  - Start acid pump
  - Stop acid pump
  - Low pH alarm
  - Low-low pH alarm; stop sending water to ECs.

Step 2: The treated water will then flow into a flocculation tank. A polymer will be fed by chemical feed pump(s) to the entrance of the flocculation tank to aid floc formation and settling. The pump will draw from a supply vessel. This process will aid in the formation of larger solids for improved settling. Mixer is provided in package costs for solids separation.

Step 3: A slant-plate clarifier will remove the settleable solids. Standard flow rate of 0.125 gpm/square foot of projected surface area.

- Inclined plates set at 55-degree angle
- Maximum inclined plate length, direction of flow, is four feet (48 inches)
- Plate spacing at 1" between slanted plates
- Dual sludge discharge points at bottom of clarifier
- Flow through unit is by gravity only

Step 4: Sludge from the bottom of the slant plate clarifier will periodically be pumped into a cone bottom sludge thickening tank. Periodic sludge removal from the clarifier is conducted automatically. The frequency, time interval between sludge pumping events, and the duration, how long the sludge pumping event lasts, is set by the operator through the HMI.

Clarifier Sludge

- Equipped with a high level switch.
- System presents an alarm and enters Standby Mode if the tank has a high level; system resumes treatment when high level clears.
- Equipped with two pneumatic actuated valves (SV-0526 and SV-0536) and a sludge pump for solids removal.
- After treating for a given time, the system opens the sludge removal valve for a preset period. Delay and duration are set through the HMI.
- Valve opens when sludge pump runs.
- System will **not** treat water if sludge pump is not in AUTO.
- System will **not** treat water if valve is not in AUTO.
- The sludge pump and valve will open if system enters Standby. Pump will run for a preset time that is adjusted by the operator through the HMI.

Overflow from the top of this tank will return to the inlet of the Defoam tank. This tank allows the clear water to rise to the top while the floc settles in the cone bottom. Sludge collected in the cone bottom tank will be pumped to a filter press for solids dewatering. The operator manually pumps sludge to the filter press using the HMI and the "remote start" signal to the filter press controls. Pumping sludge to the filter press is conducted daily. Draining the sludge thickener is implemented manually by the operator.

2.1.4 Solids Management

FILTER PRESS

The filter press provided with your system is designed and sized to handle the expected solids load. The base frame and plumbing were manufactured and assembled by United Rentals. The filter plates are supplied by Evoqua. The cloth is polypropylene. The hydraulic pump is operated as an air over hydraulic system. The chutes under the press facilitate collection of the solids falling from the plate into barrels facilitating transport to a disposal facility.

CLOSE PRESS:

- Verify the plates are clean of solid residue around the gaskets. Wipe any remaining material from the o-rings on the plates to allow a good water tight seal between the plates.
- View the plates from the side. Verify the plates have a one-dot and three-dot alignment along the length of the press. Plates must alternate between a one-dot and three-dot plate to have good water flow through the plates.
- Align the plates beginning with the intermediate plate adjacent to the tail plate and press them lightly against each other by sliding them along the frame rail. The side frame rails of the press serve as an alignment rail for the plates. Push the head plate into position last.
- The J-PRESS controller is used to operate the hydraulic cylinder of the filter press (Figure2). The ON/OFF switch engages the air pressure to facilitate hydraulic operation. OPEN/CLOSE switch allows pressurizing the dual acting hydraulic cylinder for opening and closing the press.
- Once the plates are aligned correctly, turn the switch to "ON" and the second switch to "CLOSE". The air over hydraulic system will close the press to engage the head plate.
- Once resistance is encountered and hydraulic pressure is sustained, operation will change to a pulsing operation. Continue in "CLOSE" mode until a pressure of greater than 5000 psi is developed. This pressure is maintained while the press is filled with sludge.

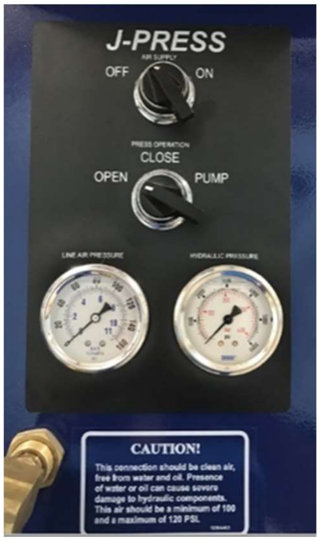

J-PRESS
OFF
AIR SUPPLY
ON
PRESS OPERATION
CLOSE
OPEN
PUMP
LINE AIR PRESSURE
HYDRAULIC PRESSURE
CAUTION!
This connection should be clean air, free from water and oil. Presence of water or oil can cause severe damage to hydraulic components. This air should be a minimum of 100 and a maximum of 120 PSI.

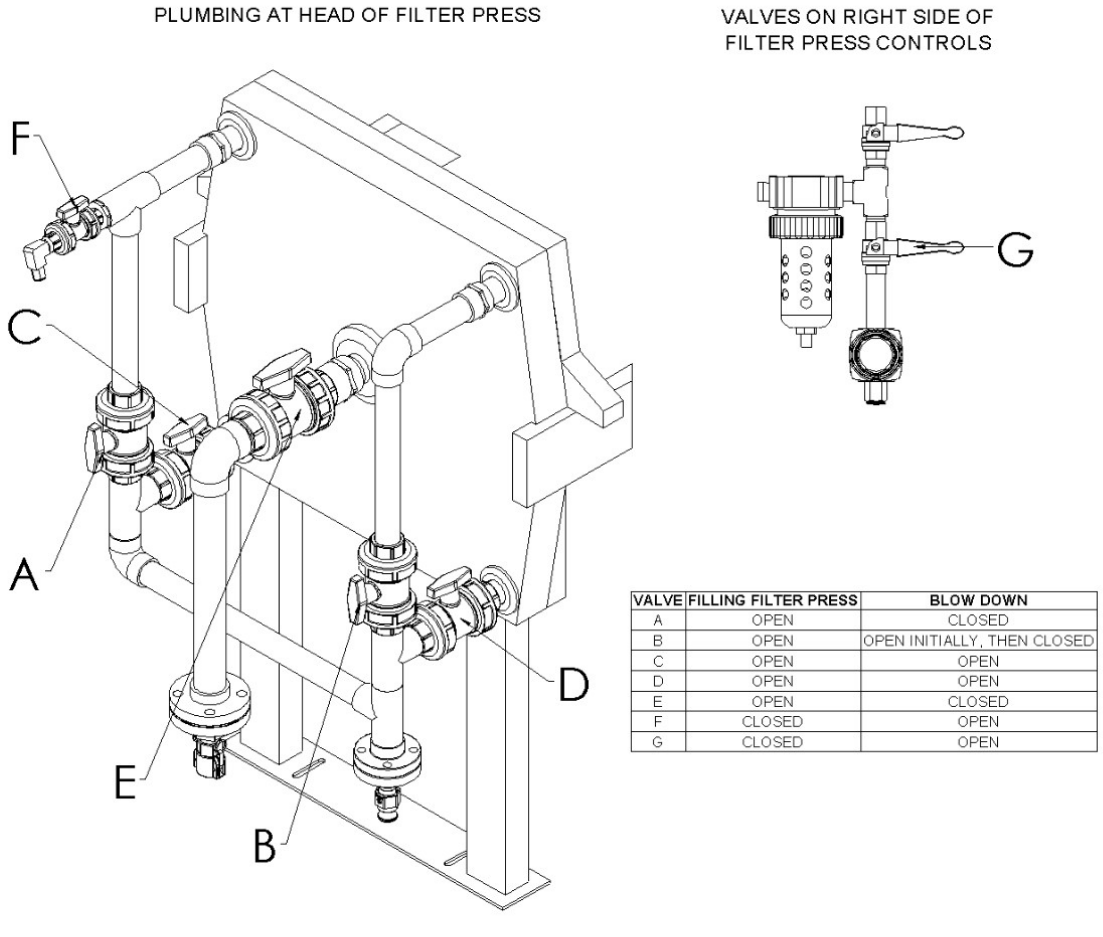
Figure 1. Filter press control panel for hydraulic cylinder operation.

SET VALVES:

- The filter press has several valves controlling operation. The valves provide two different functions: controlling water flow, and controlling air flow. The water control valves are schedule 80 PVC manual ball valves. The air control valves are ½" PVC ball valves.

Water control valves:

- The AODD pump inlet plumbing has a ball valve, open the ball valve connected to the bottom of the settling tanks. The filter press has an inlet ball valve (Valve E). Valve E should be open to fill filter press (Figure 3).
- Piping connected to the outlet of the filter press conveys liquid to the primary holding tank 1. All four outlet valves are open when filling the filter press (Valves A, B, C &D). Valves C & D can be closed during the first portion of the press cycle to fill all of the voids between the plates. The press is ready to operate once solids can enter and exit the press.


PLUMBING AT HEAD OF FILTER PRESS
VALVES ON RIGHT SIDE OF FILTER PRESS CONTROLS
F
C
A
E
B
D
G

VALVE	FILLING FILTER PRESS	BLOW DOWN
A	OPEN	CLOSED
B	OPEN	OPEN INITIALLY, THEN CLOSED
C	OPEN	OPEN
D	OPEN	OPEN
E	OPEN	CLOSED
F	CLOSED	OPEN
G	CLOSED	OPEN

Figure 2. Filter press valve numbering and valve positions.

Air control valves:

- A main air control valve regulates air delivery to the filter press (Valve G).
- A secondary air control valve regulates air delivery to the filter press for conducting air blow down (Valve F). Valve F is opened to conduct an air blow down event, once the filter press is full of sludge.

FILLING THE PRESS:

- The filter press pump (sludge pump) is operated to fill the press by opening the manual ball valve at the inlet to the AODD filter press pump and the main air inlet valve. The air supply to the AODD pump is delivered through a three- stage air supply. The three-stage controller provides a method to slowly coat the plates while minimizing the solids pressed through the filter press cloth covering the plates.

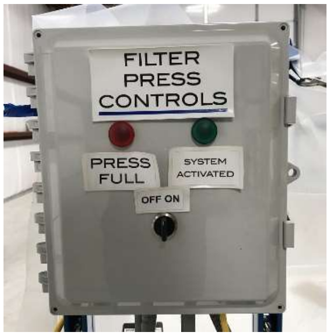


Figure 3. Filter press controls panel.

- The three-stage press system is started by turning the selector knob on the filter press panel to the "ON" position (Figure 4). A green light should illuminate indicating the press system is activated. The first timer will start delivering air to the first stage. The filter press pump will operate for a period of six to ten minutes at the first stage pressure of 20 psi. The second timer will then deliver sludge to the press using the second stage for a period of up to two hours at a pressure of 60 psi. The third stage will deliver sludge to the filter press at a pressure up to 100 psi. When the filter press pump stalls between strokes for 60 seconds or more at its full set pressure, the filter press is full and the panel is turned off. A red light will illuminate indicating the press is full.

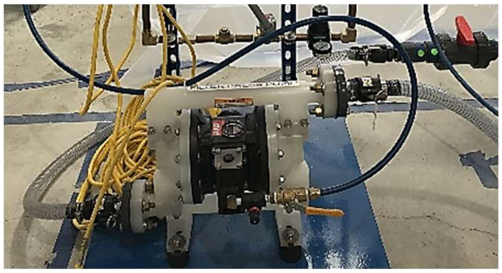


Figure 4. AODD filter press pump.

- Make sure the press does not run out of sludge in the source tank. If the tank is emptied, stop the press by closing the ball valve in the airline at the pump.

BLOWDOWN:

- When the press is full, it will still contain considerable water in the plate channels and the cake. A compressed air blowdown valve located off the upper left water removal line is used to blow this water from the press. The valves are set to the 'blowdown" position: A – closed, B – open initially then closed, C – open, D – open, E – closed, F- open, and G-open (Figure 3).

- The air ball valve (F) is opened slowly allowing air to enter the sludge inlet line at the end of the press to activate press blowdown. Liquid will first be blown from the press, followed by an air-liquid mixture. Watch the end of the discharge line. Once water stops exiting the discharge line, the blowdown operation is complete. Close the ball valve in the air line to stop the blowdown process.

- **NOTE:** This press is equipped with two additional valves in the filter press discharge lines. These valves are located to stop discharge from the top two ports (A, B) of the blowdown manifold (the blowdown manifold originates at the four corners of the plates on the inlet/outlet end). Air will preferentially exhaust from the upper two ports and will not blow down the cake in the lower part of the press when a filter press is not filled completely with sludge. Closing the two valves after several minutes during blowdown will ensure the lower portion of the cake will be properly blown down. Re-open the top two valves for several minutes near the end of the blowdown cycle.

- To use the valve B initiate blowdown normally. Close the valve in the blowdown manifold after several minutes. Open the valve for several minutes when blowdown is nearly complete.

EMPTYING THE PRESS:

- Make sure that blowdown is complete and the blowdown air valve and sludge inlet valves are closed.
- Open the Press by turning the OPEN/CLOSE valve to the OPEN position (Figure 2).
- Wait for the cylinder to reach its fully retracted position. Then, turn the ON/OFF knob to the OFF position.
- Grasp the handles on the plastic head plate and pull it all the way to the pressure plate. A section of the filter cake will be exposed.
- Using a **plastic spatula** (never metal), loosen the cake from the plate and let it fall into a roll off. Then move the second plate, etc. Try to pry, rather than scrape, the sludge cake from the plates. **BE CAREFUL TO NOT DAMAGE THE PLATE CLOTH.**
- When all the cake has been removed, clean the O-ring gasket areas thoroughly with a brush or paper towels and return the plates to the tail plate end, aligning them as you go.
- See CLOSE PRESS section, above for the next cycle.

ROLL-OFF OVERVIEW:

Sludge is processed from the treatment system using a 25 cubic foot filter press. The dried solids are removed from the treatment system using a roll-off for disposal. The roll-off box is transported to and from the site using a truck. An empty roll-off is placed at the building door area, approximately 1/3 to 1/2 of the roll-off is expected to be placed into the building by the truck driver.

A metal guide rail system is mounted on the floor inside the building. This allows the truck driver to have a guide for placing the roll-off. In addition, the guide rail will ensure the roll-off will move in a straight path and not into the metal structure and catwalk when the winch is in use.

A winch, located inside the building and manually operated, is used to pull the roll-off into the building. The roll-off will be filled with dried solids. As the roll-off is filled with dried solids the operator will use the winch to pull the roll-off further underneath the filter press to evenly fill the roll-off.

A full roll-off is removed from the building by using a truck. The truck will connect to the roll-off and pull the roll-off out of the building before loading the roll-off onto the truck for disposal. The guide rails will ensure the roll-off is pulled out of the building without damaging the metals structure or building.

SLUDGE MANAGEMENT:

- Dried sludge will leave filter press and drop into a section of a roll-off
- Filling the roll-off evenly requires the use of a winch, controlled by the operator
    - Winch is mounted inside the building on the concrete floor and filter press frame structure
- As roll-off is filled, the winch is activated by the operator and will pull the roll-off towards the filter press to evenly distribute dried sludge to fill the roll-off
- Estimated weight of roll-off when full is 25,000 pounds

ROLL-OFF OPERATIONS:

- A roll-off will be delivered to the site using a truck
- Truck will place the back third or half of the roll-off into the building
    - Concrete pad must be flat for roll-off to travel
- To accomplish this, an unobstructed area is required outside the building door
    - Approximate unobstructed area is 20’ wide by 40’ long
- Roll-off is then pulled into the building using the winch and a guiderail track
    - Guiderail track installed on the floor to ensure roll-off is pulled straight
- A full roll-off is removed from the building using a roll-off truck by pulling the roll-off out of the building for transport and disposal

REFRESHING THE CLOTHS:

- After a period of time, the cloths will begin plugging with fine material and performance will deteriorate.
- Traditionally, the cloth would be cleaned by circulating hydrochloric acid through the press. Equivalent results can be obtained by drying the plates completely. With the press open and sludge removed, spread the plates out evenly so that air can circulate between them. A fan can help speed drying.
- Leave the plates open until dry, then the press is ready to close and use. A brush with soft plastic bristles can be used to wipe dried material from the press.

RESTARTING:

- If the press cycle has been interrupted for less than a day before the press was filled it can be restarted by checking valve positions, then resetting and re-starting the cycle.
- If it has been more than a day **OR** if the press has been blown down, re-start at the lower (20psi) pressure to re-coat the plates where cake shrinkage has exposed the cloth.

To remove heavy particles of rust or scale that may slough off of the treatment plates and that are not entrained in the water stream, a sub-system called "Scale Purge" is occasionally energized to remove heavy solids from the bottom of the treatment reactor. The time is adjustable and the PLC manages this cycle. The cycle time for scale purge is set by the operator based on needs for this specific installation. The scale system provided will include two basket strainers, two air-operated valves, the 1.5" AODD pump, and the interconnecting plumbing. The scale purge system requires no chemicals. The scale purge cycle can be manually engaged to remove water from the reactor vessel for maintenance and inspection activities.

2.1.5 Treated Water

Treated water will flow by gravity from the clarifier to a post treatment tank. The water will be pumped from the post treatment tank to multi-media filters and bag filters for final clarification before being pumped to the infiltration basin.

<u>Multimedia (Sand/Anthracite) Filter System</u>

- The multimedia filter system includes a packaged control system.
- Backwash is required when a pressure differential of 10 PSI is seen between the inlet and outlet pressure readings. This occurs when the media has been dirtied by solids in the process line. Backwashing lifts the media bed allowing solids to be washed from the media.
- The media filter controller sends one discrete signal to the PLC to indicate a backwash is required. The PLC returns a discrete signal to indicate the Media system may perform a backwash.
- Pressure differential transmitter provides 4-20mA signals for pressure drop across the media filters. Pressure drop will be recorded by the HMI.
- Backwash cycles through a single pod at a time. Water from the post treatment tank that has been through "non-backwashing" sand filters is used to backwash. Pneumatically actuated valves close the influent line into the pod being backwashed and allows water to flow backwards from the discharge piping of the other pods. When the signal is received to backwash, the skid will automatically cycle through all pods.
- When signaling to "backwash now", the PLC will hold the post treatment pump at a constant speed.
- Pump speed is held for a specified time to allow sand filter controller to complete a backwash cycle.

- Before, initiating a backwash:
  - The level in the Post Treatment Tank must be above a prescribed level. If level is below the prescribed level, the post treatment pump is stopped until the prescribed level is reached.
- Backwashed water is sent to the Equalization Tank.

Post-Treatment Bag Filters

- One (1) micron bag filters
- Pressure differential transmitter provides 4-20mA signals for pressure drop across the bag filters. Pressure drop will be recorded by the HMI.
- Bag change is required when a pressure differential of 10 PSI is seen between the inlet and outlet pressure readings.
- System presents an alarm (and continues to treat) when pressure drop across bag filters exceeds preset limit.
- Manual switch from one bag filters to other bag filter.
- Bag filter units are plumbed in parallel allowing bag of one unit to be changed during system operation.

2.2 Controls

An enclosure panel contains the control and electrical system. A Programmable Logic Controller (PLC) serves as the controller for the treatment package. A touch-screen OIT provides the operator with easy monitoring of operating conditions and control of the system. All components controlled can be run in either Automatic or Manual mode.

Remote access is being implemented through a cellular modem. This remote access feature allows customer connection to the treatment system remotely. The access allows control of all outputs and to remotely monitor system operating status. Valves do not have feedback switches.

The EC system can be set by the operator in either Manual, Off, or Automatic mode. When the operator enables automatic mode, the EC system will function on-off in response to the liquid level in the equalization vessel. A level indicating transmitter in the equalization vessel supplies a 4-20mA signal to the PLC representing the level in the equalization vessel. This signal will be calibrated to start and stop the treatment system at High and Low level set points and sound alarm at High-High and Low-Low conditions.

While operating, the PLC monitors these conditions and shuts the package down if parameters are outside of range:

- Treatment power delivered to the reactors: If the power decreases below a preset level, the PLC shuts down the system and indicates a treatment power fault.

- Wastewater flow into the reactor: If the flow decreases below a preset level, the system shuts down and a fault is indicated.
- Wellfield valve will be shut upon loss of power and after EQ Hi-Hi level has alarmed for a specified time.

All sub-systems (rectifier, control power…) are internally fused on all legs. Motors are protected by fuses and/or overload relays.

2.3 Structure

The United Rentals Hi-Flo Treatment Vessel and support stand is mounted in a heated and ventilated building. A structural steel platform is built around the reactor to allow personnel easy access and viewing of the treatment process. Guardrails are used where required.

The treatment power rectifier cabinets are mounted in the same building adjacent to the system.

2.4 Hoist

To facilitate changing of the reactor cartridges, a hoist trolley monorail system is suspended above the reactors on their centerline. A 3-ton electric hoist (4.9 hp motor) with tractor (1/8 hp motor) is used by an operator to lift the treatment cartridge from the reactor vessel, move it to the reactor re-build area, and lower it onto a cartridge pan. The operator uses this same hoist to re-install a fresh cartridge into the reactor. Hoist system is a free standing monorail system over the treatment vessel support structure.

Section 3: Equipment Description and Specifications

Unless otherwise stated:

- Valves are two-way schedule 80 PVC ball valves
- Plumbing is Schedule 80 PVC
- Valves are manual and pneumatic
- Flanged connections are 150# ANSI
- Electrical and control conduit is employed where necessary (PVC).
- Pneumatic systems are aluminum pipe and air pressure hose.

This is an overview of the equipment to be supplied by United Rentals.

3.0 Summary of Supplied Equipment

The table below provides a summary for the equipment provided as part of the water treatment system. Greater discussion regarding the components is provide in other sections of this specifications document.

System Component	Manufacturer
PLC & Controls	Siemens
Sensors	Endress + Hauser, George Fischer
pH Controller	Endress + Hauser
Tank Mixing	Baldor, Dodge Gear, United Rentals
Rectifiers	Aldonex
Air Compressor	Kaeser
Chemical Metering Pumps	Pulsatron
AODD Pumps	ARO
Electric Pumps	Gorman-Rupp, Grundfos, Zoeller
Plumbing	United Rentals
Hoist	Bay Area General Crane Service Co.
Electrocoagulation Reactors	United Rentals
Process Tanks	LF Manufacturing, Regal Plastics, Snyder, ChemTainer
Clarifier	Pan American
Solids Dewatering	Evoqua, Gilmore-Kramer, United Rentals
Multi-Media Filters	Yardney
Bag Filters	Rosedale
Catwalk	United Rentals

3.1 PLC and Controls

- PLC controller with digital and analog modules programmed to monitor and control the United Rentals Electrocoagulation wastewater treatment system. Controls include tank level sensing, pump control, rectifier control, reactor auto scale purge, solids management, filter press availability controls, air system controls, and alarms.
- Touchscreen operator interface panel for ease of operator control and maximum functionality mounted in a control cabinet.
- Controls for alarm/start-stop notification via cell phone, or web e-mail
- Main electrical control panel:
  - 80 Amp/480 Volt/3 phase
- Free standing skid mounted enclosure
- Air Cooled
- PLC controls
- Touch Screen Panel (Operator Interface Terminal, OIT)
- Treatment Volt meter
- Treatment Ammeter
- Various parameter alarms
- Fused field control input device connections
- Fused field outputs (control and power)
- Motor starters with overload relays as needed
- Electrical/air solenoids to operate air-operated valves
- Data logging with graphical data display, temporary storage

3.2 Sensors

3.2.1 Level Switch High (LSH)

- Madison M8000 Miniature Plastic float switch
- Alarm PLC of Hi-Hi tank level
- Stem Material: Polypropylene
- Float Material: Polypropylene
- Max Temperature: 105° C
- Max Pressure: 100 PSIG
- Float SG: 0.80 SG
- Switch Rating: 30 Watt, 240V max (AC/DC), SPST

3.2.2 Level Switch Low (LSL)

- Model: P7300
- MFG: Advanced Control Technology
- 73 Series Plastic paddle switch to alarm PLC of Low tank level
- Switch differential: 90°

- Housing: Polypropylene
- PVC Jacketed Cable

3.2.3 Level Indicating Transmitter (LIT)

- MJK Expert™ 2100 Hydrostatic Level Transmitter (0-15 ft)
- Piezoresistive measuring device used to monitor tank levels
- Nominal measuring range (ftWG): 0-15 ft.
- Measuring Principle: Piezoresistive
- Min. programmable range: 0-6 ft.
- Max programmable range: 0-36 ft.
- Max overpressure: 50 psi
- Temperature range: 15-150 ^oF
- Measurement accuracy: Better than +/- 0.5% FS @ full temperature range
- Materials:
    - Housing: PP
    - Diaphragm: Stainless steel (AISI 316L)
- Supply Voltage: 10-30 V DC (12-30 V DC for cable lengths above 315 ft)
- Output signal: 2-wire 4-20 mA (passive transmitter)

3.2.4 pH Probe

- CPF81D Orbipac pH probe by Endress + Hauser
- The membrane glass of the electrode supplies an electrochemical potential which is dependent upon the pH value of the medium. This potential is generated by the selective penetration of H+ ions through the outer layer of the membrane. An electrochemical boundary layer with an electric potential forms at this point. An integrated Ag/AgCl reference system serves as the required reference electrode. The transmitter converts the measured voltage into the corresponding pH value using the Nernst equation.
- pH is monitored and adjusted in the EQ Tank and Defoam Tank.
- Storage Temperature: 32-120 ^oF
- Process Temperature: LH – 32-230 ^oF or NN 32-170 ^oF
- Process Pressure: 15-145 psia at 176 ^oF
- Glass Impedance: 150 MΩ at 77 ^oF
- Minimum Conductivity: 50 µS/cm
- Weight: 0.26-0.33 lbs
- Materials
    - Housing, electrode shaft: PPS
    - Electrode: Lead-free membrane glass, suitable for process applications
- Process Connection: ¾” NPT

- Double chamber reference system: KNO_3 AND KCl/AgCl

3.2.5 Conductivity Probe

- Condumax CLS21D Conductivity Probe by Endress + Hauser
- Conductivity of liquids is determined with a measuring arrangement where two electrodes are located in the medium. An alternating voltage that causes a current to flow through the medium is applied at these electrodes. The electrical resistance, or its reciprocal value - conductance G - is calculated based on Ohm's law. The specific conductance κ is determined from the conductance value using the cell constant k, which depends on the sensor geometry.

3.2.6 Flow Meter

- George Fischer Signet 2551 Magmeter
- PN: 3-2551-P0-42
- Quantity: (3)
- Sends 4-20mA signal to PLC to measure flow in pipe
- Pipe size range: DN15 to DN 300 (0.5 in. to 12 in.)
- Flow Range
  - Minimum: 0.05 m/s (0.15 ft/s)
  - Maximum: 10 m/s (33 ft/s)
- Linearity: ±1% reading plus 0.01m/s (0.033 ft/s)
- Repeatability: ±0.5% of reading @ 25°C (77°F)
- Minimum Conductivity: 20 µS/cm
- Power Requirements:
  - 4 to 20 mA: 21.6 to 26.4 VDC, 22.1 mA max.
  - Frequency: 5 to 26.4 VDC, 15 mA max.
  - Digital (S3L): 5 to 6.5 VDC, 15 mA max.
- Reverse polarity and short circuit protected

3.2.7 Pressure Differential Switch

- Series 629 Dwyer Pressure differential switch
- Sends signal to the PLC that the influent and effluent lines on the bag filters have a pressure differential of 10 PSI and require bags to be changed
- Working Pressure: 100 PSI
- Accuracy: ±0.5% FS
- Temperature Limits: 0 to 200°F
  Output Signal: 4 to 20 mA

3.3 pH Controller

- Liquiline CM444 by Endress + Hauser

- Multi parameter transmitter/controller for monitoring and controlling processes in industry and the environmental sector
- Supply Power: 100 to 230 V AC ± 15 %, 50/60 Hz

3.4 Tank Mixing

- Mechanical mixing will take place in the Equalization, defoam, and flocculation process tanks as well as the polymer tank. The mixers are used to help with pH adjustment and prevent stratification in the tanks.

3.4.1 Mixer motors

- Baldor motors used to drive prop
- 1.5 HP Equalization tank agitator motor:
    - Model: CM 3554
    - Power Supply: 208-230/460 3-ph
    - Amps: 2.5 FLA
    - RPM: 1800
- 1.5 HP Defoam tank agitator motor:
    - Model: CM 3554
    - Power Supply: 208-230/460V 3-ph
    - Amps: 2.5 FLA
    - RPM: 1800
- 1.0 HP flocculation tank agitator motor:
    - Model: CM 3538
    - Power Supply: 230/460V 3-ph
    - Amps: 1 FLA
    - RPM: 1800
- 0.25 HP Polymer Tank Agitator motor
    - MFG: Leeson
    - Power Supply: 115/208-230 V
    - Amps: 5.4/2.4-2.7 FLA
    - RPM: 1725 RPM

3.4.2 Gear Boxes

- Defoam/EQ
    - Dodge Tigear-2 reducers – Size 20
    - Part Number: 20Q05H56
    - Ratio: 5
    - Output RPM: 350
    - Mechanical Input HP: 3.47

  - Output Torque: 581 lb in.
  - Shaft Position: Hollow
- Flocculation
  - Dodge Tigear-2 reducers – Size 17
  - Part Number: 17Q05H56
  - Ratio: 5
  - Output RPM: 350
  - Mechanical Input HP: 2.59
  - Output Torque: 430 lb in.
  - Shaft Position: Hollow

3.4.3 Shaft and Propeller

Appropriate shaft lengths and propeller sizing to promote tank mixing

- EQ Tank:
  - Propeller: One (1) 12” right handed (upward mixing) stainless steel propeller
  - Shaft: 1.25” diameter x 118” long stainless steel shaft
- Defoam Tank:
  - Propeller: One (1) 6” left handed (downward mixing), stainless steel propeller, one (1) 12” right handed (upward mixing), stainless steel propeller
  - Shaft: 1.25” diameter x 88” long stainless steel shaft
- Flocc Tank:
  - Propeller: One (1) 7” right handed (upward mixing) stainless steel propeller
  - Shaft: 1.00” diameter x 72” long stainless steel shaft
- Polymer Tank:
  - Propeller: One (1) 3” right handed (upward mixing) stainless steel propeller
  - Shaft: 0.50” diameter x 48” long stainless steel shaft

3.4.4 Aerators

- Model: FlexAir 12” High Capacity Aeration discs
- Utilized in the Equalization and Defoam tanks
- Peak Airflow: 18 SCFM
- Design Airflow: 2.0-13.0 SCFM
- Diffuser Diameter: 13.8”
- Active Surface Area: 0.73 FT^2
- Coupler: ¾” MNPT
- Diffuser Membrane Material: EPDM

3.5 Rectifiers

- MFG: Aldonex
- Model No: T-448-20CR-CCV-APR-IOS
- A Silicon-Controlled Rectifier (SCR) serves to convert AC power to DC power for the reactor. The DC power operates at or below 48 volts, which allows the operator to be in direct contact with the electrical supply based on OSHA specifications (less than 50 VDC).
- Output Rating: 2000 Amps @ 48VDC Max Voltage output
- Rectifier Elements: Utilizes multi-cell semiconductor diode assemblies. Diode assemblies are oversized by approximately 45% or better in order to withstand any excessive surge in current.
- Power Transformer: Transformer core consists of steel laminations of grain oriented silicon steel. The Primary and Core are separated by a solid preformed silicon impregnated class H insulation coil form, to minimize the possibility of Primary to Core short circuits. The transformer has heavy duty solid copper buss bar secondary windings for greatest rigidity.
- Current in windings limited to a density of 600 circular mils per ampere.
- Complete transformer assembly is double dipped in the highest quality insulating varnish, resulting in quiet units which will withstand the typical plating shop environment and operate cool under a full load.
- Controls: Main Starter, Motor Starter, Control Step Down Transformer, SCR Gate Drive, and V/C Control Board are located behind an Easy-Access Panel. Control equipment is kept dust proof and entry of potentially corrosive moisture is minimized.
- Overload relay on main contactor
- Treatment Power Busses and wiring
- Independent Constant Current and Constant Voltage control with automatic crossover provide + 0.5% voltage and current regulation.
- Soft start allows the power delivered to the load to be brought up slowly when the unit is turned on. Prevents possible clearing of fuses when the unit is turned on due to high current surge.
- Current Trip (limit) Circuitry protects the Power Supply against direct short circuit of the output buss. When a continuous short-circuit occurs, the trip circuitry shuts down the SCR Firing Board, thus protecting the Diodes, SCR's, and Power Transformer from damage.
- Direct process control with 4-20MA signal input for automatic operation.
- Primary SCR Design, incorporates SCR's connected in inverse parallel, (back to back), configuration and placed between the AC Mains and Power Transformer.
- Secondary SCR Design, incorporates the SCR's as rectifying elements, changing secondary AC Voltage and Current to DC Voltage and Current.

- All ALDONEX, SCR POWER SUPPLY Components are designed to operate continuously at 50°C maximum. Operating below this will insure a Longer Life Cycle.
- All ALDONEX TAP SWITCH POWER SUPPLY Components are designed to Operate Continuously at 50°C Maximum. Operating below this will insure a Longer Life Cycle
- Reactor Power Monitor: If reactor treatment power supply voltage drops below an adjustable voltage set-point the PLC shuts down the reactor package and indicates treatment power failure on the control panel.

3.6 Air Compressor

- Kaeser Air compressor used to supply air for automated treatment system valves and for air operated dual diaphragm pumps
- Model: SK 20
- Dryer Model: Integral
- Capacity: 88cfm at 125 PSIG
- Drive Motor: 20 HP
- Controller: Sigma Control 2™
- Electrical: 480VAC, 60 Hz, 3-phase
- Cooling Method: Air-cooled
- Air Receiver Size: 92.5 GAL
- Sound level: 68 dB(A)

3.7 Chemical Metering Pumps

- Metering pumps are used to convey chemical to process tanks for treatment. Pumps are chemical and dose specific.

3.7.1 Calcium Chloride Pump

- LMI Excel XR 5.6 GPH electronic metering pump
- Max Flow: 5.6 GPH
- Lift: 13.1’
- Max Pressure: 175 PSIG
- Power Input: 120 VAC
- Average Current Draw: 0.42 A
- Head and Materials: PVDF
- Seats Materials: PTFE
- Diaphragm: PTFE/PVDF
- Ball Materials: Ceramic
- Connection Type: 3/8” PE Tube

3.7.2 Sulfuric Acid Pump

- LMI Excel XR 5.6 GPH electronic metering pump
- Max Flow: 5.6 GPH
- Lift: 13.1’
- Max Pressure: 175 PSIG
- Power Input: 120 VAC
- Average Current Draw: 0.42 A
- Head and Materials: PVDF
- Seats Materials: PTFE
- Diaphragm: PTFE/PVDF
- Ball Materials: Ceramic
- Connection type: ½” NPT/BSP

3.7.3 Polymer Pump

- Pulsatron LPH6 PTC 120 GPD electronic metering pump
- Max Flow: 120 GPD
- Max Pressure: 50 PSIG
- Power Input: 115 VAC/50-60 HZ/1 ph
- Average Current Draw: 1.0 A @115 VAC
- Head and Fittings Materials: PVDF (Kynar)
- Seats Materials: TFE
- Ball Materials: Ceramic

3.8 AODD Pumps

- MFG: ARO
- Model: 06-PD15P-FPS-PTT
- ARO diaphragm pumps are pneumatically powered positive displacement pumps used in the solids removal and solids dewatering processes
- ARO 1.5” Air Operated Double Diaphragm Pump
- Air Inlet Pressure Range: 20-120 PSI
- Maximum Flow Rate: 123.1 GPM
- Displacement per Cycle @ 100 PSI: 0.617 GAL
- Maximum Particle Size: ¼”

3.8.1 Scale Purge Pump

- Quantity: (1)
- Removes the scale buildup from the bottom of the reactor vessel sumps. One scale purge pump is used for multiple sumps in a sequential operation. This pump is also

used to drain the Defoam, Flocculation, and Post Treatment tanks for periodic maintenance.

3.8.2 Filter Press Sludge Pump

- Quantity: (1)
- Removes the settled sludge from the bottom of the sludge thickener and delivers it to the filter press for dewatering.

3.8.3 Clarifier Sludge Pump

- Quantity: (1)
- Removes the sludge accumulation from the bottom of the clarifier and delivers it to the sludge thickener tank.

3.9 Electric Pumps

3.9.1 Electrocoagulation Feed Pump

- Model: Gorman-Rupp 490B-98 3 HP
- Quantity: (2)
- Gorman-Rupp duplex centrifugal pump system with variable frequency drive for feeding EC reactors from the EQ Tank.
- Power Supply: 230/460V 3-ph
- FLA: 8/4
- Housing Material: Cast Stainless Steel
- Seal Material: Viton
- Max Head: 149 FT. (65 PSI)
- Max Flow: 118 GPM

3.9.2 Post Electrocoagulation Pump

- Model: Gorman-Rupp 490B-98 3 HP
- Quantity: (2)
- Gorman-Rupp duplex centrifugal pump system with variable frequency drive for pumping from Post EC tank to downstream processing
- Power Supply: 230/460V 3-ph
- FLA: 8/4
- Housing Material: Cast Stainless Steel
- Seal Material: Viton
- Max Head: 149 FT. (65 PSI)
- Max Flow: 118 GPM

3.9.3 Post Treatment Pump

- Model: Grundfos CRI 10-6
- Quantity: (2)
- Grundfos duplex Centrifugal pump system with variable frequency drive for feeding filtration components after processing through the Defoam, Flocculation, Clarifier, and Post treatment tanks
- Vertical, multistage centrifugal pump with inlet and outlet ports on same the level (inline). Pump materials in contact with the liquid are in stainless steel. A cartridge shaft seal ensures high reliability, safe handling, and easy access and service. Power transmission is via a rigid split coupling. Pipe connection is via combined DIN-ANSI-JIS flanges.
- The pump is fitted with a 3-phase, fan-cooled asynchronous motor
- Motor Power: 5 HP
- Supply Power: 480V
- Max Flow: 69 GPM
- Suction: 2” ANSI 300# Flange
- Discharge: 2” ANSI 300# Flange

3.9.4 Water Safety/Wash Water Pump

- Quantity: (1)
- The Grundfos CMBE TWIN Booster is a compact two-booster system for water supply in domestic and commercial applications. The integrated speed controller allows the CMBE Booster to maintain constant pressure in the pipe system. The cascade control ensures that the performance of the CMBE Booster is automatically adapted to consumption by switching pumps on or off and by changing the speed of the pumps in operation.
- The CME Booster consists of 2 units of CMBE Booster which each include
  - 5-way valve
  - expansion tank
  - pressure gauge
  - Pressure sensor
- Motor Power: 2 HP
- Supply Power: 1P 220V, 18.
- Max Flow: GPM
  - Max Pressure: 145 PSI

3.9.5 Sump Pump

- Zoeller sump pump for building containment sump
- Model: N140

- Supply Power: 115V
- Amps: 12 A
- TDH: 20 FT
- Flowrate: 66 GPM

3.10 General Plumbing

3.10.1 Water and Sludge Lines

- Plumbing will be done by United Rentals employees. Plumbing will include pneumatic actuated and manually actuated valves for process control.
- SCH 80 PVC
- WeldOn 711 PVC Glue
- WeldOn P70 Primer
- EPDM/Viton seals in valve and union fittings

3.10.2 Chemical Plumbing/Tubing

- Plastic tubing will be supplied for the polymer and calcium chloride metering pumps. This tubing is specific to the chemical and to the size of the pump. Chemical tubing connections are made using compression fittings of the appropriate material. The sulfuric acid will be hard plumbed using SCH 80 CPVC.

3.10.2a 98% Sulfuric Acid Plumbing

- Size: Double wall ½ ” ID delivery pipe with 2” ID containment pipe; ½” ID in the chemical tank
- Material: CPVC
- Temperature Range: 32° – 200° F
- Maximum Pressure: 850 psi @ 73° F
- Clarity: Opaque

3.10.2b 9901 NALCO Polymer Tubing

- Size: 3/8” ID x ½” OD
- Material: PP
- Temperature Range: 40° – 200° F
- Maximum Pressure: 120 psi @ 72° F
- Clarity: Semi-Clear

3.10.2c Calcium Chloride Tubing

- Suction: PE ¼” x 0.38” tubing
- Discharge: Reinforced PVC ¼”x ½” tubing

3.10.3 Primary Air Lines

- Aluminum tubing ran from compressor branches to the filter press and runs on to the controls skid
- TransAir® Aluminum Pipe
- Size:
  - From compressor up to filter press: 25 mm,
    - Kaeser Compressors Part No.: AN66022500
  - From filter press to controls skid: 17 mm
    - Kaeser Compressors Part No.: AN1004A1704
- Max Working Pressure: 232 PSI from -4°F to +115°F
- Working Temperature: -4° to +140° F

3.11 Influent Plumbing

- Plumbing allows for wetlands bypass into EC system. All water pumped from wells is run through flowmeter. Wetlands bypass and post treatment divert are automated.
- Plumbing into the EC building will be 3” pipe but will be reduced to 2”

3.11.1 Wellfield Water Transfer Piping

- One each Inlet flange – 2” 150# ANSI flange customer connection from extraction wells
- System isolation valve, manual
- Flow Shut Off 2" fail close valve, air-operated
- Flow Monitoring Pipe Section: Sch. 80 PVC pipe, 2” flange, with fitting for FIT-1
- Saddle to connect flow monitor section with inlet flange
- Flow Indicating Transmitter, 4-20mA
- Sample port: ½”
- Piping to bypass the constructed wetlands to equalization tank
- Outlet flange – 2" 150# ANSI flange customer connection

3.11.2 Inlet piping to EC Reactors

- System isolation valve, manual
- Flow Shut Off 2", air-operated
- Variable Frequency Drive output (4-20ma)
- Flow Monitoring Pipe Section: Sch. 80 PVC pipe, 2” flange, with fitting for flow meter (FIT-1)
- Saddle to connect flow monitor section with inlet flange
- Flow Indicating Transmitter, 4-20mA
- Sample port, ½”

3.12 Emergency Wash Station

3.12.1 EEmax Tankless Water Heater

- Model: AP063480 EFD N4
- "EFD": Intended for Emergency Eye, Face & Drench showers
- N4 Powdered coated steel enclosure
- GFCI
- Min. Operating Pressure: 35 PSI
- Max Operating Pressure: 150 PSI
- Optimum Operating Pressure: 60-90 PSI
- Max outlet temperature: 90 ^{o}F
- Power: 76 A/ph.
- Turn on GPM: 2.5 GPM
- Water Hammer arrestor in-line

3.12.2 Guardian Safety Station

- Model: GFR3100
- Heat traced unit intended for cold weather use down to -40 ^{o}F
- Self-regulated heating cable with external termination guards.
- Thermostat activates below 75 ^{o}F
- Power: 120 VAC
- Single flow throw switch for remote sensing
- 1.25" FNPT top inlet

3.12.3 Heat Trace

- 2" PVC (Safety Shower/hose bib water)
    - Thermon BSX 8-1 Self Regulating Heating Cable
    - Watt Density: 8 W/FT @ 50^{o} F
    - Supply voltage: 120 VAC
    - Indoor and outdoor circuits on individual thermostats
- 1/2" PVC (Calcium Chloride)
    - Thermon BSX 5-1 Self Regulating Heating Cable
    - Watt Density: 5 W/FT @ 50^{o} F
    - Supply voltage: 120 VAC

3.13 Insulation

- Material: Fiberglass
- R-Value: 4.3
- Thickness: 1"

3.14 Hoist

- Bay Area Crane Services' I beam supported mono-rail system for overhead cartridge change and removal. Multi speed lift and travel functions with wireless controller for user friendly operation
- Crane Type: Freestanding Monorail Crane System(CT)
- Runway Capacity: 6,000 lbs.
- Monorail Overall Length: 37'-6"(OAL)
- CL to CL Baseplates(Length): 19'-0"(CL to CL) & 16'-6"(CL to CL)
- Number of Support Columns: (6)
- Hoist: Electric Chain Hoist
- Hoist Mfg.: Gorbel
- Hoist Capacity: 6,000 LB
- Lifting Speed: Dual Speed(12/3 fpm)
- Trolley Speed: Dual Speed(78/19 fpm)
- Crane Wireless Controls: Included with Spare Transmitter
- Supply Voltage: 480V, 3-phase, 60hz

3.15 Electrocoagulation Reactors

- Electrical busses for single configuration on each cartridge to bolt to rectifier busses
- Scale removal system with (1) sump each plus 2" air-operated valves and 1.5" AODD pump

3.15.1 Cartridge

- Lifting frame for cartridge change
- Four cartridge pans
- Four reactor treatment cartridges (Two for each reactor unit, one spare unit per reactor unit)
- Four sets of steel and aluminum/Iron treatment plates
- The Treatment Reactor Cartridge is constructed of PVC or HDPE and is assembled with stainless steel bolts to allow repairs. Stainless steel straps around the cartridge allow for attachment of a lifting frame (included) so the whole cartridge can be removed and replaced easily and reliably. The treatment reactor plates in this reactor are in a parallel vertical arrangement in a cartridge that lifts in and out of the reactor vessel to facilitate plate replacement. A chain hoist is provided to facilitate the movement of and replacement of the treatment cartridges.

3.15.2 Vessels

- The Treatment Reactor Vessel is fiberglass and rests in a steel support structure.
- The reactor treatment vessels are molded from fiberglass along with the scale sumps to create one integrated unit.

- The purpose of the sumps is to catch the scale that sloughs off of the sacrificial plates and funnels it to a collection port so the scale can be removed during the descale cycle of the treatment system. Without the sumps to collect the scale, the plates can short together from the scale staying between the plates creating a zone in the reactor where there will be no treatment thus reducing the systems effectiveness.
- Periodically, pneumatic valves and an AODD pump are energized to remove residuals from the sumps. Electrochemical reactions are maintained through protection of the reactive plate surfaces.
- All plumbing connections are made with ANSI Class 150 flanges.
- 3” wide foam rubber gasket where the reactor cartridge will sit creating a seal that forces the untreated water to rise up through the reactor for treatment.

3.15.3 Plate Pack

- The Reactor Treatment Plates are ¼” thick metal and are energized to serve as the electrodes in the reactor. For this application, the power plates are carbon steel and intermediate plates are two rows of carbon steel and the top row aluminum. The plates must be flat to maintain the separation distance between the electrodes in the reactor.
    - 24” x 38” Steel power plates (16)
    - 24” x 10.3” Steel intermediate plates (60)
    - 24” x 10.3” Aluminum intermediate plates (30)

3.15.4 Reactor Leads

- Quantity: (4) per rectifier/reactor pair
- Reactor leads are cable that run from the rectifiers to power plates of EC reactors
- CCI Royal 4/0 Cable
- Stranding: 532/24
- Voltage Rating: 2000V rms Max
- Temperature Range: -40°C to 90°C
- Net Weight: 753 lb per 1000 feet

3.15.5 Hayward Strainer Baskets:

- Model: SB1300F
- Quantity: (2)
- Hayward Strainer Baskets are used to filter out solids pumped from reactor vessel sumps. The strainers have manual and pneumatic ball valves.
- Material: SCH 80 PVC
- Seal Material: FPM
- Size: 3”
- Pressure Rating: 150 PSI @ 70° F Non-Shock

3.16 Process Tanks

3.16.1 Equalization (EQ) Tank

- Quantity: (1)
- Raw water flows into the EQ Tank from the KM Lift Station. The water will be dosed with calcium chloride and sulfuric acid. This tank serves as a mix tank and buffers the water before it enters the EC reactors. The EQ tank contains a mixer and aerator to ensure mixing of chemical and inhibit stratification.
- One hour holding capacity
- Volume: 6,463 GAL
- Vertical FRP tank for Above Ground service - Open top, Flat bottom
- 10’-0” dia. X 11’-0” straight sidewall length
- Gray gel coat exterior
- Top 3” inside flange lip
- (2) 2” FRP threaded half couplings
- 4” FRP threaded half coupling
- Galvanized lifting lugs
- Hydro Test Chop Liner 1/8” – VE liner
- Service acid water, waste water,
- Ambient temperature, atmospheric pressure
- With hold-down lugs, wind rated to 130 mph under all fill conditions.

3.16.2 Defoam Tank

- Quantity: (1)
- After undergoing the EC reactions, the Post-EC pumps send water into the Defoam Tank. The defoam tanks serve to remove gas from the solids generated in the EC reactions. A second pH adjustment will be performed in the Defoam Tank as needed. After passing through the defoam tank, the water gravity flows into the floc tank. This tank contains a mixer and aerator to prevent stratification.
- Volume: 6,463 GAL
- Vertical FRP tank for Above Ground service - Open top, Flat bottom
- 10’-0” dia. X 11’-0” straight sidewall length
- Gray gel coat exterior
- Top 3” flange lip
- (2) 2” FRP threaded half couplings
- (1) 4” FRP threaded full couplings
- (1) 6” FRP threaded full couplings
- (2) Galvanized lifting lugs
- Hydro Test Chop Liner 1/16” – ISO liner

- Service: Waste water
- Ambient temperature, Atmospheric pressure
- With hold-down lugs, wind rated to 130 mph under all fill conditions.

3.16.3 Floc Tank

- Quantity: (1)
- After passing through the Defoam Tank, the water gravity flows into the Floc Tank. The water will be dosed and mixed with polymer to aid in floc formation with the goal of solids removal in the clarifier. After polymer treatment, the water will flow into the Clarifier. This tank will contain a mixer to assist in floc formation.
- Volume:3,760 GAL
- Vertical FRP tank for Above Ground service, Open top, Flat bottom
- 8’-0” dia. X 10’-0” straight sidewall length
- Gray gel coat exterior
- Top 3” flange lip
- (2) 2” FRP threaded half couplings
- (1) 4” FRP threaded full couplings
- (1) 6” FRP threaded full couplings
- (2) Galvanized lifting lugs
- Hydro Test Chop Liner 1/16” – ISO liner
- Service: Waste water
- Ambient temperature, Atmospheric pressure
- With hold-down lugs, wind rated to 130 mph under all fill conditions.

3.16.4 Post Treatment Tank

- Quantity: (1)
- Clarified water from the Clarifier will gravity flow into the Post-Treatment Tank prior to filtration. This tank serves as a buffer for automation of the post-treatment pumps.
- Volume: 1,057 GAL
- Vertical FRP tank for Above Ground service, Open top, Flat bottom
- 6’-0” dia. X 5’-0” straight sidewall length
- Gray gel coat exterior
- Top 3” flange lip
- (2) 2” FRP threaded half couplings
- (1) 4” FRP threaded half coupling
- Galvanized lifting lugs
- Hydro Test Chop Liner 1/16” – ISO liner
- Service: Waste water

- Ambient temperature, Atmospheric pressure
- With hold-down lugs, wind rated to 130 mph under all fill conditions.

3.16.5 Sludge Thickener

- Manufacturer: Snyder Industries Inc.
- Tank Model: 5100
- Stand Model: 79400
- Quantity: (1)
- Sludge from the Clarifier will be pumped into this cone bottom tank. The sludge will be allowed to further settle in this tank and separate from the water. Water with the settled solids will be drawn from the bottom of the tank and sent to the Filter Press. Decanted water from the sludge thickener will gravity over-flow to the defoam tank.
- Capacity: 2600 GAL
- Bottom: 45° Cone Bottom
- Type II Resin: molded from linear polyethylene resin (not cross-linkable resin).

3.16.6 Polymer Tank

- Quantity: (1)
- 150-gallon chemical pretreatment tank (polymer)
- Manufacturer: Snyder Industries Inc.
- Dimensions: 30” D x 57” Height

3.16.7 Water Safety/Wash Water Tank

- Quantity: (1)
- 1900 GAL Water holding tank
- Dimensions: 64” x 147.3”
- Specific gravity 1.9
- Rotational molded tank with closed top, High-density linear polyethylene (HDLPE) natural white color, 18” Polyethylene manway with 15” access at top of tank.
- Flush gallonage marks on side of tank.
- Bulkhead at base of tank for connection to water reuse pumps
- Bulkhead fittings for water entering and exiting the tank.

3.16.8 Calcium Chloride Tank (provided by others)

- Quantity: (1)
- Mini bulk tank

3.16.9 Acid Tank (provided by others)

- Quantity: (1)
- Mini bulk tank

3.17 Clarifier

- Pan American Slant Plate Clarifier for solids settling after primary water treatment processes. Dual sump bottom for solids removal.
- Model: SPC-42-P-600
- Manufacturer: Pan America
- Quantity: (1)
- Slant Plate clarifier equivalent footprint: 600 ft^2
- Plate Loading: 0.3 GPM/FT^2 (at manufactures max flow); 0.125 GPM/FT^2 (expected at max flow of system)
- Tank and interior baffles: 3/16” ASTM A-36 Carbon Steel
- All Steel pipe: Black Schedule 40 ASTM-A53
- All Flanges flat face type and match 150# ANSO B16.5 Flange. Bolt holes to straddle main centerlines.
- Wetted hardware: 316 SS material
- Interior surfaces: Prepare to SSPC-SP10 near white metal blast, and coated with ameron high build coal tar epoxy Amercoat 78 HB, 16 mils dft minimum
- Exterior surfaces: Prepare to SSPC-SP6 commercial blast and coat with Ameron epoxy primer, Amerlock 2 5-8 mils DFT final coated to be Amershield aliphatic polyurethane enamel, 5 mils DFT

3.18 Solids Dewatering

3.18.1 Filter Press

- Model: Evoqua 800G32-49-25SYLW
- Quantity: (1)
- The Filter Press will press entrained water out of the sludge from the clarifier. The Filter Press will run through a cycle until it fills up with solids or a predetermined time has passed. After a cycle ends, the Filter Press needs to be opened and cleaned, then reassembled for the next cycle. The Filter Press is mounted on a stand over a roll off box for easier collection of solids. The pressed water is sent back to the EQ Tank.
- The Filter Press Controls are mounted on a skid with the Filter Press Pump. This skid controls the pressure the Filter Press is operating under. The Filter Press Controls cycle the Filter Press Pump through a low, medium, and then high pressure. The pressure changes after a predetermined time has passed.
- Press Capacity: 25 FT^3
- Design Operating Pressure: 100 PSI
- Plate Size: 800 mm x 800 mm
- Cake Thickness: 1.25”
- Dimensions:

  - Approx. Overall length: 210”
  - Approx. Overall width: 57”
  - Approx. Overall height: 65”
  - Approx. Overall equipment dry weight: 6,100 lbs
- Filter Plates: Standard recessed, center feed, alternating 4 corner discharge
- Material of construction: Polypropylene
- Maximum operating pressure 100 psi @ 120°F operating temperature
- Gasketed sealing area with EPDM elastomer O-ring type gaskets
- Filter Cloths:
  - Polypropylene filter cloths with sewn-in, high-density cord for caulked-in-place installation
- Filter Press Frame:
  - Sidebar style
- Material of construction: ASTM-A36 steel
- Design pressure: 100 psi
- Rugged solid steel components and sidebars
- Full width 304 stainless steel, sidebar caps
- Feed and Discharge Manifold
- Designed for air blow, even fill
- Materials of construction: ABS/PVC
- One (1) center feed valve on feed pipe assembly
- Four (4) discharge valves on discharge pipe assembly
- One (1) air blow valve on discharge pipe assembly
- Manual valve actuation

3.18.2 Roll-Off Box (provided by others)

- Quantity: (1)
- Provided by Others for solids collection below the filter press
- Capacity: 20 YD^3
- Height: 5’-6” (grade to top of tarp bow)
- Length: 21’-0”
- Width: 8’-4” (top cap, side to side), 9’4” (tarp roll on side of box to opposite side of top cap)
- Inside dimensions: 192” L x92” W x42” H
- Wheels: 8” wide x 9” diameter
- Hook-up: 1” thick open hook, bulkhead end
- Structural Design:
- Floor: ¼” thick steel plate

- Walls: 3/16” thick steel plate
- Door Sheet: 3” x 3” x 11 ga. Structural tubing
- Bulkhead: 3/16” thick steel plate
- Top cap: 4” x 3” x 11 ga. Structural tubing
- Wetted Materials
- Carbon steel: Shell and door sheet
- Door gasket: EPDM

3.18.3 Roll-Off Winch and Rail

3.18.3a Winch

- Winch used to pull Roll-off under the filter press after unloading from truck
- Manufacturer: Allied Power Products Inc. Electric Winch
- Pulling capacity: 11,000 lbs
- 460 VAC, 3 phase, 3 HP, 1725 RPM motor
- Gear ratio: 261:1
- First layer speed: 8 fpm
- Cable: 3/8” wire rope
- Cable material: 7x19 Galvanized Aircraft Cable
- Breaking strength: 14,400 lbs

3.18.3b Rail

- Rail frame built to guide the 20 YD^3 roll off box to/from under the filter press.

3.19 Multi-Media Filters

- Yardney Multi-media filter skid filled with different media to provide fine particulate filtration. The filter housing has a designated controller to provide automatic backwashing. System backwashing is implemented based upon a differential pressure reading across the media filter beds
- Yardney Model: MM-1860-4A
- Quantity: (1) – 4 pod skid
- Standard Flow Range: 36-88 GPM
- Total Filtration Surface Area: 7.08 FT^2
- Backwash Flowrate: 27 GPM
- Max Pressure: 100 PSI
- Number of tanks: 4
- Diameter: 18”
- Media Requirements (per tank):

  - 1 FT^3 1/2”- 3/4” Gravel
  - 1 FT^3 1.45 mm Garnet
  - 2.5 FT^3 0.35 mm Garnet
  - 2.5 FT^3 0.75 mm Anthracite
- Tank material: Carbon Steel
- Interior Coating: 3M ScotchKote 134 Fusion bonded epoxy
- Underdrain: 304 Stainless steel wedgewire lateral
- Inlet and Outlet Pipe Size: 3”
- Backwash Pipe Size: 2”

3.20 Bag Filters

- Rosedale bag filters
- Model: NC08-302P-*-150-S-V-PB
- Quantity: (2)
- Filter housings will be plumbed in parallel with one bag filter sock per housing. Bag filters are used as a final or polishing solids removal.
- Housing Height: 30”
- Inlet/Outlet size/fitting: 2” NPT
- Pressure Rating: 150 psi
- Housing Material: 304 Stainless Steel
- Cover Seal: Flouroelastomer
- Basket Type: Filter bag basket

3.21 Catwalk

- Steel walk platform structure, sandblasted and painted, used to navigate system. Gives operator ability to look into reactor vessels, handle filter press plates, and look into process water tanks

Section 4: Component List – P&ID Identification

4.1 Manual Valves:

BV-	***DESCRIPTION***	***MANUFACTURER***	***PART NO.***
0116	2" PVC BALL VALVE	SPEARS	2339-020
0117	1/2" PVC BALL VALVE	SPEARS	2339-005
0118	2" PVC BALL VALVE	SPEARS	2339-020
0119	2" PVC BALL VALVE	SPEARS	2339-020
0120	2" PVC BALL VALVE	SPEARS	2339-020
0121	2" PVC BALL VALVE	SPEARS	2339-020
0125	1/2" PVC BALL VALVE	SPEARS	2339-005
0201	2" PVC BALL VALVE	SPEARS	2339-020
0202	2" PVC BALL VALVE	SPEARS	2339-020
0203	4" PVC Ball Valve	SPEARS	3632-040
0205	2" PVC BALL VALVE	SPEARS	2339-020
0206	2" PVC BALL VALVE	SPEARS	2339-020
0207	2" PVC BALL VALVE	SPEARS	2339-020
0208	2" PVC BALL VALVE	SPEARS	2339-020
0220	2" PVC BALL VALVE	SPEARS	2339-020
0304	2" PVC BALL VALVE	SPEARS	2339-020
0305	1/2" BRASS BALL VALVE	MCMASTER	47865K23
0311	2" PVC BALL VALVE	SPEARS	2339-020
0312	2" PVC BALL VALVE	SPEARS	2339-020
0321	2" PVC BALL VALVE	SPEARS	2339-020
0350	2" PVC BALL VALVE	SPEARS	2339-020
0353	2" PVC BALL VALVE	SPEARS	2339-020
0409	3" PVC BALL VALVE	SPEARS	2332-030
0410	2" PVC BALL VALVE	SPEARS	2339-020
0411	2" PVC BALL VALVE	SPEARS	2339-020
0412	2" PVC BALL VALVE	SPEARS	2339-020
0413	2" PVC BALL VALVE	SPEARS	2339-020
0420	2" PVC BALL VALVE	SPEARS	2339-020
0511	2" PVC BALL VALVE	SPEARS	2339-020
0515	2" PVC BALL VALVE	SPEARS	2339-020
0525	2" PVC BALL VALVE	SPEARS	2339-020
0530	2" PVC BALL VALVE	SPEARS	2339-020
0535	2" PVC BALL VALVE	SPEARS	2339-020
0540	2" PVC BALL VALVE	SPEARS	2339-020
0541	1 1/2" PVC BALL VALVE	SPEARS	2339-015
0550	1 1/2" PVC BALL VALVE	SPEARS	2339-015
0551	1/2" PVC BALL VALVE	SPEARS	2339-005

0552	1 1/2" PVC BALL VALVE	SPEARS	2339-015
0553	1/2" BRASS BALL VALVE	MCMASTER	47865K23
0621	1/2" BRASS BALL VALVE	MCMASTER	47865K23
0622	1/2" BRASS BALL VALVE	MCMASTER	47865K23
0630	1 1/2" PVC BALL VALVE	SPEARS	2339-015
0632	1 1/2" PVC BALL VALVE	SPEARS	2339-015
0633	1 1/2" PVC BALL VALVE	SPEARS	2339-015
0634	1 1/2" PVC BALL VALVE	SPEARS	2339-015
0635	1 1/2" PVC BALL VALVE	SPEARS	2339-015
0636	1 1/2" PVC BALL VALVE	SPEARS	2339-015
0637	1/2" BRASS BALL VALVE	MCMASTER	47865K23
0640	1/2" BRASS BALL VALVE	MCMASTER	47865K23
0701	4" PVC BALL VALVE	SPEARS	2339-040
0702	2" PVC BALL VALVE	SPEARS	2339-020
0706	2" PVC BALL VALVE	SPEARS	2339-020
0707	2" PVC BALL VALVE	SPEARS	2339-020
0708	2" PVC BALL VALVE	SPEARS	2339-020
0709	2" PVC BALL VALVE	SPEARS	2339-020
0721	1/4" CHROME PLATED BALL VALVE	MCMASTER	4912K92
0722	1/4" CHROME PLATED BALL VALVE	MCMASTER	4912K92
0741	1/4" CHROME PLATED BALL VALVE	MCMASTER	4912K92
0742	2" PVC BALL VALVE	SPEARS	2339-020
0743	2" PVC BALL VALVE	SPEARS	2339-020
0744	2" PVC BALL VALVE	SPEARS	2339-020
0745	2" PVC BALL VALVE	SPEARS	2339-020
0747	1/4" CHROME PLATED BALL VALVE	MCMASTER	4912K92
0749	2" PVC BALL VALVE	SPEARS	2339-020
0750	2" PVC BALL VALVE	SPEARS	2339-020
0751	1/2" PVC BALL VALVE	SPEARS	2339-005
0752	2" PVC BALL VALVE	SPEARS	2339-020
0753	2" PVC BALL VALVE	SPEARS	2339-020
0754	2" PVC BALL VALVE	SPEARS	2339-020
0755	2" PVC BALL VALVE	SPEARS	2339-020
0756	2" PVC BALL VALVE	SPEARS	2339-020
0757	2" PVC BALL VALVE	SPEARS	2339-020
0761	2" PVC BALL VALVE	SPEARS	2339-020
0762	2" PVC BALL VALVE	SPEARS	2339-020
0775	1 ¼” PVC BALL VALVE	SPEARS	2339-012
0776	1 ¼” PVC BALL VALVE	SPEARS	2339-012
0777	½” PVC BALL VALVE	SPEARS	2339-005
0778	½” PVC BALL VALVE	SPEARS	2339-005
0810	1/2" CPVC BALL VALVE	SPEARS	2339-005C
0812	1/2" PVC BALL VALVE	SPEARS	2339-005

0821	1/2" CPVC BALL VALVE	SPEARS	2339-005C
0822	1/2" CPVC BALL VALVE	SPEARS	2339-005C
0823	1/2" CPVC BALL VALVE	SPEARS	2339-005C
0824	1/2" CPVC BALL VALVE	SPEARS	2339-005C
0825	1/2" PVC BALL VALVE	SPEARS	2339-005
0826	1/2" PVC BALL VALVE	SPEARS	2339-005
0831	1/2" CPVC BALL VALVE	SPEARS	2339-005C
0832	1/2" CPVC BALL VALVE	SPEARS	2339-005C
0833	1/2" CPVC BALL VALVE	SPEARS	2339-005C
0834	1/2" CPVC BALL VALVE	SPEARS	2339-005C

4.2 Gate Valves

GV-	***DESCRIPTION***	***MANUFACTURER***	***PART NO.***
0520	1.25" GV	SPEARS	2022-012
0717	2" GV	SPEARS	2022-020
0770	HOSE BIB #1	EVERBILT	VHNSTDB4EB*
0771	HOSE BIB #2	EVERBILT	VHNSTDB4EB*
0772	HOSE BIB #3	EVERBILT	VHNSTDB4EB*
0773	HOSE BIB #4	EVERBILT	VHNSTDB4EB*

*= or similar

4.3 Air Controlled Valves

ACV-	***DESCRIPTION***	***MANUFACTURER***	***PART NO.***
0115	2" PNEUMATIC BALL VALVE	GEORG FISHER	199-233-078
0129	2" PNEUMATIC BALL VALVE	GEORG FISHER	199-233-078
0204	4" PNEUMATIC BALL VALVE	GEORG FISHER	199-233-081
0303	2" PNEUMATIC BALL VALVE	GEORG FISHER	199-233-078
0311	2" PNEUMATIC BALL VALVE	GEORG FISHER	199-233-078
0321	2" PNEUMATIC BALL VALVE	GEORG FISHER	199-233-078
0409	3" PNEUMATIC BALL VALVE	GEORG FISHER	199-233-080
0414	3" 3-WAY PNEUMATIC VALVE	GEORG FISHER	199-285-388
0526	2" PNEUMATIC BALL VALVE	GEORG FISHER	199-233-078
0536	2" PNEUMATIC BALL VALVE	GEORG FISHER	199-233-078
0705	4" PNEUMATIC BALL VALVE	GEORG FISHER	199-233-081
0708	3" 3-WAY PNEUMATIC VALVE	ASAHI/AMERICA	2513-030 (VALVE BODY) 2302-030 (ACTUATOR)
0717	3" 3-WAY PNEUMATIC VALVE	ASAHI/AMERICA	2513-030 (VALVE BODY) 2302-030 (ACTUATOR)

4.4 Solenoid Valves

SV-	*DESCRIPTION*	*MANUFACTURER*	*PART NO.*
0115	1/4" TUBING AIR SOLENOID	BURKERT	5470
0129	1/4" TUBING AIR SOLENOID	BURKERT	5470
0204	1/4" TUBING AIR SOLENOID	BURKERT	5470
0212	1/2" TUBING AIR SOLENOID	ASCO	8210G002
0302	1/2" TUBING AIR SOLENOID	ASCO	8210G002
0303	1/4" TUBING AIR SOLENOID	BURKERT	5470
0311	1/4" TUBING AIR SOLENOID	BURKERT	5470
0321	1/4" TUBING AIR SOLENOID	BURKERT	5470
0409	1/4" TUBING AIR SOLENOID	BURKERT	5470
0414	1/4" TUBING AIR SOLENOID	BURKERT	5470
0526	1/4" TUBING AIR SOLENOID	BURKERT	5470
0527	1/2" TUBING AIR SOLENOID	ASCO	8210G002
0536	1/4" TUBING AIR SOLENOID	BURKERT	5470
0553	1/2" TUBING AIR SOLENOID	ASCO	8210G002
0705	1/4" TUBING AIR SOLENOID	BURKERT	5470
0708	1/4" TUBING AIR SOLENOID	BURKERT	5470
0717	1/4" TUBING AIR SOLENOID	BURKERT	5470

4.5 Check Valves

CV-	*DESCRIPTION*	*MANUFACTURER*	*PART NO.*
0116	2" PVC SPRING CHECK VALVE	GEORG FISCHER	562
0118	2" PVC SPRING CHECK VALVE	GEORG FISCHER	562
0120	2" PVC SPRING CHECK VALVE	GEORG FISCHER	562
0201	2" PVC SPRING CHECK VALVE	GEORG FISCHER	562
0202	2" PVC SPRING CHECK VALVE	GEORG FISCHER	562
0220	2" PVC SPRING CHECK VALVE	GEORG FISCHER	562
0410	2" PVC SPRING CHECK VALVE	GEORG FISCHER	562
0411	2" PVC SPRING CHECK VALVE	GEORG FISCHER	562
0706	2" PVC SPRING CHECK VALVE	GEORG FISCHER	562
0707	2" PVC SPRING CHECK VALVE	GEORG FISCHER	562
0754	WATER SAEFTY/WASH WATER PUMP	GRUNDFOS	CMBE 10-54
0755	WATER SAEFTY/WASH WATER PUMP	GRUNDFOS	CMBE 10-54
0761	2" PVC SPRING CHECK VALVE	GEORG FISCHER	562
0762	2" PVC SPRING CHECK VALVE	GEORG FISCHER	562
0775	1 ¼” CHECK VALVE	GEORG FISCHER	562

4.6 Flow Meters

FT-	*DESCRIPTION*	*MANUFACTURER*	*PART NO.*
0101	EXTRACTION WELL FLOW METER	GEORGE FISCHER	3-2551-P0-42
0305	EC FEED FLOW METER	GEORGE FISCHER	3-2551-P0-42
0770	DISCHARGE FLOW METER	GEORGE FISCHER	3-2551-P0-42

4.7 Rectifiers

RC-	*DESCRIPTION*	*MANUFACTURER*	*PART NO.*
0401	RECTIFIER	ALDONEX	T-448-20CR-CCV-APR-IOS
0402	RECTIFIER	ALDONEX	T-448-20CR-CCV-APR-IOS

4.8 Basket Strainers

STR-	*DESCRIPTION*	*MANUFACTURER*	*PART NO.*
0311	BASKET STRAINER	HAYWARD	SB1300F
0321	BASKET STRAINER	HAYWARD	SB1300F

4.9 Pumps

PMP-	*DESCRIPTION*	*MANUFACTURER*	*PART NO.*
0201	EC FEED PUMP (DUPLEX)	GORMAN-RUPP	490B-98
0202	EC FEED PUMP (DUPLEX)	GORMAN-RUPP	490B-98
0220	SUMP PUMP	ZOELLER	N140
0302	SCALE PURGE PUMP	ARO	06-PD15P-FPS-PTT
0410	POST EC PUMP (DUPLEX)	GORMAN-RUPP	490B-98
0411	POST EC PUMP (DUPLEX)	GORMAN-RUPP	490B-98
0514	POLYMER PUMP	PULSATRON	LPH6-PTC
0518	POLYMER PUMP	PULSATRON	LPH6-PTC
0527	SLUDGE PUMP	ARO	06-PD15P-FPS-PTT
0631	SLUDGE PUMP	ARO	06-PD15P-FPS-PTT
0706	POST TREATMENT PUMP (DUPLEX)	GRUNDFOS	CRI 10-6
0707	POST TREATMENT PUMP (DUPLEX)	GRUNDFOS	CRI 10-6
0754, 0755	WATER SAFETY/WASH WATER PUMP (DUPLEX)	GRUNDFOS	CMBE 10-54 TWIN
0831	ACID PUMP	LMI	XRD121A74TCA7PN
0832	ACID PUMP	LMI	XRD121A74TCA7PN
0833	ACID PUMP	LMI	XRD121A74TCA7PN
0834	ACID PUMP	LMI	XRD121A74TCA7PN
0835	CALCIUM CHLORIDE	LMI	XRD121A74TCA7T1
0836	CALCIUM CHLORIDE	LMI	XRD121A74TCA7T1

4.10 Filter Press Controls

	DESCRIPTION	***MANUFACTURER***	***PART NO.***
	FILTER PRESS 25 CU. FT	EVOQUA	800G32-49-25SYLW
PS-0611	PRESSURE SWITCH	UNITED ELECTRIC	H54-25
PR-0612	PRESSURE REGULATOR	WILKERSON	R18-04-F000
SV-0613	1/2" TUBING AIR SOLENOID	ASCO	8210G002
PR-0614	PRESSURE REGULATOR	WILKERSON	R18-04-F000
SV-0615	1/2" TUBING AIR SOLENOID	ASCO	8210G002
PR-0616	PRESSURE REGULATOR	WILKERSON	R18-04-F000
SV-0617	1/2" TUBING AIR SOLENOID	ASCO	8210G002
PR-0618	PRESSURE REGULATOR	WILKERSON	R18-04-F000
NV-0619	NEEDLE VALVE	ARO	104104-N04
NV-0620	NEEDLE VALVE	ARO	104104-N04
CV-0638	1/2" FILTER PRESS	MILWAUKEE VALVE	UP0967000012
CV-0639	1/2" FILTER PRESS	MILWAUKEE VALVE	UP0967000012
PR-0641	PRESSURE REGULATOR	WILKERSON	R18-04-F000

4.11 Pressure Gauges

	DESCRIPTION	***MANUFACTURER***	***PART NO.***
PG	BAG FILTER INLET LIQUID PRESSURE GAUGE	WEKSLER	BY12YPG4LW
PG	BAG FILTER OUTLET LIQUID PRESSURE GAUGE	WEKSLER	BY12YPG4LW
PG	BAG FILTER INLET LIQUID PRESSURE GAUGE	WEKSLER	BY12YPG4LW
PG	BAG FILTER OUTLET LIQUID PRESSURE GAUGE	WEKSLER	BY12YPG4LW

4.12 Safety Shower

PR	***DESCRIPTION***	***MANUFACTURER***	***PART NO.***
	WATER HEATER	EEMAX	AP063480 EFD N4
	SAFETY SHOWER	GUARDIAN SAFETY STATION	GFR3100
PR-0775	WATER HEATER PRESSURE REGULATOR	WATTS	11/4 25AUB-GG-Z3
HR-0776	WATER HAMMER ARRESTOR SAFETY SHOWER #1	ZURN LC	WH2950XL
HR-0777	WATER HAMMER ARRESTOR SAFETY SHOWER #2	ZURN LC	WH2950XL
ST- 0775	WATER HEATER Y-STRAINER 40 MESH	HAYWARD	YS10125SU1/16

4.13 Tank Mixer

MXR-	***DESCRIPTION***	***MANUFACTURER***	***PART NO.***
0211	EQ TANK 1.5 HP	BALDOR	CM 3554
----	GEAR BOX	DODGE TIGEAR	20Q05H56
0504	DEFOAM TANK 1.5 HP	BALDOR	CM 3554
----	GEAR BOX	DODGE TIGEAR	20Q05H56
0516	FLOCCULATION TANK 1.0 HP	BALDOR	CM 3538
----	GEAR BOX	DODGE TIGEAR	17Q05H56
0521	POLYMER TANK 0.25 HP	LEESON	C4C17FB21E

4.14 Pressure Switches

	DESCRIPTION	***MANUFACTURER***	***PAT NO.***
PSL-0305	PRESSURE SWITCH LOW	UNITED ELECTRIC	H54-25
PT-0723	MULTI MEDIA FILTER PRESSURE SWITCH	DWYER	SERIES 629
PT-0749	BAG FILTER PRESSURE SWITCH	DWYER	SERIES 629

4.15 Tanks

DESCRIPTION	***MANUFACTURER***	***PART NO.***
EQ TANK	LF MANUFACTURING	A-LP10104
POST EC TANK	REGAL PLASTICS	TA00230S19X36X80
DEFOAM TANK	LF MANUFACTURING	A-LP10105
FLOCCULATION TANK	LF MANUFACTURING	A-LP10106
CLARIFER	PAN AMERICAN	SPC-42-P-600
POLYMER TANK	SNYDER	57100VOT45S
SLUDGE THICKENER	SNYDER	TANK: 5100 STAND: 79400
POST TREATMENT TANK	LF MANUFACTURING	A-LP10107
MULTI MEDIA FILTER (FLTR-0709)	YARDNEY	MM-1860-4A
BAG FILTER (FLTR-0748-1)	ROSEDALE	NC08-302P-*-150-S-V-PB
BAG FILTER (FLTR-0748-1)	ROSEDALE	NC08-302P-*-150-S-V-PB
WATER SAFETY/WASH WATER TANK	SNYDER	8300000N45
CALCIUM CHLORIDE MINI BULK TANK (BY OTHERS)	-	-
ACID MINI BULK TANK (BY OTHERS)	-	-

4.16 Tank Sensors

	DESCRIPTION	*MANUFACTURER*	*PART NO.*
LSH-0201	CONTAINMENT SUMP FULL	MADISON	M8000
LSL-0202	LEVEL SENSOR LOW SUMP	ADVANCED CONTROL TECHNOLOGY	P7300
LT-0213	EQ TANK LEVEL TRANSMITTER	MJK	EXPERT 2100
LSH-0214	EQ REDUNDANT HIGH LEVEL	MADISON	M8000
LSL-0215	EQ TANK REDUNDANT LOW LEVEL	ADVANCED CONTROL TECHNOLOGY	P7300
AIC-0217	EQ FEED LINE CONDUCTIVITY PROBE	ENDRESS + HAUSER	CLS21D
AIC-0218	EQ TANK pH PROBE	ENDRESS + HAUSER	CPF81D
AIC-0219	EQ TANK CONDUCTIVITY PROBE	ENDRESS + HAUSER	CLS21D
LSH-0404	POST EC TANK REDUNDANT HIGH LEVEL	MADISON	M8000
LSL-0407	POST EC TANK REDUNDANT LOW LEVEL	ADVANCED CONTROL TECHNOLOGY	P7300
LT-0408	POST EC TANK LEVEL TRANSMITTER	MJK	EXPERT 2100
AIC-0505	DEFOAM TANK pH PROBE	ENDRESS + HAUSER	CPF81D
LSH-0506	DEFOAM TANK HIGH LEVEL	MADISON	M8000
LSH-0517	FLOCCULATION TANK HIGH LEVEL	MADISON	M8000
LSL-0520	POLYMER TANK LOW LEVEL	ADVANCED CONTROL TECHNOLOGY	P7300
LSH-0523	CLARIFIER HIGH LEVEL	MADISON	M8000
LT-0702	POST TREATMENT TANK LEVEL TRANSMITTER	MJK	EXPERT 2100
LSH-0703	POST TREATMENT TANK REDUNDANT HIGH LEVEL	MADISON	M8000
LSL-0704	POST TREATMENT TANK REDUNDANT LOW LEVEL	ADVANCED CONTROL TECHNOLOGY	P7300
LSL-0751	WATER SAFETY/WASH WATER TANK LOW LEVEL	ADVANCED CONTROL TECHNOLOGY	P7300
LSL-0803	CALCIUM CHLORIDE TANK LOW LEVEL	ADVANCED CONTROL TECHNOLOGY	P7300

Section 5: Applicable Standards

5.1 Fiberglass Tanks

Tanks shall be designed, fabricated, and inspected in accordance with the latest issue of the following standards:

ASTM D-3299, Filament-Wound Glass-Reinforced Chemical-Resistant Tanks, latest edition.

ASTM C-582, Contact-Molded Reinforced Thermosetting Plastic Laminates for Corrosion-Resistant Equipment.

ANSI B 16.5, Flange Dimensions.

ASTM D-2583, Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impression tester.

ASTM D-2584, Test Method for Ignition Loss of Cured Reinforced Resins.

National Bureau of Standards (NBS) Voluntary Product Standard PS 15-69, Custom Contact-Molded Reinforced-Polyester Chemical-Resistant Process Equipment.

ASTM D-2563, Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts.

ASTM D-4097, Contact Molded Glass – Fiber Reinforced Thermosetting Resin Chemical-Resistant Tanks.

FRP tanks shall be corrosion-resistant to the specified tank contents and shall be suitable for the intended service life.

Additional loads from pumps, or catwalks shall be supported externally from the tank.

Dimensional Requirements-Cylindrical Vessels and Tanks: Diameters shall be measured internally. Tolerance on nominal diameter including out-of-roundness shall be plus or minus 1 percent. Measurements shall be taken with the tank in the vertical position. Taper shall not exceed 0.25 percent per side. The minimum knuckle radius on formed heads shall be 1-1/2 inches unless noted otherwise on the attached data sheets.

The final locations of nozzles and accessories shall be subject to change until shop drawing approvals.

All FRP tanks shall be designed for outdoor service with direct sunlight exposure.

Tanks shall be designed to meet pressure, loading or seismic criteria using strengthening ribs, unless otherwise indicated on the data sheets. Where no strengthening ribs are specified, loads shall be distributed over a uniform side shell thickness.

5.2 Plastic Tanks

All plastic tanks utilized will be of adequate specific gravity to meet the type of water being stored within. Water Safety/Wash Water tank fabricated to ASTM standards. Polymer and sludge thickener tanks are fabricated according to specific gravity rating.

5.3 ASTM (American Society for Testing and Materials) Standards

D618 Conditioning Plastics and Electrical Insulating Materials for Testing

D638 Tensile Properties of Plastics

D790 Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

D883 Definitions of Terms Relating to Plastics

D1505 Density of Plastics by the Density-Gradient Technique

D1525 Test Method for Vicat Softening Temperature of Plastics

D1693 Test Method for Environmental Stress-Cracking of Ethylene Plastics

D1998 Standard Specification for Polyethylene Upright Storage Tanks

D2765 Degree of Crosslinking in Crosslinked Ethylene Plastics as Determined by Solvent Extraction

D2837 Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials

D3892 Practice for Packaging/Packing of Plastics

F412 Definitions of Terms Relating to Plastic Piping Systems

5.4 ARM (Association of Rotational Molders) Standards

- Low Temperature Impact Resistance (Falling Dart Test Procedure)

5.5 ANSI Standards

- B-16.5 Pipe Flanges and Flanged Fittings

5.6 OSHA Standards

- 29 CFR 1910.106 Occupational Safety and Health Administration, Flammable and Combustible Liquids

5.7 UBC CODE

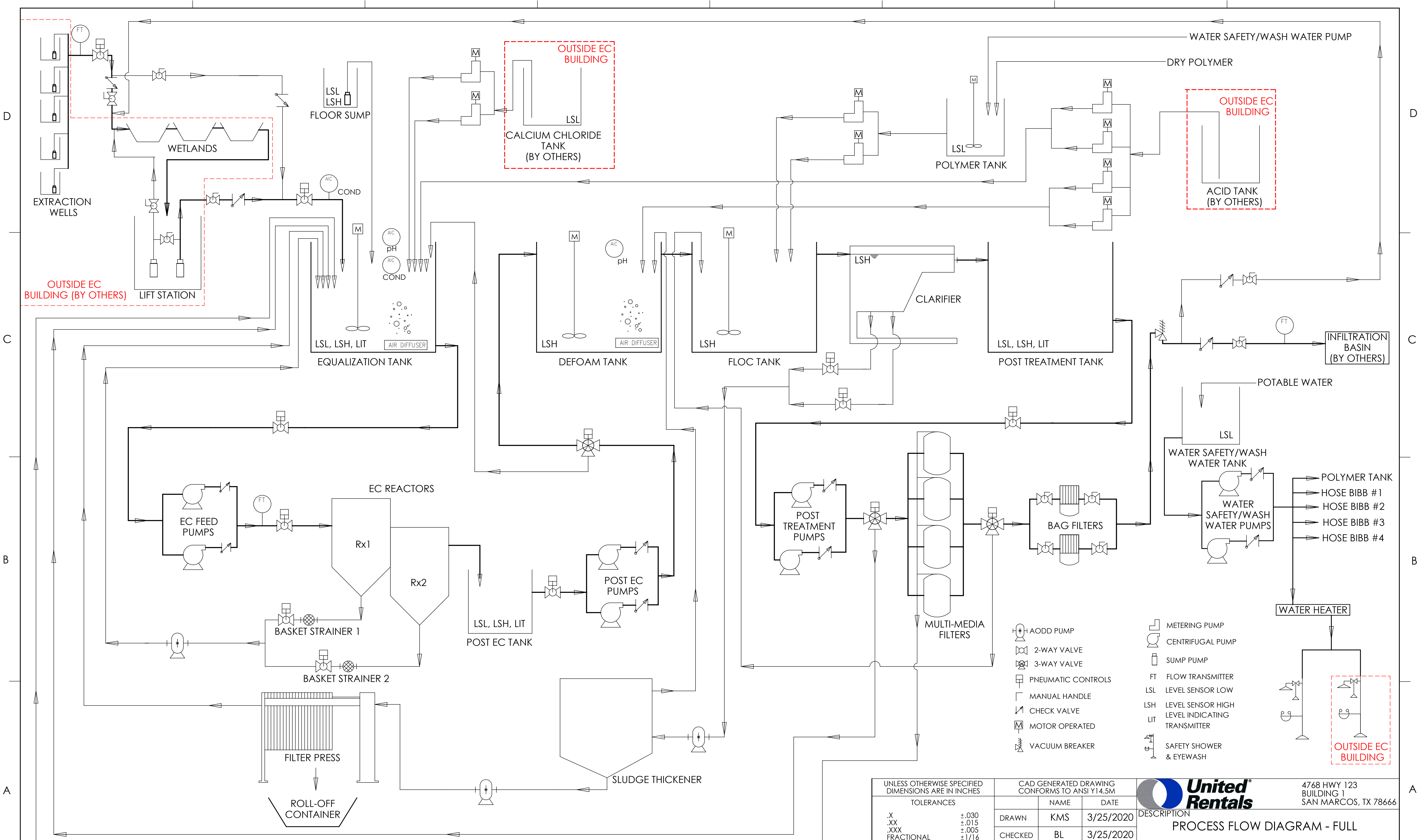
- Uniform Building Code 2006 Edition

5.8 IBC CODE

- International Building Code 2009 Edition

Section 6: Site Requirements

- All site work and concrete slab pouring are the responsibility of site General Contractor.
- A suitable structure to protect the treatment system components from rain or moisture and freezing conditions with a minimum interior width of 40 feet, minimum interior length of 84 feet and minimum clearance height of 21 feet. Assume temperature maintained at or above 40 degrees F during winter months.
- The floor of the structure should be level or graded to provide adequate drainage if desired. The floor should be formed to provide any required containment.
- A sulfuric acid storage/containment area should be constructed into the facility to store the 93% sulfuric acid being used in the treatment process.
- Storage area for process materials: calcium chloride and polymer
- Electrical service panel with 480VAC, 3-phase power with amperage load to be calculated based upon total building load.
- Electrical drops providing 120VAC, single phase power at specified locations.
- Electrical drop with two disconnects in a local panel for connecting water safety/wash water pumps. Each pump requires 240 VAC, 1 phase, 9.1 amps for 2 HP motor.
- Ethernet connection between VPN router and local network; an assigned IP address for the router in customer’s local area network (must port forward 5900, 10443 and 1194 to the IP address assigned to the VPN router). A virtual network computing (VNC) client to customer’s remote access device(s) to allow remote access to and control of the EC Treatment System HMI screens.
- Potable water supply for chemical make-up and wash water.
- Safety facilities and equipment as required by national, state, and local codes including any safety showers and personal protection equipment.
- Any equipment not supplied by United Rentals required for completing the installation and operation of the treatment system.



UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES

TOLERANCES

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.XX	±.015
.XXX	±.005
FRACTIONAL	±1/16
ANGULAR:	
MACH	±.5°
BEND	±1°

REMOVE BURRS AND
BREAK ALL SHARP EDGES

DRAWING SIZE: B
DO NOT SCALE DRAWING

CAD GENERATED DRAWING
CONFORMS TO ANSI Y14.5M

	NAME	DATE
DRAWN	KMS	3/25/2020
CHECKED	BL	3/25/2020
APPRV	DH	3/25/2020

PROJECTION

MATERIAL

United Rentals

4768 HWY 123
BUILDING 1
SAN MARCOS, TX 78666

DESCRIPTION
PROCESS FLOW DIAGRAM - FULL

PROJECT KAISER - MEAD

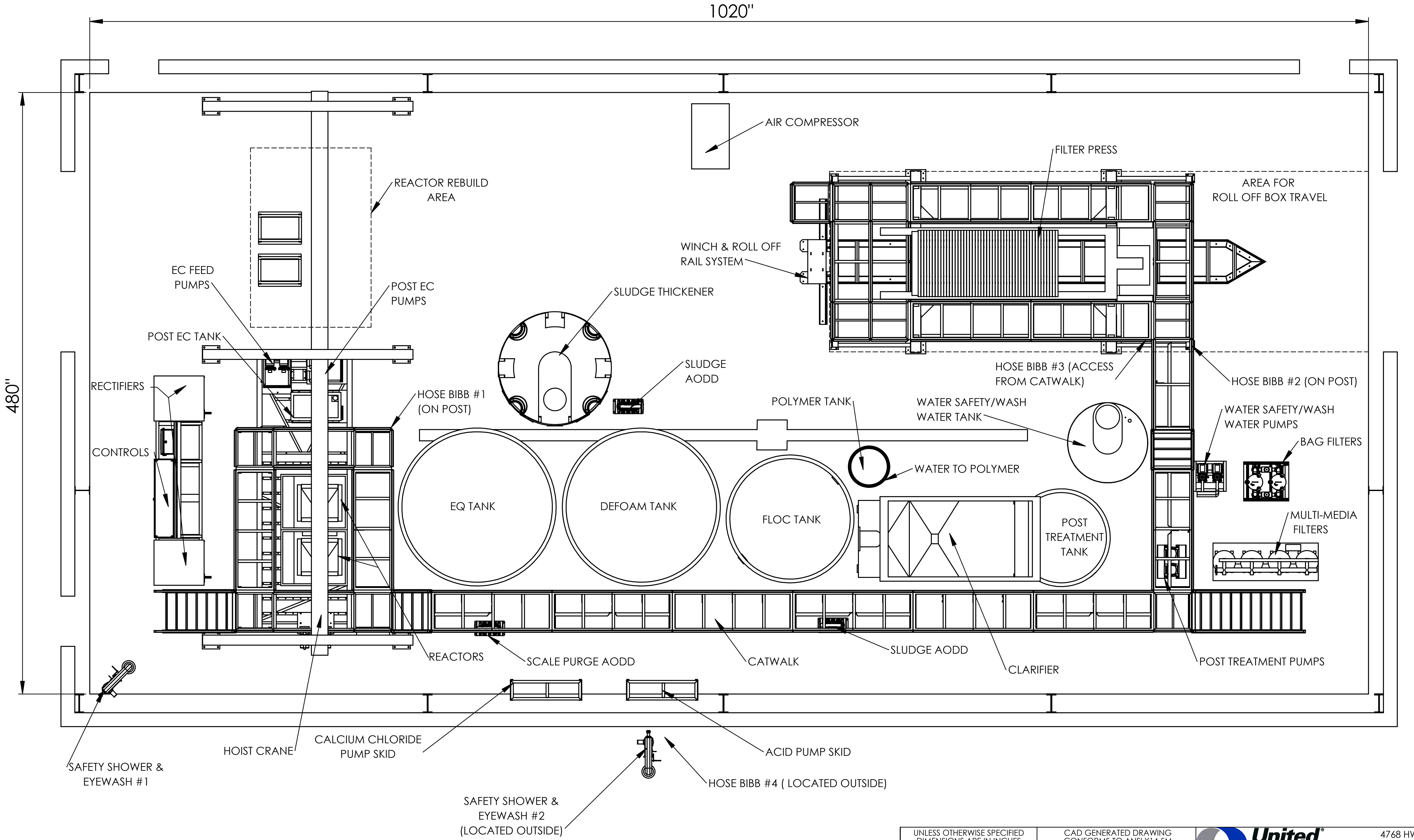
DWG NO. KM-001

REV -

SCALE NONE

WEIGHT (lbs)

SHEET 1 OF 1



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UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES

TOLERANCES

.X	±.030
.XX	±.015
.XXX	±.005
FRACTIONAL	±1/16
ANGULAR:	
MACH	±.5°
BEND	±1°

REMOVE BURRS AND
BREAK ALL SHARP EDGES

DRAWING SIZE: B
DO NOT SCALE DRAWING

CAD GENERATED DRAWING
CONFORMS TO ANSI Y14.5M

	NAME	DATE
DRAWN	KMS	3/25/2020
CHECKED	BL	3/25/2020
APPRV	DH	3/25/2020

PROJECTION

MATERIAL

United Rentals®

4768 HWY 123
BUILDING 1
SAN MARCOS, TX 78666

DESCRIPTION
FULL SYSTEM LAYOUT

PROJECT
KAISER-MEAD

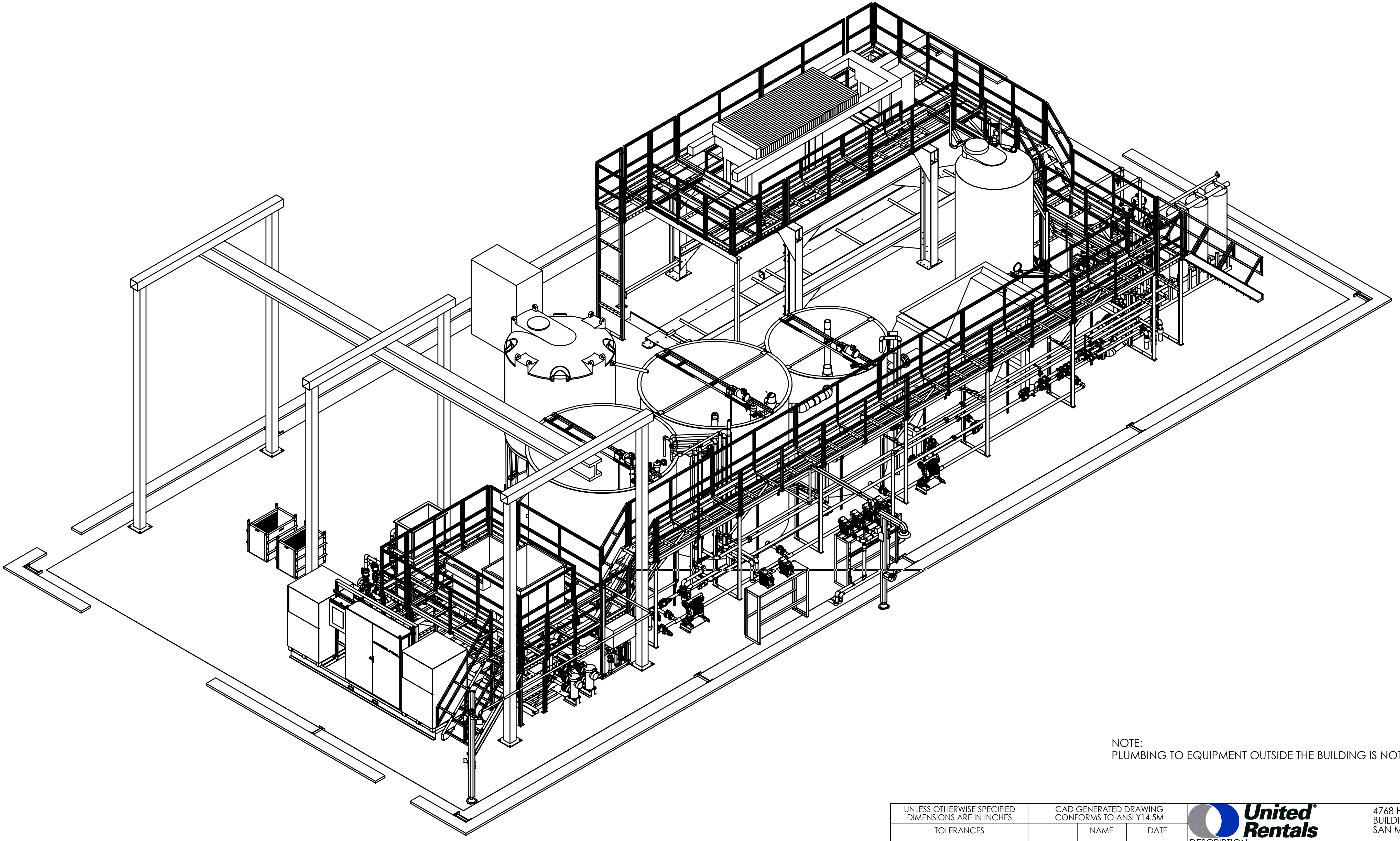
PART NO.
KM-011

REV

SCALE NONE

WEIGHT (lbs)

SHEET 1 OF 1



NOTE:
PLUMBING TO EQUIPMENT OUTSIDE THE BUILDING IS NOT SHOWN

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REV.	DESCRIPTION	DATE	APPROVED
	REVISIONS		

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES

TOLERANCES

.X	±.030
.XX	±.015
.XXX	±.005
FRACTIONAL	±1/16
ANGULAR:	
MACH	±.5°
BEND	±1°

REMOVE BURRS AND
BREAK ALL SHARP EDGES

DRAWING SIZE: B
DO NOT SCALE DRAWING

CAD GENERATED DRAWING
CONFORMS TO ANSI Y14.5M

	NAME	DATE
DRAWN	KMS	3/25/2020
CHECKED	BL	3/25/2020
APPRV	DH	3/25/2020

PROJECTION

MATERIAL

United Rentals
4768 HWY 123
BUILDING 1
SAN MARCOS, TX 78666

DESCRIPTION
FULL LAYOUT
3D MODEL VIEWS WITH PLUMBING

PROJECT
KAISER- MEAD

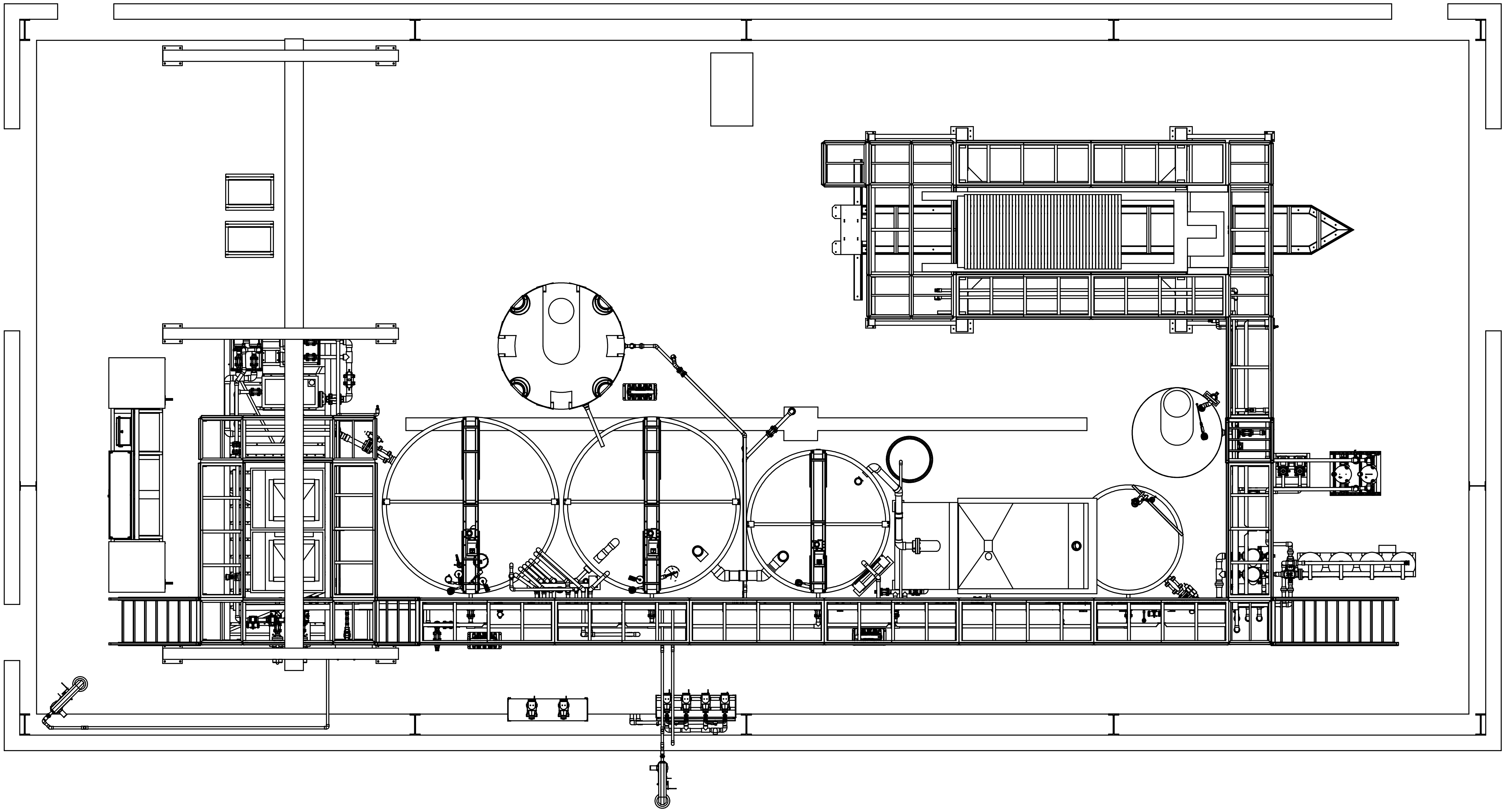
PART NO.
KM-014

REV
-

SCALE
NONE

WEIGHT (lbs)

SHEET
1 OF 4



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REV.	DESCRIPTION	DATE	APPROVED
REVISIONS			

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES

TOLERANCES

.X	±.030
.XX	±.015
.XXX	±.005
FRACTIONAL	±1/16
ANGULAR:	
MACH	±.5°
BEND	±1°

REMOVE BURRS AND
BREAK ALL SHARP EDGES

DRAWING SIZE: B
DO NOT SCALE DRAWING

CAD GENERATED DRAWING
CONFORMS TO ANSI Y14.5M

	NAME	DATE
DRAWN	KMS	3/25/2020
CHECKED	BL	3/25/2020
APPRV	DH	3/25/2020

PROJECTION

MATERIAL

United Rentals®

4768 HWY 123
BUILDING 1
SAN MARCOS, TX 78666

DESCRIPTION
FULL LAYOUT
3D MODEL VIEWS WITH PLUMBING

PROJECT
KAISER- MEAD

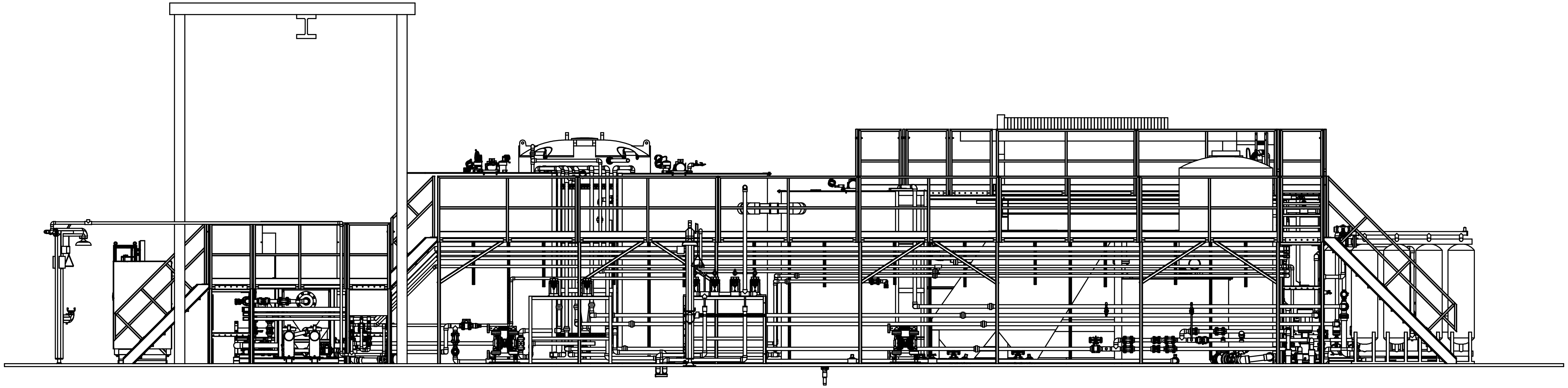
PART NO.
KM-014

REV
-

SCALE
NONE

WEIGHT (lbs)

SHEET
2 OF 4



SOUTH SIDE VIEW

NOTE:
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REV.	DESCRIPTION	DATE	APPROVED

REVISIONS

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES

TOLERANCES

.X	±.030
.XX	±.015
.XXX	±.005
FRACTIONAL	±1/16
ANGULAR:	
MACH	±.5°
BEND	±1°

REMOVE BURRS AND
BREAK ALL SHARP EDGES

DRAWING SIZE: B
DO NOT SCALE DRAWING

CAD GENERATED DRAWING
CONFORMS TO ANSI Y14.5M

	NAME	DATE
DRAWN	KMS	3/25/2020
CHECKED	BL	3/25/2020
APPRV	DH	3/25/2020

PROJECTION

MATERIAL

United Rentals

4768 HWY 123
BUILDING 1
SAN MARCOS, TX 78666

DESCRIPTION
FULL LAYOUT
3D MODEL VIEWS WITH PLUMBING

PROJECT KAISER- MEAD

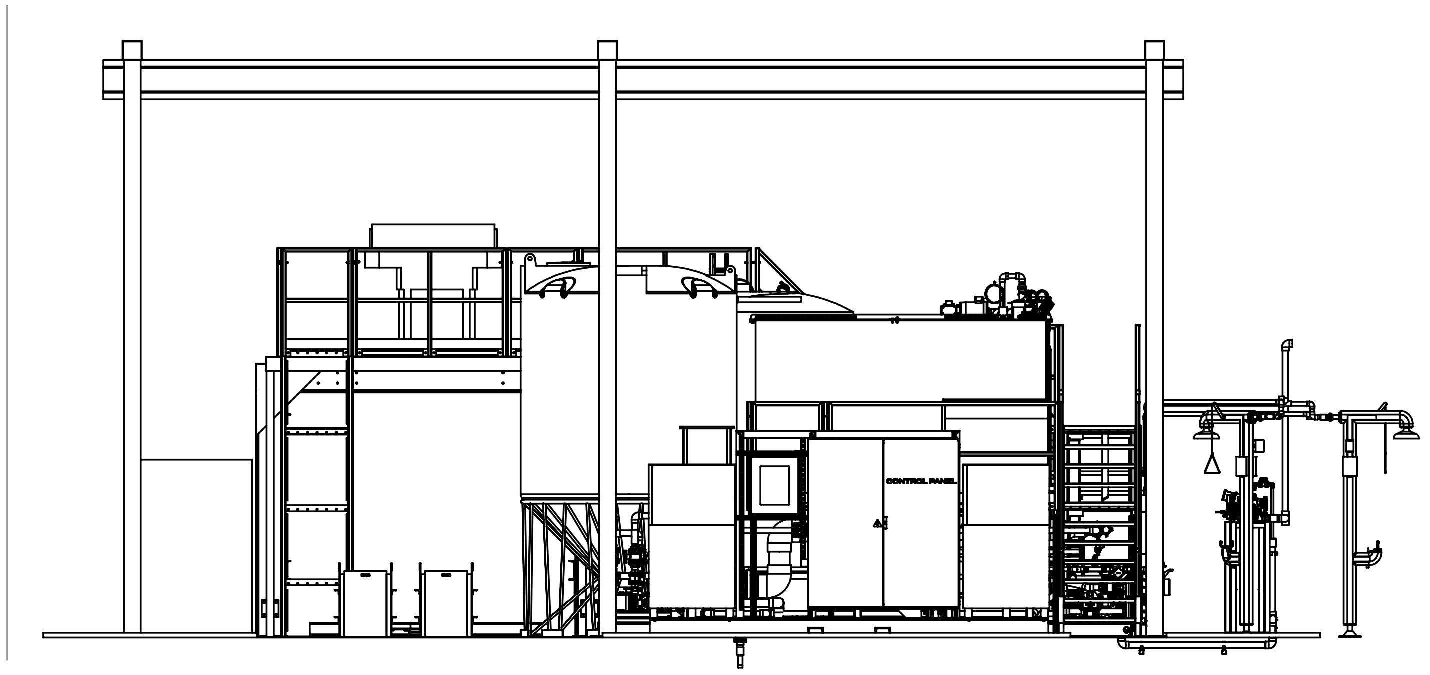
PART NO. KM-014

REV -

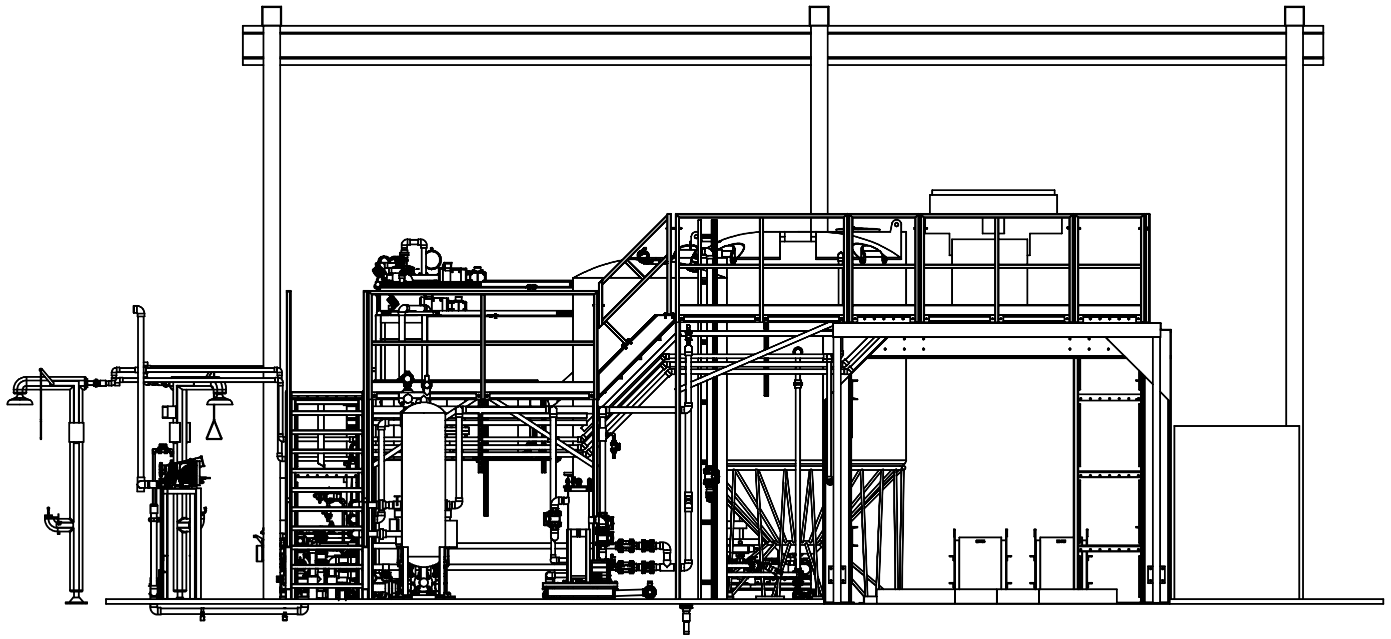
SCALE NONE

WEIGHT (lbs)

SHEET 3 OF 4



WEST SIDE VIEW



EAST SIDE VIEW

NOTE:
PLUMBING TO EQUIPMENT OUTSIDE THE BUILDING IS NOT SHOWN

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES	
TOLERANCES	
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.XX	±.015
.XXX	±.005
FRACTIONAL	±1/16
ANGULAR:	
MACH	±.5°
BEND	±1°
REMOVE BURRS AND BREAK ALL SHARP EDGES	
DRAWING SIZE: B DO NOT SCALE DRAWING	

CAD GENERATED DRAWING
CONFORMS TO ANSI Y14.5M

	NAME	DATE
DRAWN	KMS	3/25/2020
CHECKED	BL	3/25/2020
APPRV	DH	3/25/2020

PROJECTION

MATERIAL

United Rentals

4768 HWY 123
BUILDING 1
SAN MARCOS, TX 78666

DESCRIPTION
FULL LAYOUT
3D MODEL VIEWS WITH PLUMBING

PROJECT KAISER- MEAD

PART NO. KM-014

REV -

SCALE NONE

WEIGHT (lbs)

SHEET 4 OF 4

REV.	DESCRIPTION	DATE	APPROVED
REVISIONS			

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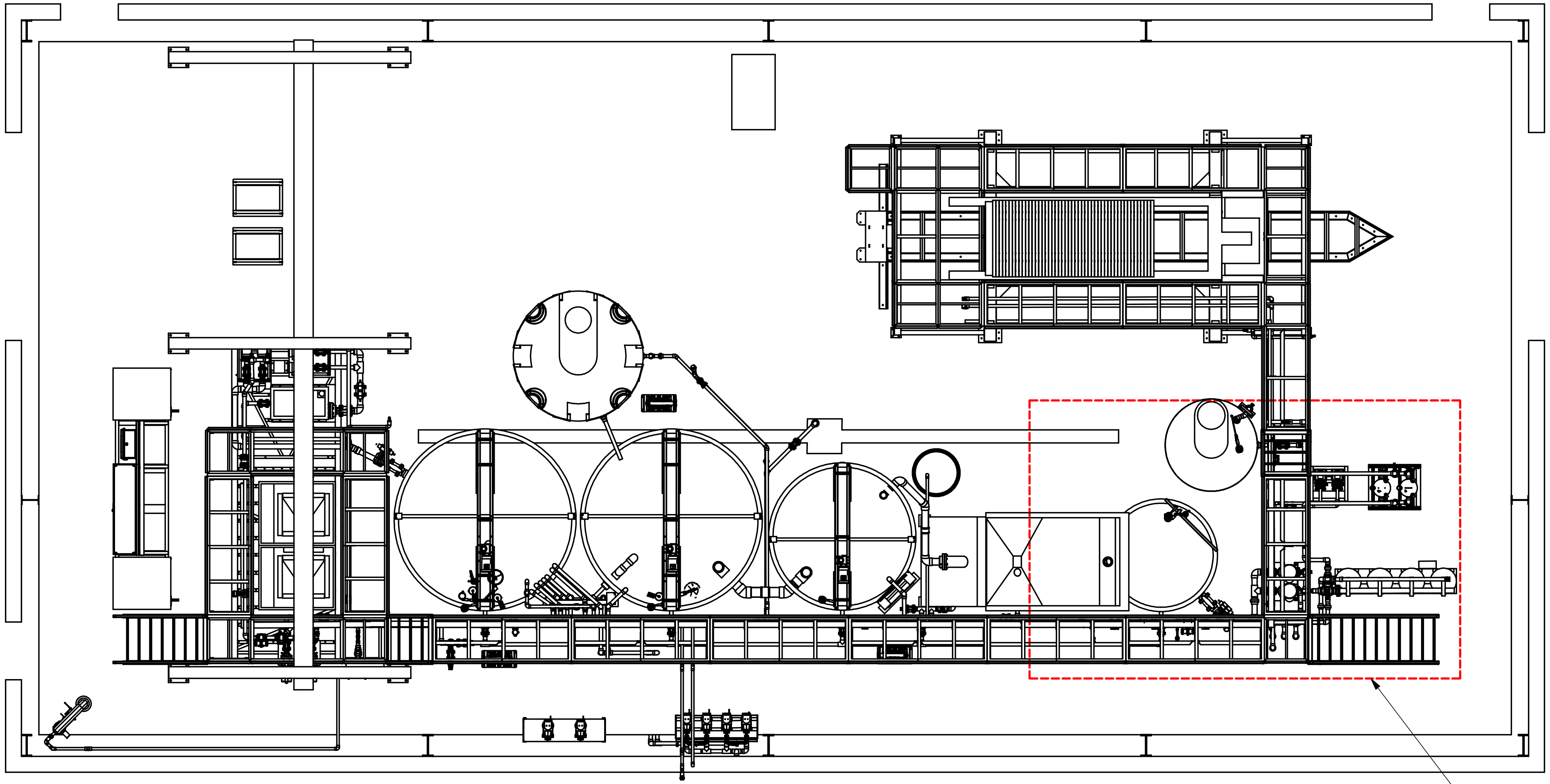

THE FOLLOWING PAGES REFERENCE THIS SECTION OF THE LAYOUT

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REV.	DESCRIPTION	DATE	APPROVED
REVISIONS			

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES

TOLERANCES

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.XXX	±.005
FRACTIONAL	±1/16
ANGULAR:	
MACH	±.5°
BEND	±1°

REMOVE BURRS AND
BREAK ALL SHARP EDGES

DRAWING SIZE: B
DO NOT SCALE DRAWING

CAD GENERATED DRAWING
CONFORMS TO ANSI Y14.5M

	NAME	DATE
DRAWN	KMS	3/25/2020
CHECKED	BL	3/25/2020
APPRV	DH	3/25/2020

PROJECTION ⊕

MATERIAL

United Rentals®

4768 HWY 123
BUILDING 1
SAN MARCOS, TX 78666

DESCRIPTION
INLET/OUTLET AND SAMPLE PORTS
OVERVIEW

PROJECT KAISER- MEAD

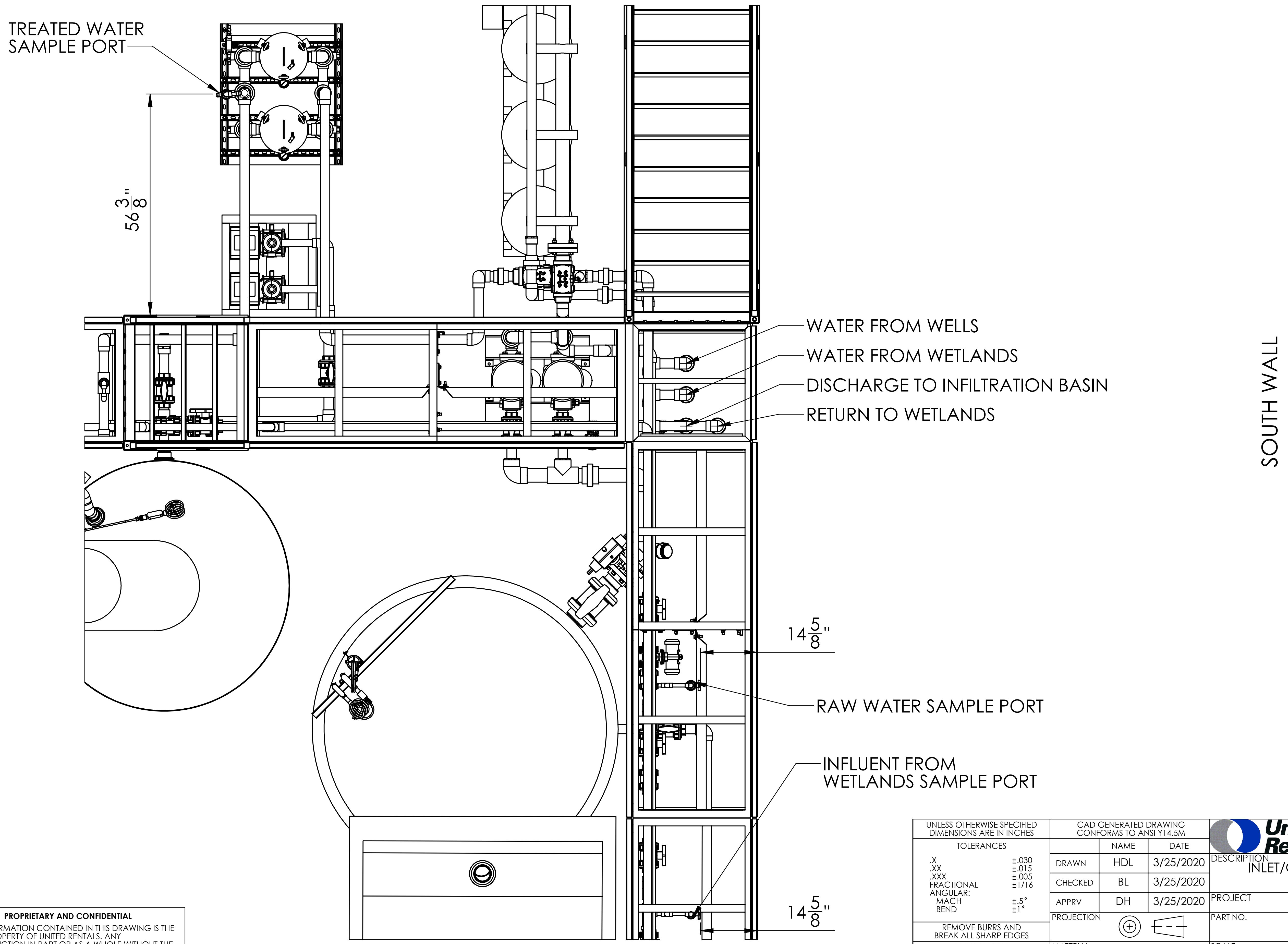
PART NO.

REV -

SCALE NONE

WEIGHT (lbs)

SHEET 1 OF 1



UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

TOLERANCES
.X ±.030
.XX ±.015
.XXX ±.005
FRACTIONAL ±1/16
ANGULAR:
MACH ±.5°
BEND ±1°

REMOVE BURRS AND BREAK ALL SHARP EDGES

DRAWING SIZE: B
DO NOT SCALE DRAWING

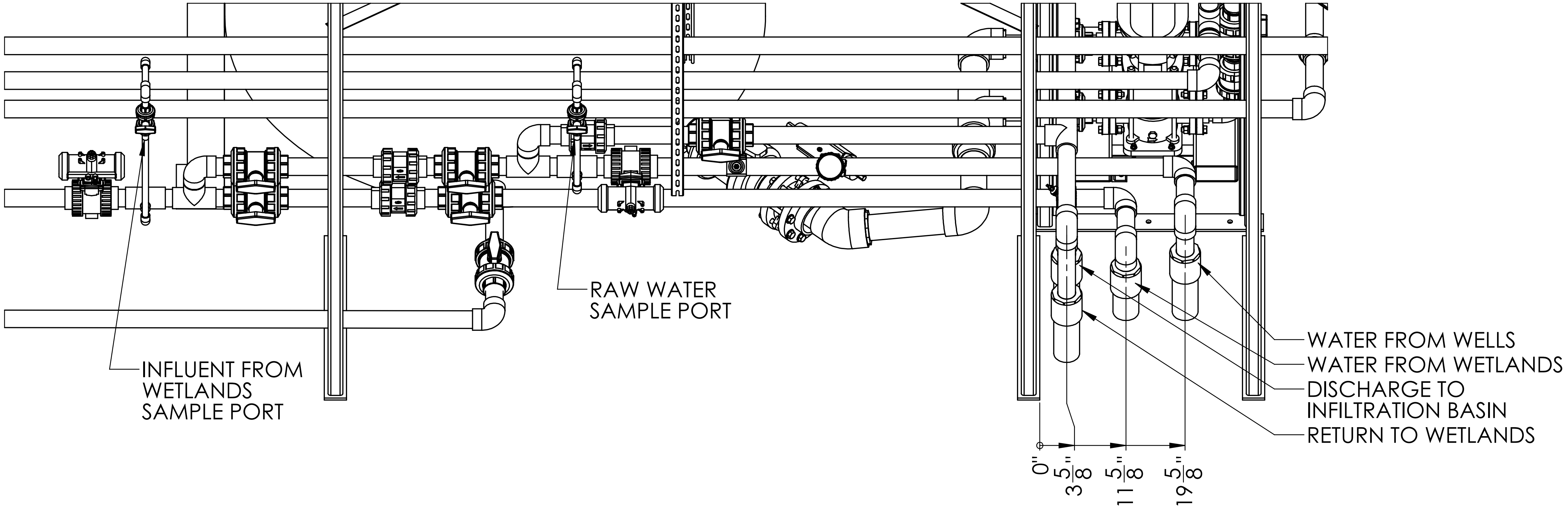
CAD GENERATED DRAWING CONFORMS TO ANSI Y14.5M

	NAME	DATE
DRAWN	HDL	3/25/2020
CHECKED	BL	3/25/2020
APPRV	DH	3/25/2020

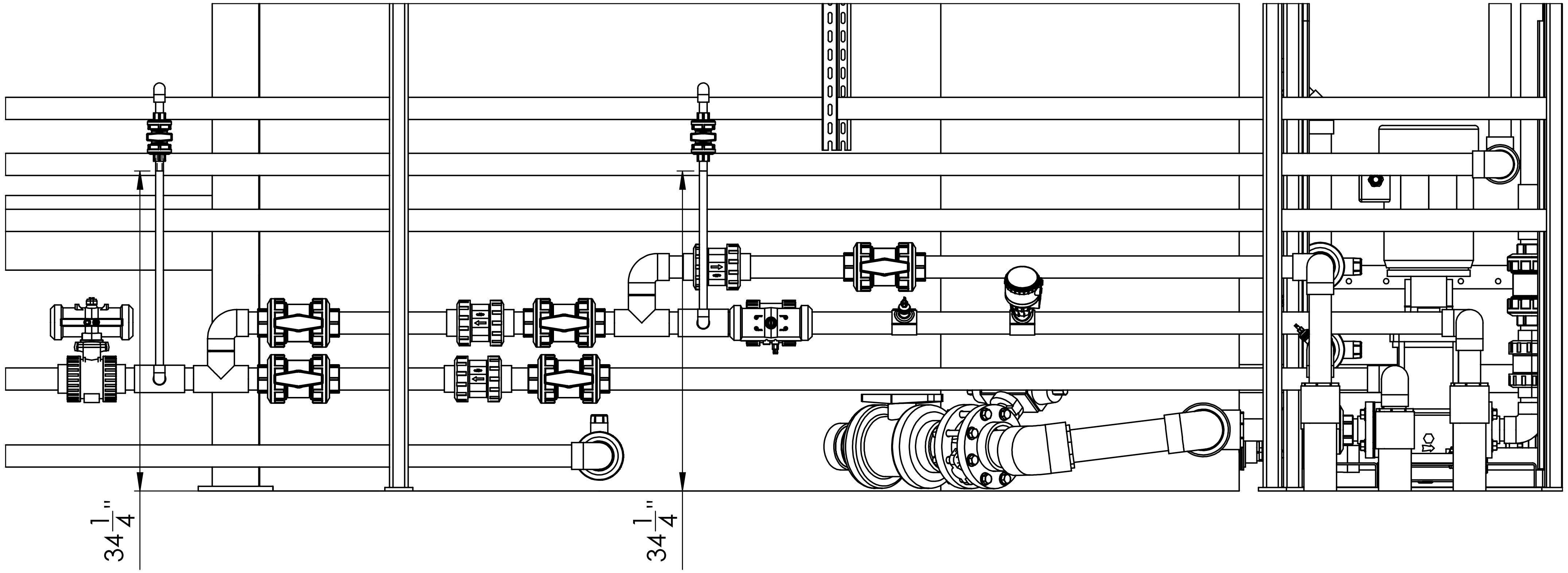
PROJECTION
MATERIAL

United Rentals®
4768 HWY 123
BUILDING 1
SAN MARCOS, TX 78666

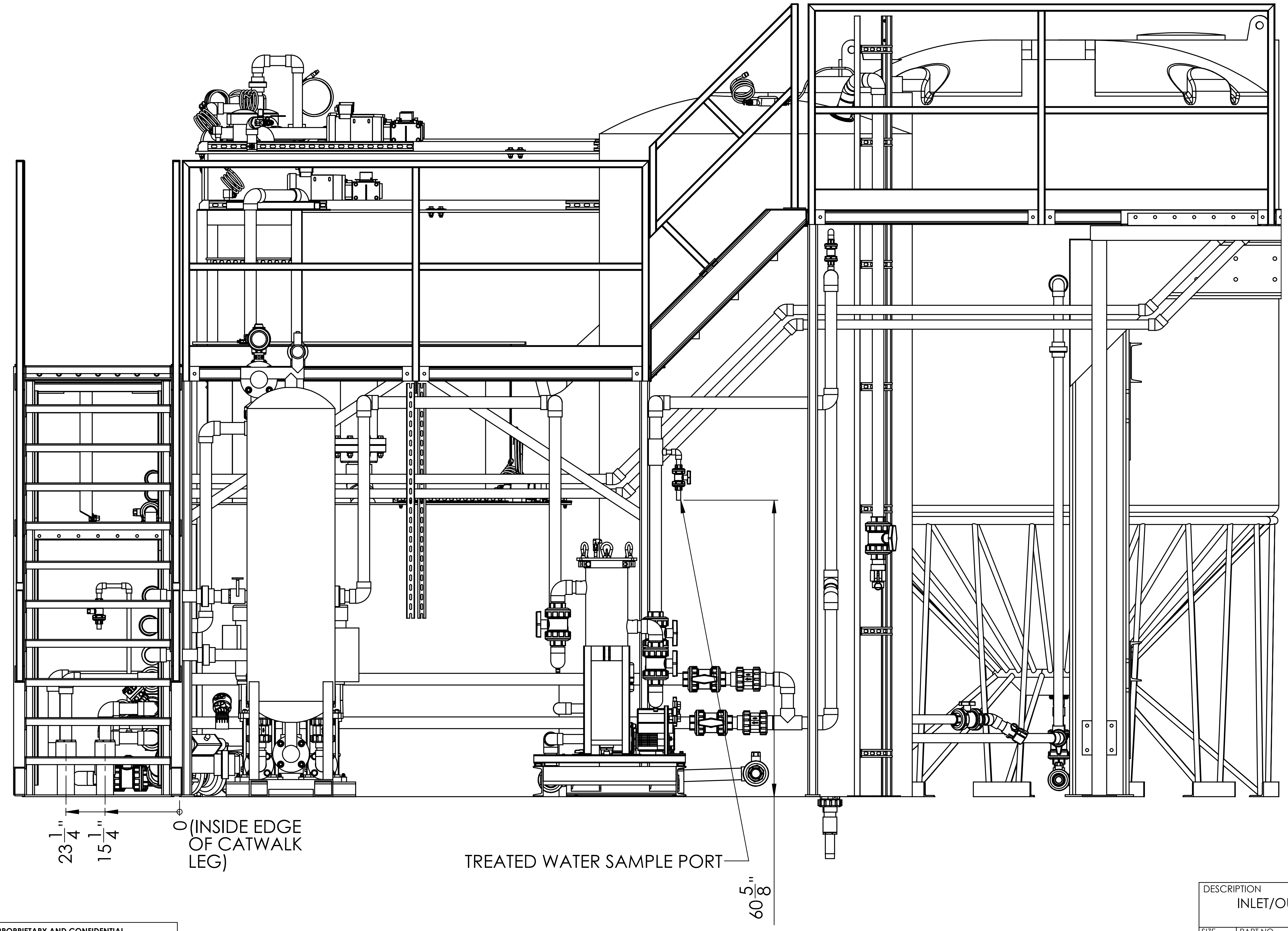
DESCRIPTION INLET/OUTLET AND SAMPLE PORTS
PROJECT
PART NO.
REV -
SCALE NONE
WEIGHT (lbs)
SHEET 1 OF 4



DESCRIPTION INLET/OUTLET AND SAMPLE PORTS			
SIZE B	PART NO.		REV -
SCALE NONE	WEIGHT (lbs)	SHEET 2 OF 4	



DESCRIPTION INLET/OUTLET AND SAMPLE PORTS			
SIZE B	PART NO.		REV -
SCALE NONE	WEIGHT (lbs)	SHEET 3 OF 4	



DESCRIPTION INLET/OUTLET AND SAMPLE PORTS			
SIZE B	PART NO.		REV -
SCALE NONE	WEIGHT (lbs)	SHEET 4 OF 4	

LEGEND:
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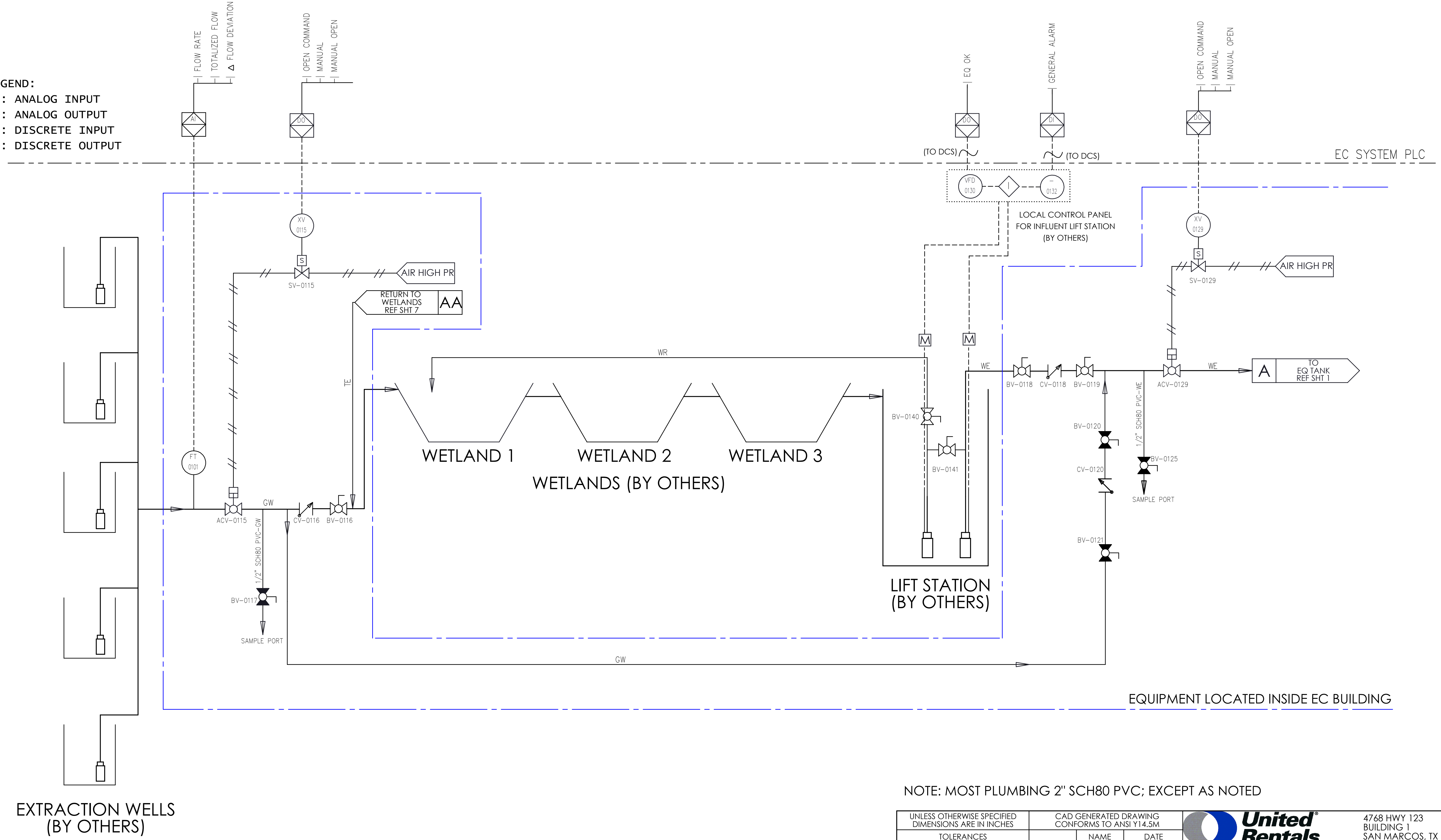
AO: ANALOG OUTPUT
DI: DISCRETE INPUT
DO: DISCRETE OUTPUT



NOTE: MOST PLUMBING 2" SCH80 PVC; EXCEPT AS NOTED

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES	CAD GENERATED DRAWING CONFORMS TO ANSI Y14.5M			United Rentals 4768 HWY 123 BUILDING 1 SAN MARCOS, TX 78666
TOLERANCES		NAME	DATE	DESCRIPTION: P&ID - RAW WATER COLLECTION
.X ±.030 .XX ±.015 .XXX ±.005 FRACTIONAL ±1/16 ANGULAR: MACH ±.5° BEND ±1°	DRAWN	KMS	11/26/2019	
	CHECKED	BL	3/25/2020	
	APPRV	DH	3/25/2020	PROJECT: KAISER -MEAD
REMOVE BURRS AND BREAK ALL SHARP EDGES	PROJECTION			SIZE B | DWG NO. KM-002 | REV -
DO NOT SCALE DRAWING	MATERIAL			SCALE NONE | WEIGHT (lbs) | SHEET 1 OF 9

PROPRIETARY AND CONFIDENTIAL

LEGEND:
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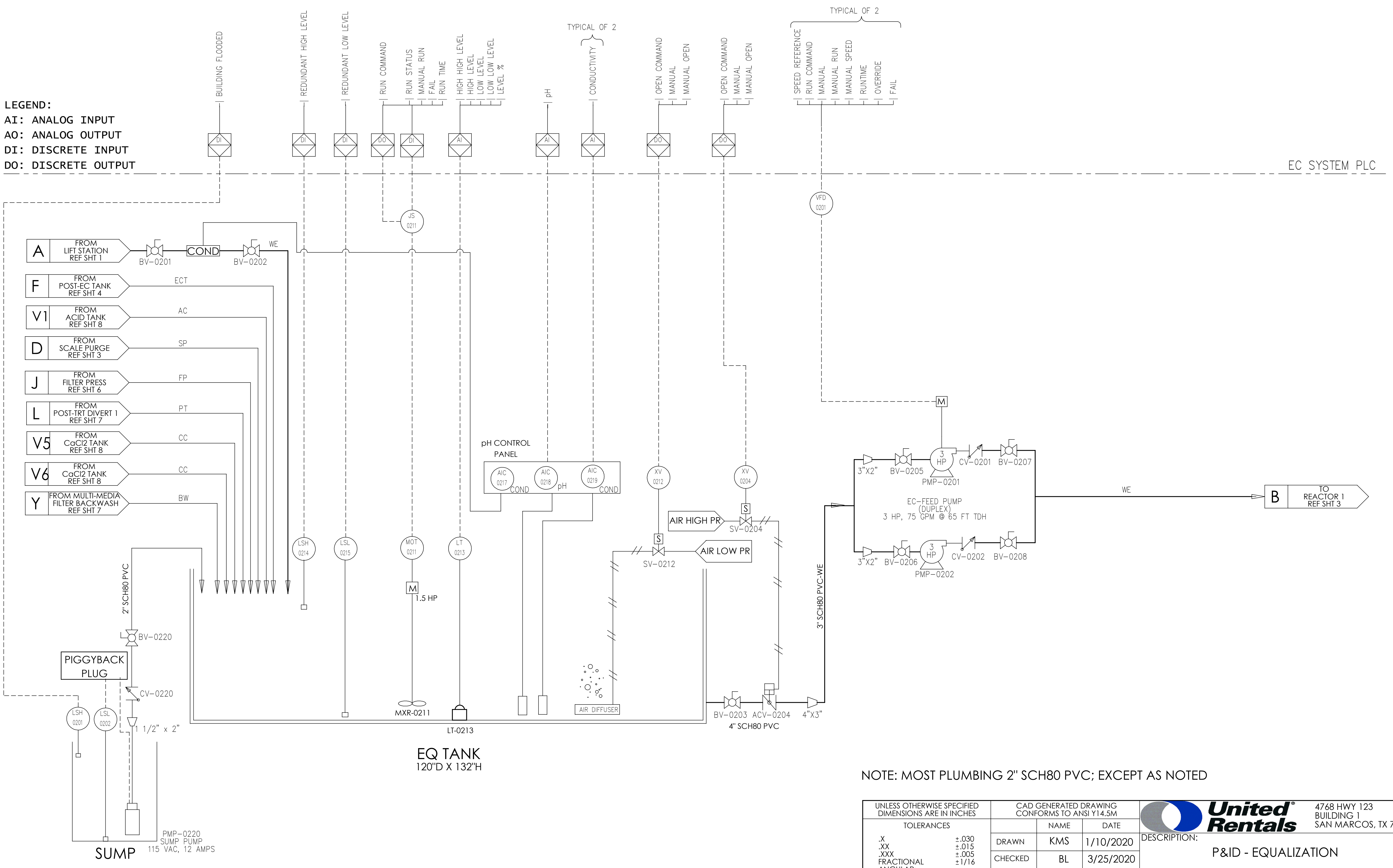
AO: ANALOG OUTPUT
DI: DISCRETE INPUT
DO: DISCRETE OUTPUT



NOTE: MOST PLUMBING 2" SCH80 PVC; EXCEPT AS NOTED

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REV.	DESCRIPTION	DATE	APPROVED
REVISIONS			

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES

TOLERANCES

.X	±.030
.XX	±.015
.XXX	±.005
FRACTIONAL	±1/16
ANGULAR:	
MACH	±.5°
BEND	±1°

REMOVE BURRS AND
BREAK ALL SHARP EDGES

DO NOT SCALE DRAWING

CAD GENERATED DRAWING
CONFORMS TO ANSI Y14.5M

	NAME	DATE
DRAWN	KMS	1/10/2020
CHECKED	BL	3/25/2020
APPRV	DH	3/25/2020

PROJECTION

MATERIAL

United Rentals

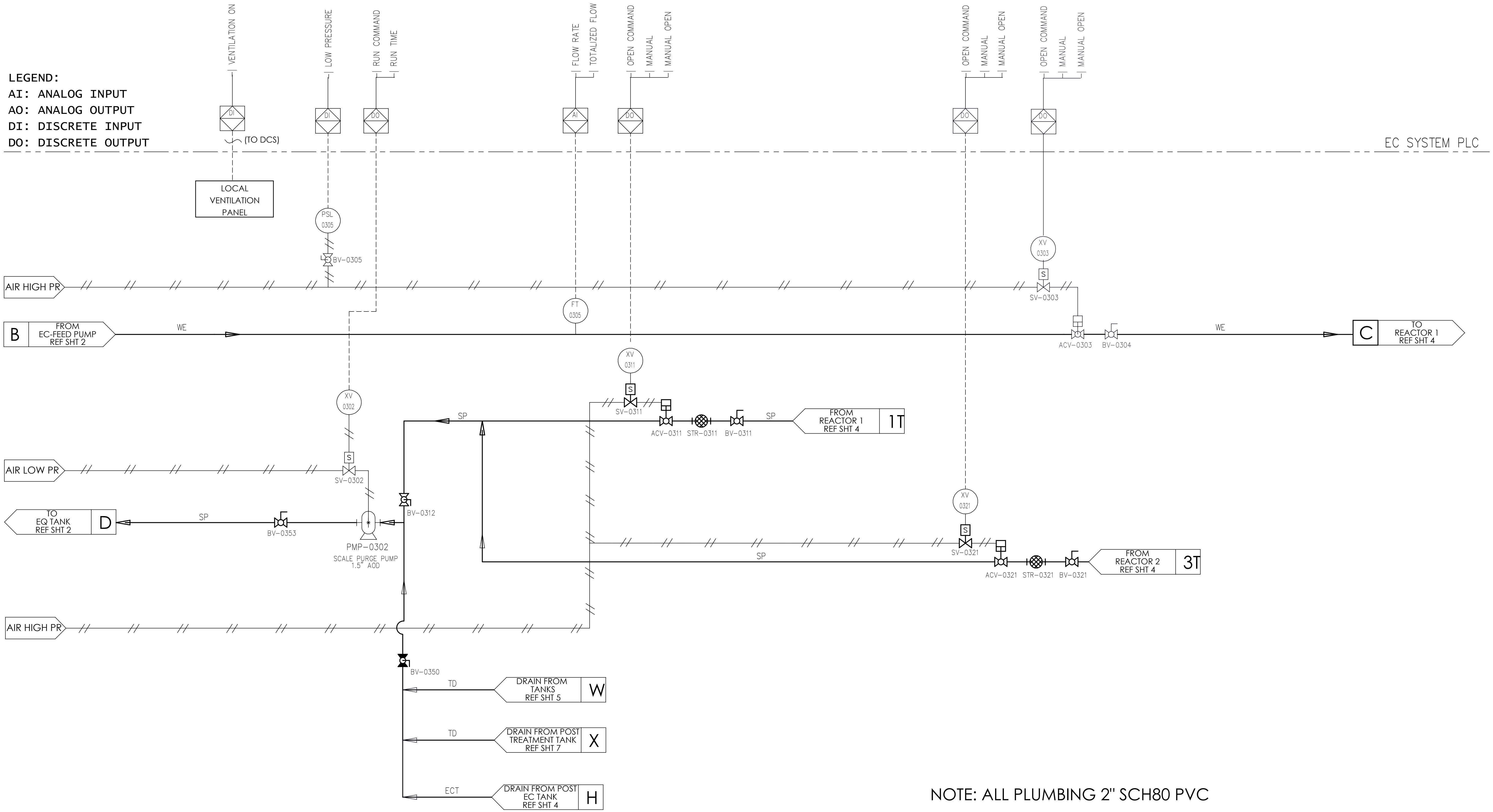
4768 HWY 123
BUILDING 1
SAN MARCOS, TX 78666

DESCRIPTION:
P&ID - EQUALIZATION

PROJECT:
KAISER - MEAD

SIZE	DWG NO.	REV
B	KM-003	

SCALE	WEIGHT (lbs)	SHEET
NONE		2 OF 9



NOTE: ALL PLUMBING 2" SCH80 PVC

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REV.	DESCRIPTION	DATE	APPROVED
REVISIONS			

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

TOLERANCES

.X	±.030
.XX	±.015
.XXX	±.005
FRACTIONAL	±1/16
ANGULAR:	
MACH	±.5°
BEND	±1°

REMOVE BURRS AND BREAK ALL SHARP EDGES

DO NOT SCALE DRAWING

CAD GENERATED DRAWING CONFORMS TO ANSI Y14.5M

	NAME	DATE
DRAWN	KMS	3/3/2020
CHECKED	BL	3/25/2020
APPRV	DH	3/25/2020

PROJECTION

MATERIAL

United Rentals

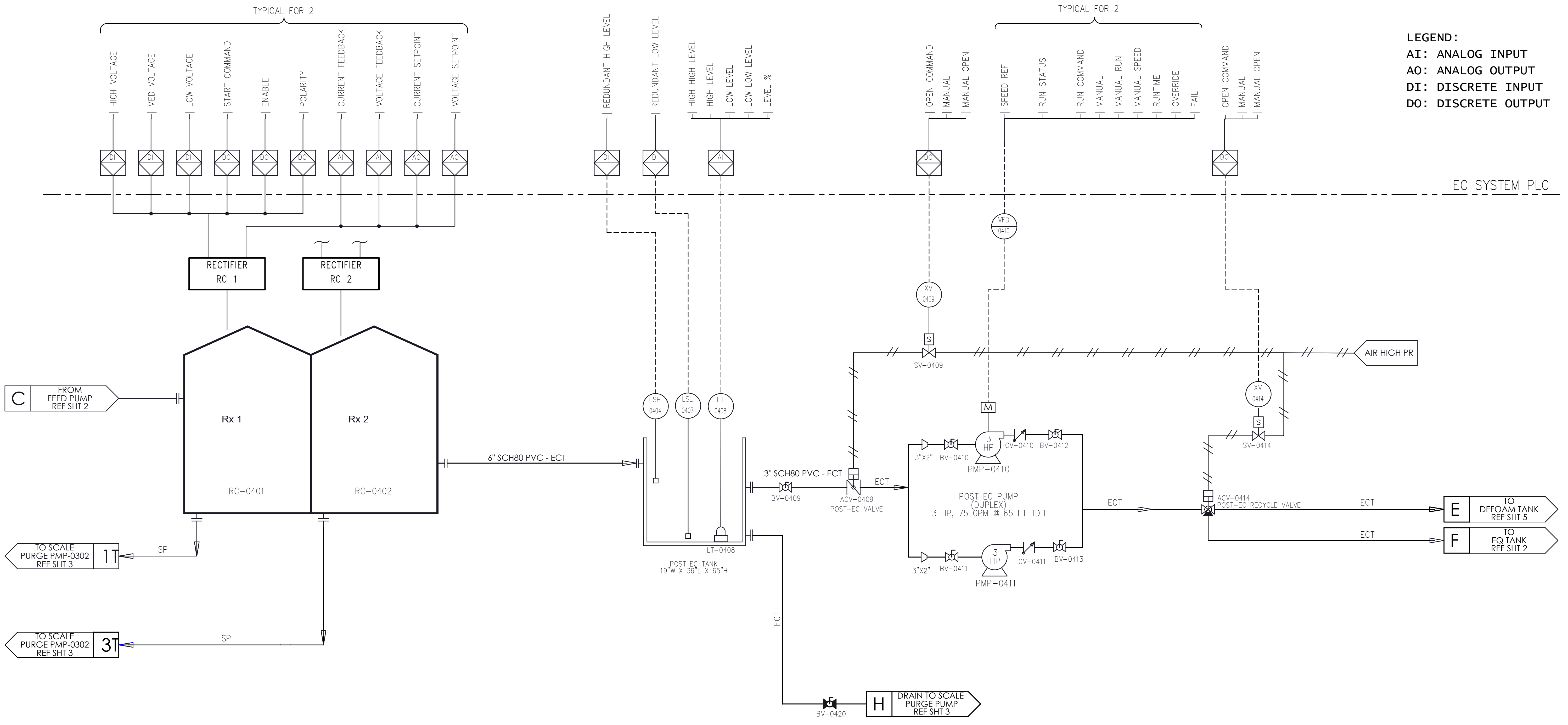
4768 HWY 123
BUILDING 1
SAN MARCOS, TX 78666

DESCRIPTION: P&ID - MASTER REACTOR SYSTEM

PROJECT: KAISER - MEAD

SIZE	DWG NO.	REV
B	KM-004	-

SCALE	WEIGHT (lbs)	SHEET
NONE		3 OF 9



LEGEND:
AI: ANALOG INPUT
AO: ANALOG OUTPUT
DI: DISCRETE INPUT
DO: DISCRETE OUTPUT

NOTE: MOST PLUMBING 2" SCH80 PVC; EXCEPT AS NOTED

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REV.	DESCRIPTION	DATE	APPROVED
REVISIONS			

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES

TOLERANCES

.X	±.030
.XX	±.015
.XXX	±.005
FRACTIONAL	±1/16
ANGULAR:	
MACH	±.5°
BEND	±1°

REMOVE BURRS AND
BREAK ALL SHARP EDGES

DO NOT SCALE DRAWING

CAD GENERATED DRAWING
CONFORMS TO ANSI Y14.5M

	NAME	DATE
DRAWN	KMS	10/31/2019
CHECKED	BL	3/25/2020
APPRV	DH	3/25/2020

PROJECTION

MATERIAL

United Rentals®

4768 HWY 123
BUILDING 1
SAN MARCOS, TX 78666

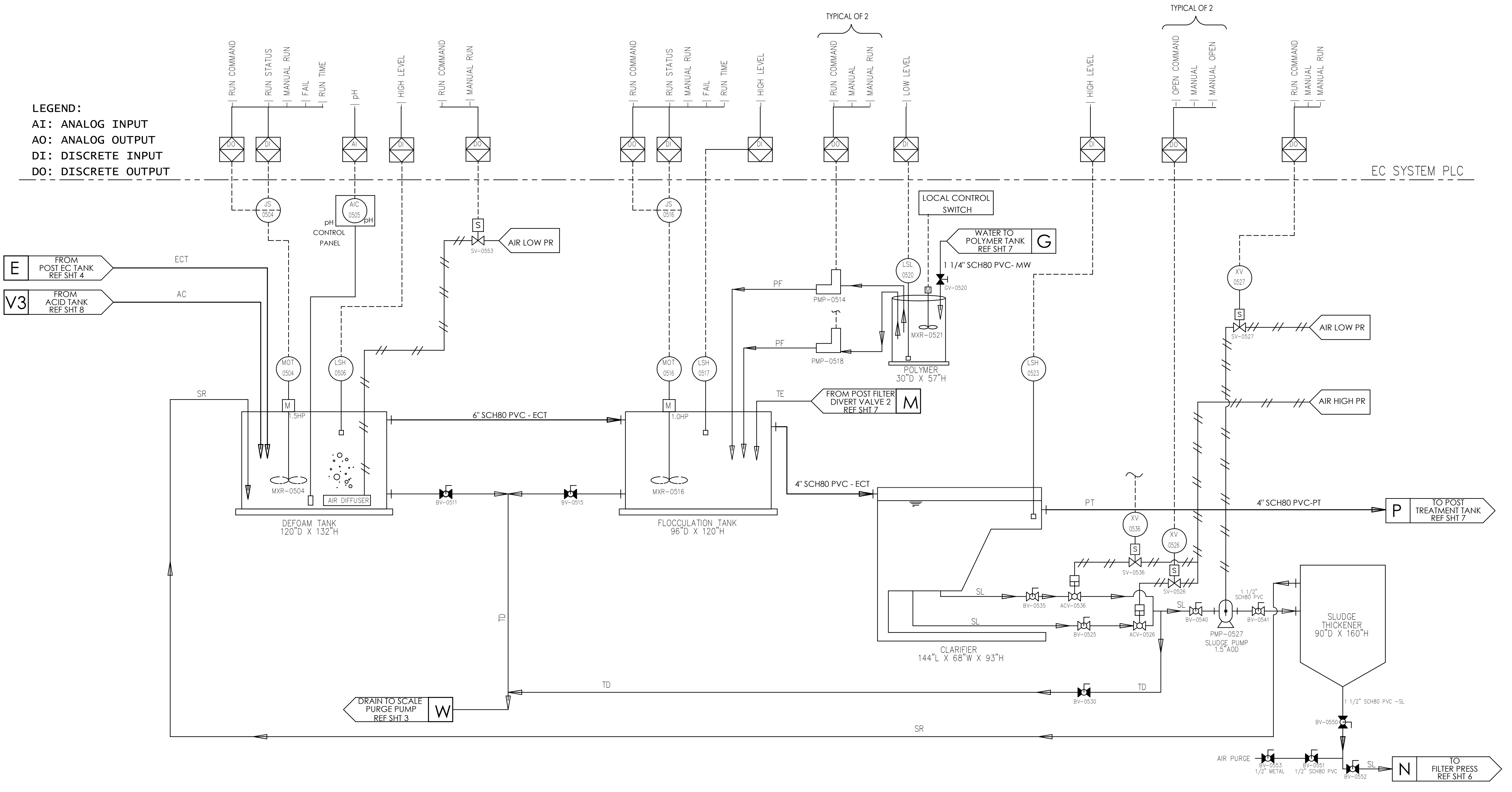
DESCRIPTION:
P&ID - MASTER REACTOR SYSTEM

PROJECT:
KAISER - MEAD

SIZE	DWG NO.	REV
B	KM-005	-

SCALE	WEIGHT (lbs)	SHEET
NONE		4 OF 9

LEGEND:
AI: ANALOG INPUT
AO: ANALOG OUTPUT
DI: DISCRETE INPUT
DO: DISCRETE OUTPUT



NOTE: MOST PLUMBING 2" SCH80 PVC; EXCEPT AS NOTED

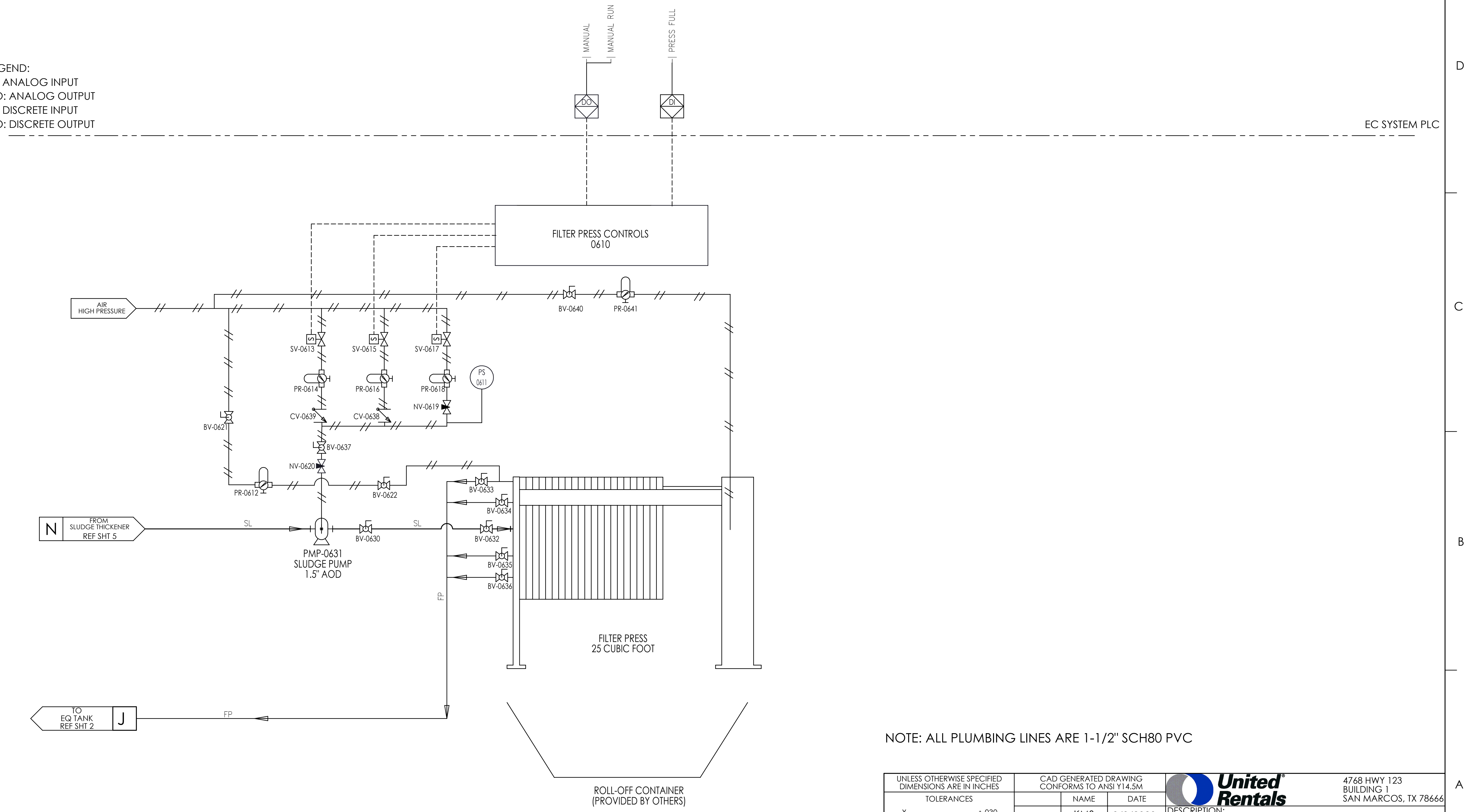
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES	CAD GENERATED DRAWING CONFORMS TO ANSI Y14.5M			
TOLERANCES		NAME	DATE	
.X ±.030 .XX ±.015 .XXX ±.005 FRACTIONAL ±1/16 ANGULAR: MACH ±.5° BEND ±1°	DRAWN	KMS	3/25/2020	DESCRIPTION: P&ID - SOLIDS SEPARATION
	CHECKED	BL	3/25/2020	
	APPRV	DH	3/25/2020	PROJECT: KAISER - MEAD
REMOVE BURRS AND BREAK ALL SHARP EDGES	PROJECTION			SIZE B · DWG NO. KM-006 · REV
DO NOT SCALE DRAWING	MATERIAL			SCALE NONE · WEIGHT (lbs) · SHEET 5 OF 9

United Rentals
4768 HWY 123
BUILDING 1
SAN MARCOS, TX 78666

REV.	DESCRIPTION	DATE	APPROVED
REVISIONS			

PROPRIETARY AND CONFIDENTIAL

LEGEND:
AI: ANALOG INPUT
AO: ANALOG OUTPUT
DI: DISCRETE INPUT
DO: DISCRETE OUTPUT



NOTE: ALL PLUMBING LINES ARE 1-1/2" SCH80 PVC

PROPRIETARY AND CONFIDENTIAL

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REV.	DESCRIPTION	DATE	APPROVED

REVISIONS

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES

TOLERANCES

.X	±.030
.XX	±.015
.XXX	±.005
FRACTIONAL	±1/16
ANGULAR:	
MACH	±.5°
BEND	±1°

REMOVE BURRS AND
BREAK ALL SHARP EDGES

DO NOT SCALE DRAWING

CAD GENERATED DRAWING
CONFORMS TO ANSI Y14.5M

	NAME	DATE
DRAWN	KMS	3/3/2020
CHECKED	BL	3/25/2020
APPRV	DH	3/25/2020

PROJECTION

MATERIAL

United Rentals

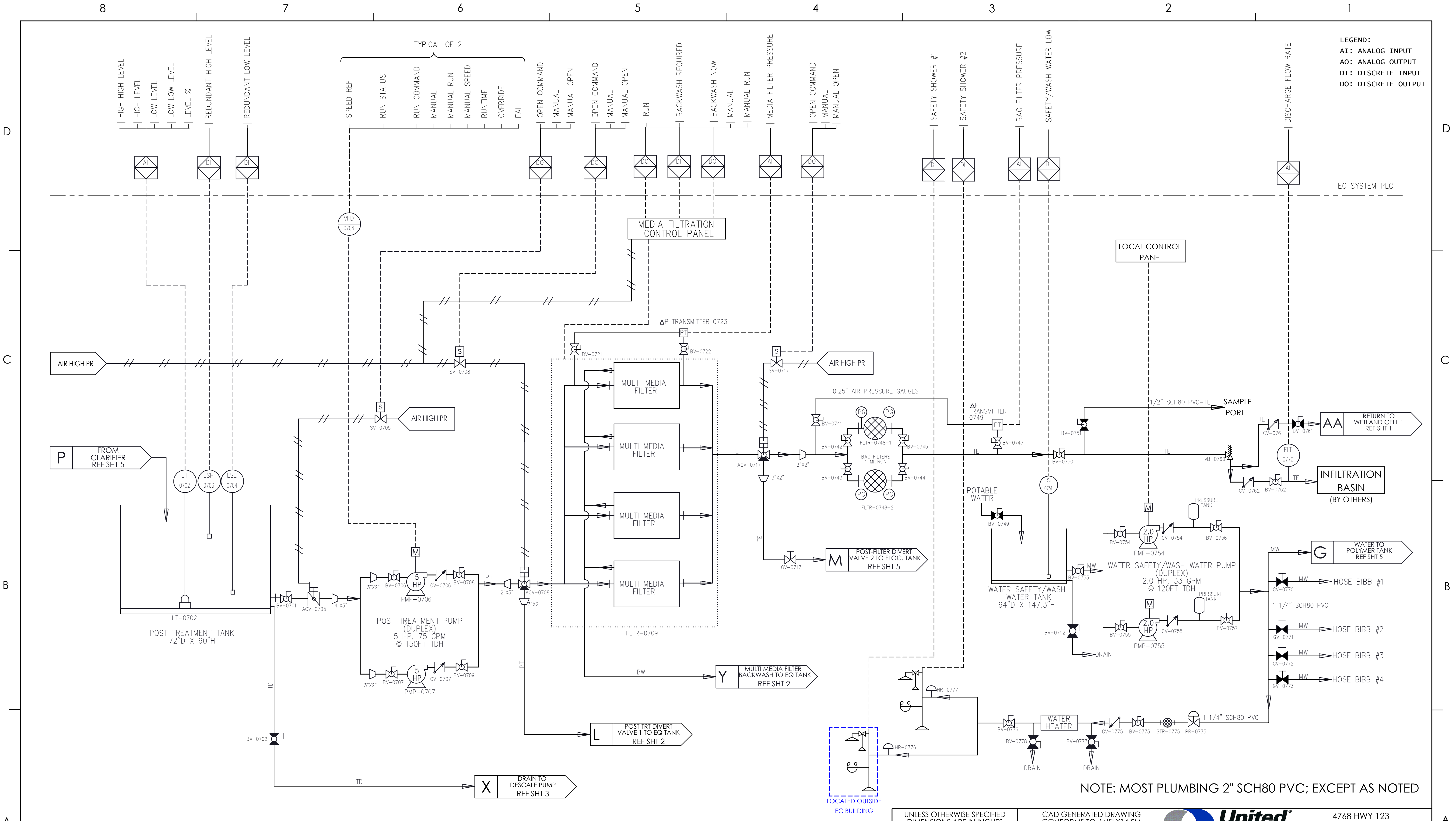
4768 HWY 123
BUILDING 1
SAN MARCOS, TX 78666

DESCRIPTION: P&ID - FILTRATION

PROJECT: KAISER - MEAD

SIZE B
DWG NO. KM-007
REV

SCALE NONE
WEIGHT (lbs)
SHEET 6 OF 9



NOTE: MOST PLUMBING 2" SCH80 PVC; EXCEPT AS NOTED

PROPRIETARY AND CONFIDENTIAL
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REV.	DESCRIPTION	DATE	APPROVED

REVISIONS

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES

TOLERANCES
.X ±.030
.XX ±.015
.XXX ±.005
FRACTIONAL ±1/16
ANGULAR:
MACH ±.5°
BEND ±1°

REMOVE BURRS AND BREAK ALL SHARP EDGES

DO NOT SCALE DRAWING

CAD GENERATED DRAWING
CONFORMS TO ANSI Y14.5M

	NAME	DATE
DRAWN	KMS	3/25/2020
CHECKED	BL	3/25/2020
APPRV	DH	3/25/2020

PROJECTION

MATERIAL

United Rentals

4768 HWY 123
BUILDING 1
SAN MARCOS, TX 78666

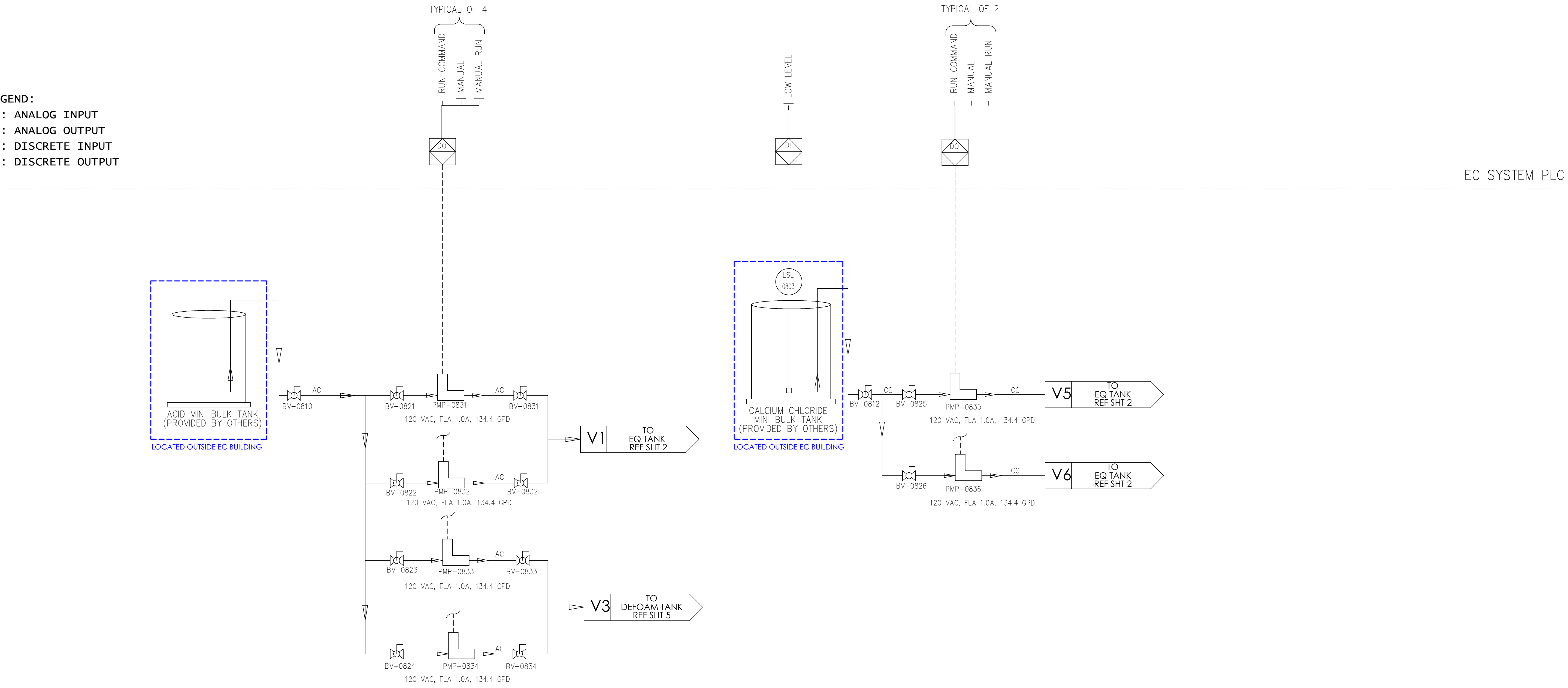
DESCRIPTION: P&ID - FINAL TREATMENT

PROJECT: KAISER - MEAD

SIZE B
DWG NO. KM-008
REV

SCALE NONE
WEIGHT (lbs)
SHEET 7 OF 9

LEGEND:
AI: ANALOG INPUT
AO: ANALOG OUTPUT
DI: DISCRETE INPUT
DO: DISCRETE OUTPUT



NOTE: ACID PLUMBING IS 1/2" ID SCH80 CPVC; CALCIUM CHLORIDE IS CHEMICAL TUBING

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REV.	DESCRIPTION	DATE	APPROVED

REVISIONS

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES

TOLERANCES

.X	±.030
.XX	±.015
.XXX	±.005
FRACTIONAL	±1/16
ANGULAR:	
MACH	±.5°
BEND	±1°

REMOVE BURRS AND
BREAK ALL SHARP EDGES

DRAWING SIZE: B
DO NOT SCALE DRAWING

CAD GENERATED DRAWING
CONFORMS TO ANSI Y14.5M

	NAME	DATE
DRAWN	KMS	3/25/2020
CHECKED	BL	3/25/2020
APPRV	DH	3/25/2020

PROJECTION

MATERIAL

United Rentals

4768 HWY 123
BUILDING 1
SAN MARCOS, TX 78666

DESCRIPTION
P&ID CHEMICAL DOSING PUMPS

PROJECT
KAISER - MEAD

DWG NO.
KM-009

REV
-

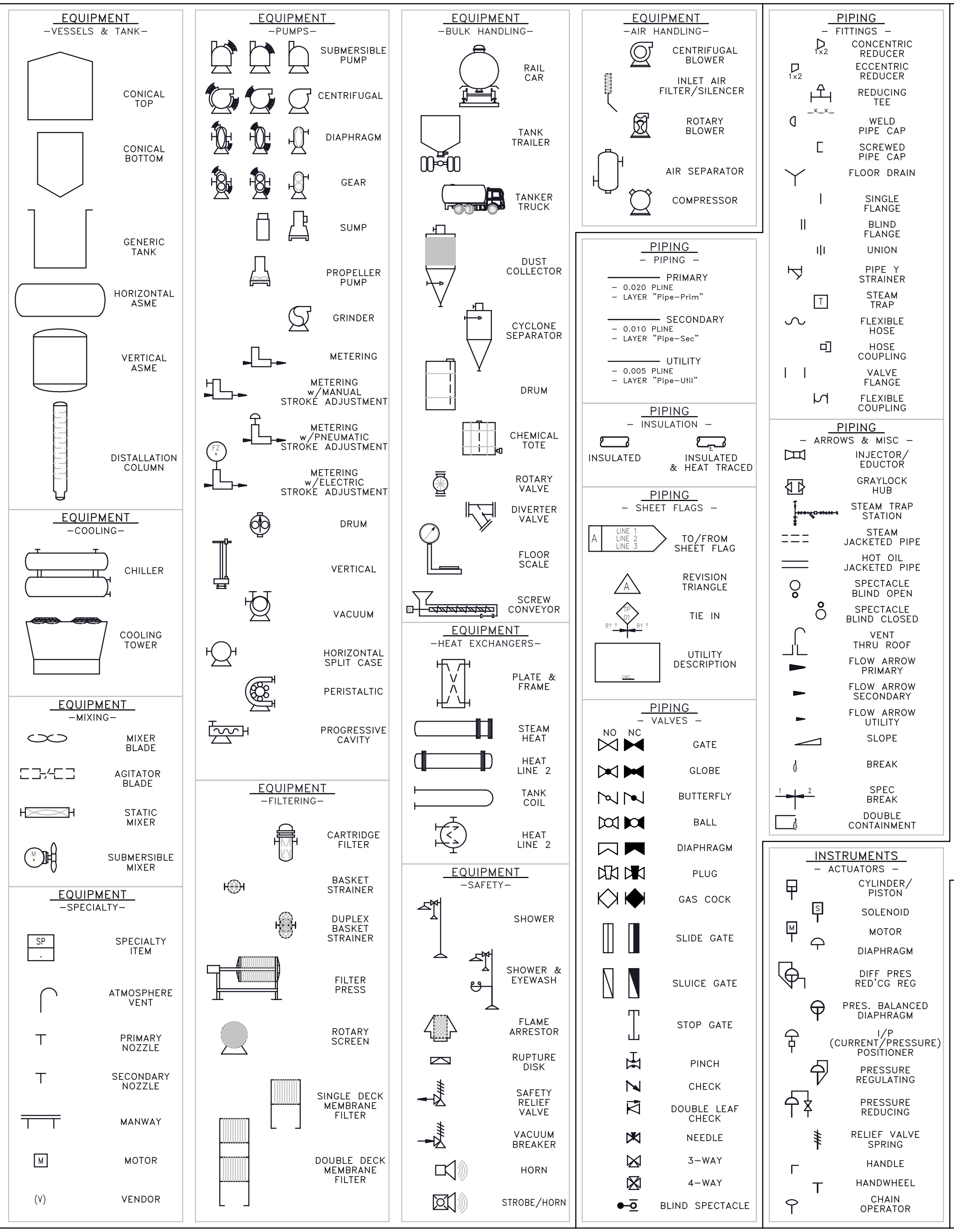
SCALE NONE

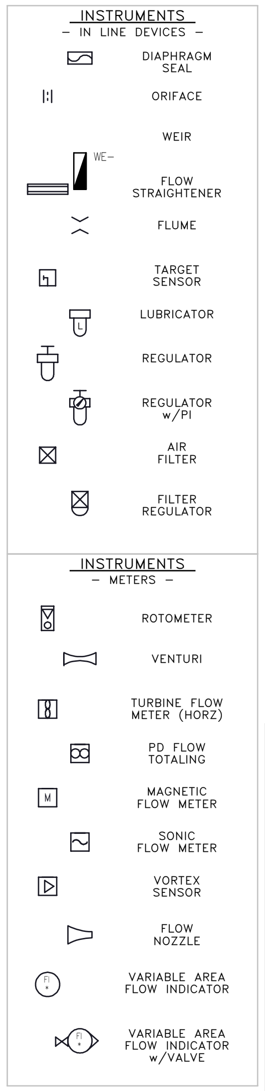
WEIGHT (lbs)

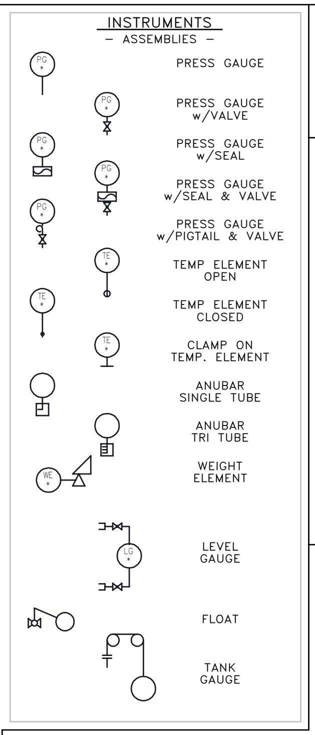
SHEET 8 OF 9

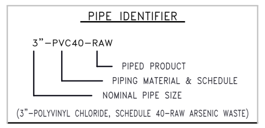
FLOW STREAMS:

AC - ACID
BW - BACKWASH
CC - CALCIUM CHLORIDE
ECT - EC TREATED
FP - FILTER PRESS
GW - GROUNDWATER
MW - MAKE-UP WATER
PF - POLYMER FLOCCULANT
PT - POST TREATMENT
SL - SLUDGE
SP - SCALE PURGE
SR - SLUDGE RETURN
TD - TANK DRAIN
TE - TREATED EFFLUENT
WE - WETLAND EFFLUENT
WR - WETLAND RETURN








PIPE IDENTIFIER
3"-PVC40-RAW
PIPED PRODUCT
PIPING MATERIAL & SCHEDULE
NOMINAL PIPE SIZE
(3"-POLYVINYL CHLORIDE, SCHEDULE 40-RAW ARSENIC WASTE)

FOR INTERNAL USE ONLY

RELEASED FOR APPROVAL
BY ____________ DATE ____________

RELEASED FOR DESIGN
BY ____________ DATE ____________

NOT FOR CONSTRUCTION

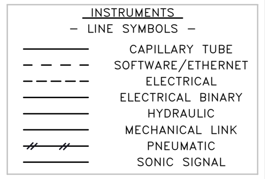
ISSUED FOR BIDS
BY ____________ DATE ____________

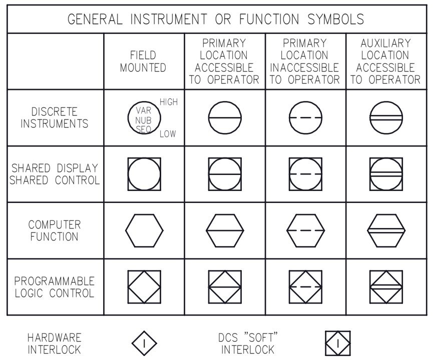
RELEASED FOR INFORMATION
BY ____________ DATE ____________

PRELIMINARY

RELEASED FOR CONSTRUCTION
BY ____________ DATE ____________

UN-CHECKED
BY ____________ DATE ____________




GENERAL INSTRUMENT OR FUNCTION SYMBOLS
FIELD MOUNTED
PRIMARY LOCATION ACCESSIBLE TO OPERATOR
PRIMARY LOCATION INACCESSIBLE TO OPERATOR
AUXILIARY LOCATION ACCESSIBLE TO OPERATOR
DISCRETE INSTRUMENTS
VAR
NUB
SEQ
HIGH
LOW
SHARED DISPLAY SHARED CONTROL
COMPUTER FUNCTION
PROGRAMMABLE LOGIC CONTROL
HARDWARE INTERLOCK
I
DCS "SOFT" INTERLOCK
I

TYPICAL VARIABLE LETTER COMBINATIONS

		CONTROLLERS				READOUT DEVICES		SWITCHES AND ALARM DEVICES			TRANSMITTERS									
FIRST LETTERS	INITIATING OR MEASURED VARIABLE	RECORDING	INDICATING	BLIND	SELF-ACTUATED CONTROL VALVES	RECORDING	INDICATING	HIGH	LOW	COMB	RECORDING	INDICATING	BLIND	SOLENOIDS, RELAYS, COMPUTING DEVICES	PRIMARY ELEMENT	TEST POINT	WELL OR PROBE	VIEWING DEVICE, GLASS	SAFETY DEVICE	FINAL ELEMENT
A	Analysis	ARC	AIC	AC	–	AR	AI	ASH	ASL	ASHL	ART	AIT	AT	AY	AE	AP	AW	–	–	AZ
B	Burner/Combustion	BRC	BIC	BC	–	BR	BI	BSH	BSL	BSHL	BRT	BIT	BT	BY	BE	–	BW	BG	–	BZ
C	User's Choice	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D	User's Choice	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E	Voltage	ERC	EIC	EC	–	ER	EI	ESH	ESL	ESHL	ERT	EIT	ET	EY	EE	–	–	–	–	EZ
F	Flow Rate	FRC	FIC	FC	FCV	FR	FI	FSH	FSL	FSHL	FRT	FIT	FT	FY	FE	FP	–	FG	–	FZ
FQ	Flow Quantity	FQRC	FQIC	–	–	FQR	FQI	FQSH	FQSL	FQSHL	–	FQIT	FQT	FQY	FQE	–	–	–	–	FQZ
FF	Flow Ratio	FFRC	FFIC	FFC	–	FFR	FFI	FFSH	FFSL	FFSHL	–	–	–	–	–	–	–	–	–	FFZ
G	User's Choice	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
H	Hand	–	HIC	HC	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
I	Current	IRC	IIC	–	–	IR	II	ISH	ISL	ISHL	IRT	IIT	IT	IY	IE	–	–	–	–	IZ
J	Power	JRC	JIC	–	–	JR	JI	JSH	JSL	JSHL	JRT	JIT	JT	JY	JE	–	–	–	–	JZ
K	Time	KRC	KIC	KC	KCV	KR	KI	KSH	KSL	KSHL	KRT	KIT	KT	KY	KE	–	–	–	–	KZ
L	Level	LRC	LIC	LC	LCV	LR	LI	LSH	LSL	LSHL	LRT	LIT	LT	LY	LE	–	LW	LG	–	LZ
M	User's Choice	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
N	User's Choice	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	User's Choice	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P	Pressure/Vacuum	PRC	PIC	PC	PCV	PR	PI	PSH	PSL	PSHL	PRT	PIT	PT	PY	PE	PP	–	–	PSE	PZ
PD	Pressure Differential	PDRC	PDIC	PDC	PDCV	PDR	PDI	PDSH	PDSL	PDSHL	PDRT	PDIT	PDT	PDY	PDE	PDP	–	–	–	PDZ
Q	Quantity	QRC	QIC	–	–	QR	QI	QSH	QSL	QSHL	QRT	QIT	QT	QY	QE	–	RW	–	–	QZ
R	Radiation	RRC	RIC	RC	–	RR	RI	RSH	RSL	RSHL	RRT	RIT	RT	RY	RE	–	–	–	–	RZ
S	Speed/Frequency	SRC	SIC	SC	SCV	SR	SI	SSH	SSL	SSHL	SRT	SIT	ST	SY	SE	–	–	–	–	SZ
T	Temperature	TRC	TIC	TC	TCV	TR	TI	TSH	TSL	TSHL	TRT	TIT	TT	TY	TE	TP	TPW	–	TSE	TZ
TD	Temperature Differential	TDRC	TDIC	TDC	TDCV	TDR	TDI	TDSH	TDSL	TDSHL	TDRT	TDIT	TDT	TDY	TDE	TDP	TDPW	–	–	TDZ
U	Multivariable	–	–	–	–	UR	UI	–	–	–	–	–	–	–	–	–	–	–	–	–
V	Vibration/Machinery Analysis	–	–	–	–	VR	VI	VSH	VSL	VSHL	VRT	VIT	VT	VY	VE	–	–	–	–	VZ
W	Weight/Force	WRC	WIC	WC	WCV	WR	WI	WSH	WSL	WSHL	WRT	WIT	WT	WY	WE	–	–	–	–	WZ
WD	Weight/Force Differntial	WDRC	WDIC	WDC	WDCV	WDR	WDI	WDSH	WDSL	WDSHL	WDRT	WDIT	WDT	WDY	WDE	–	–	–	–	WDZ
X	Unclassified	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Y	Event/State/Presence	–	YIC	YC	–	YR	YI	YSH	YSL	YSHL	YRT	YIT	YT	YY	YE	–	–	–	–	YZ
Z	Position/Dimension	ZRC	ZIC	ZC	ZCV	ZR	ZI	ZSH	ZSL	ZSHL	ZRT	ZIT	ZT	ZY	ZE	–	–	–	–	ZZ
ZD	Gauging/Deviation	ZDRC	ZDIC	ZDC	ZDCV	ZDR	ZDI	ZDSH	ZDSL	ZDSHL	ZDRT	ZDIT	ZDT	ZDY	ZDE	–	–	–	–	ZDZ

NOTE: This table is not all-inclusive.

PIPING ABBREVIATIONS – MATERIAL

CPVC – CHLORINATED POLYVINYL CHLORIDE
CI – CAST IRON
CS – CARBON STEEL
CU – COPPER
EPSS – 316L STAINLESS STEEL (ELECTRO POLISHED)
FRP – FIBER REINFORCED PLASTIC
MI – MALLEABLE IRON
PE – POLYETHYLENE
PFA – PERFLUOROALKOXY
PP – POLYPROPYLENE
PPL – POLYPROYLENE LINED CARBON STEEL
PVC – POLYVINYL CHLORIDE
PVDF – POLYVINYLIDENE FLUORIDE
PVFB – PVDF BEADLESS & CREVICE FREE
PVFL – PVDF LINED
TFE – TEFLON
TFEL – TEFLON LINED (PTFE)
304 – 304 STAINLESS STEEL
304L – 304L STAINLESS STEEL
316 – 316 STAINLESS STEEL
316L – 316L STAINLESS STEEL
SS – STAINLESS STEEL (UNSPECIFIED)

PIPING ABBREVIATIONS – GAS

Ar – ARGON
ASH3 – ARSINE
B2H6 – DIBORANE MIXES
BCL3 – BORON TRICHLORIDE
BHF3 – BORON TRIFLUORIDE
C2F6 – HALOCARBON 116
C3F8 – PERFLUOROPROPANE
CCL2F2 – HALOCARBON 12
CF4 – HALOCARBON 14
ChF3 – HALOCARBON 23
Cl2 – CHLORINE
CO2 – CARBON DIOXIDE
DCS – DICHLOROSILANE
H2 – HYDROGEN GAS
H2S – HYDROGEN SULFIDE
HBR – HYDROGEN BROMIDE
HCL(g) – HYDROGEN CHLORIDE (GAS)
He – HELIUM
N2 – NITROGEN GAS
N2O – NITROUS OXIDE
NF3 – NITROGEN TRIFLUORIDE
NH3 – AMMONIA
O2 – OXYGEN
PH3 – PHOSPHINE
S12H6 – DISILANE
SF6 – SULFUR HEXAFLUORIDE
SiCL4 – SILICONE TETRACHLORIDE
SiF4 – SILICONE TETRAFLUORIDE
SiH4 – SILANE
WF6 – TUNGSTEN HEXAFLUORIDE

PIPING ABBREVIATIONS – SUPPLY

AA – AGITATION AIR
AS – AIR SUPPLY
CAIR – COMPRESSED AIR
CAOH – CALCIUM HYDROXIDE
CW – CITY WATER
CWS – CHILLED WATER SUPPLY
CWR – CHILLED WATER RETURN
DA – DRY AIR
DECANT – DECANT OFF OF CLARIFIER/TANK
DI – DEIONIZED WATER
FECL3 – FERRIC CHLORIDE
FP – FLOCCULATION POLYMER
FW – FIRE PROTECTION WATER
GS – GAS SUPPLY
HCl – HYDROCHLORIC ACID
HS – HYDROLIC SUPPLY
HW – HOT WATER
H2O2 – HYDROGEN PEROXIDE
H2SO4 – SULFURIC ACID
IAS – INSTRUMENT AIR SUPPLY
IVAC – INSTRUMENT VACUUM
KOH – POTASSIUM HYDROXIDE
NAOH – SODIUM HYDROXIDE
NG – NATURAL GAS
NPW – NON-POTABLE WATER
NS – NITROGEN SUPPLY
PA – PLANT AIR
PHWR – PROCESS HOT WATER RETURN
PHWS – PROCESS HOT WATER SUPPLY
PR – PERMEATE RETURN
PS – PERMEATE SUPPLY
PW – PROCESS WATER
R22 – REFRIGERANT R-22
RO – REVERSE OSMOSIS WATER
RT – RETREAT LINE
RW – RECYCLE WATER
S(###) – STEAM SUPPLY @### PSIG
SCR – STEAM CONDENSATE RETURN
TWR – TOWER WATER RETURN
TWS – TOWER WATER SUPPLY
VAC – VACUUM
WS – WATER SUPPLY

PIPING ABBREVIATIONS – DRAIN

ABR – ABRASIVE RINSE
ACR – ALKALINE CLEANER RINSE
ACW – ALKALINE CLEANER WASTE
AEW – ALKALINE ETCH WASTE
AR – AMMONIA RINSE
AS – ARSENIC SLUDGE
AQD – AQUEOUS DUMP
AWFS – ACID WASTE FLOOR SPILL
CAC – CONCENTRATED ACID W/COPPER
CAL – CONCENTRATED ACID W/LEAD
CBR – COPPER BEARING RINSEWATER
CCW – CONCENTRATED CAUSTIC WASTES
CN – CYANIDE WASTE WATER
CNCA – CONCENTRATED ACID
CR – CHROME RINSE
DR – DILUTE RINSEWATER
ECR – ELECTROLESS COPPER RINSE
ECW – ELECTROLESS COPPER WASTE
FD – FLOOR DRAIN
FLR – FLUORIDE RINSE
FLD – FLUORIDE RINSE DRAIN
FS – FLOOR SPILL
IW – INDUSTRIAL WASTE
LBR – LEAD BEARING RINSEWATER
MR – METAL RINSE
PUR – PUMICE RINSE
RAW – RAW ARSENIC WASTE
SAN – SANITARY SEWER
STS – STORM SEWER
SW – SLUDGE WASTE
TL – TIN LEAD
WA – WASTE ACID

MISCELLANEOUS ABBREVIATIONS

CFM –CUBIC FEET PER MINUTE
GPM –GALLONS PER MINUTE
GPD –GALLONS PER DAY
GPH –GALLONS PER HOUR
B.O.P. –BOTTOM OF PIPE
IE –INVERT ELEVATION (INSIDE BOTTOM OF PIPE)
FBO –FURNISHED BY OTHERS
A.F.F. –ABOVE FINISHED FLOOR
OC –ON CENTER

UNLESS OTHERWISE SPECIFIED
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TOLERANCES
.X ±.030
.XX ±.015
.XXX ±.005
FRACTIONAL ±1/16
ANGULAR:
MACH ±.5°
BEND ±1°

REMOVE BURRS AND
BREAK ALL SHARP EDGES

DO NOT SCALE DRAWING

CAD GENERATED DRAWING
CONFORMS TO ANSI Y14.5M

	NAME	DATE
DRAWN	KMS	10/30/2019
CHECKED	BL	3/25/2020
APPRV	DH	3/25/2020

PROJECTION
MATERIAL

United Rentals
4768 HWY 123
BUILDING 1
SAN MARCOS, TX 78666

DESCRIPTION: P&ID - LEGEND
PROJECT: KAISER - MEAD
SIZE: B
DWG NO.: KM-010
REV: -
SCALE: NONE
WEIGHT (lbs)
SHEET: 9 OF 9

PROPRIETARY AND CONFIDENTIAL

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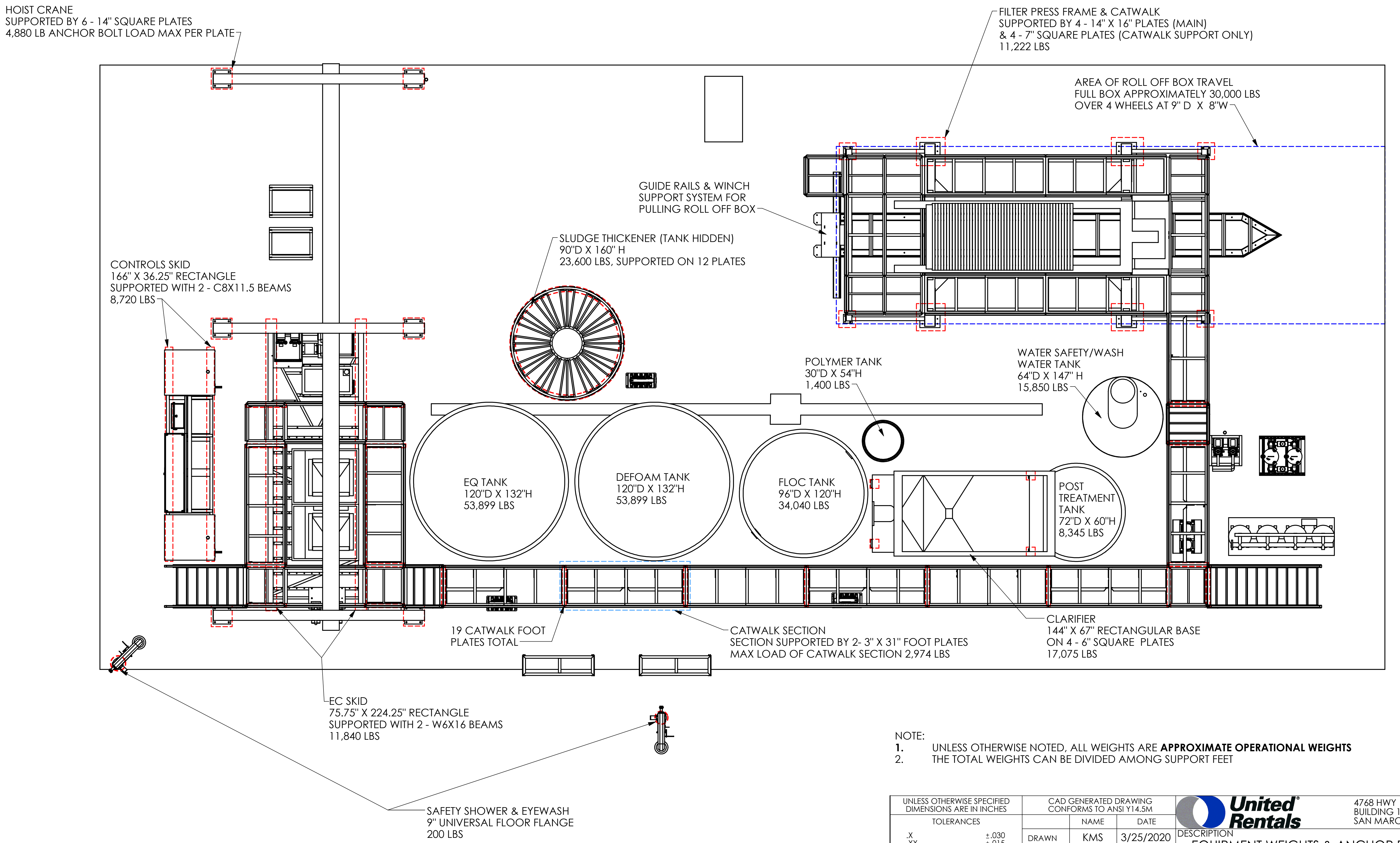
HOIST CRANE
SUPPORTED BY 6 - 14" SQUARE PLATES
4,880 LB ANCHOR BOLT LOAD MAX PER PLATE
FILTER PRESS FRAME & CATWALK
SUPPORTED BY 4 - 14" X 16" PLATES (MAIN)
& 4 - 7" SQUARE PLATES (CATWALK SUPPORT ONLY)
11,222 LBS
AREA OF ROLL OFF BOX TRAVEL
FULL BOX APPROXIMATELY 30,000 LBS
OVER 4 WHEELS AT 9" D X 8"W
GUIDE RAILS & WINCH
SUPPORT SYSTEM FOR
PULLING ROLL OFF BOX
SLUDGE THICKENER (TANK HIDDEN)
90"D X 160" H
23,600 LBS, SUPPORTED ON 12 PLATES
CONTROLS SKID
166" X 36.25" RECTANGLE
SUPPORTED WITH 2 - C8X11.5 BEAMS
8,720 LBS
POLYMER TANK
30"D X 54"H
1,400 LBS
WATER SAFETY/WASH
WATER TANK
64"D X 147" H
15,850 LBS
EQ TANK
120"D X 132"H
53,899 LBS
DEFOAM TANK
120"D X 132"H
53,899 LBS
FLOC TANK
96"D X 120"H
34,040 LBS
POST
TREATMENT
TANK
72"D X 60"H
8,345 LBS
19 CATWALK FOOT
PLATES TOTAL
CATWALK SECTION
SECTION SUPPORTED BY 2- 3" X 31" FOOT PLATES
MAX LOAD OF CATWALK SECTION 2,974 LBS
CLARIFIER
144" X 67" RECTANGULAR BASE
ON 4 - 6" SQUARE PLATES
17,075 LBS
EC SKID
75.75" X 224.25" RECTANGLE
SUPPORTED WITH 2 - W6X16 BEAMS
11,840 LBS
SAFETY SHOWER & EYEWASH
9" UNIVERSAL FLOOR FLANGE
200 LBS

NOTE:

1. UNLESS OTHERWISE NOTED, ALL WEIGHTS ARE **APPROXIMATE OPERATIONAL WEIGHTS**
2. THE TOTAL WEIGHTS CAN BE DIVIDED AMONG SUPPORT FEET

PROPRIETARY AND CONFIDENTIAL

REV.	DESCRIPTION	DATE	APPROVED
REVISIONS			

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DIMENSIONS ARE IN INCHES

TOLERANCES

.X	±.030
.XX	±.015
.XXX	±.005
FRACTIONAL	±1/16
ANGULAR:	
MACH	±.5°
BEND	±1°

REMOVE BURRS AND
BREAK ALL SHARP EDGES

DRAWING SIZE: B
DO NOT SCALE DRAWING

CAD GENERATED DRAWING
CONFORMS TO ANSI Y14.5M

	NAME	DATE
DRAWN	KMS	3/25/2020
CHECKED	BL	3/25/2020
APPRV	DH	3/25/2020

PROJECTION

MATERIAL

United Rentals

4768 HWY 123
BUILDING 1
SAN MARCOS, TX 78666

DESCRIPTION
EQUIPMENT WEIGHTS & ANCHOR POINTS
LAYOUT

PROJECT KAISER - MEAD

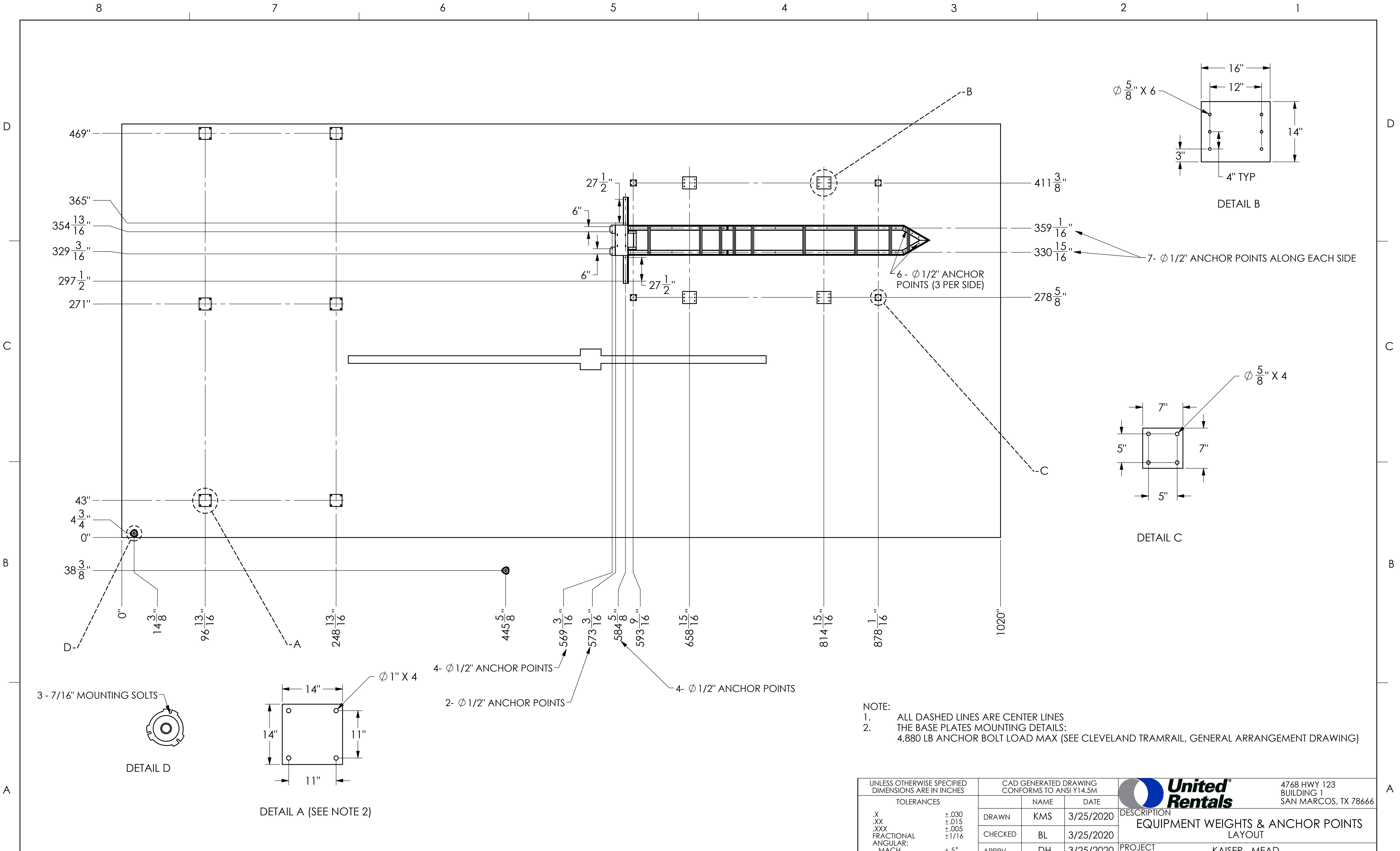
PART NO. KM-013

REV -

SCALE NONE

WEIGHT (lbs)

SHEET 1 OF 3



NOTE:
1. ALL DASHED LINES ARE CENTER LINES
2. THE BASE PLATES MOUNTING DETAILS:
4,880 LB ANCHOR BOLT LOAD MAX (SEE CLEVELAND TRAMRAIL, GENERAL ARRANGEMENT DRAWING)

PROPRIETARY AND CONFIDENTIAL

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REV.	DESCRIPTION	DATE	APPROVED
REVISIONS			

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES
.X ±.030
.XX ±.015
.XXX ±.005
FRACTIONAL ±1/16
ANGULAR:
MACH ±.5°
BEND ±1°
REMOVE BURRS AND BREAK ALL SHARP EDGES
DRAWING SIZE: B
DO NOT SCALE DRAWING

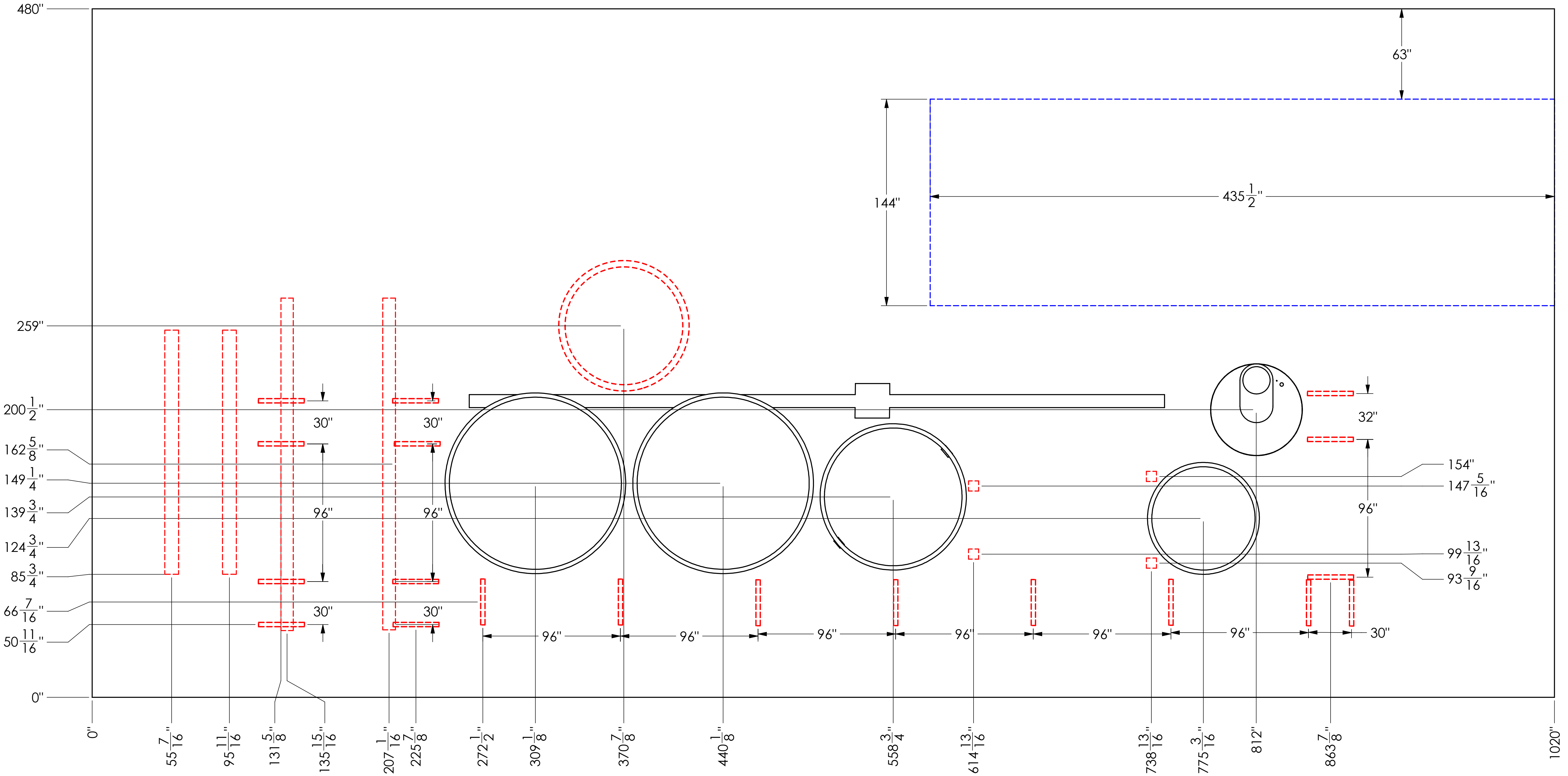
CAD GENERATED DRAWING
CONFORMS TO ANSI Y14.5M

	NAME	DATE
DRAWN	KMS	3/25/2020
CHECKED	BL	3/25/2020
APPRV	DH	3/25/2020

PROJECTION
MATERIAL

United Rentals
4768 HWY 123
BUILDING 1
SAN MARCOS, TX 78666

DESCRIPTION
EQUIPMENT WEIGHTS & ANCHOR POINTS
LAYOUT
PROJECT KAISER - MEAD
PART NO. KM-013
REV -
SCALE NONE
WEIGHT (lbs)
SHEET 2 OF 3



PROPRIETARY AND CONFIDENTIAL

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REV.	DESCRIPTION	DATE	APPROVED
REVISIONS			

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES

TOLERANCES

.X	±.030
.XX	±.015
.XXX	±.005
FRACTIONAL	±1/16
ANGULAR:	
MACH	±.5°
BEND	±1°

REMOVE BURRS AND
BREAK ALL SHARP EDGES

DRAWING SIZE: B
DO NOT SCALE DRAWING

CAD GENERATED DRAWING
CONFORMS TO ANSI Y14.5M

	NAME	DATE
DRAWN	KMS	3/25/2020
CHECKED	BL	3/25/2020
APPRV	DH	3/25/2020

PROJECTION

MATERIAL

United Rentals

4768 HWY 123
BUILDING 1
SAN MARCOS, TX 78666

DESCRIPTION
EQUIPMENT WEIGHTS & ANCHOR POINTS
LAYOUT

PROJECT
KAISER - MEAD

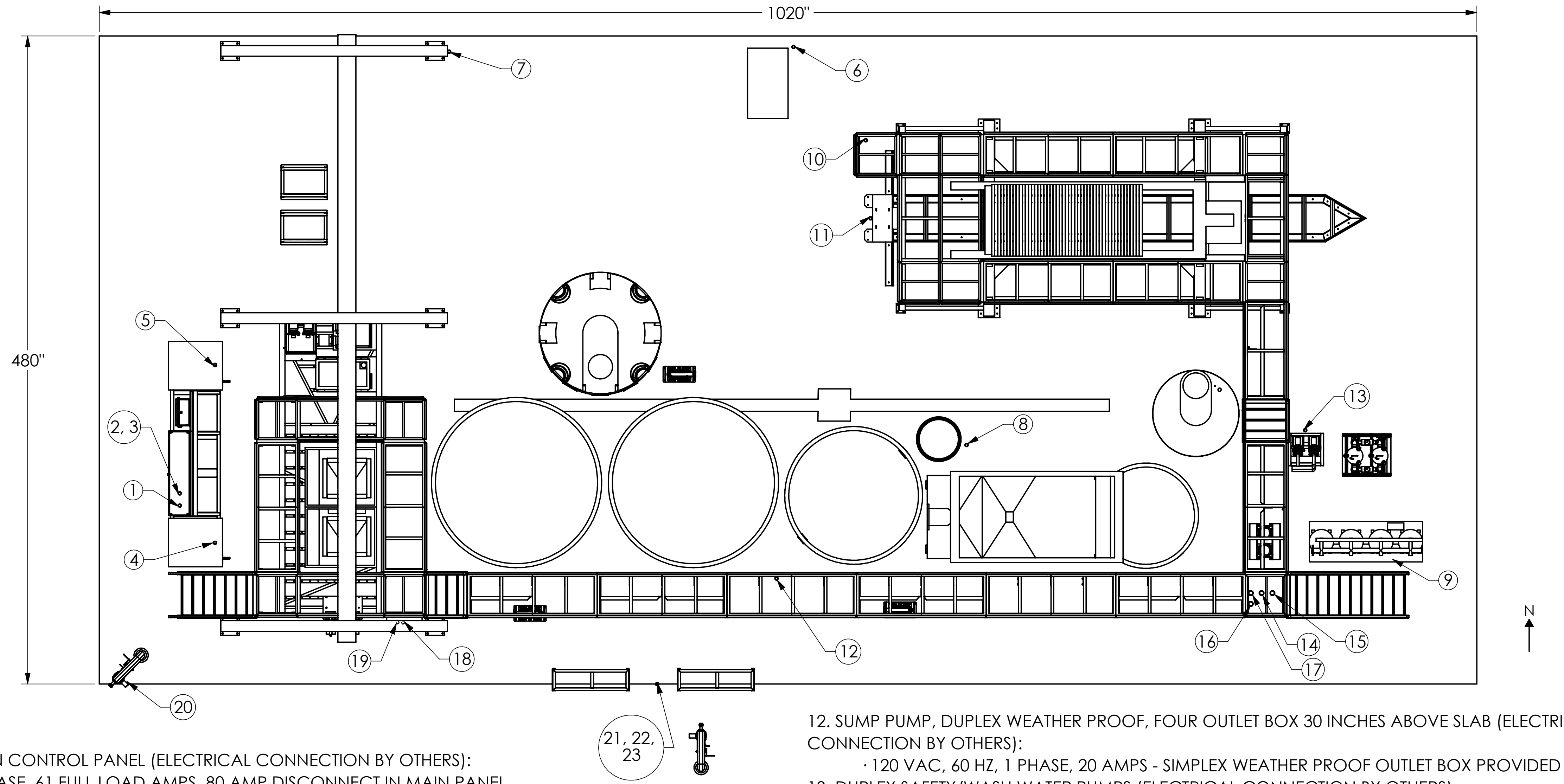
PART NO.
KM-013

REV
-

SCALE NONE

WEIGHT (lbs)

SHEET 3 OF 3



LEGEND (NUMBERED ITEMS):

1. ELECTRICAL DROP AT MAIN CONTROL PANEL (ELECTRICAL CONNECTION BY OTHERS):
   - 480 VAC, 60 HZ, 3 PHASE, 61 FULL LOAD AMPS, 80 AMP DISCONNECT IN MAIN PANEL
2. ELECTRICAL DROP AT MAIN CONTROL PANEL (ELECTRICAL CONNECTION BY OTHERS):
   - 120 VAC, 60 HZ, 1 PHASE, 30 AMPS
3. ELECTRICAL DROP AT MAIN CONTROL SKID DUPLEX WEATHER PROOF, FOUR OUTLET BOX 30 INCHES ABOVE SLAB (ELECTRICAL CONNECTION BY OTHERS):
   - TWO - 120 VAC, 60 HZ, 1 PHASE, 20 AMPS CIRCUITS - DUPLEX WEATHER PROOF OUTLET BOX PROVIDED BY OTHERS.
4. ELECTRICAL DROP AT RECTIFIER #1 (ELECTRICAL CONNECTION BY OTHERS):
   - 480 VAC, 60 HZ, 3 PHASE, 145 FULL LOAD AMPS
5. ELECTRICAL DROP AT RECTIFIER #2 (ELECTRICAL CONNECTION BY OTHERS):
   - 480 VAC, 60 HZ, 3 PHASE, 145 FULL LOAD AMPS
6. ELECTRICAL DROP AT AIR COMPRESSOR (ELECTRICAL CONNECTION BY OTHERS):
   - 480 VAC, 60 HZ, 3 PHASE, 27 FULL LOAD AMPS
7. ELECTRICAL DROP AT HOIST CRANE (ELECTRICAL CONNECTION BY OTHERS):
   - 480 VAC, 60 HZ, 3 PHASE, 5 FULL LOAD AMPS
8. ELECTRICAL DROP AT POLYMER TANK SIMPLEX WEATHER PROOF, FOUR OUTLET BOX (ELECTRICAL CONNECTION BY OTHERS):
   - 120 VAC, 60 HZ, 1 PHASE, 20 AMP CIRCUIT - SIMPLEX WEATHER PROOF OUTLET BOX PROVIDED BY OTHERS.
9. MULTI-MEDIA FILTRATION CONTROLS (ELECTRICAL CONNECTION BY OTHERS):
   - 120 VAC, 60 HZ, 1 PHASE, 20 AMPS
10. FILTER PRESS CONTROLS (ELECTRICAL CONNECTION BY OTHERS):
    - 120 VAC, 60 HZ, 1 PHASE, 20 AMPS
11. WINCH FOR SOLIDS MANAGEMENT (ELECTRICAL CONNECTIONS BY OTHERS):
    - 480 VAC, 60 HZ, 3 PHASE, 4.8 FULL LOAD AMPS
12. SUMP PUMP, DUPLEX WEATHER PROOF, FOUR OUTLET BOX 30 INCHES ABOVE SLAB (ELECTRICAL CONNECTION BY OTHERS):
    - 120 VAC, 60 HZ, 1 PHASE, 20 AMPS - SIMPLEX WEATHER PROOF OUTLET BOX PROVIDED BY OTHERS.
13. DUPLEX SAFETY/WASH WATER PUMPS (ELECTRICAL CONNECTION BY OTHERS):
    - 220 VAC, 60 HZ, 1 PHASE, 30 AMPS
14. 3 INCH SCH80 PVC FOR WATER FROM WETLANDS
15. 3 INCH SCH80 PVC FOR WATER FROM WELLS
16. 3 INCH SCH80 PVC FOR WATER TO WETLANDS
17. 3 INCH SCH80 PVC FOR DISCHARGE TO INFILTRATION BASIN
18. TANKLESS WATER HEATER (ELECTRICAL CONNECTION BY OTHERS):
    - 480 VAC, 60 HZ, 3 PHASE, 78 FULL LOAD AMPS
19. HEAT TRACE CONTROLLER #1 (ELECTRICAL CONNECTION BY OTHERS)
    - 120 VAC, 60 HZ, 1 PHASE, 20 AMP CIRCUIT
20. SAFETY SHOWER #1 (ELECTRICAL CONNECTION BY OTHERS)
    - 120 VAC, 60 HZ, 1 PHASE, 20 AMP CIRCUIT
21. HEAT TRACE CONTROLLER #2 (ELECTRICAL CONNECTION BY OTHERS)
    - 120 VAC, 60 HZ, 1 PHASE, 20 AMP CIRCUIT
22. SAFETY SHOWER #2 (ELECTRICAL CONNECTION BY OTHERS)
    - 120 VAC, 60 HZ, 1 PHASE, 20 AMP CIRCUIT
23. HEAT TRACE CONTROLLER #3 (ELECTRICAL CONNECTION BY OTHERS)
    - 120 VAC, 60 HZ, 1 PHASE, 20 AMP CIRCUIT

REV.	DESCRIPTION	DATE	APPROVED
REVISIONS			

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES

TOLERANCES

.X	±.030
.XX	±.015
.XXX	±.005
FRACTIONAL	±1/16
ANGULAR:	
MACH	±.5°
BEND	±1°

REMOVE BURRS AND BREAK ALL SHARP EDGES

DRAWING SIZE: B
DO NOT SCALE DRAWING

CAD GENERATED DRAWING CONFORMS TO ANSI Y14.5M

	NAME	DATE
DRAWN	KMS	3/25/2020
CHECKED	BL	3/25/2020
APPRV	DH	3/25/2020

PROJECTION

MATERIAL

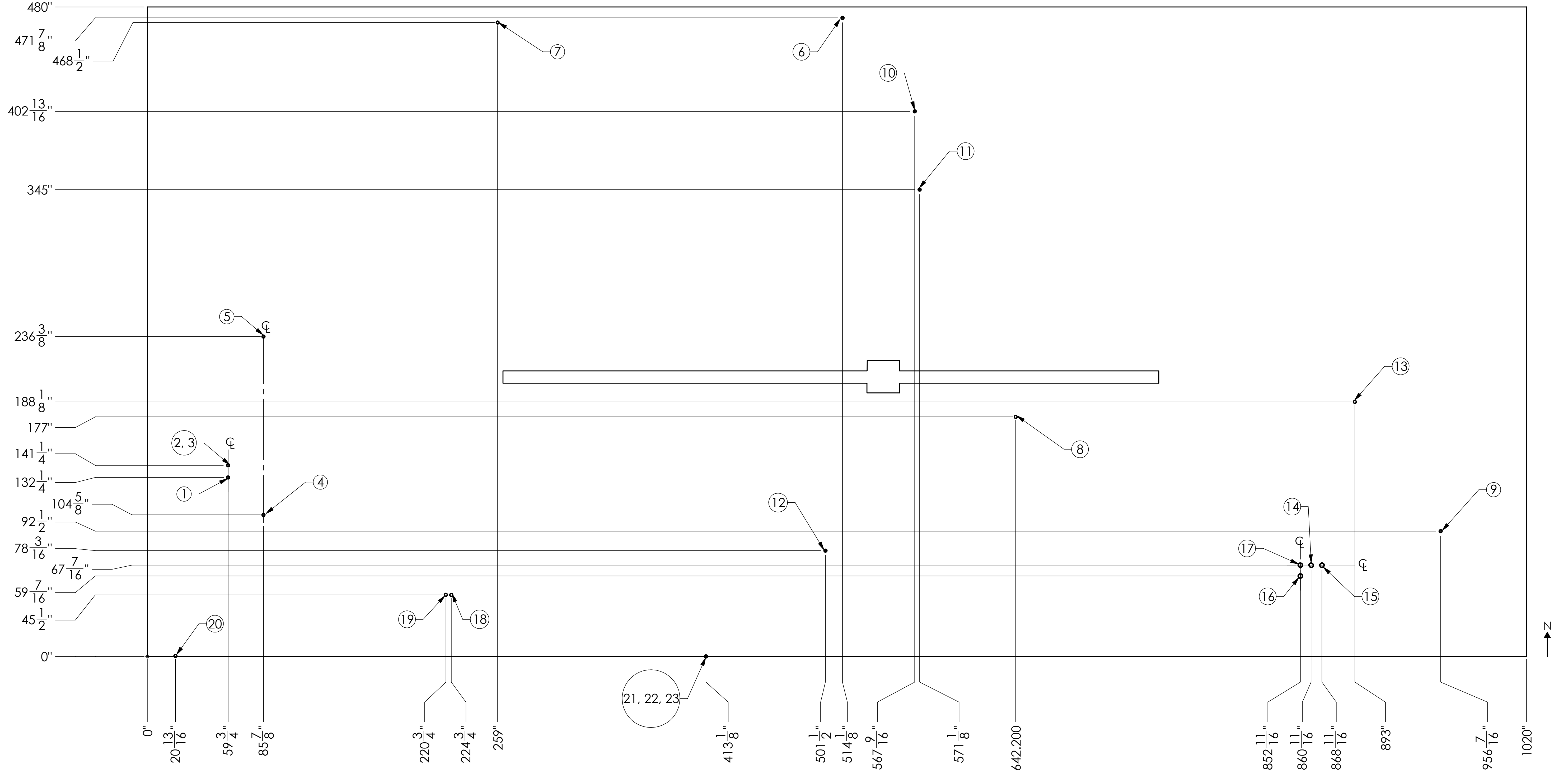
United Rentals
4768 HWY 123
BUILDING 1
SAN MARCOS, TX 78666

DESCRIPTION
SLAB PENETRATION LAYOUT
PLUMBING & ELECTRICAL

PROJECT KAISER - MEAD

PART NO. KM-012
REV -

SCALE NONE
WEIGHT (lbs)
SHEET 1 OF 2



NOTE: ALL DIMENSIONS ARE FROM THE CENTER POINT.

PROPRIETARY AND CONFIDENTIAL

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REV.	DESCRIPTION	DATE	APPROVED
REVISIONS			

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES

.X	±.030
.XX	±.015
.XXX	±.005
FRACTIONAL	±1/16
ANGULAR:	
MACH	±.5°
BEND	±1°

REMOVE BURRS AND
BREAK ALL SHARP EDGES
DRAWING SIZE: B
DO NOT SCALE DRAWING

CAD GENERATED DRAWING
CONFORMS TO ANSI Y14.5M

	NAME	DATE
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PROJECTION
MATERIAL

United Rentals
4768 HWY 123
BUILDING 1
SAN MARCOS, TX 78666

DESCRIPTION
SLAB PENETRATION LAYOUT
PLUMBING & ELECTRICAL

PROJECT
KAISER - MEAD

PART NO.
KM-012

REV
-

SCALE NONE
WEIGHT (lbs)
SHEET 2 OF 2

PART 1.0 GENERAL NOTES

1.1 THIS DESIGN IS SITE SPECIFIC AND MAY NOT BE USED AT A DIFFERENT SITE WITHOUT THE ENGINEER'S WRITTEN PERMISSION.

1.2 ASE IS NOT RESPONSIBLE FOR ANY OF THE EXISTING BUILDING STRUCTURE IN WHICH THIS NEW FRAME SYSTEM WILL BE PLACED. SPECIFIC ELEMENTS OF THE NEW FRAME SYSTEM IS ALSO NOT INCLUDED IN OUR SCOPE OF WORK AS REQUESTED BY OUR CLIENT, INCLUDING BUT NOT LIMITED TO HANDRAILS, CATWALK ELEMENTS, HANDRAIL/CATWALK CONNECTIONS, AND SPECIFIC PRE-MANUFACTURED AND/OR PROPRIETARY ITEMS.

1.3 DO NOT SCALE THIS DRAWING. THIS IS A SCHEMATIC PLAN TO BE USED TO LOCATE AND IDENTIFY STRUCTURAL FRAMING ELEMENTS ONLY. DIMENSIONAL CONTROL IS THE RESPONSIBILITY OF THE BUILDER AND/OR CONTRACTORS TO FOLLOW THE ARCHITECTURAL PLANS, DESIGNER PLANS, OR EXISTING SITE CONDITIONS. USE THIS PLAN FOR PLACEMENT OF STRUCTURAL FRAMING ELEMENTS ONLY.

1.4 THE CONTRACTORS SHALL VERIFY ALL DIMENSIONS, ELEVATIONS AND ALL OTHER NOTED ITEMS WITH ORIGINAL DESIGN PLANS PROVIDED BY UNITED RENTALS AND EXISTING SITE CONDITIONS PRIOR TO STARTING CONSTRUCTION. CONTRACTOR SHALL NOTIFY UNITED RENTALS AND ASE IN WRITING OF ANY DISCREPANCY AND FOR DIRECTIONS TO RESOLVE THE DISCREPANCY. THE ORIGINAL PLANS PROVIDED BY UNITED RENTALS TAKE PRECEDENCE OVER THIS DRAWING IF ANY NON-STRUCTURAL DIMENSIONAL DISCREPANCY EXISTS.

1.5 ASSUMPTIONS HAVE BEEN MADE BY THIS OFFICE REGARDING EXISTING CONDITIONS. ACTUAL CONDITIONS MAY VARY FROM THOSE ASSUMED. THE CONTRACTOR IS TO REPORT ANY SUCH DISCREPANCIES TO ASE FOR POSSIBLE MODIFICATIONS NEEDED TO THE CONTRACT DRAWINGS.

1.6 THE BUILDER SHALL COORDINATE THIS DRAWING WITH ALL STRUCTURAL, CIVIL, ELECTRICAL, AND MECHANICAL PLANS AND EXISTING SITE CONDITIONS AND SHALL NOTIFY THE DESIGNER AND ASE IN WRITING OF ANY DISCREPANCY AND FOR DIRECTIONS TO RESOLVE THE DISCREPANCY.

1.7 SEE ORIGINAL DESIGN DRAWINGS PROVIDED BY UNITED RENTALS FOR MISCELLANEOUS ITEMS NOT SHOWN HEREIN.

1.8 ALL EXISTING FOUNDATION, SLAB, AND FOOTING MEMBERS ARE THE DESIGN RESPONSIBILITY OF OTHERS.

PART 2.0 STRUCTURAL STEEL (DESIGNED PER AISC ASD 14TH EDITION)

2.1 ALL STRUCTURAL STEEL SHALL BE SUPPLIED AS FOLLOWS:

CHANNELS & ANGLES	ASTM A36
I BEAMS	ASTM A992, GRADE 50
STEEL TUBE	ASTM A500, GRADE B
STEEL PIPE	ASTM A53, GRADE B
HIGH-STRENGTH BOLTS	ASTM A325
ANCHOR RODS	ASTM F1554, GRADE 36

2.2 ALL STRUCTURAL STEEL PERMANENTLY EXPOSED TO WEATHER SHALL BE HOT-DIP GALVANIZED AFTER FABRICATION CONFORMING TO ASTM A-123.

2.3 STRUCTURAL STEEL SHALL BE ERECTED TRUE AND PLUMB W/ TEMPORARY SUPPORTS AND BRACING FOR LATERAL STABILITY UNTIL ALL FRAMING ELEMENTS ARE IN PLACE AND STEEL CONNECTIONS ARE COMPLETED. STEEL ERECTION SHALL COMPLY WITH ALL APPLICABLE OSHA REQUIREMENTS.

2.4 NO STRUCTURAL MEMBER SHALL BE CUT, NOTCHED OR OTHERWISE ALTERED UNLESS APPROVED IN WRITING BY ASE.

2.5 WELDED CONNECTIONS: WELDING ELECTRODES FOR A36, A572 GRADE 50 AND SCHEDULE NO. 40 STEEL SHALL BE E70XX. RETURN FILLET WELDS FOR FRAMED CONNECTIONS 1/2" AT EACH END. SHOP CONNECTIONS SHALL BE WELDED.

2.6 ALL CONTACT POINTS BETWEEN ANGLES, PLATES, BEAMS, ETC. SHALL BE WELDED USING E70XX ELECTRODES UNLESS NOTED OTHERWISE.

2.7 WELDING SHALL CONFORM TO AWS D1.1. ALL WELDERS SHALL BE CURRENTLY CERTIFIED WITH THE AMERICAN WELDING SOCIETY.

2.8 ALL BOLT HOLES SHALL BE MACHINE PUNCHED OR DRILLED, NOT FIELD BURNED. ALL BOLT HOLES SHALL BE 1/16" LARGER THAN BOLT DIAMETER.

PART 3.0 SHOP DRAWINGS AND SUBMITTALS

3.1 SUBMIT SHOP DRAWINGS TO ASE FOR REVIEW PRIOR TO FABRICATION. DIMENSIONS WILL NOT BE CHECKED AND ANY ERRORS IN DIMENSIONS SHOWN ON SHOP DRAWINGS SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR.

3.2 MATERIAL FABRICATORS SHALL PROVIDE COMPLETE DRAWINGS SHOWING LOCATION AND POSITION OF ALL STRUCTURAL ITEMS. ALL SUBMITTED SHOP DRAWINGS SHALL CONTAIN CLEAR IDENTIFICATION OF ALL DEVIATIONS FROM THE CONTRACT DOCUMENTS.

3.3 SHOP DRAWINGS SHALL NOT CONTAIN REPRODUCTIONS OF THE CONTRACT DOCUMENTS. SUBMITTALS SHALL CONFORM TO REQUIREMENTS OF CONTRACT DOCUMENTS, AND SHALL BE CHECKED AND MARKED "APPROVED" BY CONTRACTOR PRIOR TO SUBMITTAL. NON-CONFORMING SUBMITTALS WILL BE RETURNED WITHOUT REVIEW.

3.4 NO CHANGES ARE PERMITTED IN CONSTRUCTION FROM THAT SHOWN IN THE APPROVED SHOP DRAWINGS EXCEPT BY SPECIFIC WRITTEN APPROVAL OF ASE.

PART 4.0 DESIGN DATA AND CRITERIA

4.1 STRUCTURAL DESIGN LOADS:

LIVE LOADS:
CATWALK LIVE LOAD - 40 PSF
FILTER CHAMBER TANK LIVE LOAD - 10 KIPS (FULL)
WENCH CAPACITY (APPLIED TO ROLL OFF BOX RAIL SYSTEM) - 11 KIPS

CATWALK DEAD LOADS - 10 PSF
SELF-WEIGHT OF STEEL ELEMENTS - VARIES

DAVID R. WILLIS
71232
2/4/20

PROPRIETARY AND CONFIDENTIAL

ASSOCIATED STRUCTURAL ENGINEERS, INC
FIRM NUMBER F-2820
2405 S. INTERSTATE 35
NEW BRAUNFELS, TX. 78130
TEL.: (830) 625-5947 E-MAIL: OFFICE@ASESTRUCTURAL.COM

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

TOLERANCES

.X	±.030
.XX	±.015
.XXX	±.005
FRACTIONAL	±1/16
ANGULAR:	
MACH	±.5°
BEND	±1°

REMOVE BURRS AND BREAK ALL SHARP EDGES

DRAWING SIZE: B
DO NOT SCALE DRAWING

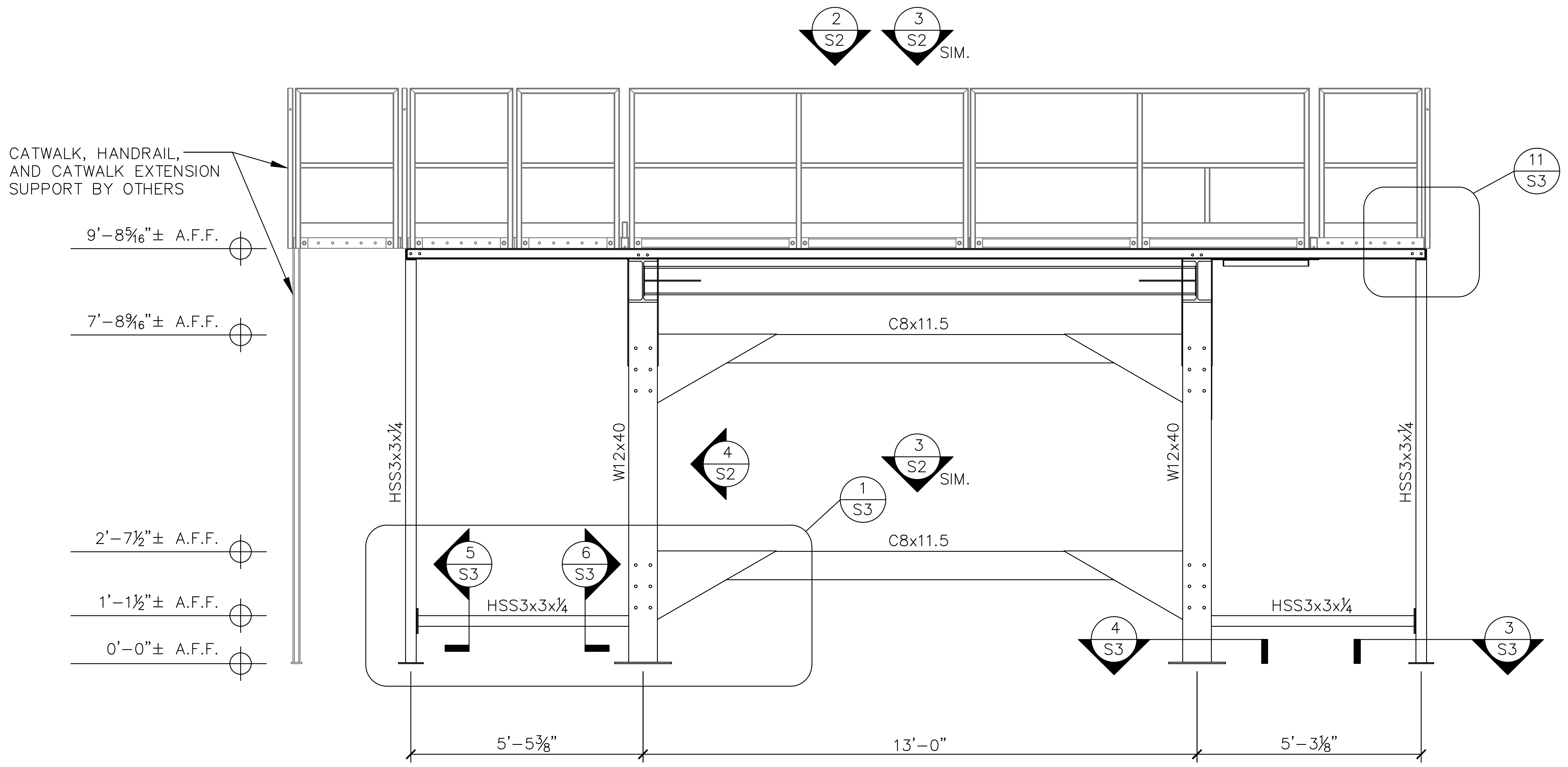
CAD GENERATED DRAWING CONFORMS TO ANSI Y14.5M

	NAME	DATE
DRAWN	ESR	2/4/2020
CHECKED	DRW	2/4/2020
APPRV	DRW	2/4/2020

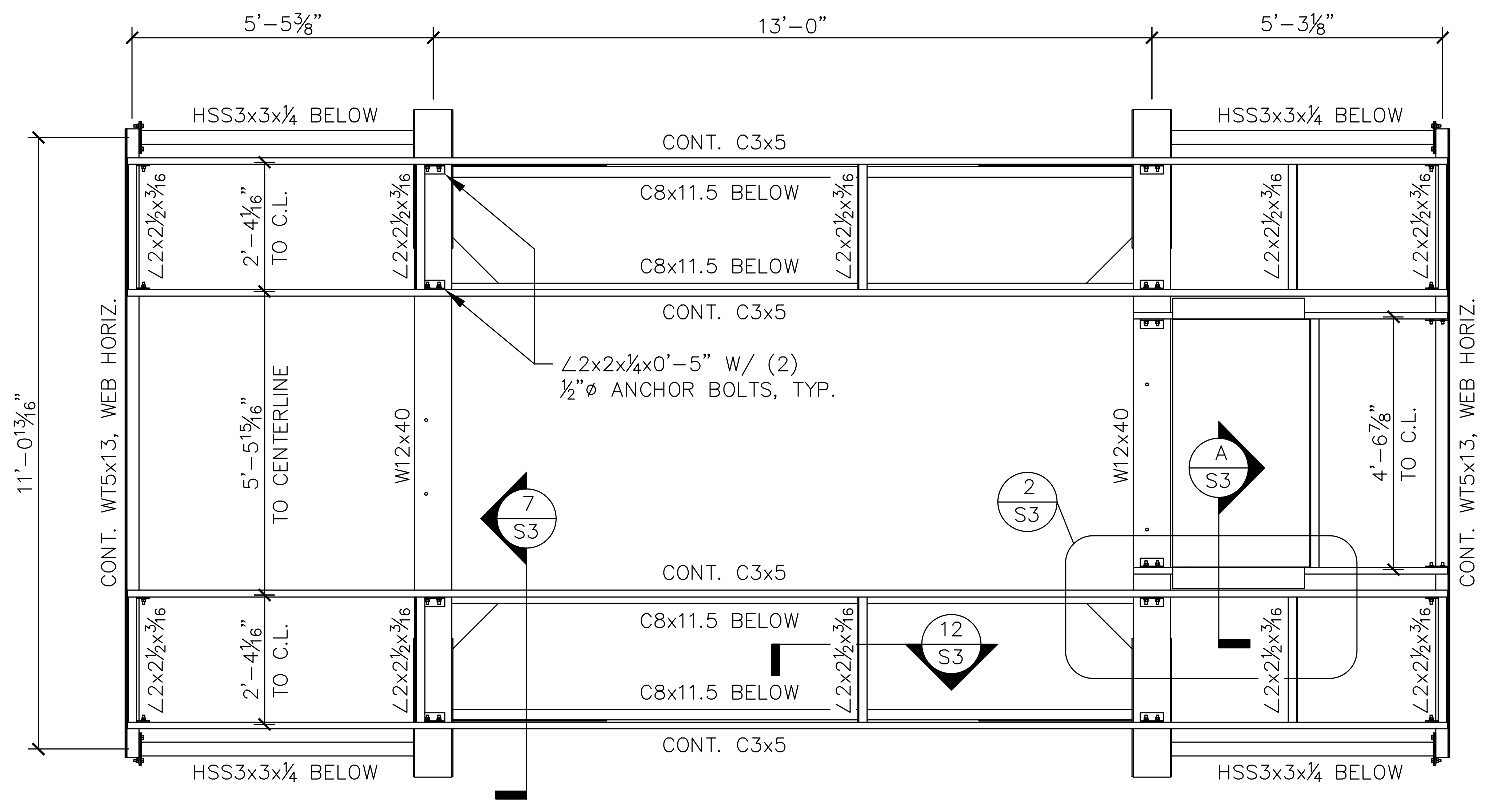
PROJECTION
MATERIAL

United Rentals
4768 HWY 123
BUILDING 1
SAN MARCOS, TX 78666

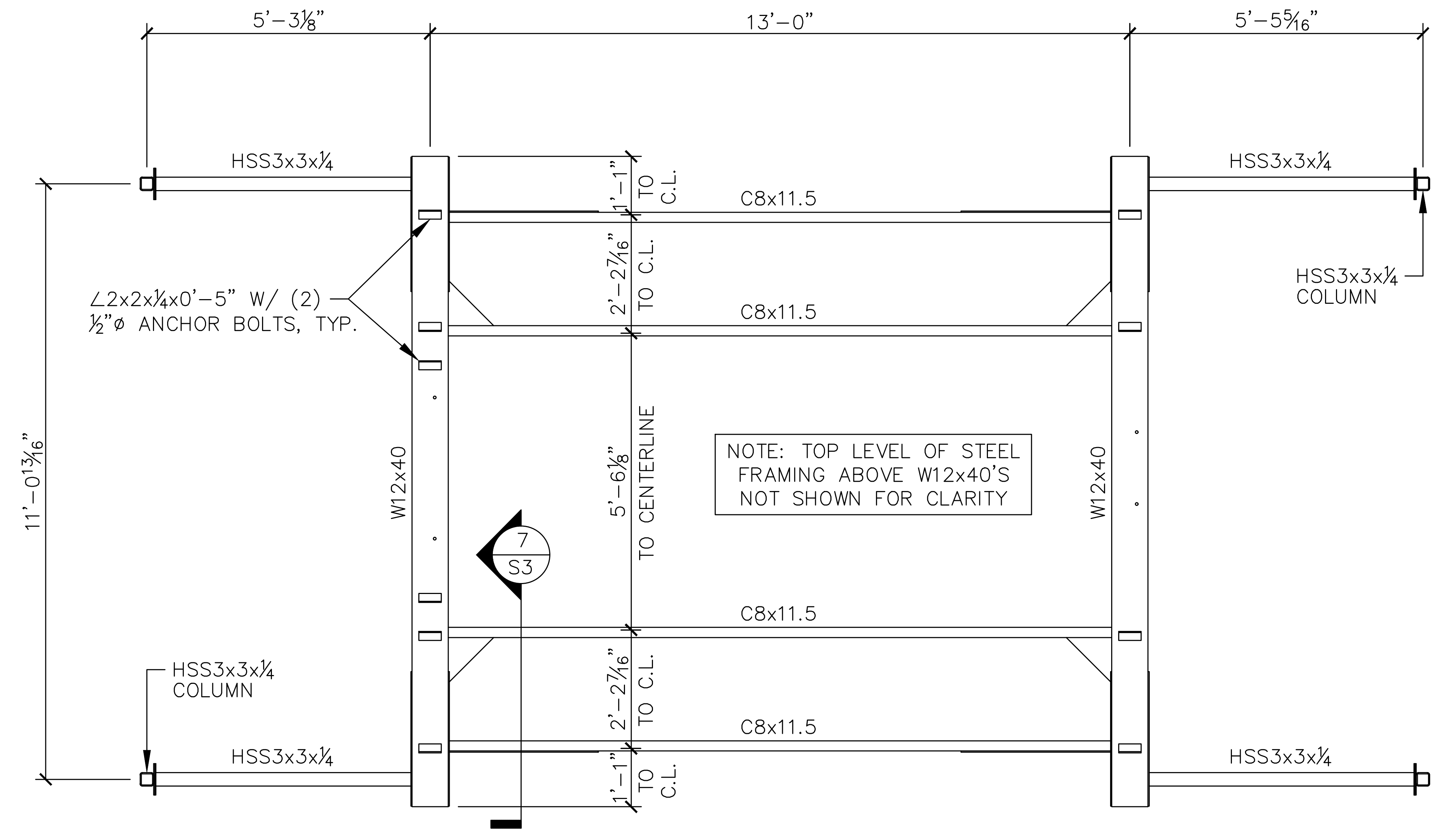
DESCRIPTION: GENERAL NOTES
PROJECT: KAISER MEAD
PART NO.: N.A.
REV: 2
SCALE: VARIES
WEIGHT (lbs): N.A.
SHEET: S1 OF 4



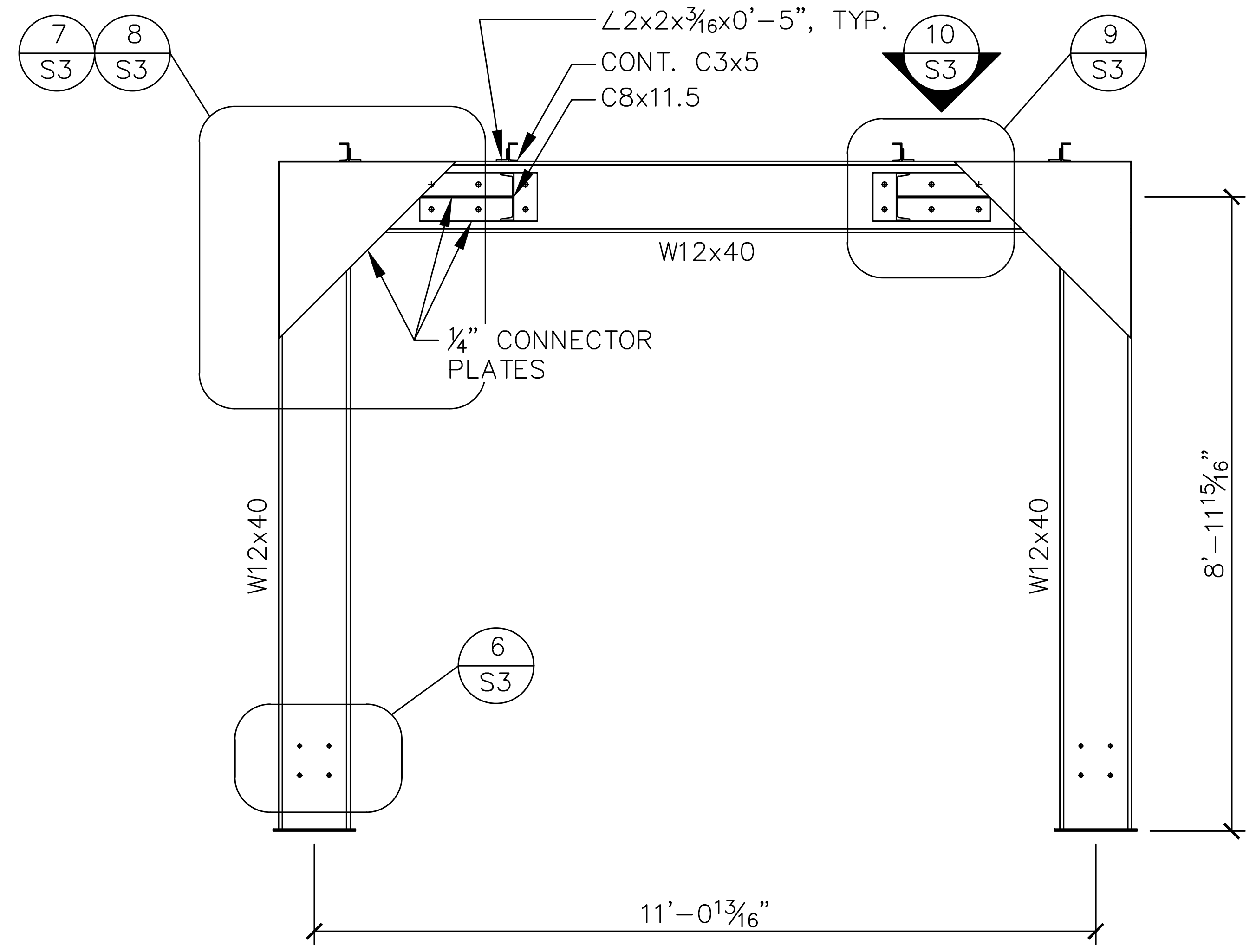
① FRAME ELEVATION
SCALE: 1/2"=1'-0"



② FRAME PLAN – W/ CATWALK SUPPORT FRAME
SCALE: 1/2"=1'-0"


5'-3⅛"
13'-0"
5'-5$\frac{5}{16}$"
HSS3x3x¼
C8x11.5
1'-1" TO C.L.
2'-2$\frac{7}{16}$" TO C.L.
∠2x2x¼x0'-5" W/ (2) ½"ø ANCHOR BOLTS, TYP.
HSS3x3x¼ COLUMN
11'-0$\frac{13}{16}$"
W12x40
5'-6⅛" TO CENTERLINE
7 S3
NOTE: TOP LEVEL OF STEEL FRAMING ABOVE W12x40'S NOT SHOWN FOR CLARITY

③ FRAME PLAN – W/OUT CATWALK SUPPORT FRAME
SCALE: 1/2"=1'-0"



④ FRAME ELEVATION – W/ CATWALK SUPPORT FRAME
SCALE: 1/2"=1'-0"

DAVID R. WILLIS
71232
2/4/20

PROPRIETARY AND CONFIDENTIAL

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ASSOCIATED STRUCTURAL ENGINEERS, INC
FIRM NUMBER F-2820
2405 S. INTERSTATE 35
NEW BRAUNFELS, TX. 78130
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UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

TOLERANCES	
.X	±.030
.XX	±.015
.XXX	±.005
FRACTIONAL	±1/16
ANGULAR:	
MACH	±.5°
BEND	±1°

REMOVE BURRS AND BREAK ALL SHARP EDGES

DRAWING SIZE: B
DO NOT SCALE DRAWING

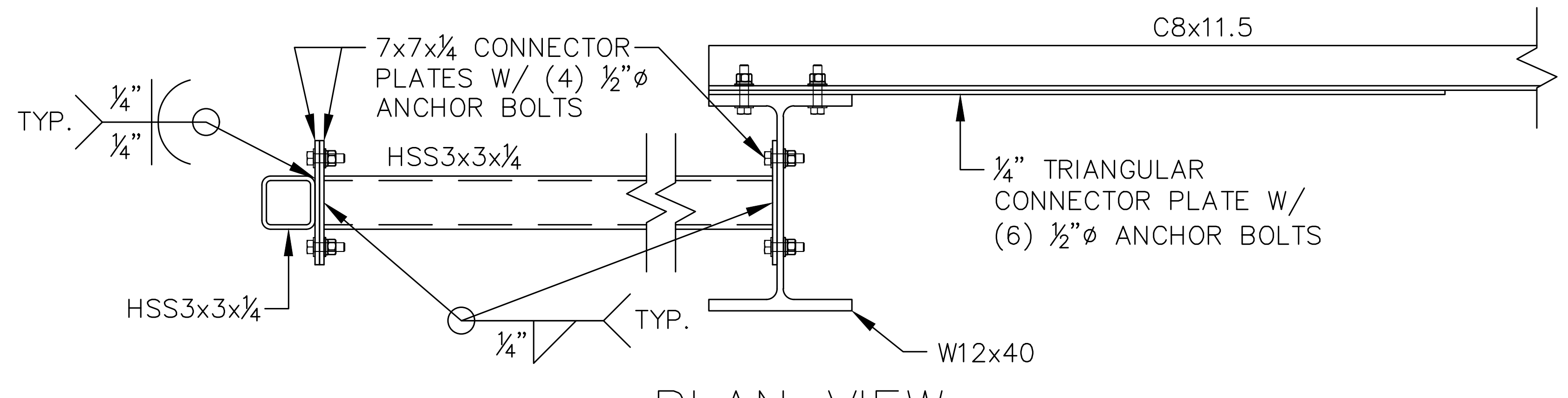
CAD GENERATED DRAWING CONFORMS TO ANSI Y14.5M

	NAME	DATE
DRAWN	ESR	2/4/2020
CHECKED	DRW	2/4/2020
APPRV	DRW	2/4/2020

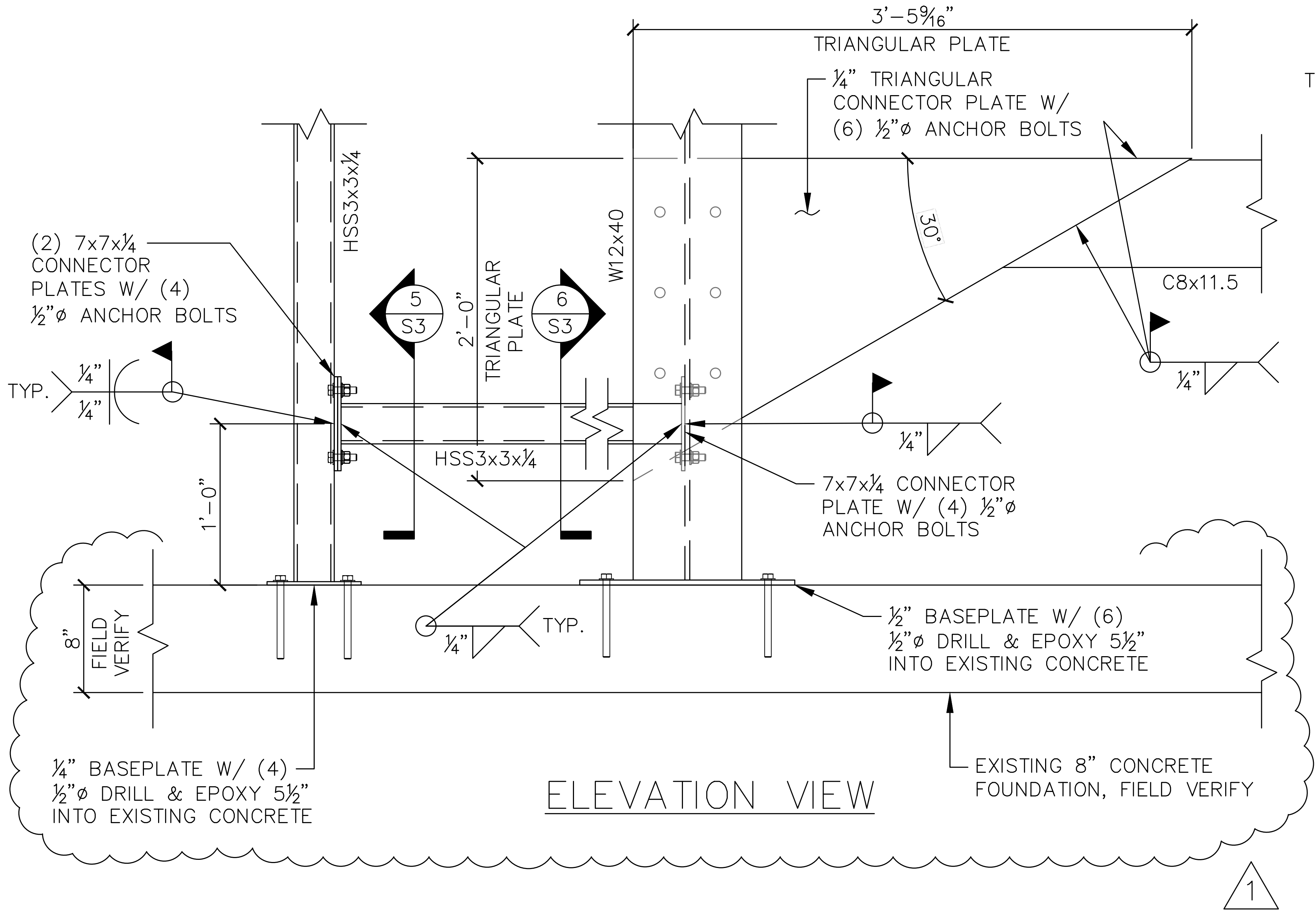
PROJECTION
MATERIAL

United Rentals
4768 HWY 123
BUILDING 1
SAN MARCOS, TX 78666

DESCRIPTION: STEEL FRAME PLANS
PROJECT: KAISER MEAD
PART NO. N.A.
REV 2
SCALE VARIES
WEIGHT (lbs) N.A.
SHEET S2 OF 4

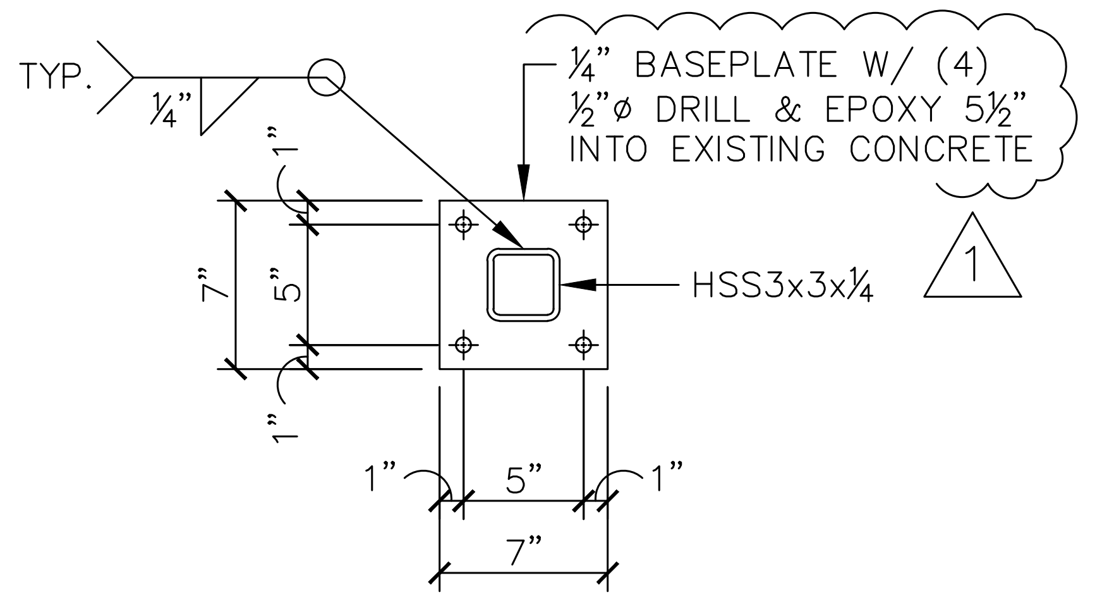

C8x11.5
7x7x¼ CONNECTOR PLATES W/ (4) ½"ø ANCHOR BOLTS
TYP.
¼"
¼"
HSS3x3x¼
¼" TRIANGULAR CONNECTOR PLATE W/ (6) ½"ø ANCHOR BOLTS
HSS3x3x¼
¼"
TYP.
W12x40

PLAN VIEW

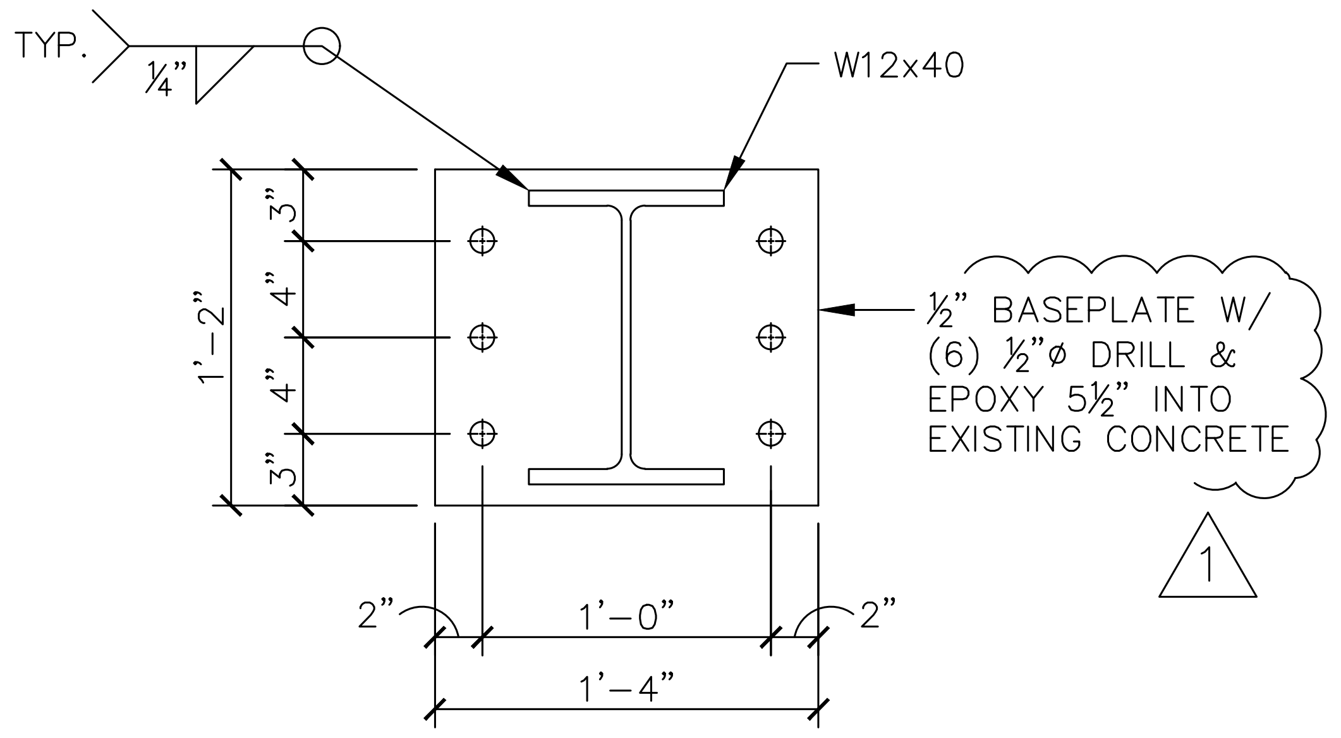

3'-5⁹⁄₁₆"
TRIANGULAR PLATE
¼" TRIANGULAR CONNECTOR PLATE W/ (6) ½"ø ANCHOR BOLTS
HSS3x3x¼
W12x40
30°
C8x11.5
(2) 7x7x¼ CONNECTOR PLATES W/ (4) ½"ø ANCHOR BOLTS
5
S3
2'-0"
TRIANGULAR PLATE
6
S3
TYP.
¼"
¼"
¼"
¼"
HSS3x3x¼
7x7x¼ CONNECTOR PLATE W/ (4) ½"ø ANCHOR BOLTS
1'-0"
8" FIELD VERIFY
TYP.
¼"
½" BASEPLATE W/ (6) ½"ø DRILL & EPOXY 5½" INTO EXISTING CONCRETE
¼" BASEPLATE W/ (4) ½"ø DRILL & EPOXY 5½" INTO EXISTING CONCRETE
EXISTING 8" CONCRETE FOUNDATION, FIELD VERIFY
1

ELEVATION VIEW

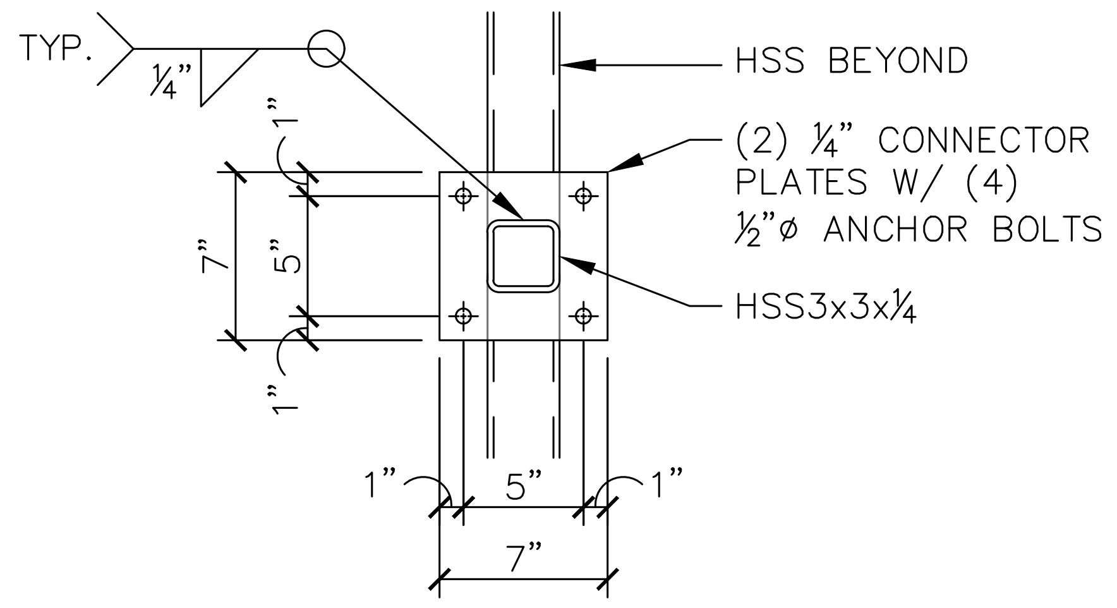
① CONNECTION DETAIL
SCALE: 1 1/2"=1'-0"


TYP.
¼"
¼" BASEPLATE W/ (4) ½"ø DRILL & EPOXY 5½" INTO EXISTING CONCRETE
1
HSS3x3x¼
1"
7"
5"
1"
1"
5"
1"
7"

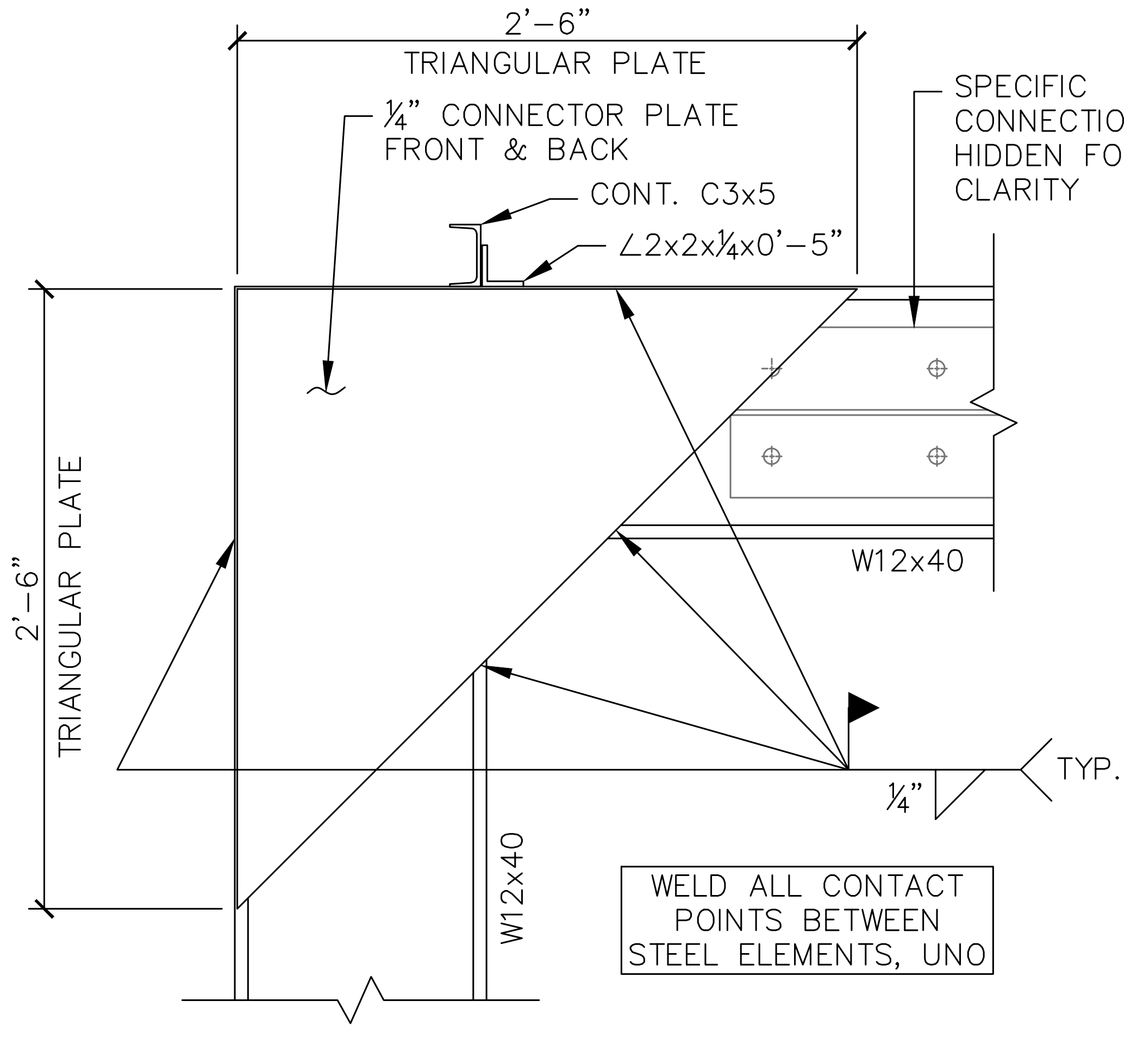
③ BASEPLATE DETAIL
SCALE: 1 1/2"=1'-0"


TYP.
¼"
W12x40
3"
4"
1'-2"
4"
3"
½" BASEPLATE W/ (6) ½"ø DRILL & EPOXY 5½" INTO EXISTING CONCRETE
1
2"
1'-0"
2"
1'-4"

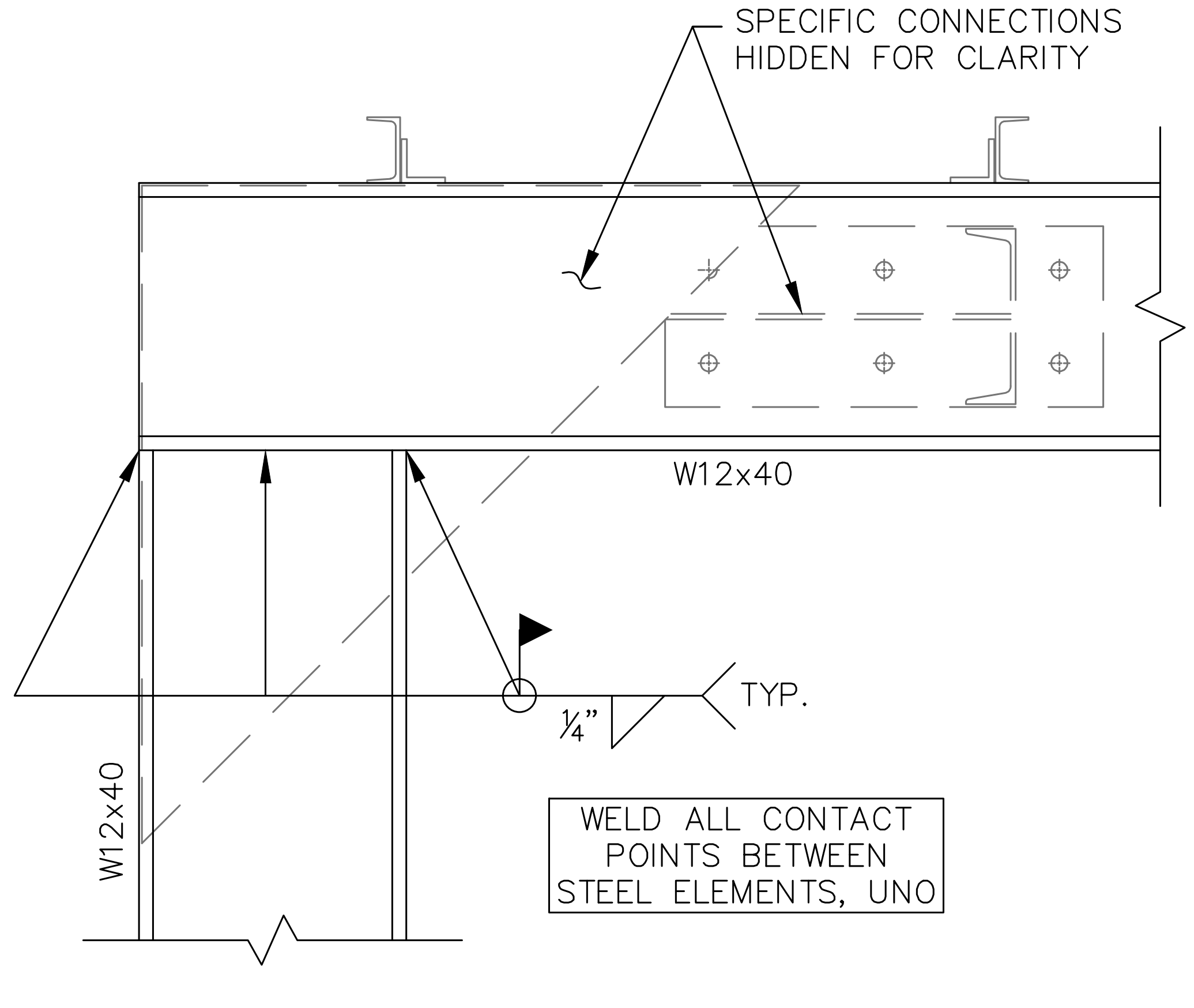
④ BASEPLATE DETAIL
SCALE: 1 1/2"=1'-0"



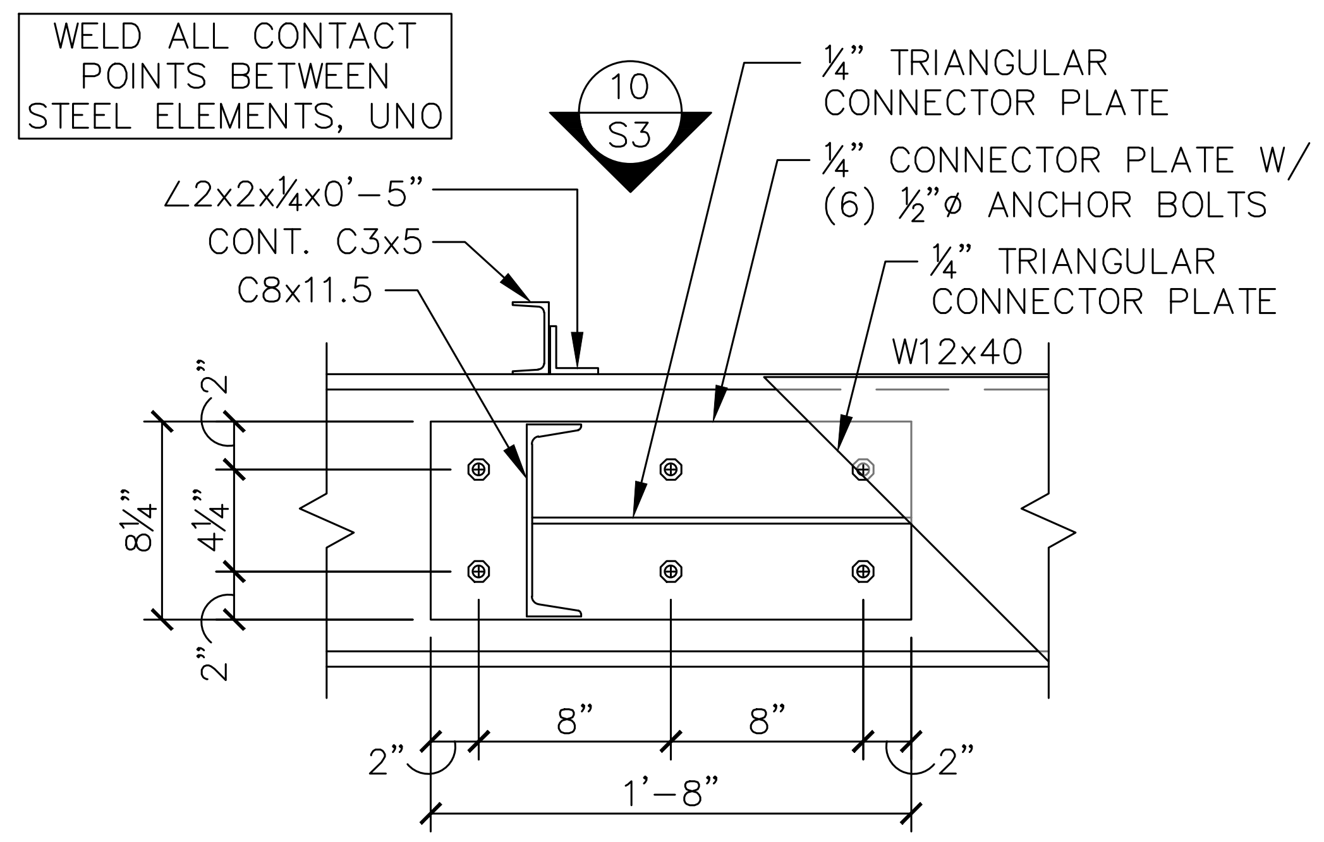
⑤ CONNECTION DETAIL
SCALE: 1 1/2"=1'-0"


2'-6"
TRIANGULAR PLATE
¼" CONNECTOR PLATE FRONT & BACK
CONT. C3x5
∠2x2x¼x0'-5"
SPECIFIC CONNECTIONS HIDDEN FOR CLARITY
2'-6"
TRIANGULAR PLATE
W12x40
W12x40
¼"
TYP.
WELD ALL CONTACT POINTS BETWEEN STEEL ELEMENTS, UNO

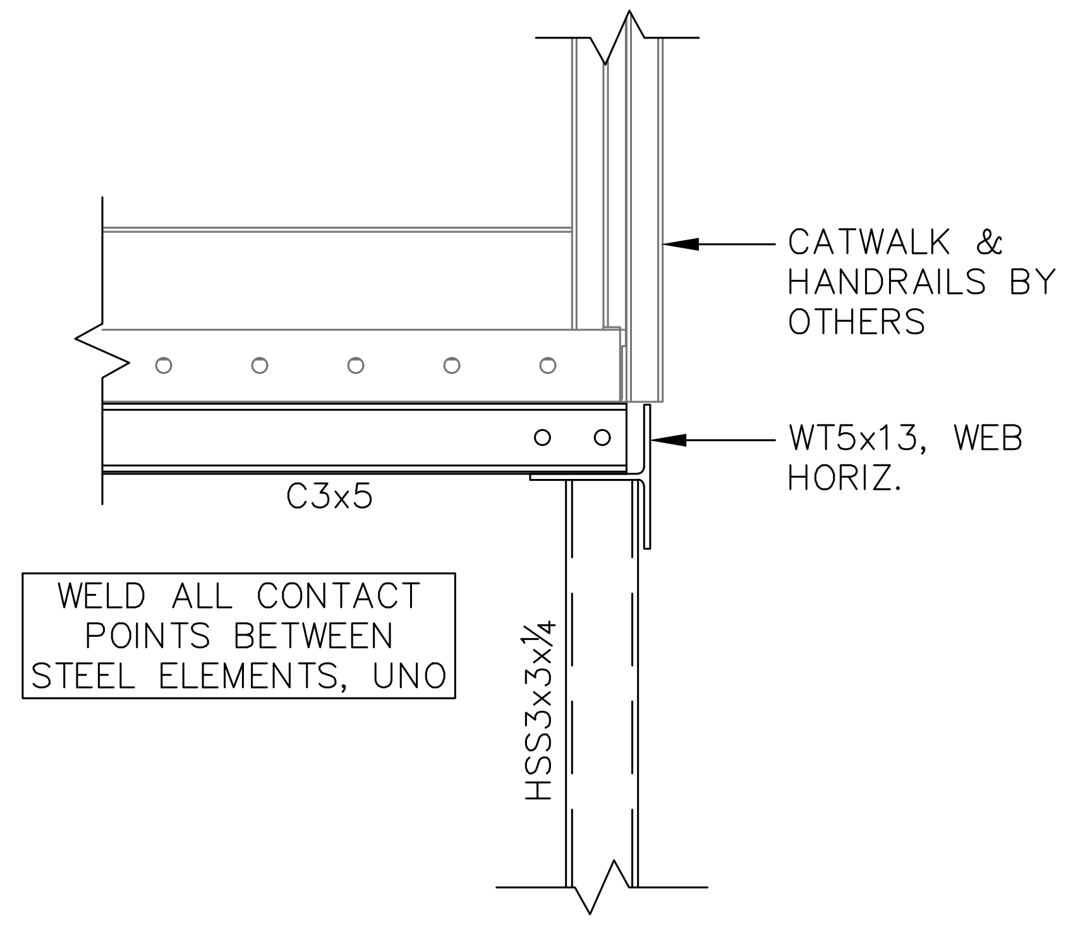
⑦ CONNECTION DETAIL
SCALE: 1 1/2"=1'-0"


SPECIFIC CONNECTIONS HIDDEN FOR CLARITY
W12x40
W12x40
¼"
TYP.
WELD ALL CONTACT POINTS BETWEEN STEEL ELEMENTS, UNO

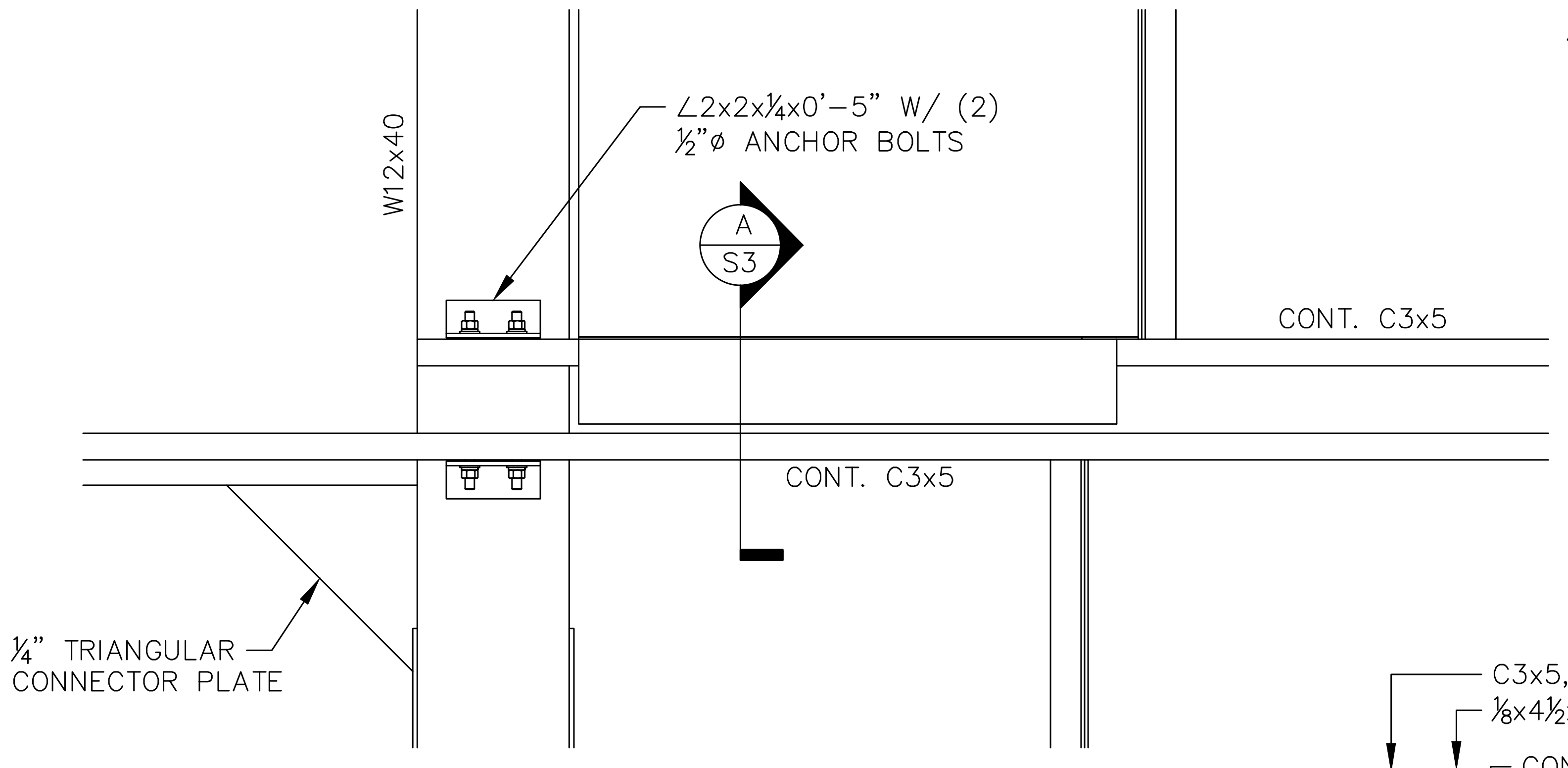
⑧ CONNECTION DETAIL
SCALE: 1 1/2"=1'-0"


WELD ALL CONTACT POINTS BETWEEN STEEL ELEMENTS, UNO
10
S3
¼" TRIANGULAR CONNECTOR PLATE
¼" CONNECTOR PLATE W/ (6) ½"ø ANCHOR BOLTS
¼" TRIANGULAR CONNECTOR PLATE
∠2x2x¼x0'-5"
CONT. C3x5
C8x11.5
W12x40
2"
4¼"
8¼"
2"
8"
8"
2"
2"
1'-8"

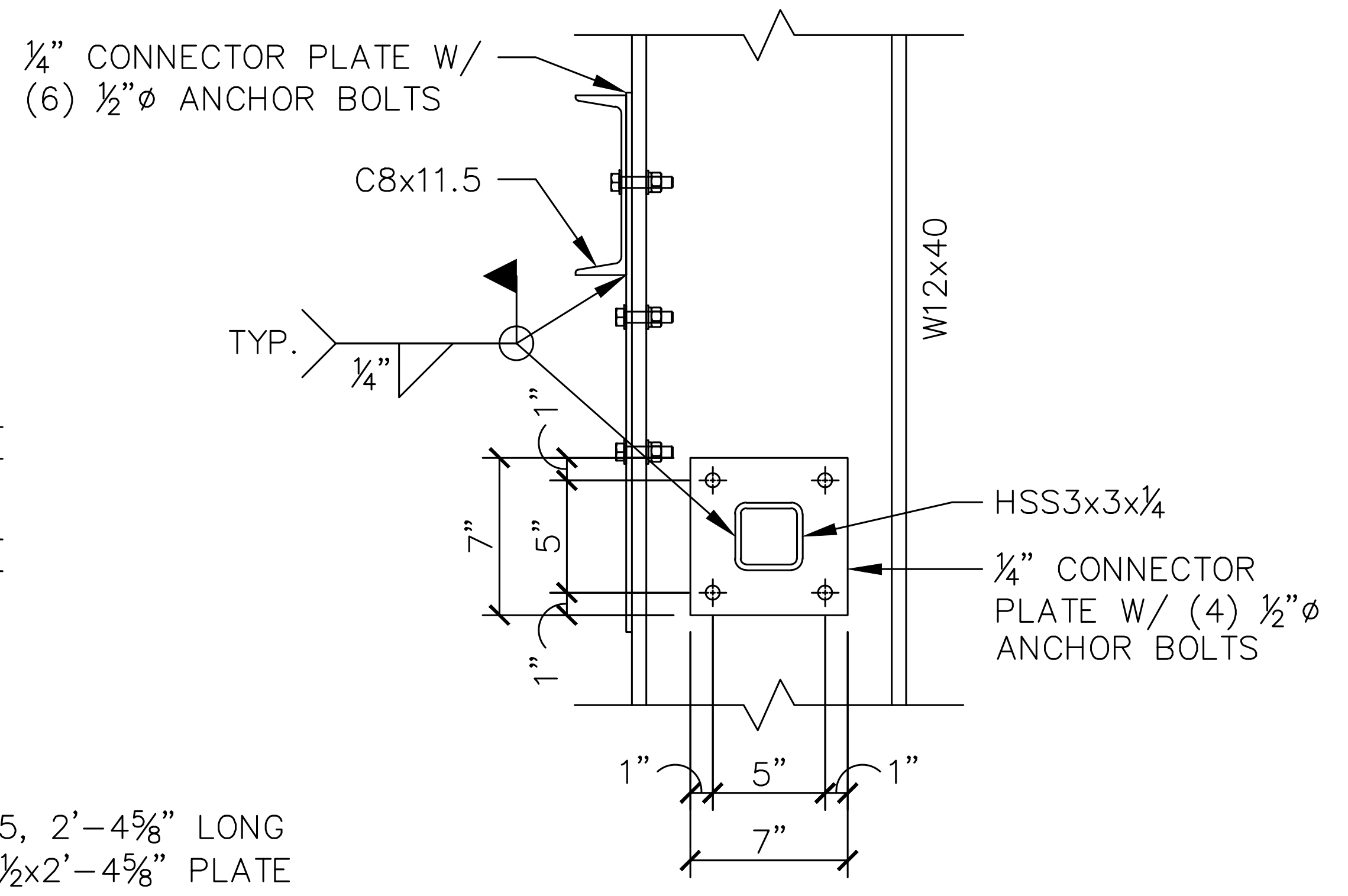
⑨ CONNECTION DETAIL
SCALE: 1 1/2"=1'-0"


CATWALK & HANDRAILS BY OTHERS
WT5x13, WEB HORIZ.
C3x5
WELD ALL CONTACT POINTS BETWEEN STEEL ELEMENTS, UNO
HSS3x3x¼

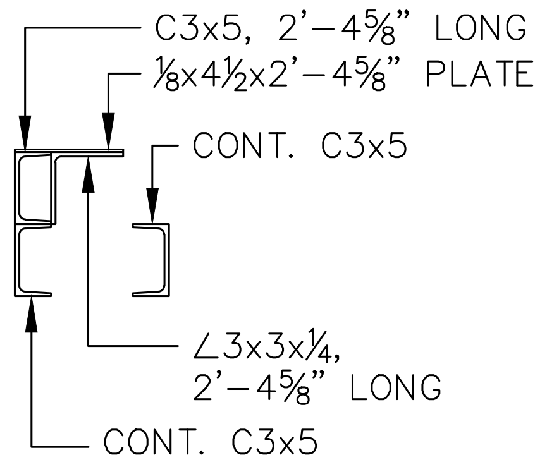
⑪ CONNECTION DETAIL
SCALE: 1 1/2"=1'-0"


W12x40
∠2x2x¼x0'-5" W/ (2) ½"ø ANCHOR BOLTS
A
S3
CONT. C3x5
CONT. C3x5
¼" TRIANGULAR CONNECTOR PLATE

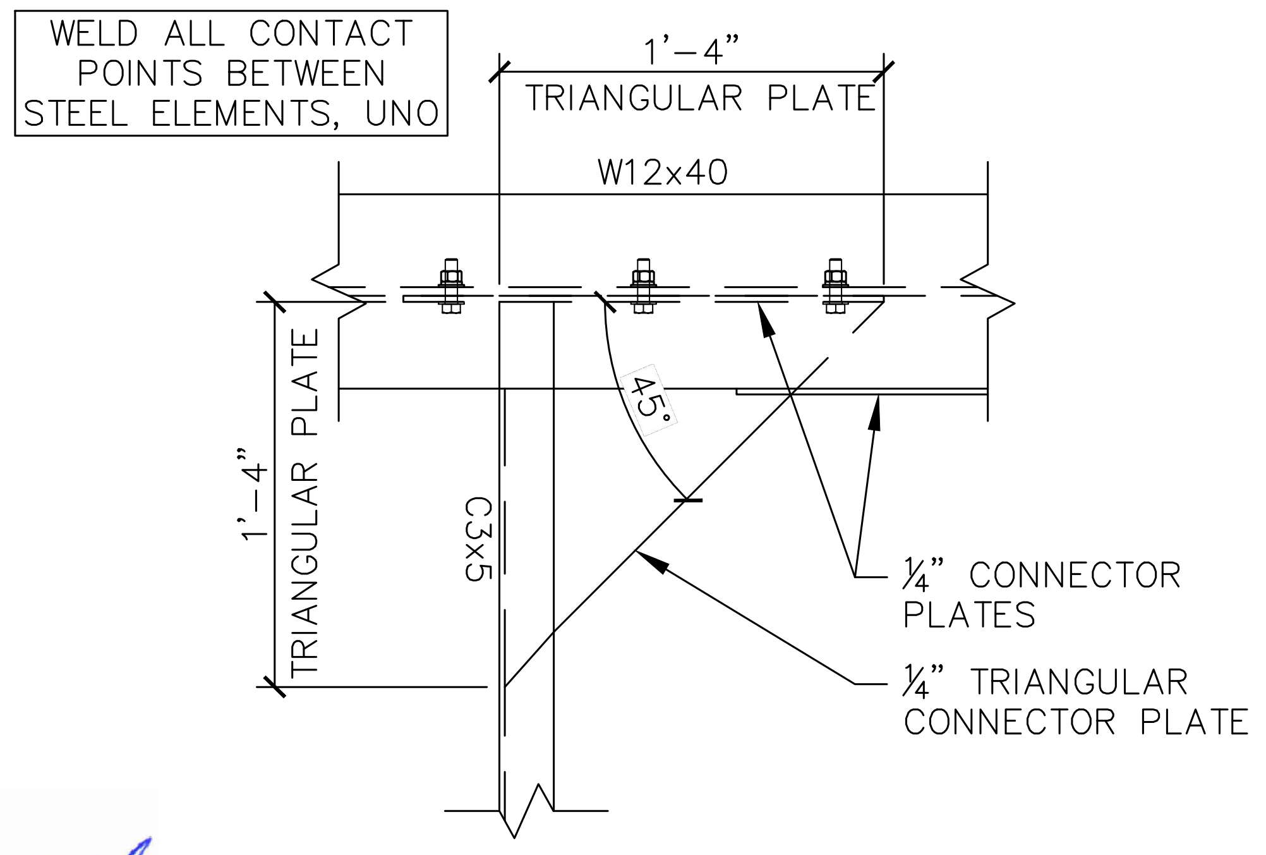
② CONNECTION DETAIL
SCALE: 1 1/2"=1'-0"


¼" CONNECTOR PLATE W/ (6) ½"ø ANCHOR BOLTS
C8x11.5
W12x40
TYP.
¼"
1"
HSS3x3x¼
¼" CONNECTOR PLATE W/ (4) ½"ø ANCHOR BOLTS
7"
5"
1"
1"
5"
1"
7"

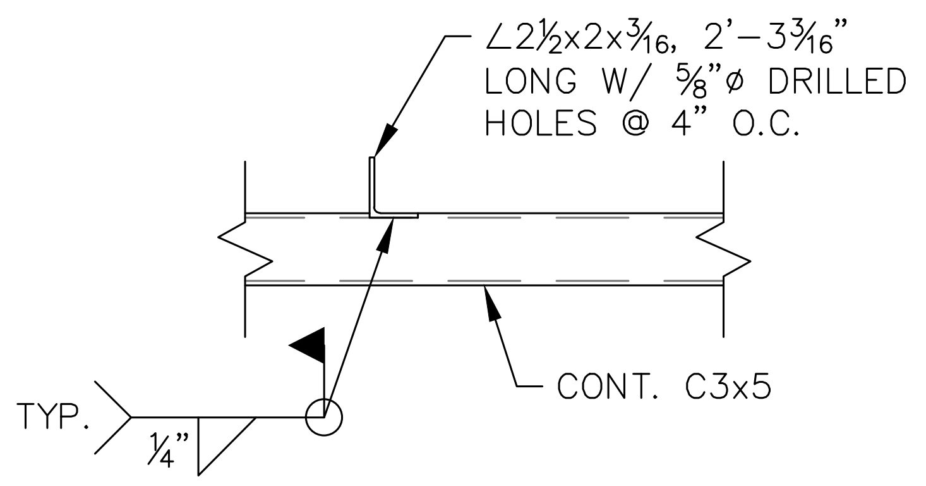
⑥ CONNECTION DETAIL
SCALE: 1 1/2"=1'-0"



Ⓐ DETAIL
SCALE: 1 1/2"=1'-0"


WELD ALL CONTACT POINTS BETWEEN STEEL ELEMENTS, UNO
1'-4"
TRIANGULAR PLATE
W12x40
45°
1'-4"
TRIANGULAR PLATE
C3x5
¼" CONNECTOR PLATES
¼" TRIANGULAR CONNECTOR PLATE

⑩ CONNECTION DETAIL
SCALE: 1 1/2"=1'-0"



⑫ CONNECTION DETAIL
SCALE: 1 1/2"=1'-0"

DAVID R. WILLIS
71232
2/4/20

PROPRIETARY AND CONFIDENTIAL

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ASSOCIATED STRUCTURAL ENGINEERS, INC
FIRM NUMBER F-2820
2405 S. INTERSTATE 35
NEW BRAUNFELS, TX. 78130
TEL.: (830) 625-5947 E-MAIL: OFFICE@ASESTRUCTURAL.COM

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

TOLERANCES	
.X	±.030
.XX	±.015
.XXX	±.005
FRACTIONAL	±1/16
ANGULAR:	
MACH	±.5°
BEND	±1°

REMOVE BURRS AND BREAK ALL SHARP EDGES

DRAWING SIZE: B
DO NOT SCALE DRAWING

CAD GENERATED DRAWING CONFORMS TO ANSI Y14.5M

	NAME	DATE
DRAWN	ESR	2/4/2020
CHECKED	DRW	2/4/2020
APPRV	DRW	2/4/2020

PROJECTION

MATERIAL

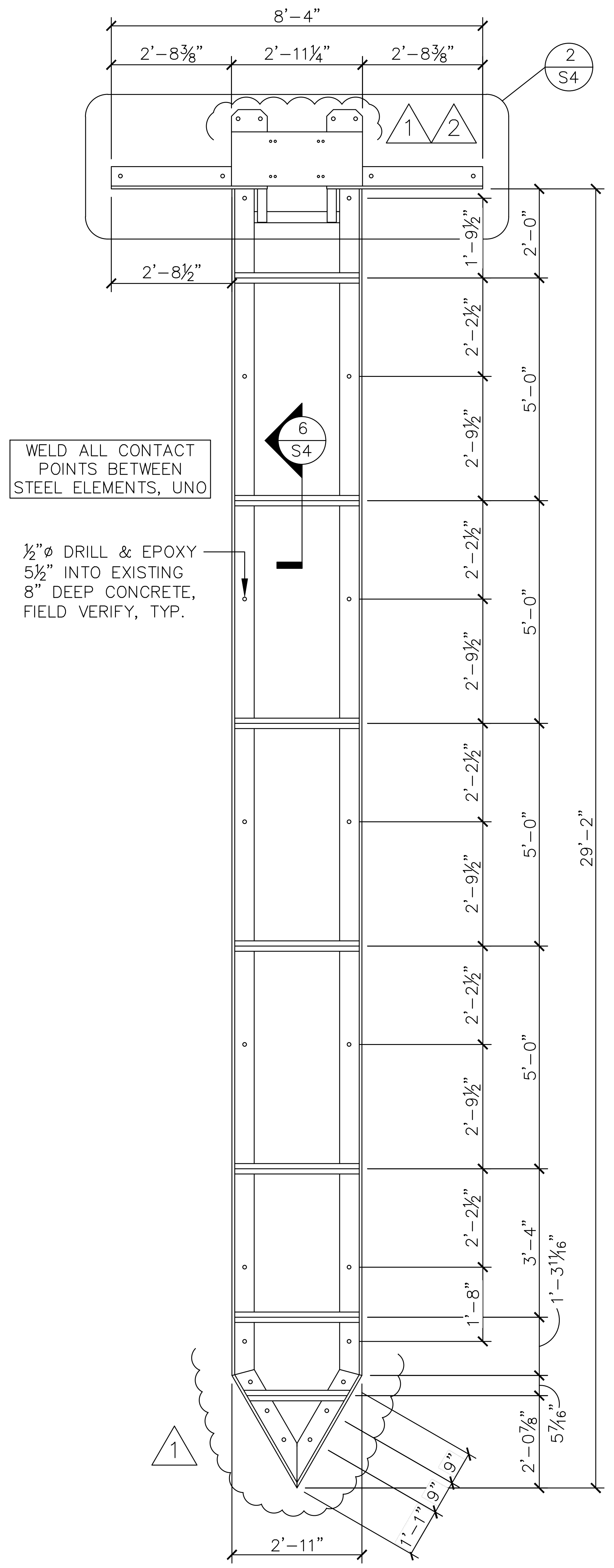
United Rentals
4768 HWY 123
BUILDING 1
SAN MARCOS, TX 78666

DESCRIPTION
STEEL FRAME DETAILS

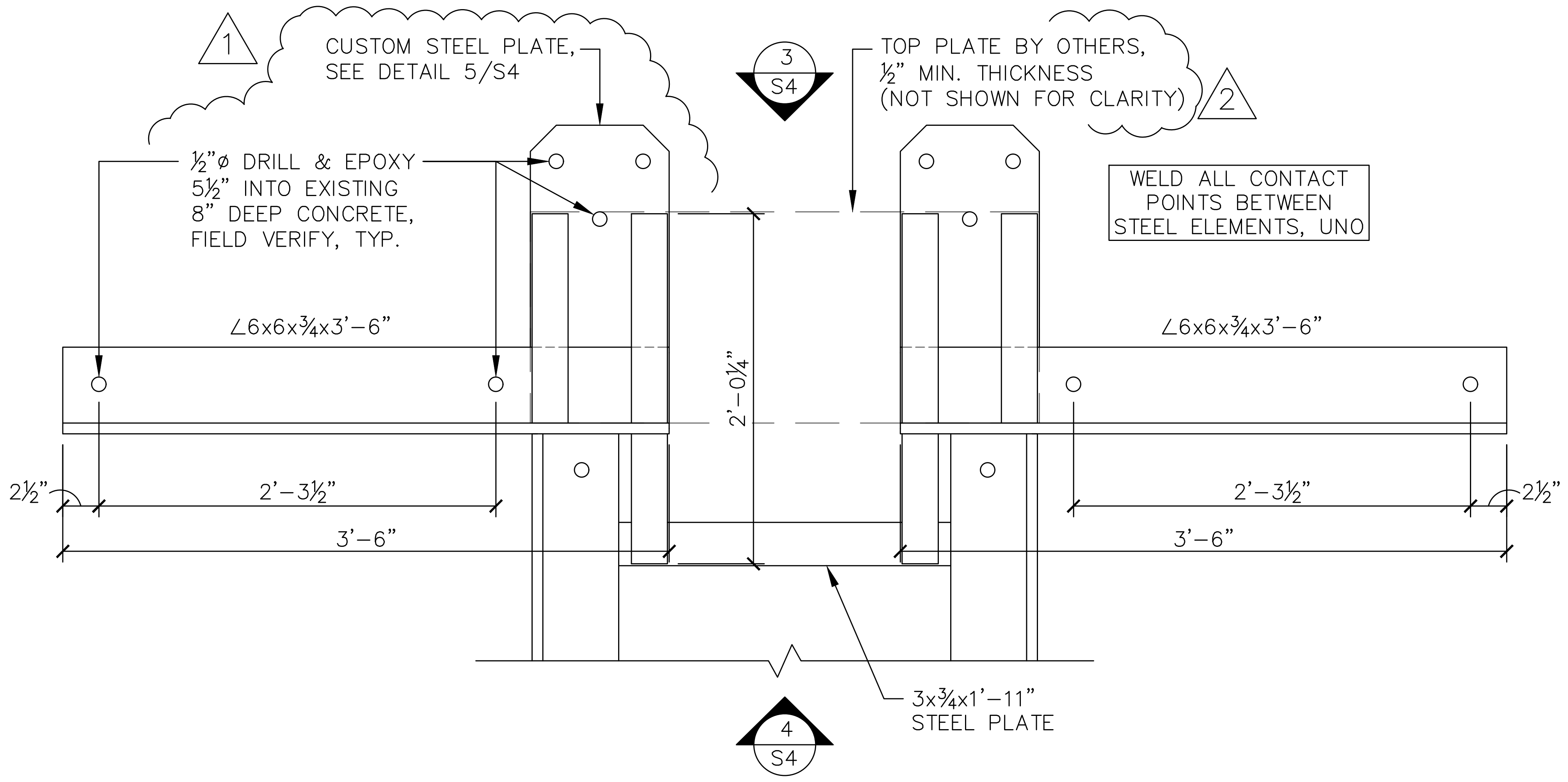
PROJECT KAISER MEAD

PART NO. N.A.
REV 2

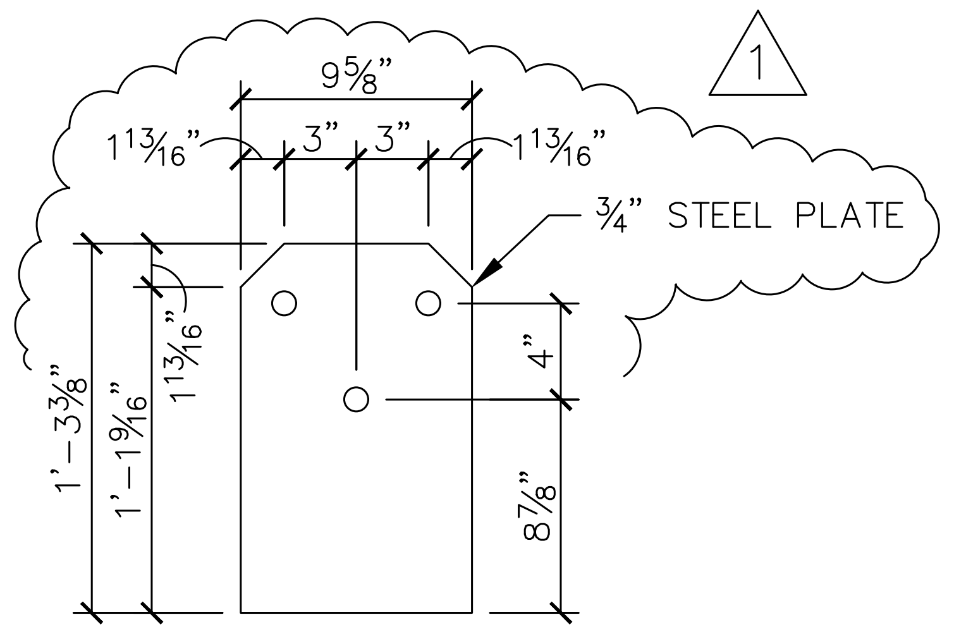
SCALE VARIES
WEIGHT (lbs) N.A.
SHEET S3 OF 4


8'-4"
2'-8⅜"
2'-11¼"
2'-8⅜"
2
S4
1
2
2'-8½"
1'-9½"
2'-0"
2'-2½"
5'-0"
2'-9½"
6
S4
WELD ALL CONTACT POINTS BETWEEN STEEL ELEMENTS, UNO
½"ø DRILL & EPOXY 5½" INTO EXISTING 8" DEEP CONCRETE, FIELD VERIFY, TYP.
29'-2"
3'-4"
1'-8"
1'-3⅟16"
2'-0⅞"
5⁷⁄₁₆"
9"
9"
1'-1"
1
2'-11"

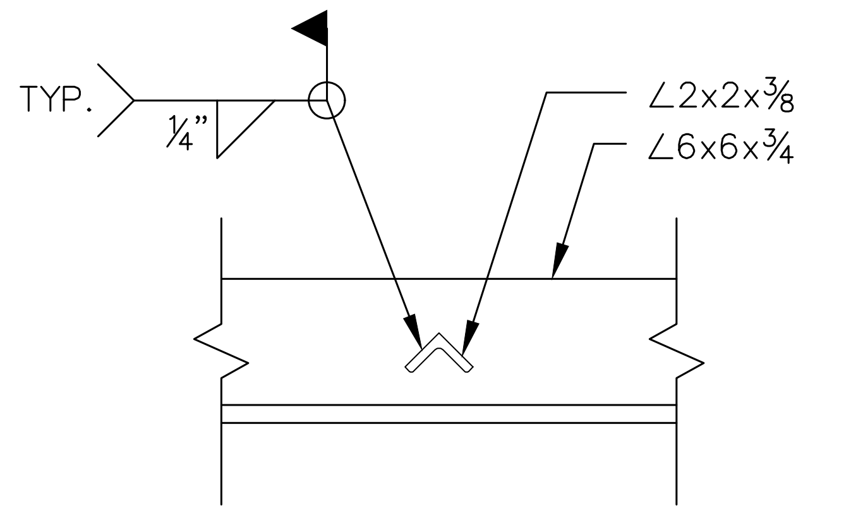
① ROLL OFF BOX RAIL PLAN
SCALE: 1/2"=1'-0"


1
CUSTOM STEEL PLATE, SEE DETAIL 5/S4
3
S4
TOP PLATE BY OTHERS, ½" MIN. THICKNESS (NOT SHOWN FOR CLARITY)
2
½"ø DRILL & EPOXY 5½" INTO EXISTING 8" DEEP CONCRETE, FIELD VERIFY, TYP.
WELD ALL CONTACT POINTS BETWEEN STEEL ELEMENTS, UNO
∠6x6x¾x3'-6"
∠6x6x¾x3'-6"
2'-0¼"
2½"
2'-3½"
3'-6"
2'-3½"
3'-6"
2½"
3x¾x1'-11" STEEL PLATE
4
S4

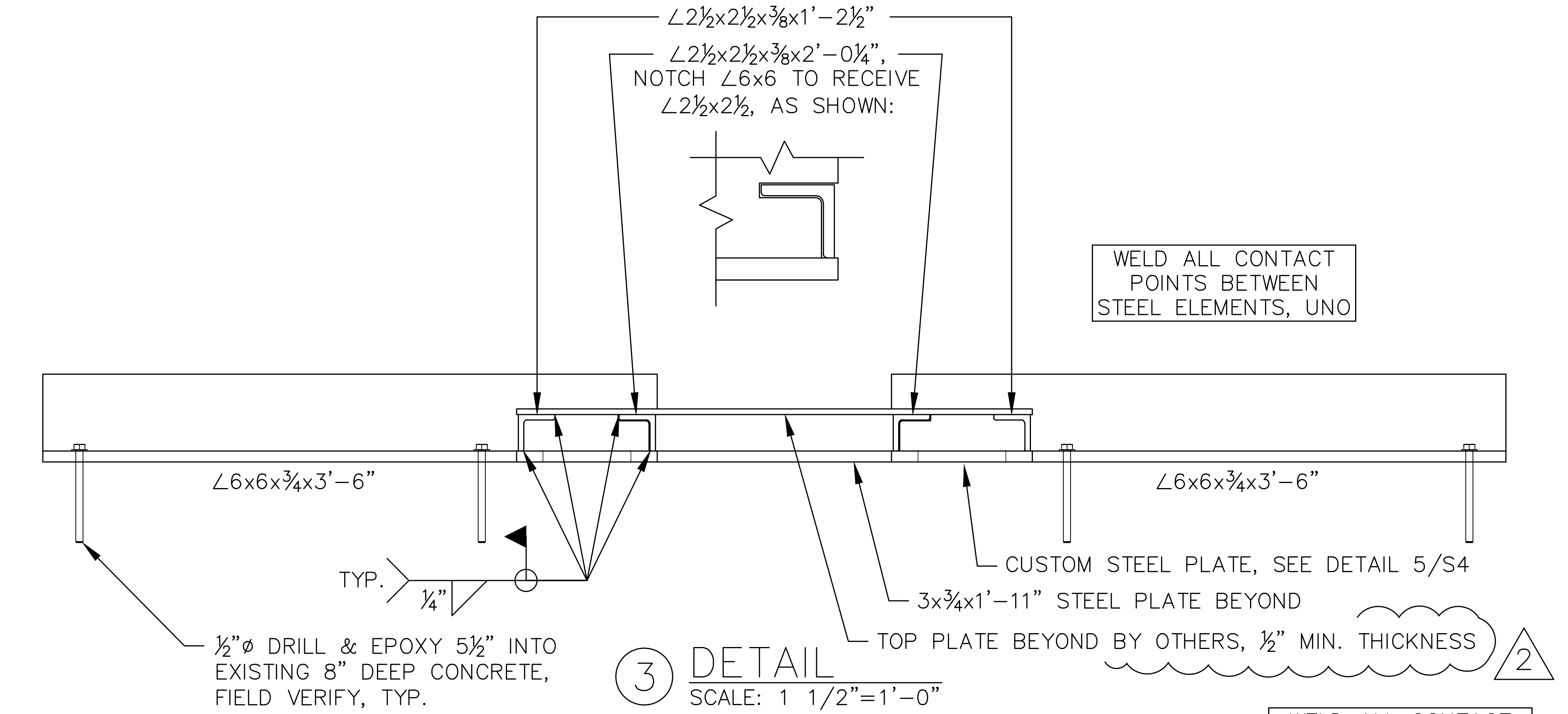
② DETAIL
SCALE: 1 1/2"=1'-0"



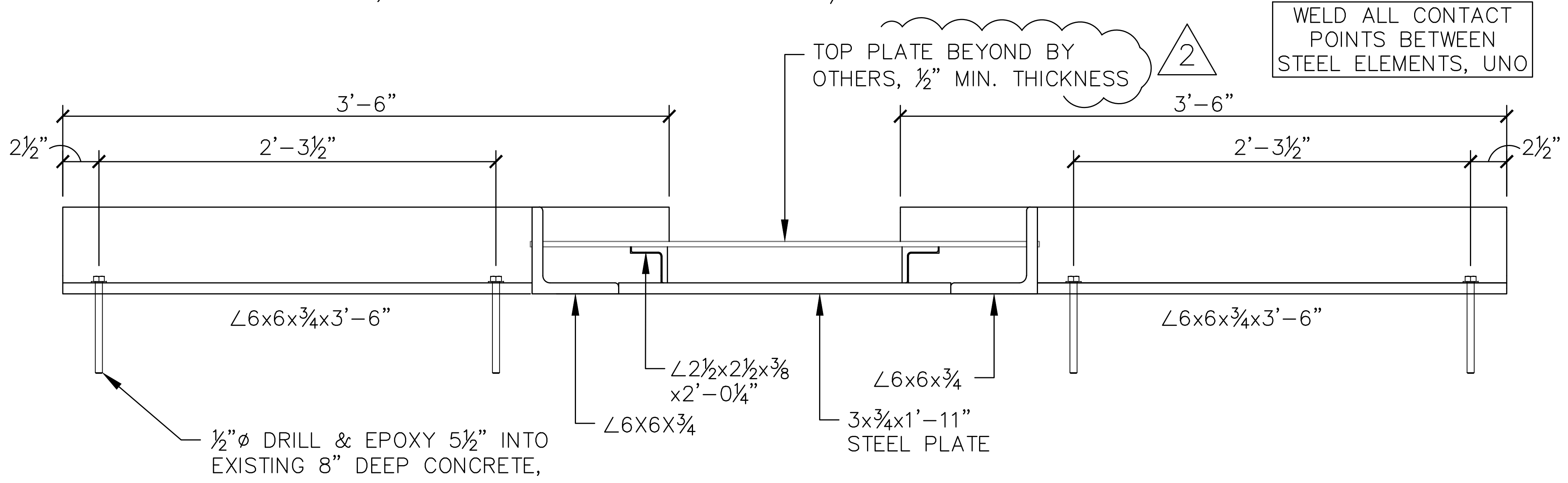
⑤ DETAIL
SCALE: 1 1/2"=1'-0"



⑥ CONNECTION DETAIL
SCALE: 1 1/2"=1'-0"


∠2½x2½x⅜x1'-2½"
∠2½x2½x⅜x2'-0¼", NOTCH ∠6x6 TO RECEIVE ∠2½x2½, AS SHOWN:
WELD ALL CONTACT POINTS BETWEEN STEEL ELEMENTS, UNO
∠6x6x¾x3'-6"
∠6x6x¾x3'-6"
TYP.
¼"
CUSTOM STEEL PLATE, SEE DETAIL 5/S4
3x¾x1'-11" STEEL PLATE BEYOND
TOP PLATE BEYOND BY OTHERS, ½" MIN. THICKNESS
2
½"ø DRILL & EPOXY 5½" INTO EXISTING 8" DEEP CONCRETE, FIELD VERIFY, TYP.

③ DETAIL
SCALE: 1 1/2"=1'-0"


TOP PLATE BEYOND BY OTHERS, ½" MIN. THICKNESS
2
WELD ALL CONTACT POINTS BETWEEN STEEL ELEMENTS, UNO
3'-6"
2½"
2'-3½"
3'-6"
2'-3½"
2½"
∠6x6x¾x3'-6"
∠6x6x¾x3'-6"
∠2½x2½x⅜ x2'-0¼"
∠6x6x¾
∠6X6X¾
3x¾x1'-11" STEEL PLATE
½"ø DRILL & EPOXY 5½" INTO EXISTING 8" DEEP CONCRETE, FIELD VERIFY, TYP.

④ DETAIL
SCALE: 1 1/2"=1'-0"

DAVID R. WILLIS
71232
LICENSED PROFESSIONAL ENGINEER
2/4/20

ASSOCIATED STRUCTURAL ENGINEERS, INC
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TOLERANCES

.X	±.030
.XX	±.015
.XXX	±.005
FRACTIONAL	±1/16
ANGULAR:	
MACH	±.5°
BEND	±1°

REMOVE BURRS AND BREAK ALL SHARP EDGES

DRAWING SIZE: B
DO NOT SCALE DRAWING

CAD GENERATED DRAWING CONFORMS TO ANSI Y14.5M

	NAME	DATE
DRAWN	ESR	2/4/2020
CHECKED	DRW	2/4/2020
APPRV	DRW	2/4/2020

PROJECTION

MATERIAL

United Rentals

4768 HWY 123
BUILDING 1
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DESCRIPTION
ROLL OFF BOX RAIL PLANS

PROJECT KAISER MEAD

PART NO. N.A.

REV 2

SCALE VARIES

WEIGHT (lbs) N.A.

SHEET S4 OF 4

Appendix D
Calculations

Table of Contents

Civil Calculations

Wetlands Process Calculations

Structural Calculations

Process Mechanical Calculations

Heating, Ventilation and Air Conditioning Calculations

Electrical Calculations

Civil Calculations

Earthwork Cut and Fill

KAISER MEAD GROUNDWATER
REMEDIATION INTERIM ACTION

CALCULATIONS

EARTHWORK CUT AND FILL

STUART W.I. BARTON
STATE OF WASHINGTON
54861
REGISTERED
PROFESSIONAL ENGINEER

Digitally Signed

on May 5, 2020

Stuart Barton

Cut/Fill Report

Generated: 2020-04-27 17:04:13

By user: BARTONS

Drawing: C:\pw_workdir\den003\jeg_bartons\d0601468\C:\pw_workdir\den003\jeg_bartons\d0601468\Wetland_Design.dwg

Volume Summary

Name	Type	Cut Factor	Fill Factor	2d Area (Sq. Ft.)	Cut (Cu. Yd.)	Fill (Cu. Yd.)	Net (Cu. Yd.)
Wetland Volume	full	1.00	1.00	106824.8	5081.95	3697.41	1384.54<Cut>
Infilitration Basin Volume	full	1.00	1.00	25657.8	1846.49	1517.93	328.56<Cut>
Fire Pond Volume	full	1.00	1.00	20064.6	1010.74	897.28	113.45<Cut>

Totals

	2d Area (Sq. Ft.)	Cut (Cu. Yd.)	Fill (Cu. Yd.)	Net (Cu. Yd.)
Total	152547.2	7939.18	6112.63	1826.55<Cut>

* Value adjusted by cut or fill factor other than 1.0

Source: AutoCAD Civil3D 2017 Stage Storage Report Generation
Contours Drawn By Stu Barton

Cell 1

Contour Elevation (ft)	Contour Area (sq. ft)	Depth Avg. End	Incremental Volume (cu. ft)	Cumulative Volume (cu. ft)	
1,940.00	15,179.70	N/A	N/A	0	
1,941.00	16,849.10	1	16014.39	16014.39	
1,942.00	18,575.00	1	17712.02	33726.41	
1,943.00	20,357.30	1	19466.15	53192.56	
1,944.00	22,196.20	1	21276.8	74469.36	Hydraulic Profile elevation
1,945.00	24,091.70	1	23143.95	97613.31	
1,946.00	26,043.60	1	25067.62	122680.9	

Cell 2A

Contour Elevation (ft)	Contour Area (sq. ft)	Depth Avg. End	Incremental Volume (cu. ft)	Cumulative Volume (cu. ft)	
1,940.00	1,509.70	N/A	N/A	0	
1,941.00	2,145.50	1	1827.59	1827.59	
1,942.00	2,837.80	1	2491.63	4319.23	
1,943.00	3,586.60	1	3212.21	7531.44	
1,944.00	4,392.00	1	3989.33	11520.77	Hydraulic Profile elevation
1,945.00	5,253.90	1	4822.98	16343.75	
1,946.00	6,172.40	1	5713.17	22056.91	

Cell 2B

Contour Elevation (ft)	Contour Area (sq. ft)	Depth Avg. End	Incremental Volume (cu. ft)	Cumulative Volume (cu. ft)	
1,938.00	9,796.70	N/A	N/A	0	
1,938.50	10,220.80	0.5	5004.36	5004.36	
1,939.00	10,651.90	0.5	5218.17	10222.53	
1,939.50	11,090.20	0.5	5435.54	15658.07	
1,940.00	11,535.60	0.5	5656.46	21314.53	Hydraulic Profile elevation
1,940.50	11,988.20	0.5	5880.95	27195.48	
1,941.00	12,447.80	0.5	6109	33304.49	
1,941.50	12,914.70	0.5	6340.62	39645.11	
1,942.00	12,604.80	0.5	6379.86	46024.97	

Cell 3A

Contour Elevation (ft)	Contour Area (sq. ft)	Depth Avg. End	Incremental Volume (cu. ft)	Cumulative Volume (cu. ft)	
1,938.00	5,005.70	N/A	N/A	0	
1,938.50	5,199.20	0.5	2551.23	2551.23	
1,939.00	5,393.00	0.5	2648.05	5199.28	
1,939.50	5,587.10	0.5	2745.03	7944.31	
1,940.00	5,781.50	0.5	2842.14	10786.45	Hydraulic Profile elevation
1,940.50	5,976.10	0.5	2939.39	13725.84	
1,941.00	6,171.00	0.5	3036.79	16762.63	

Cell 3B

Contour Elevation (ft)	Contour Area (sq. ft)	Depth Avg. End	Incremental Volume (cu. ft)	Cumulative Volume (cu. ft)	
1,938.00	20,061.20	N/A	N/A	0	
1,938.50	20,606.60	0.5	10166.94	10166.94	
1,939.00	21,157.70	0.5	10441.08	20608.03	
1,939.50	21,714.60	0.5	10718.07	31326.1	
1,940.00	22,277.10	0.5	10997.9	42324	Hydraulic Profile elevation
1,940.50	22,845.30	0.5	11280.58	53604.58	
1,941.00	23,418.90	0.5	11566.04	65170.62	

Infiltration Basin

Contour Elevation (ft)	Contour Area (sq. ft)	Depth Avg. End	Incremental Volume (cu. ft)	Cumulative Volume (cu. ft)	
1,919.00	6,659.00	N/A	N/A	0	
1,920.00	8,800.20	1	4400.22	4400.22	
1,921.00	10,997.70	1	9898.93	14299.15	Hydraulic Profile elevation
1,922.00	13,251.70	1	12124.73	26423.87	

Fire Pond

Contour Elevation (ft)	Contour Area (sq. ft)	Depth Avg. End	Incremental Volume (cu. ft)	Cumulative Volume (cu. ft)	
1,929.00	1,100.00	N/A	N/A	0	
1,930.00	1,578.30	1	1339.13	1339.13	
1,931.00	2,113.00	1	1845.65	3184.79	
1,932.00	2,704.40	1	2408.7	5593.49	Do not draw water down below 1,932
1,933.00	3,352.20	1	3028.27	8621.76	
1,934.00	4,056.50	1	3704.37	12326.13	
1,935.00	4,817.40	1	4436.99	16763.12	
1,936.00	5,634.80	1	5226.13	21989.25	
1,937.00	6,508.80	1	6071.8	28061.05	Water fill line designed as 1,937
1,938.00	7,439.20	1	6973.99	35035.04	
1,939.00	8,426.20	1	7932.7	42967.74	

Stability Calculations

CALCULATIONS

STABILITY CALCULATIONS

4-3-2020

DAVID PAIKO
STATE OF WASHINGTON
20100686
REGISTERED
PROFESSIONAL ENGINEER

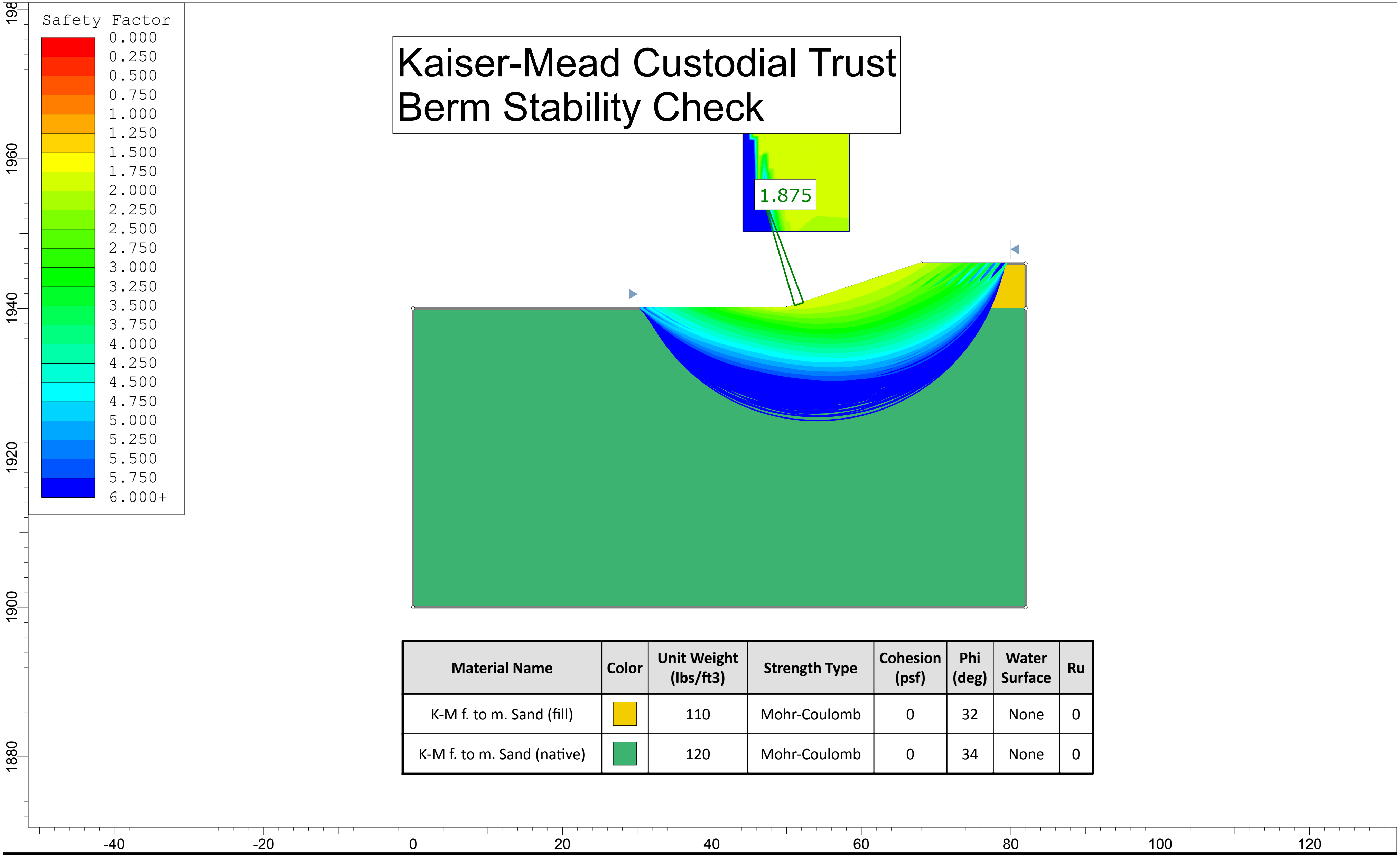
David J. Paiko

Digitally Signed on

April 3, 2020

Dave Paiko

Kaiser-Mead Custodial Trust
Berm Stability Check



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
K-M f. to m. Sand (fill)	🟨	110	Mohr-Coulomb	0	32	None	0
K-M f. to m. Sand (native)	🟩	120	Mohr-Coulomb	0	34	None	0

SLIDEINTERPRET 8.016

Project Kaiser-Mead Custodial Trust

Analysis Description Berm Stability Analysis

Drawn By Jacobs

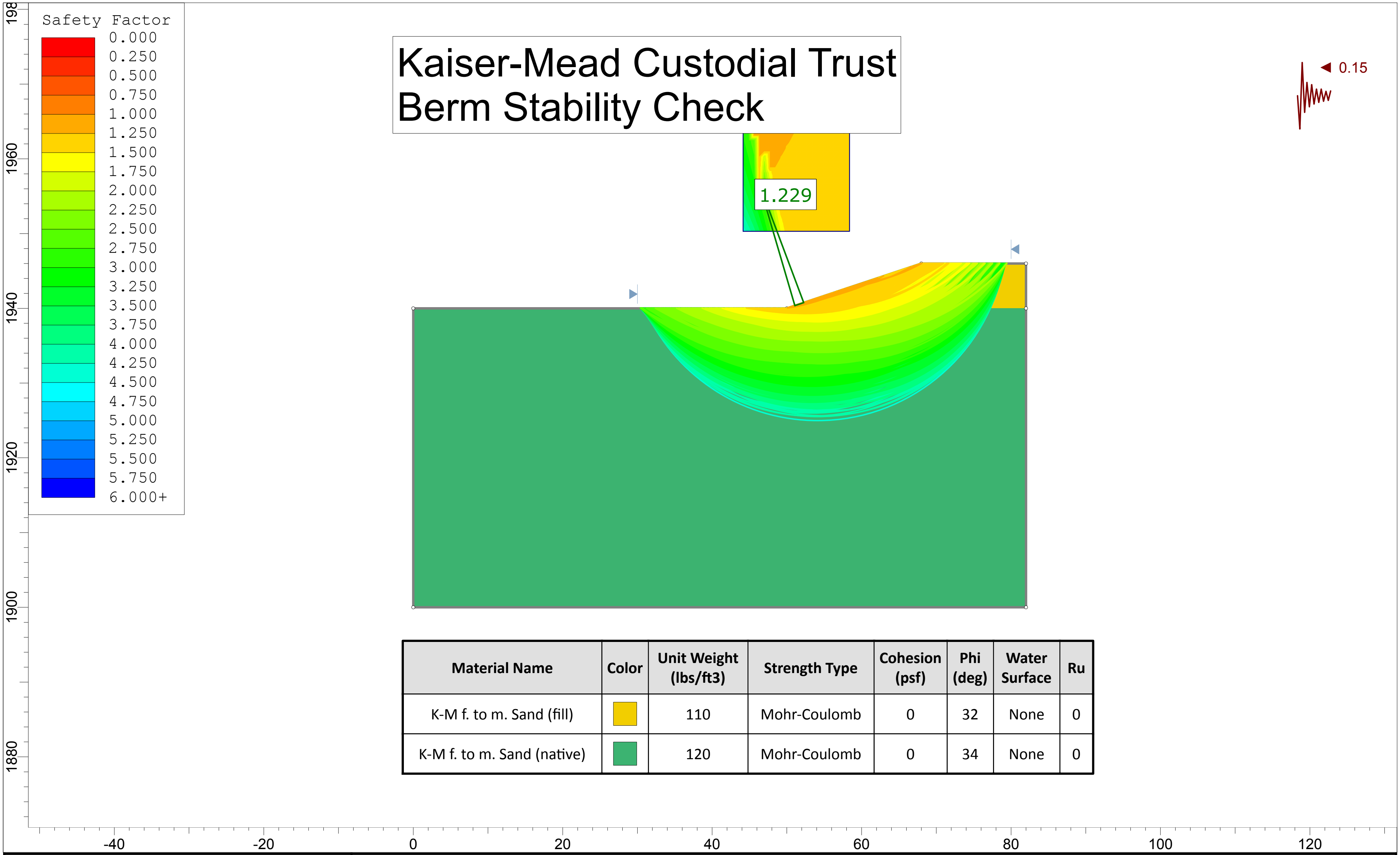
Scale 1:213

Company

Date Jan 9, 2020

File Name Berm Stability.slmd

Kaiser-Mead Custodial Trust
Berm Stability Check



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
K-M f. to m. Sand (fill)	🟨	110	Mohr-Coulomb	0	32	None	0
K-M f. to m. Sand (native)	🟩	120	Mohr-Coulomb	0	34	None	0

Project	Kaiser-Mead Custodial Trust		
Analysis Description	Berm Stability Analysis		
Drawn By Jacobs	*Scale* 1:213	*Company*	
Date Jan 9, 2020		*File Name* Berm Stability.slmd	

SLIDEINTERPRET 8.016

Project: Kaiser-Mead Custodial Trust

Calculation: Slope Stability with Static and Pseudo-static analyses

Date: January 10, 2020

Material Properties – Design properties from Robert Martin/SPK 1/8/20 as follows:

Martin, Robert/SPK 2:39 PM:

I put on the design criteria sheet, 0 cohesion, 34 degrees friction angle, 120 pcf

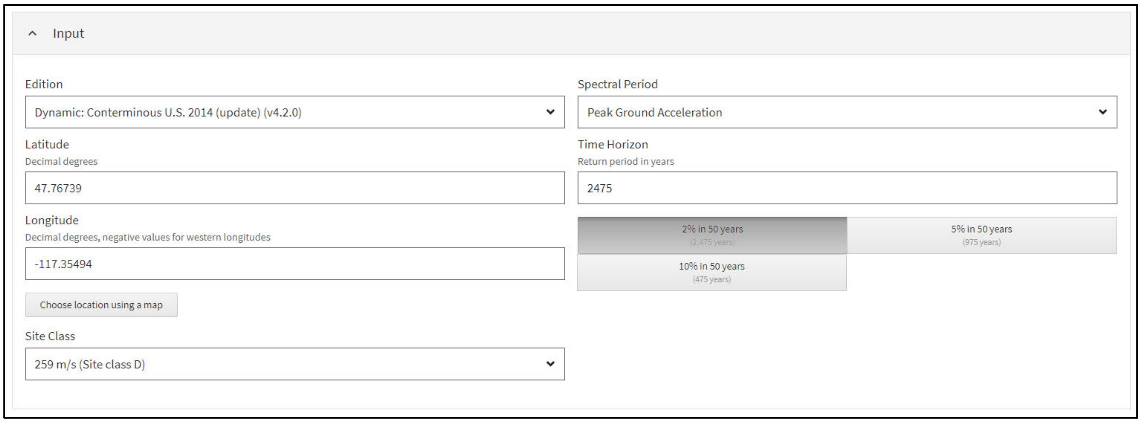
Static FS = 1.8 (Acceptable)

Psuedo-Static FS = 1.3 (Acceptable)

Max PGA for 2% in 50 years (2,475 years event) = 0.199

Typically use Kh = 0.5*PGA = 0.10 – used 0.15 (assumed max PGA = 0.30) to be conservative

https://earthquake.usgs.gov/hazards/interactive/



Input

Edition: Dynamic: Conterminous U.S. 2014 (update) (v4.2.0)

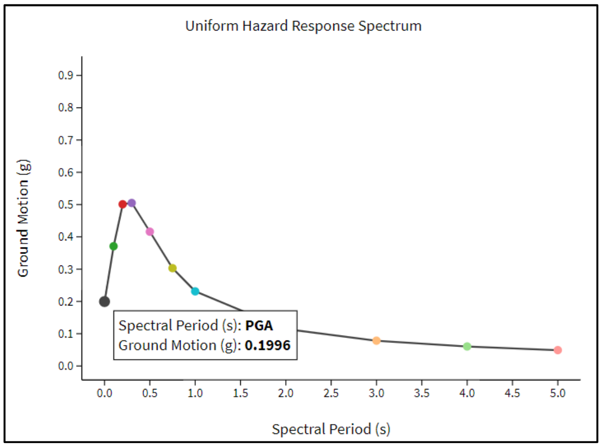
Spectral Period: Peak Ground Acceleration

Latitude (Decimal degrees): 47.76739

Time Horizon (Return period in years): 2475

Longitude (Decimal degrees, negative values for western longitudes): -117.35494

Site Class: 259 m/s (Site class D)



Liner Anchor Trench Pullout

The following Liner Anchor Trench Pullout calculation is for the geocomposite liner material GundSeal. The wetland liner system has since been revised to be constructed of separate geomembrane and geosynthetic clay composite lining materials. This revision does not substantively alter the properties of the geocomposite anchor trench relative to the conclusions of the calculation that the anchor forces do not exceed the geomembrane liner tensile strength. No revision of this calculation is necessary.

JAY G. DEHNER
STATE OF WASHINGTON
0023455
REGISTERED
PROFESSIONAL ENGINEER

JUNE 2, 2020

KAISER MEAD GROUNDWATER
REMEDIATION INTERIM ACTION

CALCULATIONS

LINER ANCHOR TRENCH
PULLOUT

4-3-2020

DAVID PAIKO
STATE OF WASHINGTON
20100686
REGISTERED
PROFESSIONAL ENGINEER

David J. Paiko

Digitally Signed on

April 3, 2020

Dave Paiko

Method Reference: Koerner, R.M. Xlibris Corporation, Bloomington, IN (2012). "Designing with Geosynthetics."

The purpose of this calculation is to verify the anchor trench design does not exceed the liner tensile strength.

Project: Kaiser-Mead Custodial Trust

Description: Project entails 3H:1V berm slopes constructed out of native or existing material. Liner subgrade consists of existing subgrade and fill material overlaine with 60-mil GSE Gundseal GCL. Liner trench will be backfilled and compacted using native fill material.

Input Variables

Backfill Soil

Unit weight of backfill soil: $\gamma := 120 \cdot \text{pcf}$

Friction angle of backfill soil: $\phi := 34 \cdot \text{deg}$

At rest earth pressure: $k_o := 1 - \sin(\phi)$

Interface friction angle: $\delta := 42\text{deg}$

Cover Soil

Unit weight of cover soil: $\gamma_{cs} := 120 \cdot \text{pcf}$

Trench Geometry

Depth of cover soil: $d_{cs} := 0 \cdot \text{ft}$

Length of run out section: $L_{ro} := 2 \cdot \text{ft}$

Depth of anchor trench: $d_{at} := 2 \cdot \text{ft}$

Length of anchor trench: $L_{at} := 1 \cdot \text{ft}$

Calculations

Surcharge pressure: $q := d_{cs} \cdot \gamma_{cs}$ $\quad q = 0 \cdot \text{psf}$

Friction force below geomembrane: $F_L := q \cdot \tan(\delta) \cdot L_{ro}$ $\quad F_L = 0 \cdot \frac{\text{lbf}}{\text{ft}}$

Friction force above geomembrane: $F_U := 0$ *assumed to be negligible*

Friction force on anchor trench side: $F_{at} := \left(d_{cs} + \frac{d_{at}}{2}\right) \cdot \gamma \cdot k_o \cdot \tan(\delta) \cdot d_{at}$ $\quad F_{at} = 95.3 \cdot \frac{\text{lbf}}{\text{ft}}$

Friction on anchor trench bottom $F_{bot} := \left(d_{cs} + d_{at}\right) \cdot \gamma \cdot \tan(\delta) \cdot L_{at}$ $\quad F_{bot} = 216.1 \cdot \frac{\text{lbf}}{\text{ft}}$

Tension on Liner

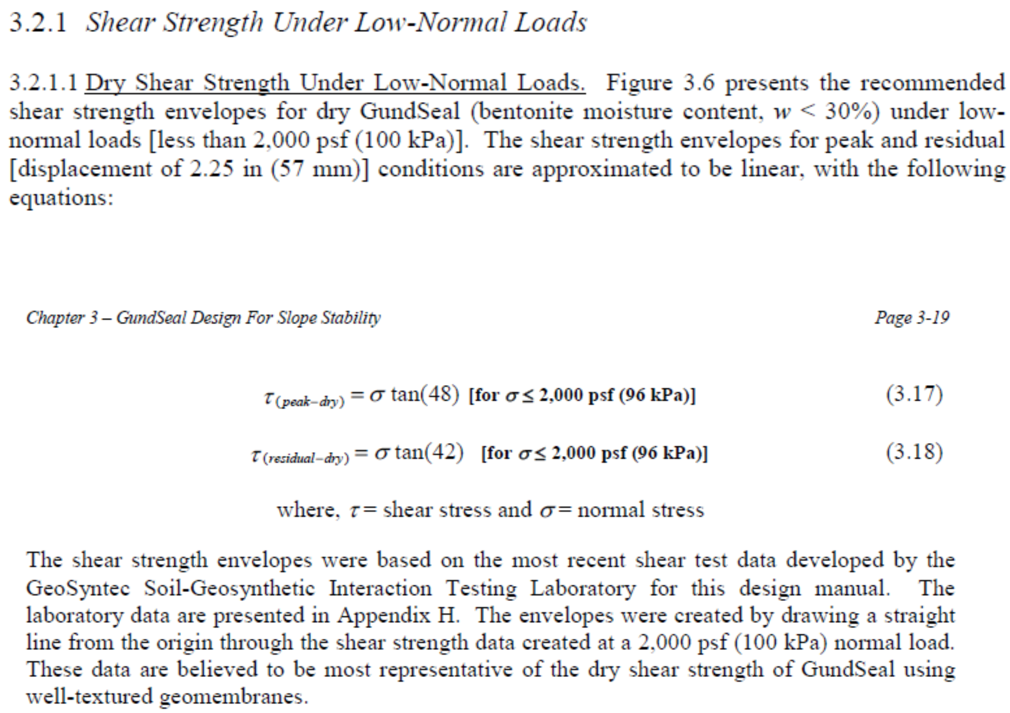
$T_A := F_L + F_U + 2 \cdot F_{at} + 2 \cdot F_{bot}$ $\quad T_A = 623 \cdot \frac{\text{lbf}}{\text{ft}}$

Liner Strength $L_{strength} := 1080 \frac{\text{lbf}}{\text{ft}}$ *based on test data of 90 lb/in (allowable) for Gundseal GCL*

Conclusion

Comparing anchor forces (T_A) to liner properties strenght, the anchor forces do not exceed liner tensile strength conservatively assuming interface friction of both sides of Gundseal is 42deg. Anchor Trench is acceptable.

Shear strength assumptions based on GSE Environmental GundSeal GCL Design Manual



3.2.1 *Shear Strength Under Low-Normal Loads*

3.2.1.1 Dry Shear Strength Under Low-Normal Loads. Figure 3.6 presents the recommended shear strength envelopes for dry GundSeal (bentonite moisture content, $w < 30\%$) under low-normal loads [less than 2,000 psf (100 kPa)]. The shear strength envelopes for peak and residual [displacement of 2.25 in (57 mm)] conditions are approximated to be linear, with the following equations:

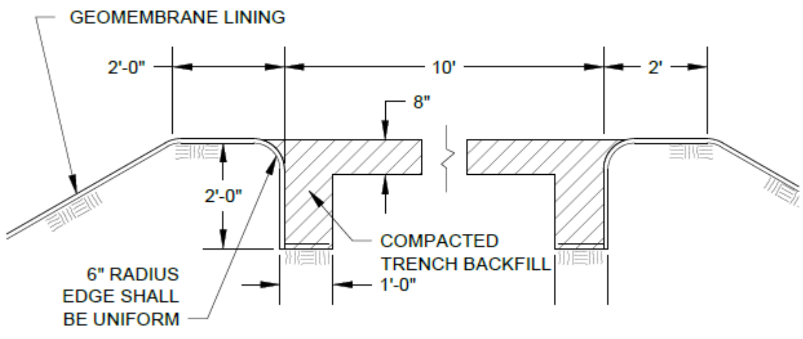
Chapter 3 – GundSeal Design For Slope Stability *Page 3-19*

$$\tau_{(peak-dry)} = \sigma \tan(48) \quad \textbf{[for } \sigma \le \textbf{2,000 psf (96 kPa)]} \qquad (3.17)$$

$$\tau_{(residual-dry)} = \sigma \tan(42) \quad \textbf{[for } \sigma \le \textbf{2,000 psf (96 kPa)]} \qquad (3.18)$$

where, τ = shear stress and σ = normal stress

The shear strength envelopes were based on the most recent shear test data developed by the GeoSyntec Soil-Geosynthetic Interaction Testing Laboratory for this design manual. The laboratory data are presented in Appendix H. The envelopes were created by drawing a straight line from the origin through the shear strength data created at a 2,000 psf (100 kPa) normal load. These data are believed to be most representative of the dry shear strength of GundSeal using well-textured geomembranes.



1 LINING ANCHOR TRENCH

NTS

Well Hydraulics

CALCULATIONS

WELL HYDRAULICS

State of Washington
HYDROGEOLOGIST
1587
Licensed Geologist
ROBERT F. MARTIN JR.

Digitally Signed on

April 3, 2020

Robert Martin

CALCULATION COVER SHEET

Project:	Kaiser Mead Groundwater Remediation Interim Action	**Issue Date:**	01/15/2020
Client:	Kaiser Mead Custodial Trust	**Project No.**	KMCT2019

Calculation Title:	Groundwater and Well Hydraulics
Calculation Originator:	Bob Martin
Calculation Checker:	Mark Henry

Version	**Originator** *Signature/Date*	**Checker** *Signature/Date*
Pre-Final	***Bob Martin*** 1/14/2020	***Mark Henry*** 1/15/2020

Comments:

Systematic approach is acceptable. Did not review explicit details of model input/calculations, but output seems reasonable given knowledge of aquifer properties. Reviewed provided tables for accuracy.

Calculation Summary:

Well Field Development drawdown, field parameters, and saturated zone profiling.

Analytic testing blending pumping rates for highest concentration blend

Correlation of TCN to EC for performance monitoring.

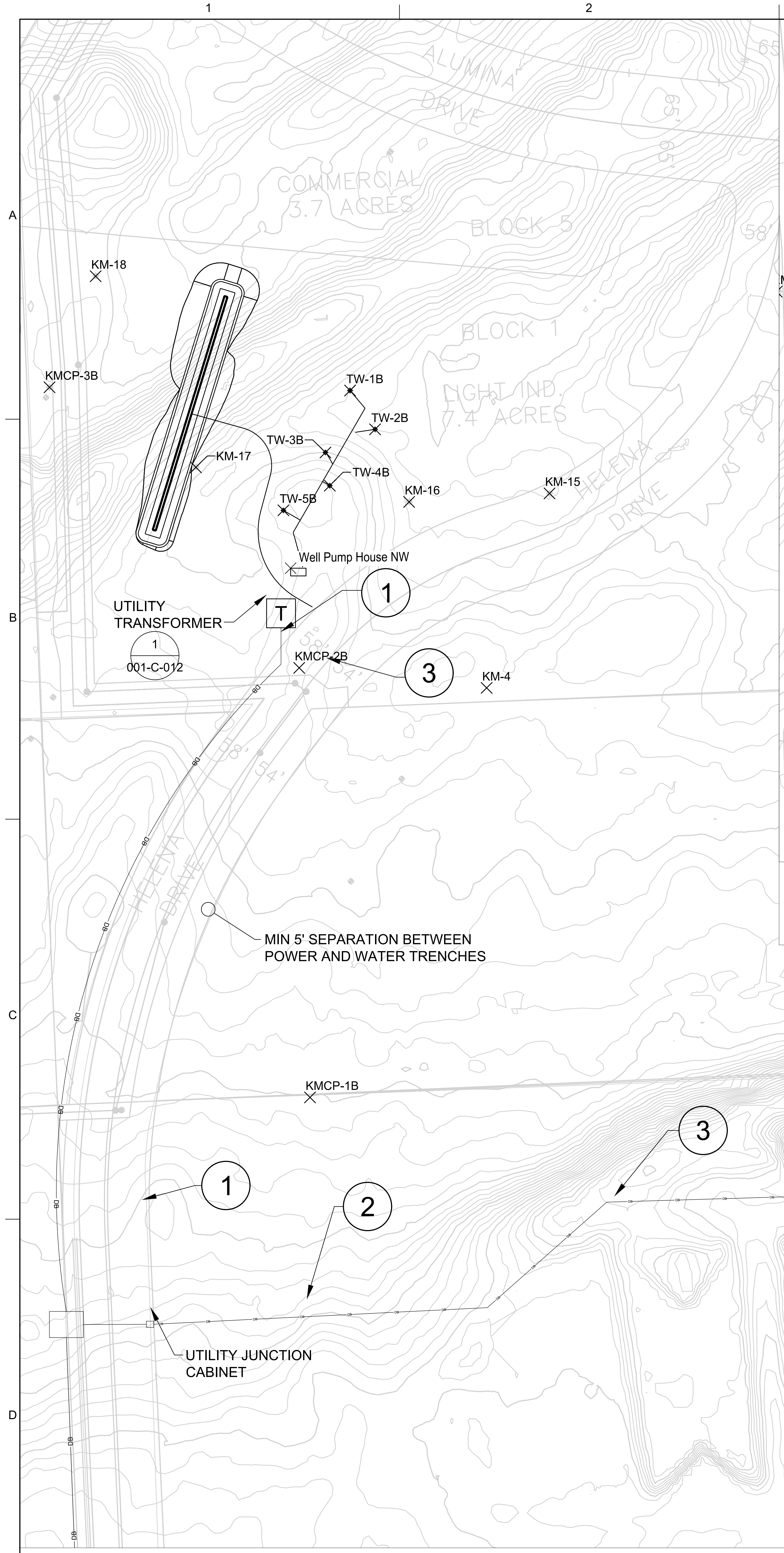
K value update based on development pumping and drawdown

Revised modeling for 3 Scenarios, includes actual well locations and updated K values

1 – Planned pumping rate schedule with infiltration

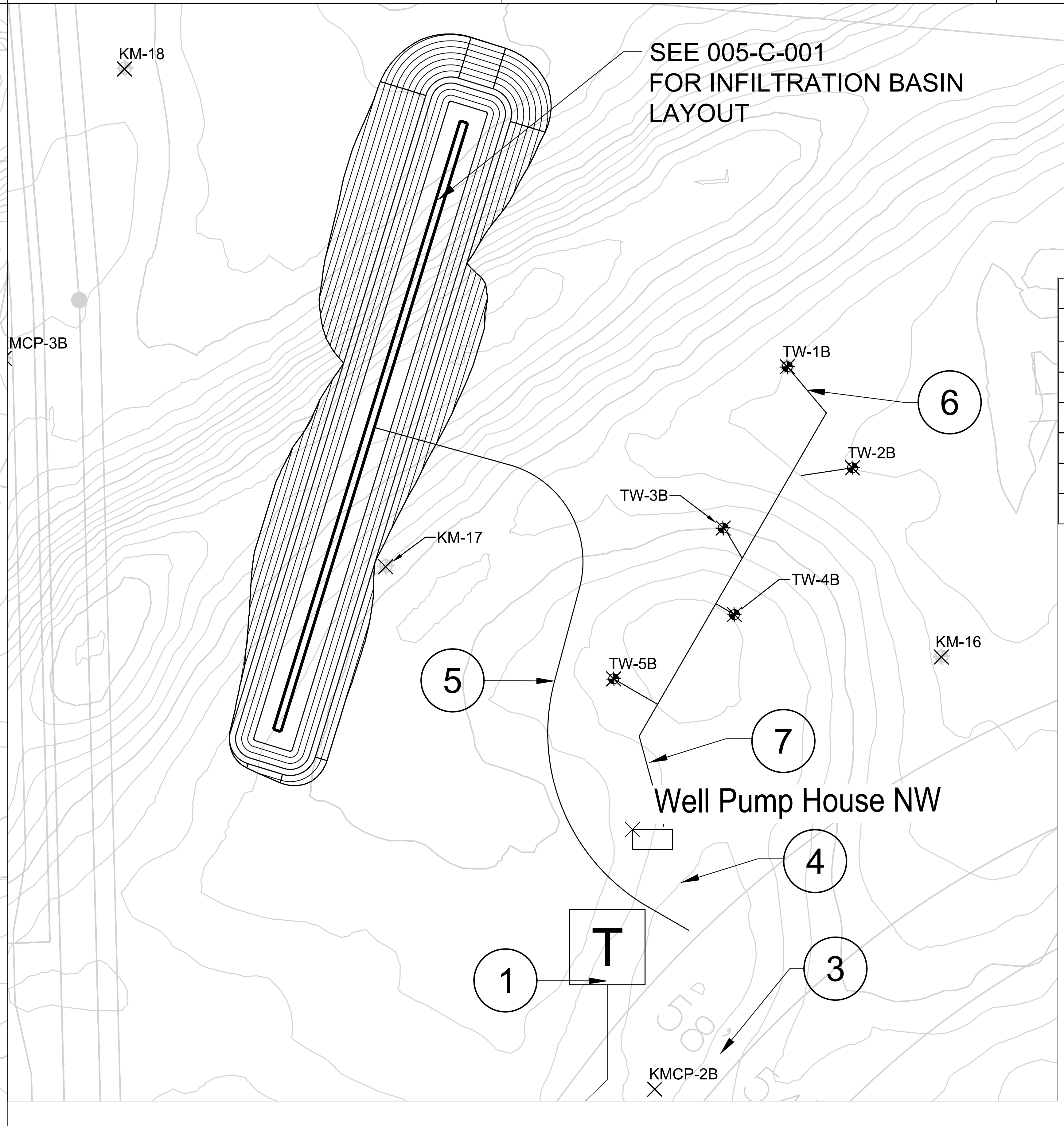
2 – Initial pumping rate schedule (10 gpm each well) with infiltration

3 – Planned pumping rate schedule without infiltration (for simulated initial startup conditions and for comparison without IB)



SITE CIVIL PLAN

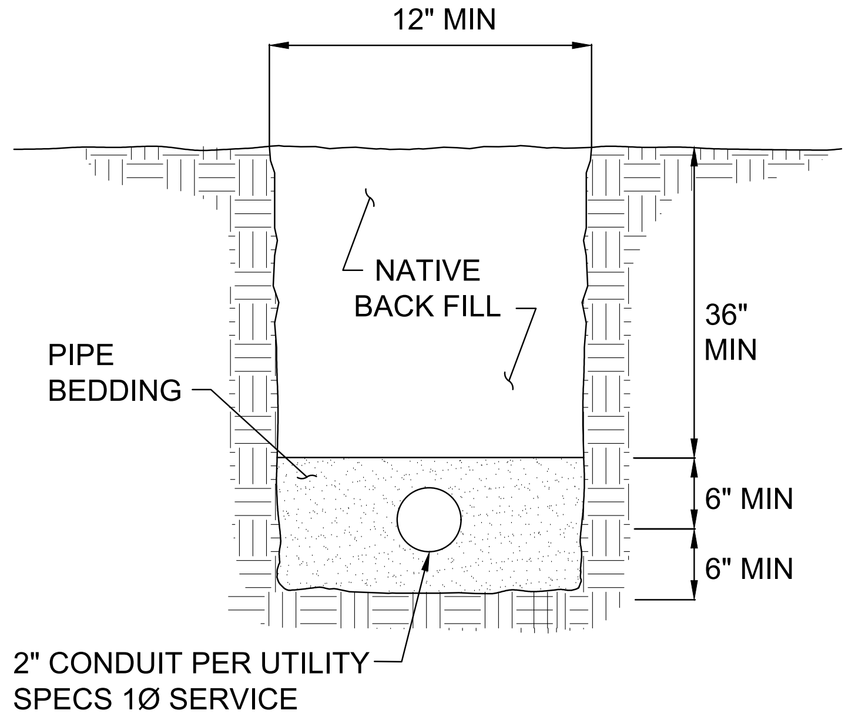
1" = 100'-0"



WELLFIELD LAYOUT

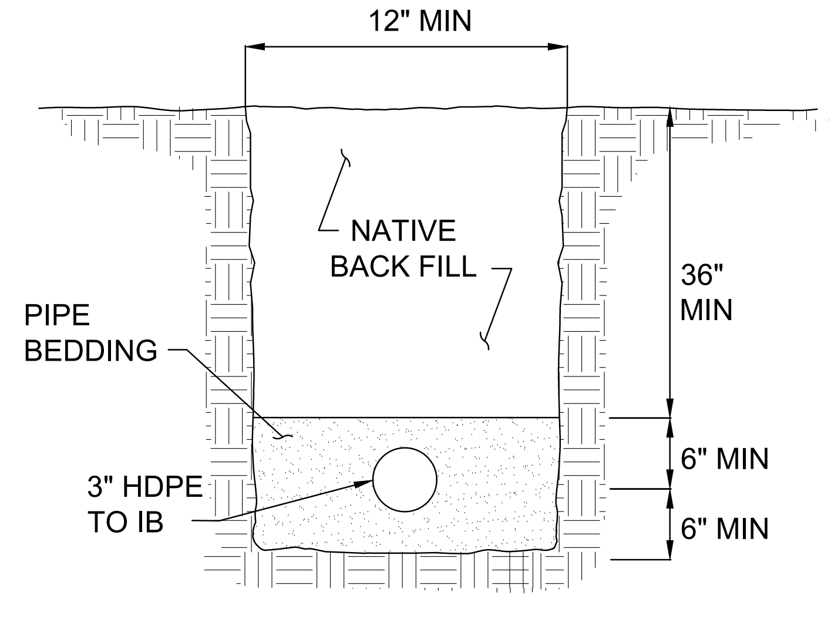
1" = 50'-0"

Point Table			
Point #	Raw Description	Northing	Easting
1	WELL PUMP HOUSE	296240.0107	2487428.2224
2	TW-5B	296315.0200	2487418.8700
3	TW-4B	296347.0500	2487479.0000
4	TW-3B	296390.0900	2487473.3900
5	TW-2B	296420.1000	2487537.7600
6	TW-1B	296470.4200	2487505.3200



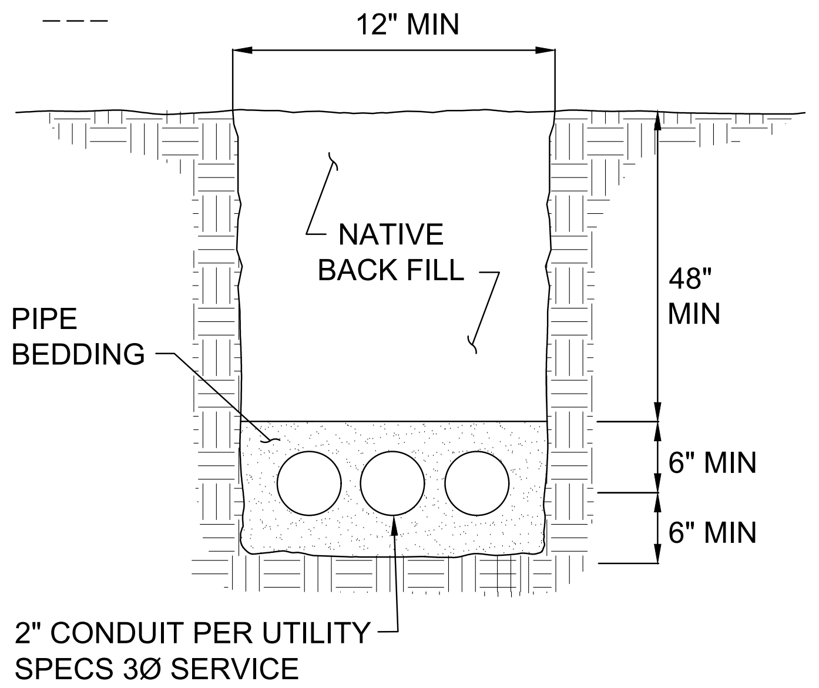
① EXTRACTION POWER TRENCH

NTS



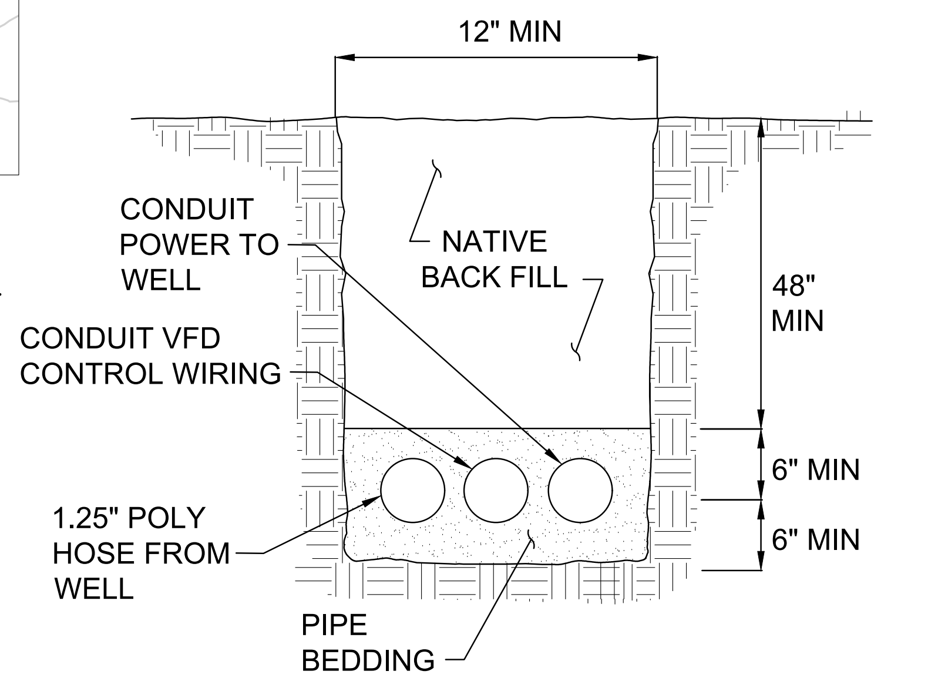
⑤ IB WATER TRENCH

NTS



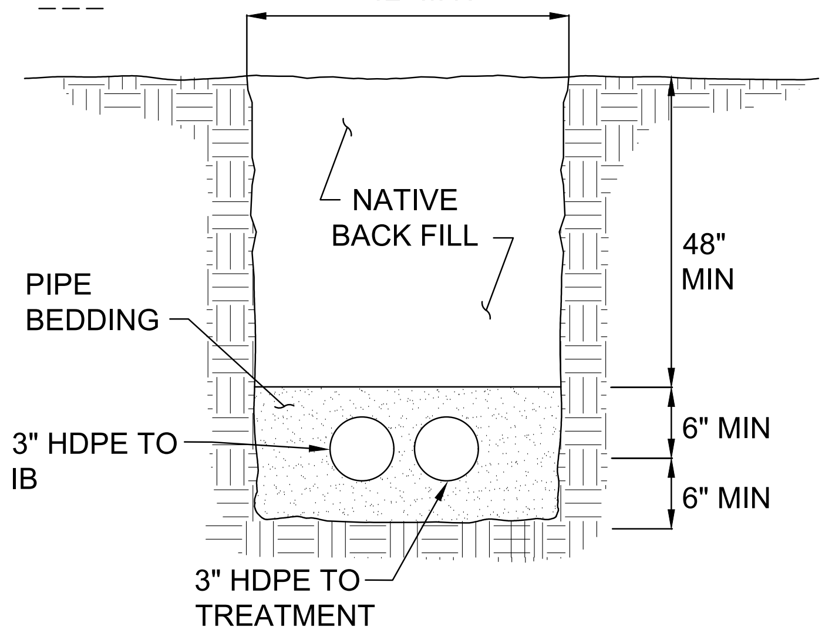
② TREATMENT POWER TRENCH

NTS



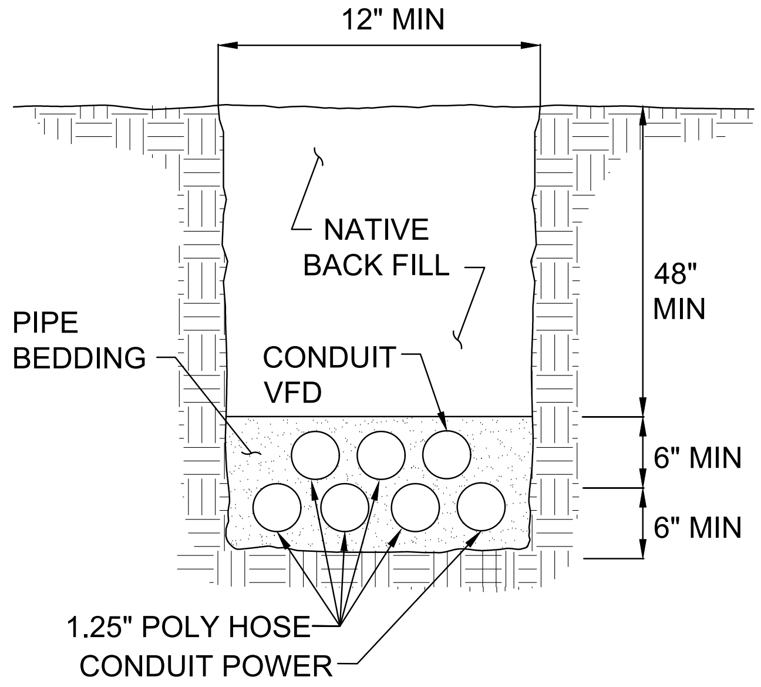
⑥ WELL TRENCH

NTS



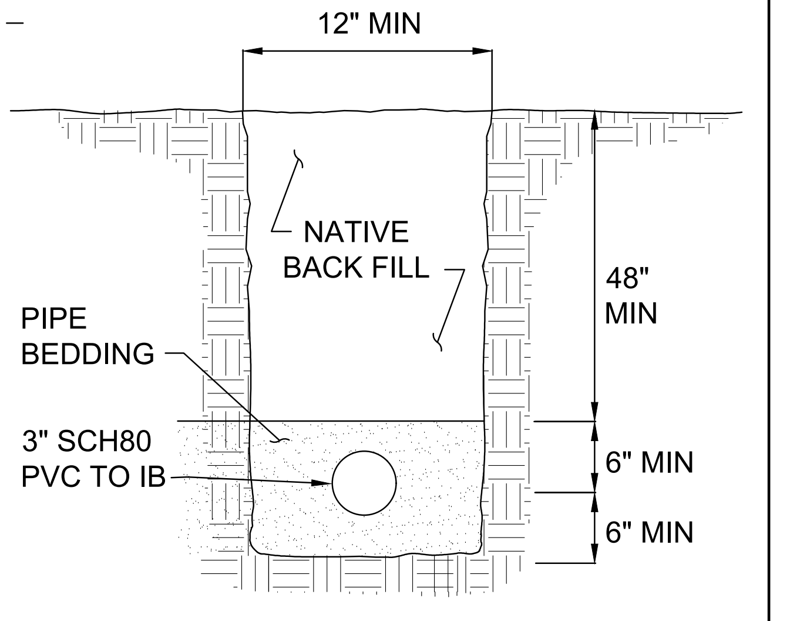
③ EXTRACTION/IB WATER TRENCH

NTS



⑦ WELL TRENCH

NTS



④ EXTRACTION WATER TRENCH

NTS

STUART W. BARTON
54861

NO.	DATE	REVISION	DR	CHK	APVD	BY	APVD
DSGN							

Ground Water Extraction and Cleanup
Mead, Washington
Kaiser Mead Custodial Trust
-

JACOBS

KAISER MEAD CUSTODIAL TRUST
SITE CIVIL PLAN

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"

DATE	
PROJ	KMCT2019
DWG	000-C-002
SHEET	11 of 28

Interim Action - Summary of Well Construction Details

	TW-1B	TW-2B	TW-3B	TW-4B	TW-5B
GS Elevation[1]	1916.6	1916.0	1920.1	1922.3	1922.5
Total Depth Drilled (ft bgs)	167	160	169	167.5	175
Top of Aquitard (ft bgs)	163	160	167	167.5	170
Top of Aquitard Elev	1754	1756	1753	1755	1753
Well casing diameter (ft)	0.5	0.5	0.5	0.5	0.5
Sump length (feet)	0.5	1	4	1	1
Bottom Constructed sump (ft bgs)	163.4	160.5	168.7	167.3	168.5
Bottom screen (ft bgs)	163	159.5	164.7	166.3	167.5
Top of screen (ft bgs)	153	149.5	154.7	156.3	152.5
Screen length (ft)	10	10	10	10	15
Bottom screen elevation	1754	1757	1755	1756	1755
Top of screen elevation	1764	1767	1765	1766	1770
Packer assembly length (ft)	?	2	5	2	2
Screen size	18 slot (153-158) 20 slot (158-163)	30 slot (150-155) 30 slot (155-160)	25 slot (155-160) 18 slot (160-165)	25 slot (156-161) 20 slot (161-166)	25 slot (153-158) 25 slot (158-163) 20 slot (163-168)
Stickup (ft)	2.4	2.4	2.4	2.3	2.7
SWL (ft bgs) (Nov 2019)	148.3	147.4	151.7	153.8	154.1
SWL elevation (Nov 2019)	1768.3	1768.6	1768.4	1768.5	1768.4

[1] Benthin & Associates survey

All elevations and as-built depths to be field verified post-drilling.

🟨 Existing

Hydrometrics, Inc.
Consulting Scientists and Engineers
Helena, Montana

Hole Name: TW-1B

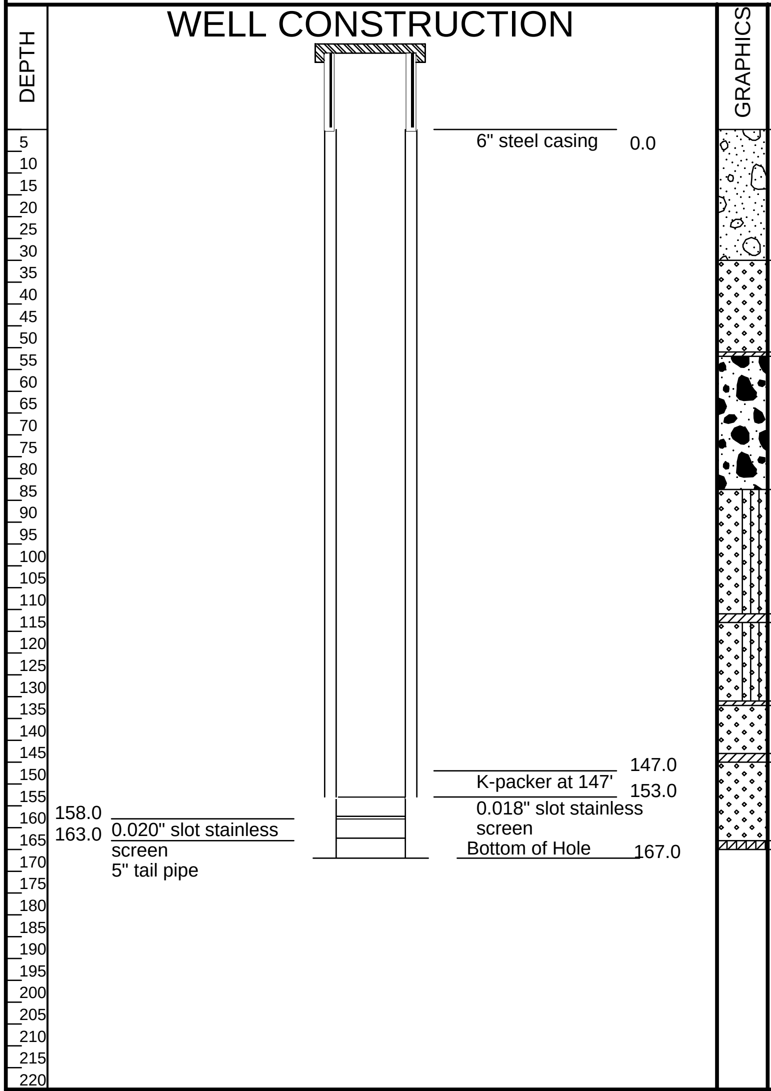
Date Hole Started: 01/09/13 Date Hole Finished: 01/13/13

Client: Mead Custodial Trust
Project: Kaiser Mead NPL
County: Spokane State: Washington
Property Owner: Kaiser Aluminum Investments Co
Legal Description: Tax ID: 36096.9060
Location Description: Approximately 300' east of Compliance well KMCP-3
Recorded By: LMJ
Drilling Company: H2O Well Service
Driller: Mark
Drilling Method: Conventional Rotary
Drilling Fluids Used: Air/Water
Purpose of Hole: Aquifer Testing
Target Aquifer: Zone B
Hole Diameter (in): 6-inch
Total Depth Drilled (ft): 167

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	6 inch Steel Casing	+2 - 167
Surface Casing Used?	Y	Temporary 10" casing	+2 - 18
Screen/Perforations?	Y	0.018" slot; 0.020" slot stainless	153 - 158; 158 - 163
Sand Pack?	N		
Annular Seal?	Y	Bentonite Chips	0 - 18
Surface Seal?	Y	Bentonite annular seal	
DEVELOPMENT/SAMPLING			
Well Developed?	Y	Air development	
Water Samples Taken?	Y	pumping test sample	
Boring Samples Taken?	Y	Split Spoon Samples from 145-160	5' intervals

Northing: 2487494 Easting: 296512
Static Water Level Below MP: 147 Surface Casing Height (ft): +2
Date: 1/16/2013 Ground Surface Elevation (ft): 1916.60
MP Description: Top of Steel Casing MP Elevation (ft): 1919.04
MP Height Above or Below Ground (ft): 2'

Remarks: Field notes reference this well as TW-B, which was corrected to TW-1B in compiled Logs and field investigation report



GEOLOGICAL DESCRIPTION

0.0 - 30.0' **Coarse Sand with Gravel**
Dark gray to brown, poorly sorted coarse sand with minor pebbles, set 10 inch casing to 18 feet, 20 foot plugging casing, injecting water.

30.0 - 51.0' **Fine to Medium Grained Sand**
Fine to medium grained sand with some silt.

51.0 - 52.0' **Clay**
Clay, less than one foot thick.

52.0 - 82.5' **Sand with Gravel**
Coarse sand with gravel, pebbles to 1/2", 60 feet, occasional pebble to 1 inch, 62 feet, decreasing pebbles, sand fining downward, 82 feet, 1/2 inch pebbles.

82.5 - 111.0' **Fine Grained Sand with Silt**
Fine grained sand with minor silt.

111.0 - 113.0' **Clay**
Light gray to green gray plastic clay.

113.0 - 131.0' **Fine Grained Sand with Silt**
Fine grained sand plus or minus silt. Spoon sample at 115 - 116.5, very fine grained sand with silt - dry.

131.0 - 132.0' **Clay**
Light gray to green gray plastic clay.

132.0 - 143.0' **Sand**
Fine grained sand, coarser grained at 134 feet.

143.0 - 145.0' **Clay**
Light gray to green gray plastic clay.

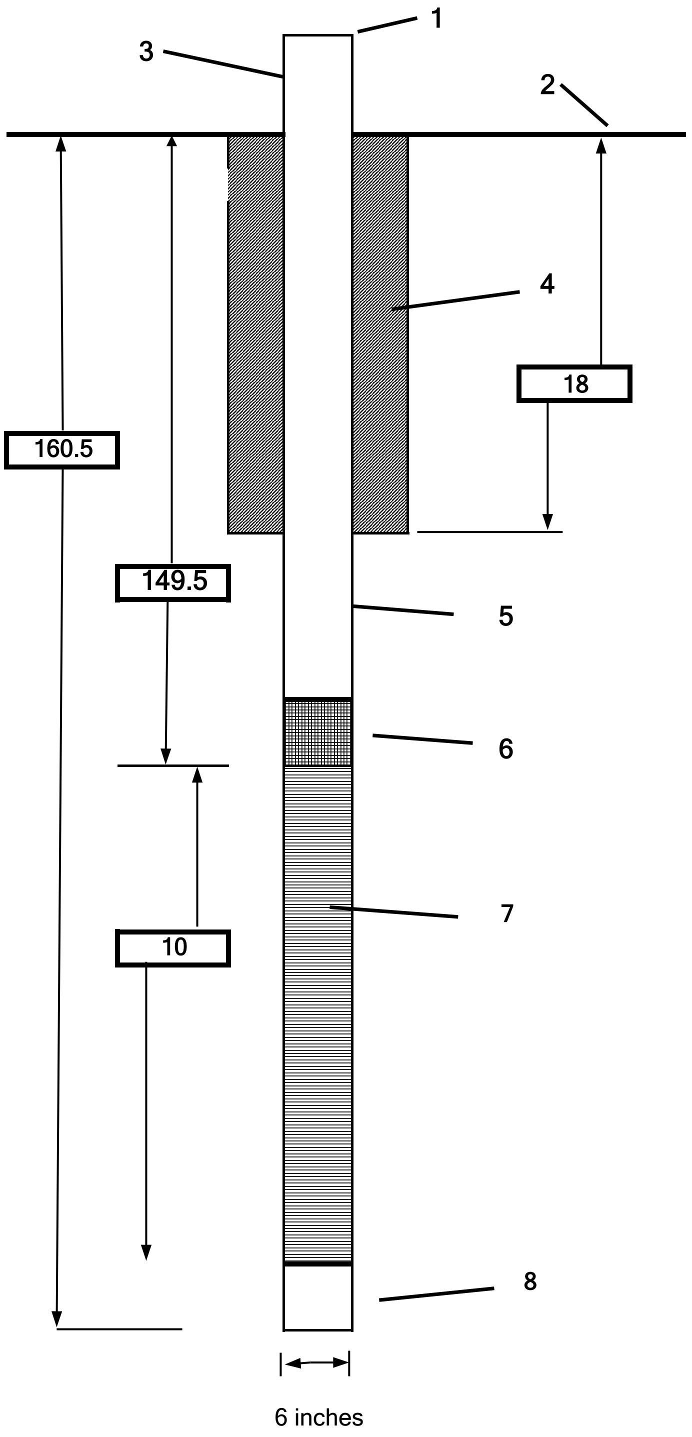
145.0 - 163.0' **Fine to Coarse Grained Sand**
Heaving sands, drill string gets sandpacked, have to inject water to free up drill rods. Let hole sit overnight and SWL = 147 feet, sample water with bailer, pH = 8.67, SC = 1249, about 1 foot of sand heave. Spoon samples at 155 feet and 160 feet, wet coarse sand, 162 feet making less than 5 gpm.

163.0 - 165.0' **Clay with Silt**
Green gray, firm, dense clay with silt, cuttings become dry.
TD at 165 feet.

PROJECT NUMBER KMCT2019.3200	WELL NUMBER TW - 2B

WELL COMPLETION DIAGRAM

PROJECT: KMCT Interim Action Extraction Well Installation
LOCATION : Approx. 700 feet E-SE of Winchester Ave./Newport Highway intersection, Spokane, WA
DRILLING CONTRACTOR: H2O Well Service Inc., Hayden ID
DRILLING METHOD AND EQUIPMENT USED: Air Rotary with Casing Hammer
WATER LEVELS : During drilling, estimated at approx. 146 ft bgs. On 11/15/19, 150.01 ft btc (147.5 ft bgs)
LOGGER: K Savage



Unique Ecology Well ID Tag	BKW-216
1- Top of casing elevation	1918.39 ft (NAVD88)
2- Ground elevation at well	1916.0 ft (NAVD88)
3- Wellhead riser and casing	6-inch ID steel casing with lockable aluminum lid. Key 2190
4- Surface seal	10-inch ID temporary casing to 18 feet bgs. At completion, 10-inch casing pulled and annulus backfilled with bentonite chips
5- Well Casing	6-inch ID mild steel casing. Upon installation of the screen, the casing was pulled back to expose the telescoping screen
6- Packer assembly	Figure K neoprene packer with 2 feet of 5-inch ID head pipe
7- Type/slot size of screen	6-inch stainless steel, continuous wire-wrapped telescoping screen (approx. 5-inch ID). 30 slot (0.030 inch) 149.5 to 159.5 ft. bgs
8- Sump	1-foot long steel sump, 5-inch ID

Comments: TD at top of clay aquitard
Development: Pumped for 45 minutes at 9 gpm; drawdown of 0.47 ft
Specific conductivity of 1,857 uS/cm and pH 9.05 at sample collection

PROJECT NUMBER	WELL NUMBER
KMCT2019.3200	TW - 3B

WELL COMPLETION DIAGRAM

PROJECT: KMCT Interim Action Extraction Well Installation

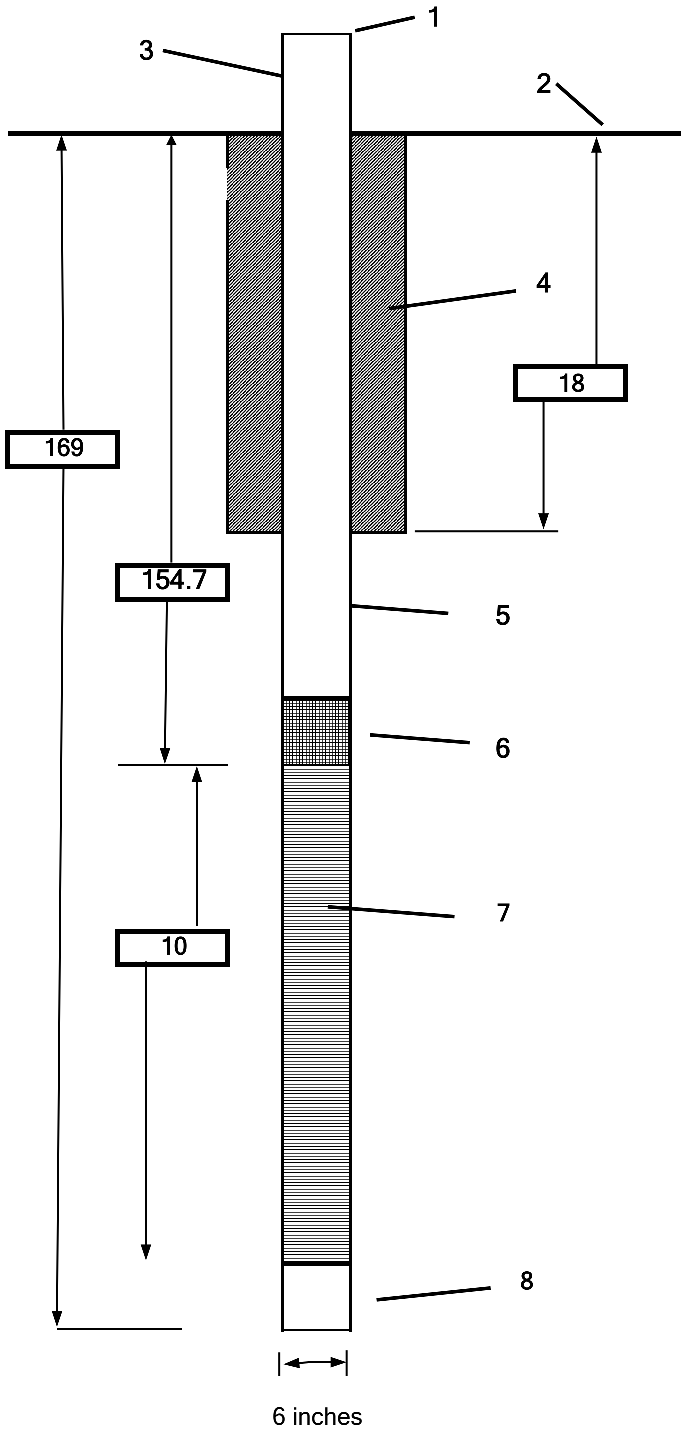
LOCATION : Approx. 700 feet E-SE of Winchester Ave./Newport Highway intersection, Spokane, WA

DRILLING CONTRACTOR: H2O Well Service Inc., Hayden ID

DRILLING METHOD AND EQUIPMENT USED: Air Rotary with Casing Hammer

WATER LEVELS : During drilling, estimated at approx. 160 ft bgs. On 11/15/19, 154.23 ft btc (151.7 ft bgs)

LOGGER: K Savage



Unique Ecology Well ID Tag BKW-213

1- Top of casing elevation	1922.53 ft (NAVD88)
2- Ground elevation at well	1920.1 ft (NAVD88)
3- Wellhead riser and casing	6-inch ID steel casing with lockable aluminum lid. Key 2190
4- Surface seal	10-inch ID temporary casing to 18 feet bgs. At completion, 10-inch casing pulled and annulus backfilled with bentonite chips
5- Well Casing	6-inch ID mild steel casing. Upon installation of the screen, the casing was pulled back to expose the telescoping screen
6- Packer assembly	Figure K neoprene packer with 5 feet of 5-inch ID head pipe
7- Type/slot size of screen	6-inch stainless steel, continuous wire-wrapped telescoping screen (approx. 5-inch ID). 25 slot (0.025 inch) 154.7 to 159.7 ft. bgs, 18 slot (0.018 inch) 159.7 to 164.7 ft bgs
8- Sump	4-foot long steel sump, 5-inch ID

Comments: Top of clay aquitard at 167 ft bgs; TD at 169 ft bgs (still in clay)

Development: Pumped for 40 minutes at 11 gpm; drawdown of 0.22 ft Specific conductivity of 3,151 uS/cm and pH 9.84 at sample collection

JACOBS

PROJECT NUMBER	WELL NUMBER
KMCT2019.3200	TW - 4B

WELL COMPLETION DIAGRAM

PROJECT: KMCT Interim Action Extraction Well Installation

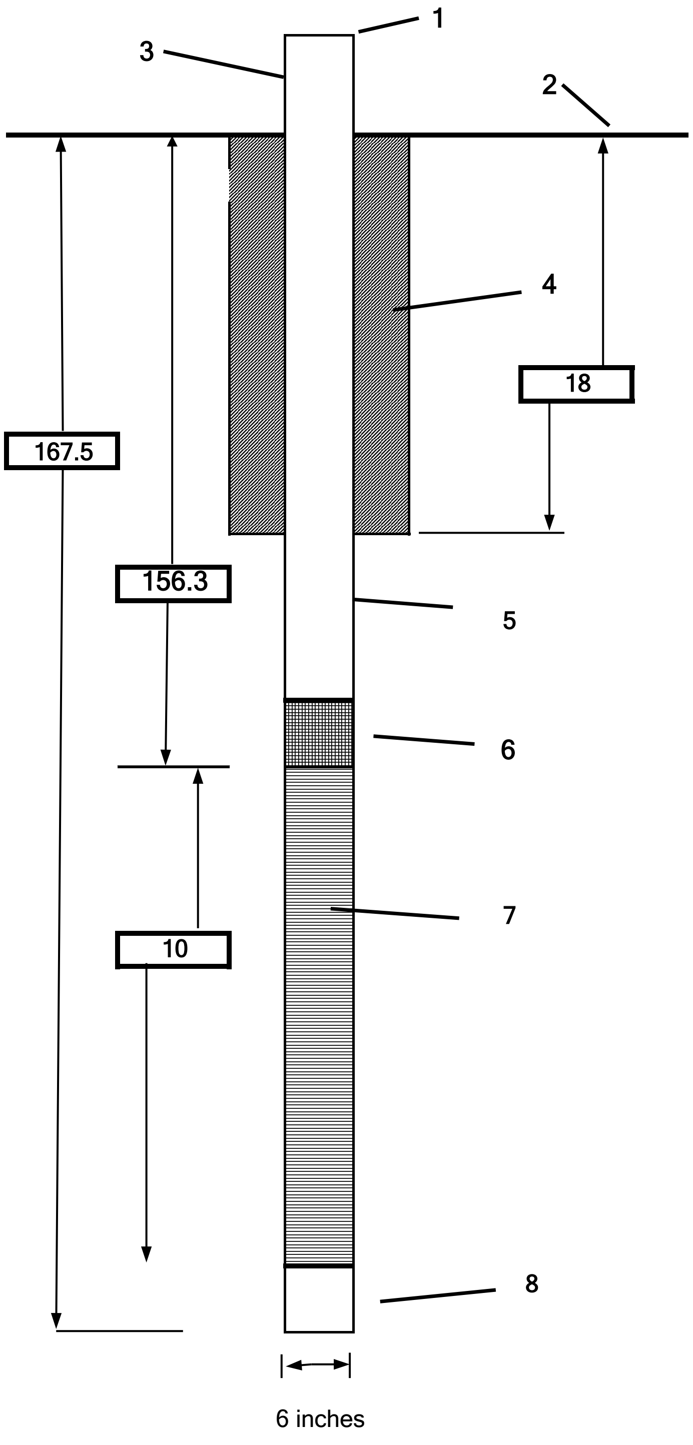
LOCATION : Approx. 700 feet E-SE of Winchester Ave./Newport Highway intersection, Spokane, WA

DRILLING CONTRACTOR: H2O Well Service Inc., Hayden ID

DRILLING METHOD AND EQUIPMENT USED: Air Rotary with Casing Hammer

WATER LEVELS : During drilling, estimated at approx. 160 ft bgs. On 11/15/19, 156.27 ft btc (153.8 ft bgs)

LOGGER: K Savage



Unique Ecology Well ID Tag	BKW-215
1- Top of casing elevation	1924.60 ft (NAVD88)
2- Ground elevation at well	1922.3 ft (NAVD88)
3- Wellhead riser and casing	6-inch ID steel casing with lockable aluminum lid. Key 2190
4- Surface seal	10-inch ID temporary casing to 18 feet bgs. At completion, 10-inch casing pulled and annulus backfilled with bentonite chips
5- Well Casing	6-inch ID mild steel casing. Upon installation of the screen, the casing was pulled back to expose the telescoping screen
6- Packer assembly	Figure K neoprene packer with 2 feet of 5-inch ID head pipe
7- Type/slot size of screen	6-inch stainless steel, continuous wire-wrapped telescoping screen (approx. 5-inch ID). 25 slot (0.025 inch) 156.3 to 161.3 ft. bgs, 20 slot (0.020 inch) 161.3 to 166.3 ft bgs
8- Sump	1-foot long steel sump, 5-inch ID

Comments: Top of clay aquitard at 167.5 ft bgs; TD at 167.5 ft bgs

Development: Pumped for 45 minutes at 9.5 gpm; drawdown of 0.07 ft Specific conductivity of 3,845 uS/cm and pH 10.05 at sample collection

PROJECT NUMBER	WELL NUMBER
KMCT2019.3200	TW - 5B

WELL COMPLETION DIAGRAM

PROJECT: KMCT Interim Action Extraction Well Installation

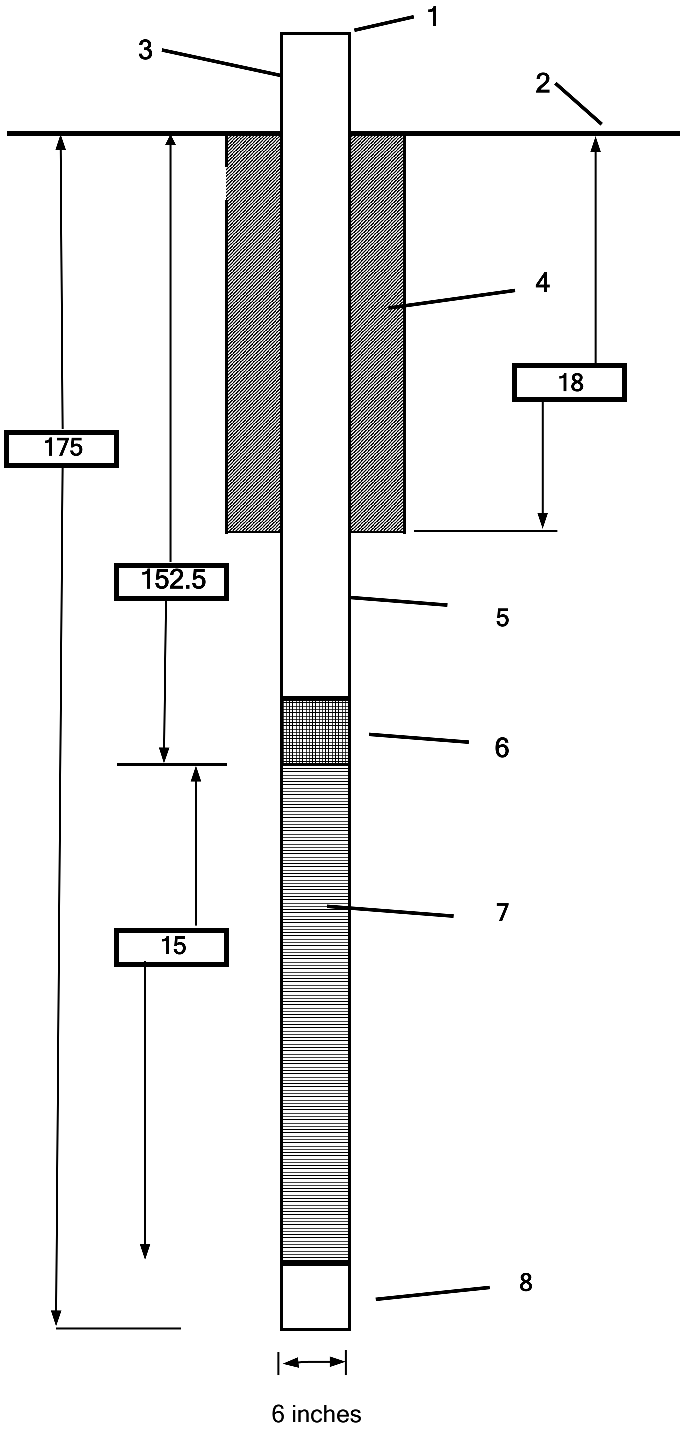
LOCATION : Approx. 700 feet E-SE of Winchester Ave./Newport Highway intersection, Spokane, WA

DRILLING CONTRACTOR: H2O Well Service Inc., Hayden ID

DRILLING METHOD AND EQUIPMENT USED: Air Rotary with Casing Hammer

WATER LEVELS : During drilling, estimated at approx. 160 ft bgs. On 11/15/19, 156.81 ft btc (154.3 ft bgs)

LOGGER: K Savage



Unique Ecology Well ID Tag BKW-214

1- Top of casing elevation	1925.15 ft (NAVD88)
2- Ground elevation at well	1922.5 ft (NAVD88)
3- Wellhead riser and casing	6-inch ID steel casing with lockable aluminum lid. Key 2190
4- Surface seal	10-inch ID temporary casing to 18 feet bgs. At completion, 10-inch casing pulled and annulus backfilled with bentonite chips
5- Well Casing	6-inch ID mild steel casing. Upon installation of the screen, the casing was pulled back to expose the telescoping screen
6- Packer assembly	Figure K neoprene packer with 2 feet of 5-inch ID head pipe
7- Type/slot size of screen	6-inch stainless steel, continuous wire-wrapped telescoping screen (approx. 5-inch ID). 25 slot (0.025 inch) 152.5 to 162.5 ft bgs 20 slot (0.020 inch) 162.5 to 167.5 ft bgs
8- Sump	1-foot long steel sump, 5-inch ID

Comments: Top of clay aquitard at 170 ft bgs; TD at 175 ft bgs. Backfilled with 3 ft of bentonite pellets from 172 to 175 ft bgs, then 2 feet of #8 - 12 colorado silica sand above. Native slough from 168.5 to 170 ft bgs

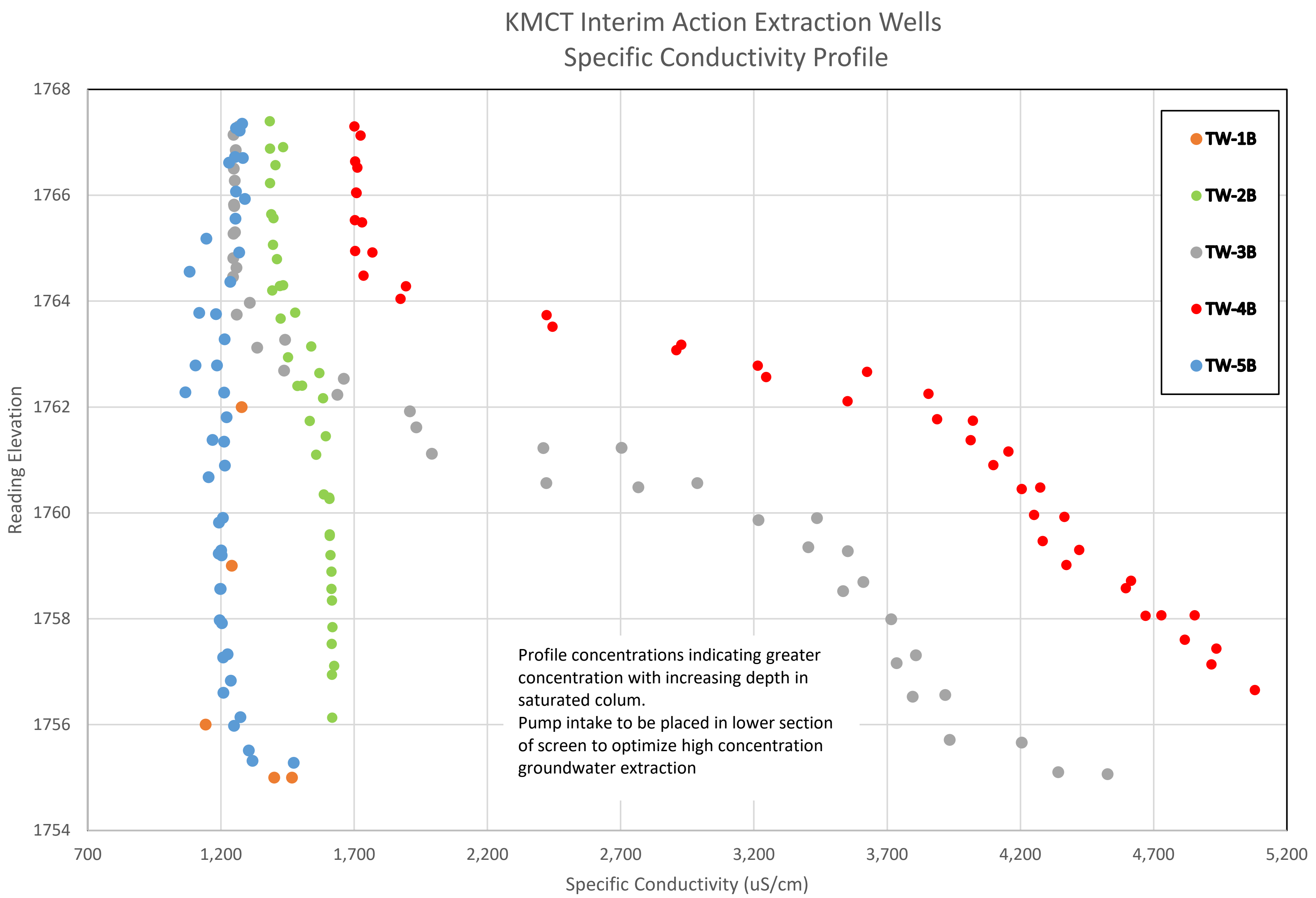
Development: Pumped for 60 minutes at 8.5 gpm; drawdown of 0.38 ft Specific conductivity of 915 uS/cm and pH 8.81 at sample collection

KMCT Interim Action Well Development Summary (November 2019)

								Drawdown in nearby wells during development (feet)				
Well	**Pumping Time (minutes)**	**Total Volume Pumped (gallons)**	**Average Pumping Rate (gpm)**	**Drawdown in Pumping Well (feet)**	**Specific Capacity (gpm/ft)[1]**	**Specific Conductivity (uS/cm)**	**pH (SU)**	**TW-1B**	**TW-2B**	**TW-3B**	**TW-4B**	**TW-5B**
TW-1B	26	320	12.3	0.33	37	1,467	8.8	xx	0.00	0.00	NM	NM
TW-2B	53	420	9.0	0.47	19	1,857	9.1	0.06	xx	0.00	0.00	NM
TW-3B	40	450	11.3	0.22	51	3,151	9.8	NM	0.00	xx	0.01	NM
TW-4B	45	430	9.6	0.07	137	3,845	10.0	NM	NM	0.03	xx	0.02
TW-5B	60	510	8.5	0.38	22	915	8.8	0.00	0.00	0.00	0.04	xx
NM - Not Measured												

Notes

1 - Specific capacity based on short pumping duration conducted as part of well screen development. These values and aquifer parameters based on this data represent an overestimate for long term aquifer characteristics.



Profile concentrations indicating greater concentration with increasing depth in saturated colum.
Pump intake to be placed in lower section of screen to optimize high concentration groundwater extraction

Specific Conductivity Profile

Comparison of Water Chemistry from Extraction Wells and Perimeter Well KMCP-3B

Parameter	Units	*Extraction Wells* [a] TW-1B	TW-2B	TW-3B	TW-4B	TW-5B		*Perimeter Well* KMCP-3B[b]
pH	s.u.	8.8	9.0	9.7	9.8	8.7		9.7
Conductivity	uS/cm	1,222	1,726	2,860	3,070	868		3600
Chloride	mg/L	20.0	24.0	35.0	37.0	19.0		17.0
Fluoride	mg/L	12.0	16.0	26.0	30.0	3.60		15.0
Sulfate	mg/L	120	190	210	210	76.0		130
Total-P	mg/L as P							0.86 J
Iron, dissolved	mg/L	5.80	8.60	13.0	13.0	1.90		8.50
Nitrogen Forms								
NO2-N	mg/L as N	1.10	1.20	3.80	3.70	0.67		3.90
NO3-N	mg/L as N	8.50	15.0	37.0	38.0	8.10		15.0
NH3-N	mg/L as N							
TKN	mg/L as N							
Cyanide Forms								
Free Cyanide	mg/L	0.27	0.36	0.46	0.50	0.16		0.77
WAD Cyanide	mg/L	0.03	0.39	0.58	0.56	0.0046 J		0.82
Total Cyanide	mg/L	14.0 B	22.0 B	39.0 B	41.0 B	4.90 B		24.0 B

Assumed to be specific conductivity
based on field measurements

[a] Samples received at the Corvallis, OR treatability lab on 11/18/2019

B = Compound was found in the blank and sample

J = Estimated value below reporting limit.

Anticipated Blend Concentrations given Specific Extraction Rates

Pumping Schedule for Highest TCN Concentration in Blended Extraction

Scenario 1

TW-1B	TW-2B	TW-3B	TW-4B	TW-5B			
10%	**20%**	**30%**	**35%**	**5%**	Percent	100%	contribution
5	10	15	17.5	2.5	Flow rate	**50**	**gpm**

Contribution

		TW-1B	TW-2B	TW-3B	TW-4B	TW-5B		**Blend conc**
pH	s.u.	0.9	1.8	2.9	3.4	0.4		**9.5**
Conductivity	uS/cm	122	345	858	1075	43		**2443**
Chloride	mg/L	2.0	4.8	10.5	13.0	1.0		**31**
Fluoride	mg/L	1.2	3.2	7.8	10.5	0.18		**23**
Sulfate	mg/L	12	38	63	73.5	3.8		**190**
Total-P	mg/L as P							
Iron, dissolved	mg/L	0.58	1.72	3.9	4.55	0.10		**11**
NO2-N	mg/L as N	0.11	0.24	1.14	1.30	0.03		**2.8**
NO3-N	mg/L as N	0.85	3.0	11.1	13.3	0.41		**28.7**
NH3-N	mg/L as N							
TKN	mg/L as N							
Free Cyanide	mg/L	0.03	0.07	0.14	0.18	0.01		**0.42**
WAD Cyanide	mg/L	0.00	0.08	0.17	0.20	0.00		**0.45**
Total Cyanide	mg/L	1.4	4.4	11.7	14.4	0.25		**32.1**

Assume EC and not SC

Scenario 2

TW-1B	TW-2B	TW-3B	TW-4B	TW-5B			
5%	**15%**	**35%**	**40%**	**5%**	Percent	100%	contribution
2.5	7.5	17.5	20	2.5	Flow rate	**50**	**gpm**

Contribution

		TW-1B	TW-2B	TW-3B	TW-4B	TW-5B		**Blend conc**
pH	s.u.	0.4	1.4	3.4	3.9	0.4		**9.5**
Conductivity	uS/cm	61	259	1001	1228	43		**2592**
Chloride	mg/L	1.0	3.6	12.25	14.8	1.0		**33**
Fluoride	mg/L	0.6	2.4	9.1	12	0.18		**24**
Sulfate	mg/L	6	28.5	73.5	84	3.8		**196**
Total-P	mg/L as P							
Iron, dissolved	mg/L	0.29	1.29	4.55	5.2	0.10		**11**
NO2-N	mg/L as N	0.055	0.18	1.33	1.48	0.03		**3.1**
NO3-N	mg/L as N	0.425	2.3	12.95	15.2	0.41		**31.2**
NH3-N	mg/L as N							
TKN	mg/L as N							
Free Cyanide	mg/L	0.01	0.05	0.16	0.20	0.01		**0.44**
WAD Cyanide	mg/L	0.00	0.06	0.20	0.22	0.00		**0.49**
Total Cyanide	mg/L	0.7	3.3	13.65	16.4	0.25		**34.3**

Assume EC and not SC

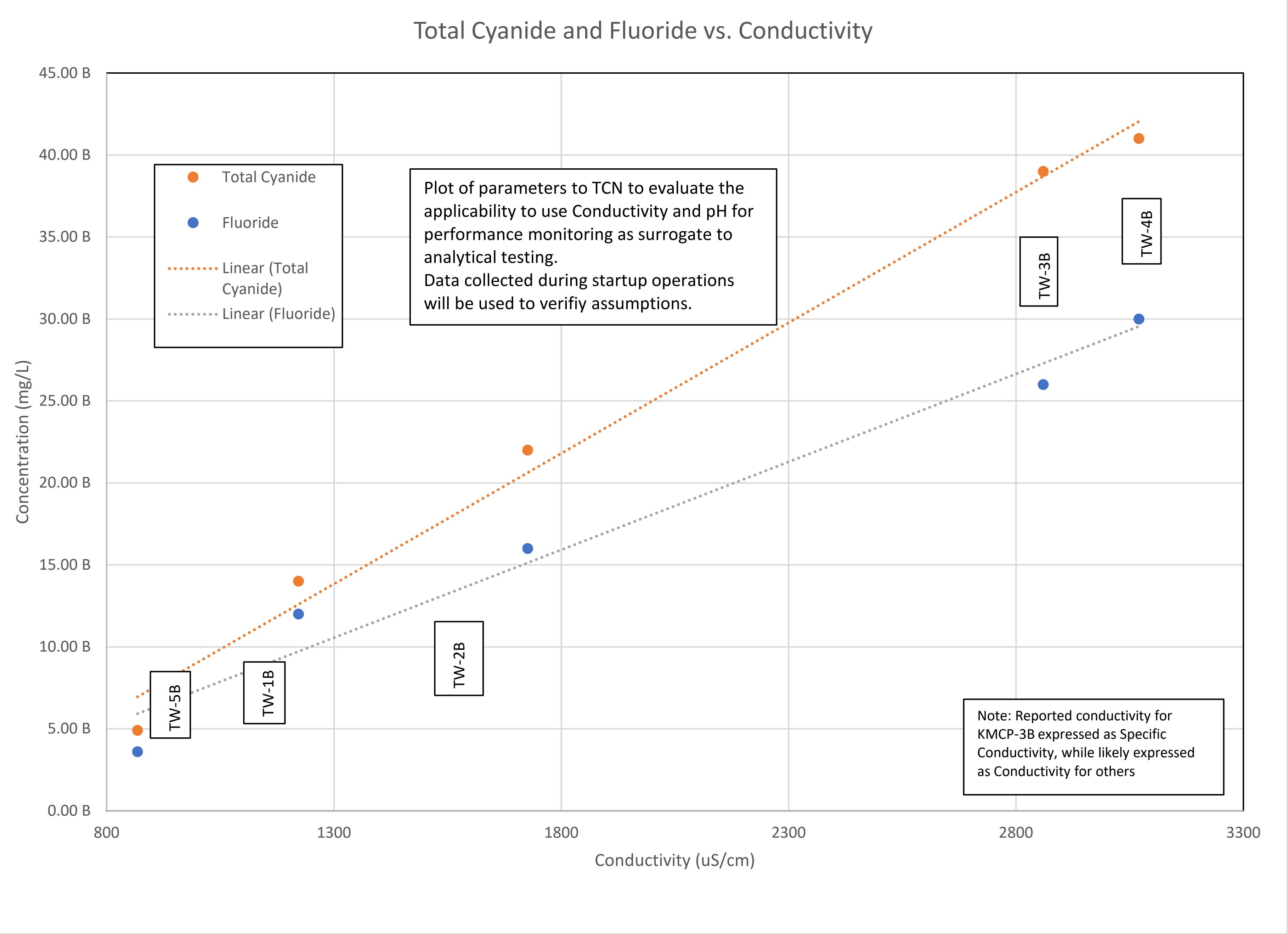
Selected **Well Field Pumpi**

Scenario 3

		TW-1B	TW-2B	TW-3B	TW-4B	TW-5B				
		5%	**10%**	**40%**	**40%**	**5%**	Percent	100%	contribution	
		2.5	5	20	20	2.5	Flow rate	**50**	**gpm**	
				Contribution				**Blend conc**		
pH	s.u.	0.4	0.9	3.9	3.9	0.4		**9.6**		
Conductivity	uS/cm	61	173	1144	1228	43		**2649**		Assume EC and not SC
Chloride	mg/L	1.0	2.4	14	14.8	1.0		**33**		
Fluoride	mg/L	0.6	1.6	10.4	12	0.18		**25**		
Sulfate	mg/L	6	19	84	84	3.8		**197**		
Total-P	mg/L as P									
Iron, dissolved	mg/L	0.29	0.86	5.2	5.2	0.10		**12**		
NO2-N	mg/L as N	0.055	0.12	1.52	1.48	0.03		**3.2**		
NO3-N	mg/L as N	0.425	1.5	14.8	15.2	0.41		**32.3**		
NH3-N	mg/L as N									
TKN	mg/L as N									
Free Cyanide	mg/L	0.01	0.04	0.18	0.20	0.01		**0.44**		
WAD Cyanide	mg/L	0.00	0.04	0.23	0.22	0.00		**0.50**		
Total Cyanide	mg/L	0.7	2.2	15.6	16.4	0.25		**35.1**		

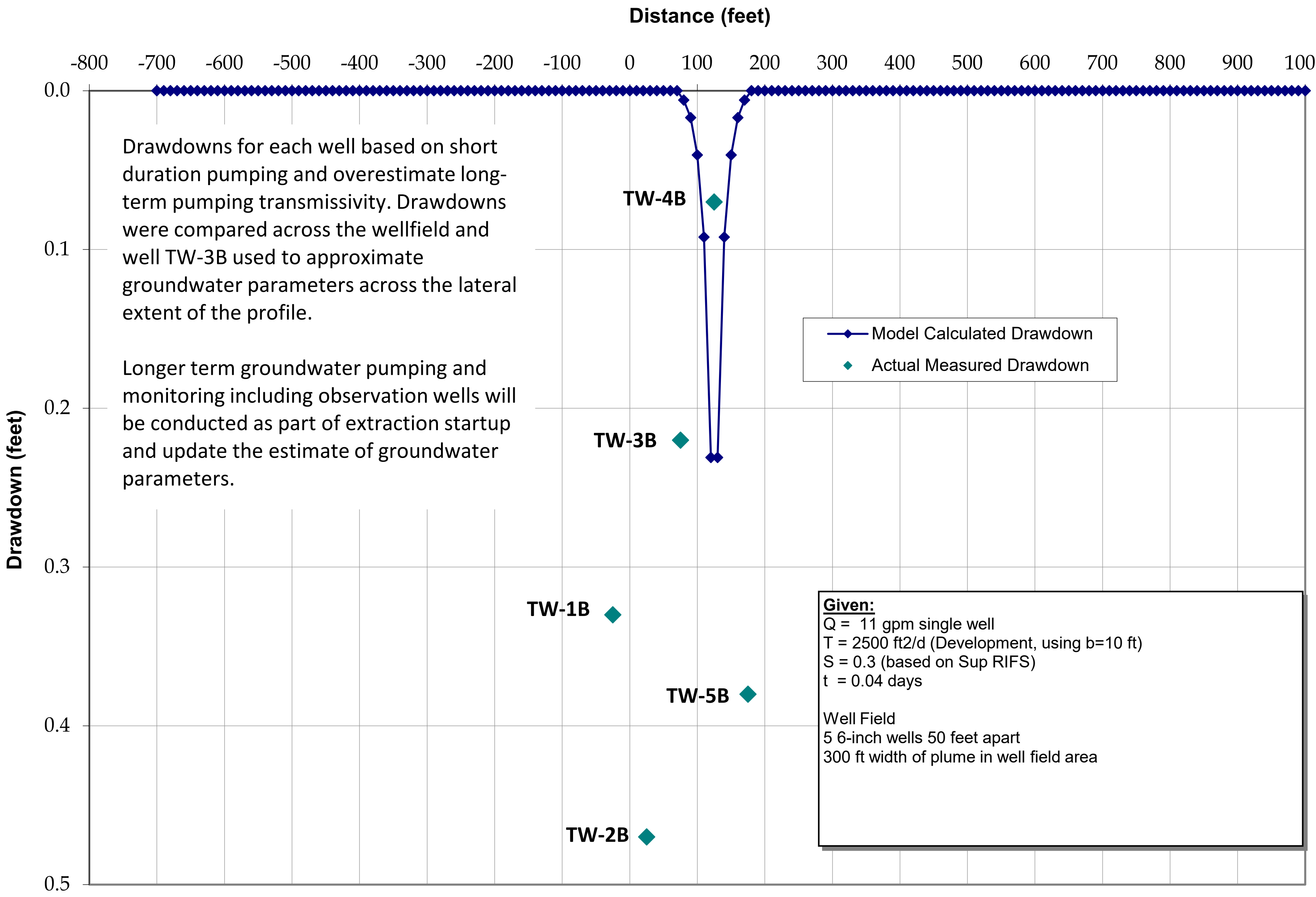
Scenario 4

		TW-1B	TW-2B	TW-3B	TW-4B	TW-5B				
		15%	**20%**	**30%**	**30%**	**5%**	Percent	100%	contribution	
		7.5	10	15	15	2.5	Flow rate	**50**	**gpm**	
				Contribution				**Blend conc**		
pH	s.u.	1.3	1.8	2.9	2.9	0.4		**9.4**		
Conductivity	uS/cm	183	345	858	921	43		**2351**		Assume EC and not SC
Chloride	mg/L	3.0	4.8	10.5	11.1	1.0		**30**		
Fluoride	mg/L	1.8	3.2	7.8	9	0.18		**22**		
Sulfate	mg/L	18	38	63	63	3.8		**186**		
Total-P	mg/L as P									
Iron, dissolved	mg/L	0.87	1.72	3.9	3.9	0.10		**10**		
NO2-N	mg/L as N	0.165	0.24	1.14	1.11	0.03		**2.7**		
NO3-N	mg/L as N	1.275	3.0	11.1	11.4	0.41		**27.2**		
NH3-N	mg/L as N									
TKN	mg/L as N									
Free Cyanide	mg/L	0.04	0.07	0.14	0.15	0.01		**0.41**		
WAD Cyanide	mg/L	0.00	0.08	0.17	0.17	0.00		**0.42**		
Total Cyanide	mg/L	2.1	4.4	11.7	12.3	0.25		**30.7**		



Plot of parameters to TCN to evaluate the applicability to use Conductivity and pH for performance monitoring as surrogate to analytical testing.
Data collected during startup operations will be used to verifiy assumptions.

Note: Reported conductivity for KMCP-3B expressed as Specific Conductivity, while likely expressed as Conductivity for others

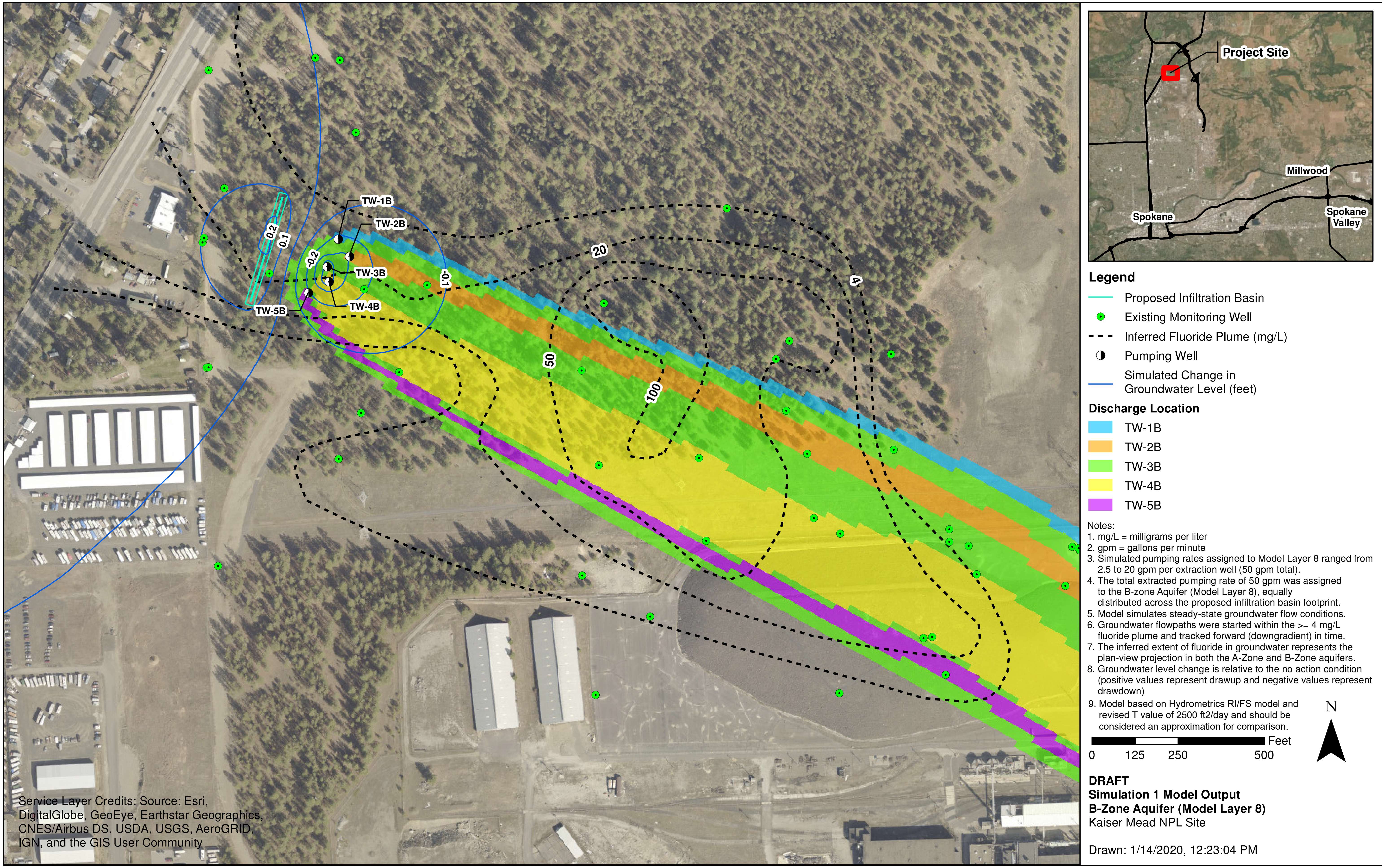


Drawdowns for each well based on short duration pumping and overestimate long-term pumping transmissivity. Drawdowns were compared across the wellfield and well TW-3B used to approximate groundwater parameters across the lateral extent of the profile.

Longer term groundwater pumping and monitoring including observation wells will be conducted as part of extraction startup and update the estimate of groundwater parameters.

Given:
Q = 11 gpm single well
T = 2500 ft2/d (Development, using b=10 ft)
S = 0.3 (based on Sup RIFS)
t = 0.04 days

Well Field
5 6-inch wells 50 feet apart
300 ft width of plume in well field area



Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend

— Proposed Infiltration Basin
● Existing Monitoring Well
- - - Inferred Fluoride Plume (mg/L)
◐ Pumping Well
— Simulated Change in Groundwater Level (feet)

Discharge Location

🟦 TW-1B
🟧 TW-2B
🟩 TW-3B
🟨 TW-4B
🟪 TW-5B

Notes:

1. mg/L = milligrams per liter
2. gpm = gallons per minute
3. Simulated pumping rates assigned to Model Layer 8 ranged from 2.5 to 20 gpm per extraction well (50 gpm total).
4. The total extracted pumping rate of 50 gpm was assigned to the B-zone Aquifer (Model Layer 8), equally distributed across the proposed infiltration basin footprint.
5. Model simulates steady-state groundwater flow conditions.
6. Groundwater flowpaths were started within the >= 4 mg/L fluoride plume and tracked forward (downgradient) in time.
7. The inferred extent of fluoride in groundwater represents the plan-view projection in both the A-Zone and B-Zone aquifers.
8. Groundwater level change is relative to the no action condition (positive values represent drawup and negative values represent drawdown)
9. Model based on Hydrometrics RI/FS model and revised T value of 2500 ft2/day and should be considered an approximation for comparison.

DRAFT
Simulation 1 Model Output
B-Zone Aquifer (Model Layer 8)
Kaiser Mead NPL Site

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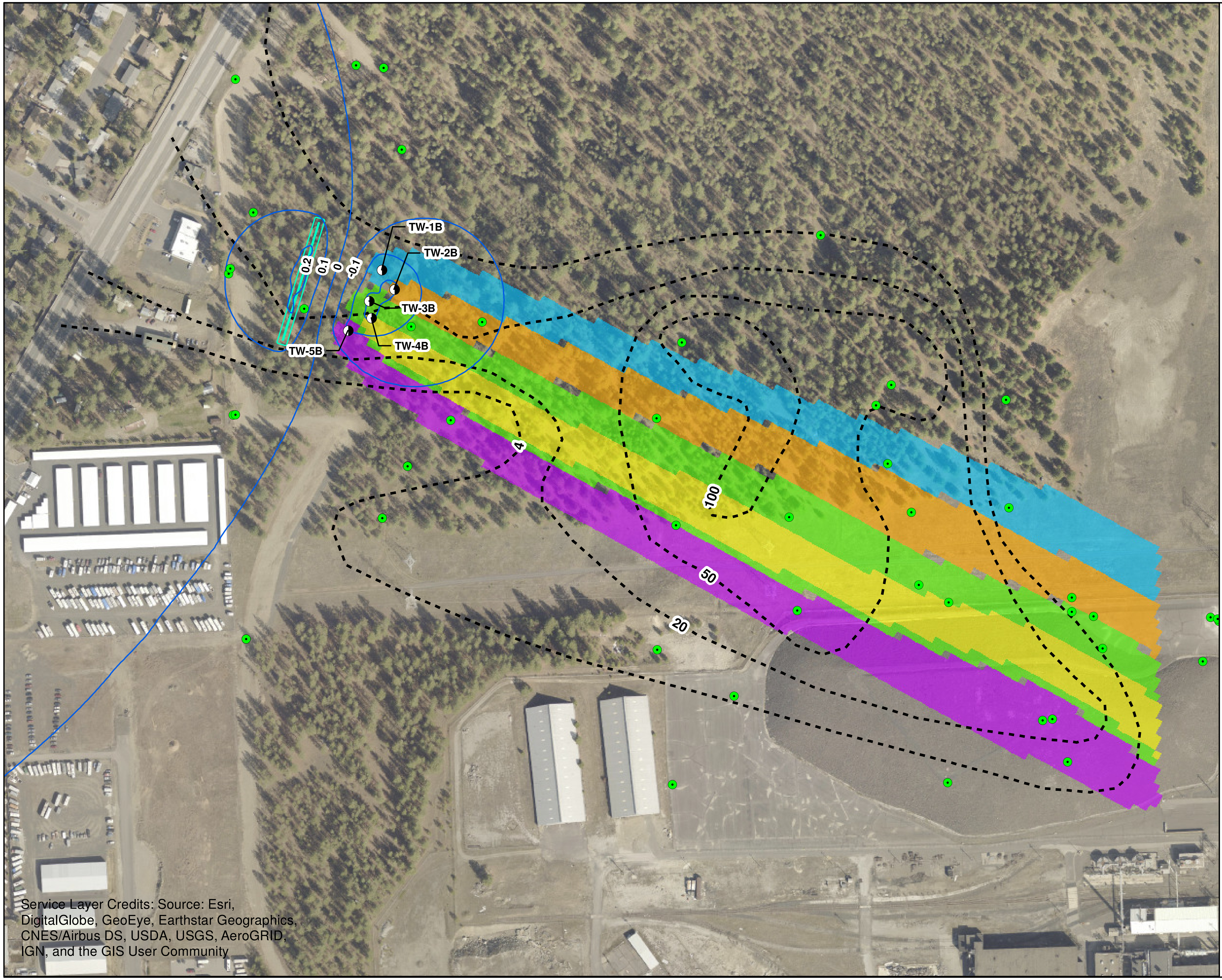
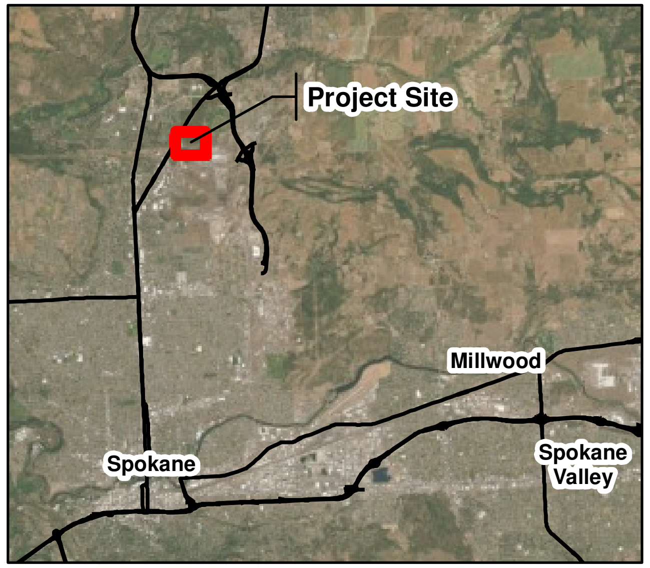


Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



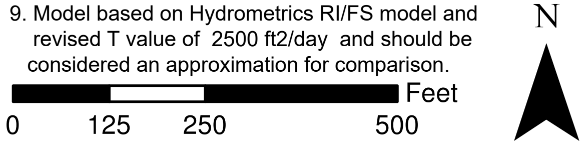
Legend

- — Proposed Infiltration Basin
- ● Existing Monitoring Well
- - - Inferred Fluoride Plume (mg/L)
- ◑ Pumping Well
- — Simulated Change in Groundwater Level (feet)

Discharge Location

- 🟦 TW-1B
- 🟧 TW-2B
- 🟩 TW-3B
- 🟨 TW-4B
- 🟪 TW-5B

Notes:
1. mg/L = milligrams per liter
2. gpm = gallons per minute
3. Simulated pumping rates assigned to Model Layer 8 was 10 gpm per extraction well (50 gpm total).
4. The total extracted pumping rate of 50 gpm was assigned to the B-zone Aquifer (Model Layer 8), equally distributed across the proposed infiltration basin footprint.
5. Model simulates steady-state groundwater flow conditions.
6. Groundwater flowpaths were started within the >= 4 mg/L fluoride plume and tracked forward (downgradient) in time.
7. The inferred extent of fluoride in groundwater represents the plan-view projection in both the A-Zone and B-Zone aquifers.
8. Groundwater level change is relative to the no action condition (positive values represent drawup and negative values represent drawdown)
9. Model based on Hydrometrics RI/FS model and revised T value of 2500 ft2/day and should be considered an approximation for comparison.



DRAFT
Simulation 2 Model Output
B-Zone Aquifer (Model Layer 8)
Kaiser Mead NPL Site

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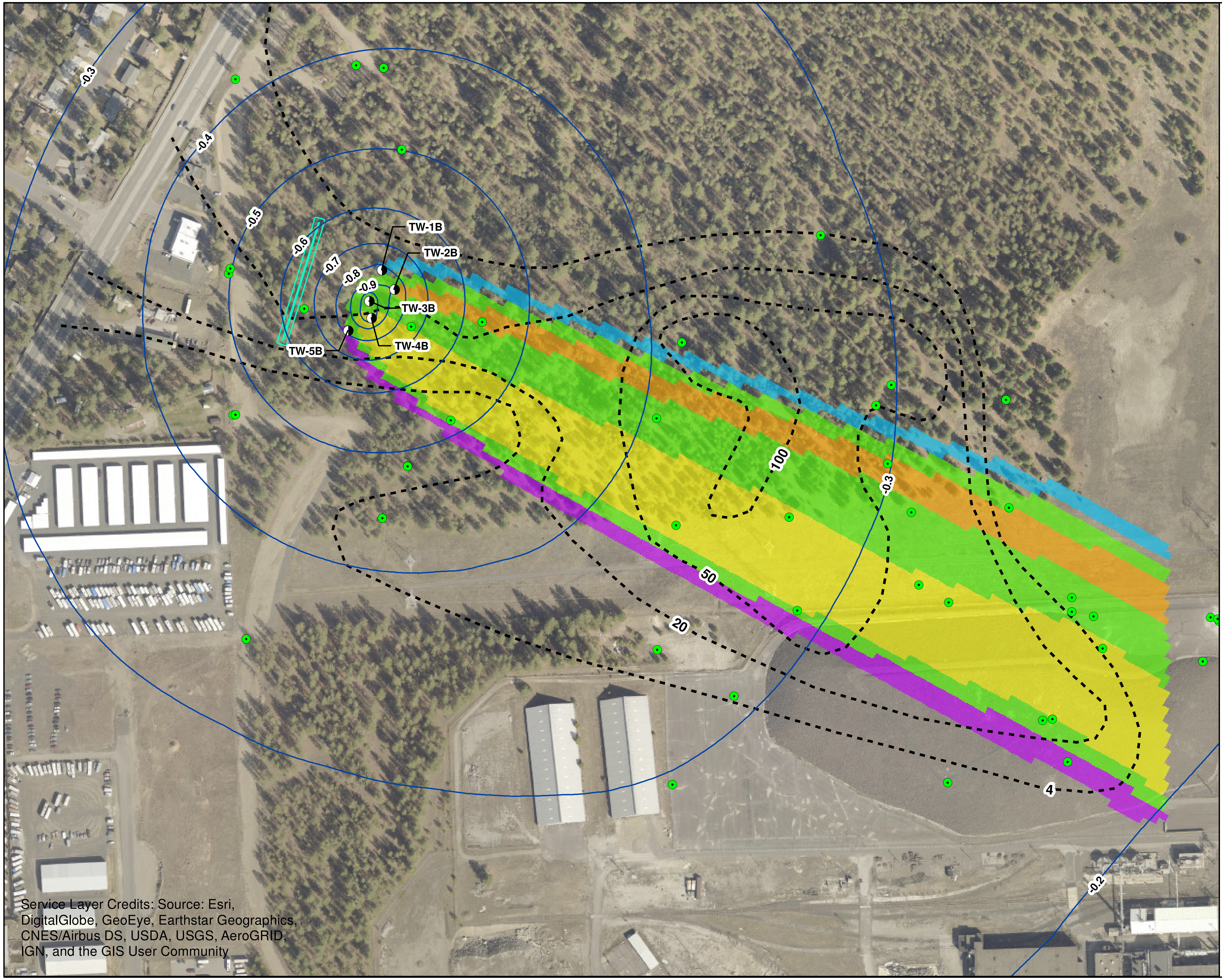
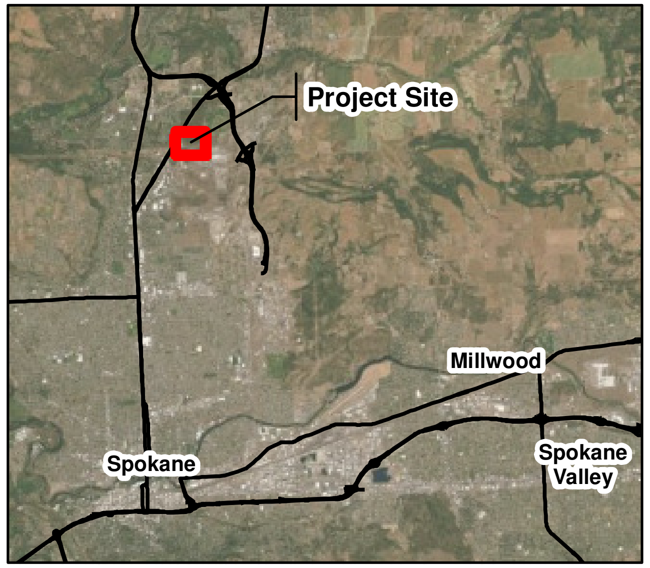


Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Legend

―	Proposed Infiltration Basin
●	Existing Monitoring Well
- - -	Inferred Fluoride Plume (mg/L)
◑	Pumping Well
―	Simulated Change in Groundwater Level (feet)

Discharge Location

🟦	TW-1B
🟧	TW-2B
🟩	TW-3B
🟨	TW-4B
🟪	TW-5B

Notes:
1. mg/L = milligrams per liter
2. gpm = gallons per minute
3. Simulated pumping rates assigned to Model Layer 8 ranged from 2.5 to 20 gpm per extraction well (50 gpm total).
4. No reinfiltration of extracted groundwater was simulated.
5. Model simulates steady-state groundwater flow conditions.
6. Groundwater flowpaths were started within the >= 4 mg/L fluoride plume and tracked forward (downgradient) in time.
7. The inferred extent of fluoride in groundwater represents the plan-view projection in both the A-Zone and B-Zone aquifers.
8. Groundwater level change is relative to the no action condition (positive values represent drawup and negative values represent drawdown)
9. Model based on Hydrometrics RI/FS model and revised T value of 2500 ft2/day and should be considered an approximation for comparison.

DRAFT
Simulation 3 Model Output
B-Zone Aquifer (Model Layer 8)
Kaiser Mead NPL Site

Drawn: 1/14/2020, 12:31:10 PM

Infiltration Basin Capacity

CALCULATIONS

INFILTRATION BASIN CAPACITY

State of Washington
HYDROGEOLOGIST
1587
Licensed Geologist
ROBERT F. MARTIN JR.

Digitally Signed on

April 3, 2020

Robert Martin

Infiltration Basin Capacity Calculations

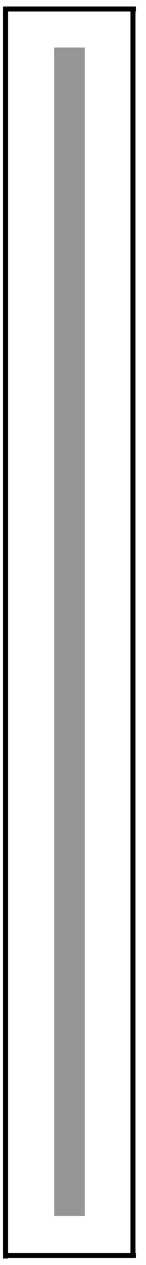
Project KMCT Groundwater Remediation Interim Action
Calculation by: Robert Martin

Date: 12/13/2019
Checked by: Mark Henry
Date: 1/2/2020

Percolation Calculations

Calculating a range of percolation rates based on maximum and minimum soil type percolation rates, and for the gravel channel and larger infiltration basin bottom.

Width
8 4 8



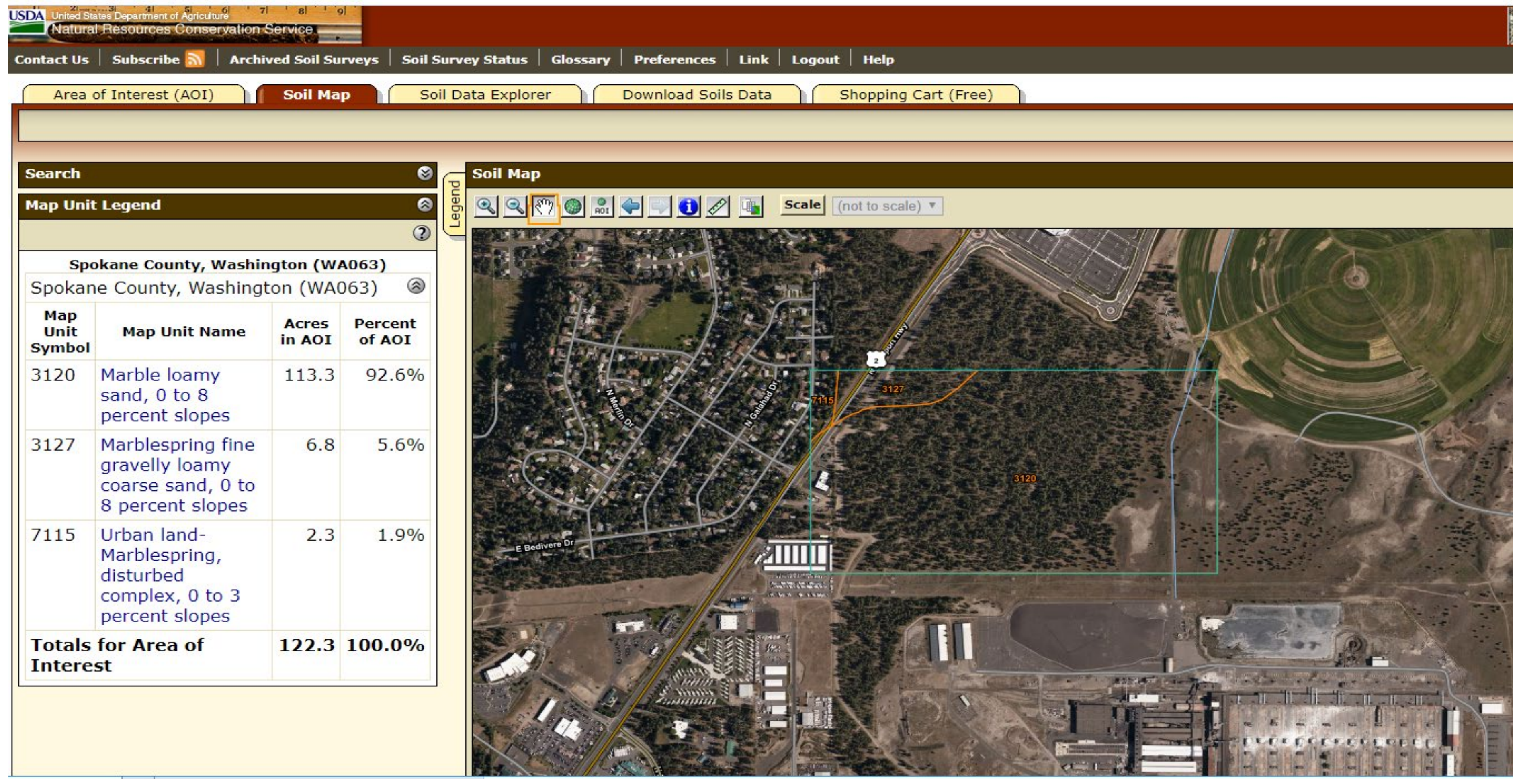
Length 300

Assumptions

Percolation Rate	0.50 ft/hr		Percolation Rate	0.50 ft/hr
Width	4 ft		Width	20 ft
Length	300 ft		Length	300 ft
Percolation	595 ft3/hr		Percolation	2975 ft3/hr
	4451 gal/hr			22253 gal/hr
	74 gpm			371 gpm

Percolation Rate	1.665 ft/hr		Percolation Rate	1.665 ft/hr
Width	4 ft		Width	20 ft
Length	300 ft		Length	300 ft
Percolation	1998 ft3/hr		Percolation	9990 ft3/hr
	14945 gal/hr			74725 gal/hr
	249 gpm			1245 gpm

USDA Natural Resources Conservation Service, reference for soil type and percolation rates


USDA United States Department of Agriculture
Natural Resources Conservation Service
Contact Us | Subscribe | Archived Soil Surveys | Soil Survey Status | Glossary | Preferences | Link | Logout | Help
Area of Interest (AOI)
Soil Map
Soil Data Explorer
Download Soils Data
Shopping Cart (Free)
Search
Map Unit Legend
Legend
Soil Map
Scale
(not to scale)

Spokane County, Washington (WA063)

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
3120	Marble loamy sand, 0 to 8 percent slopes	113.3	92.6%
3127	Marblespring fine gravelly loamy coarse sand, 0 to 8 percent slopes	6.8	5.6%
7115	Urban land-Marblespring, disturbed complex, 0 to 3 percent slopes	2.3	1.9%
Totals for Area of Interest		**122.3**	**100.0%**

Web Soil Survey
National Cooperative Soil Survey
Natural Resources Conservation Service
https://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx
Spokane County, Washington
3120 Marble loamy sand, 0 - 8 percent slopes
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Typical profile
Oi - 0 to 1 inches: slightly decomposed plant material

A - 1 to 4 inches: loamy sand
E - 4 to 8 inches: loamy sand
E and Bt1 - 8 to 27 inches: sand
E and Bt2 - 27 to 53 inches: sand
C - 53 to 60 inches: sand

Flow in Channel

Calculating estimated distance for flow within the gravel channel based on distance between risers. Used for approximating riser spacing

Width (W)	4 ft		Width (W)	4 ft
Depth (b)	2 ft		Depth (b)	2 ft
Hydraulic Cond (K)	2 cm/s		Hydraulic Cond (K)	2 cm/s
Hydraulic Cond (K)	42400 gallons/day/ft2		Hydraulic Cond (K)	42400 gallons/day/ft2
Gradient (i)	0.02 ft/ft for 50 ft		Gradient (i)	0.003333 ft/ft for 300 ft
Flow (Q)	6784 gallons/day		Flow (Q)	1130.667 gallons/day
Flow (Q)	4.7 gallons/min		Flow (Q)	0.79 gallons/min

Number of Discharge points

Flow	75 gpm
Flow at each point	9 gpm
Number of points	8

Fencing

WSDOT reference for infiltration basins

560.02(4) Special Sites

Fencing may be needed at special sites such as pit sites, stockpiles, borrow areas, and stormwater detention facilities.

Fencing is not normally installed around stormwater detention ponds. Evaluate the need to provide fencing around stormwater detention facilities when pedestrians or bicyclists are frequently present. Document your decision in the Design Documentation Package.

The following conditions suggest a need to evaluate fencing:

- Children or persons with mobility impairments are frequently present in significant numbers in locations adjacent to the facility, such as routes identified in school walk route plans or nearby residential areas or parks.
- Water depth reaches or exceeds 12 inches for several days.
- Sideslopes into the facility are steeper than 3H:1V.

Fencing proposed at sites that will be outside WSDOT right of way requires that local ordinances be followed if they are more stringent than WSDOT's.

Wetland mitigation sites are not normally fenced. When evaluating fencing for wetland mitigation sites, balance the need to restrict human access for safety considerations (such as the presence of children) with the need to provide animal habitat.

Other special sites where fencing may be required are addressed in the following chapters:

- Chapter 720, Bridges (refers to protective screening)
- Chapter 1510, Pedestrian Design Considerations

Page 560-2 **WSDOT Design Manual M 22-01.14**
July 2017

Wetlands Process Calculations

Enhanced Wetland Treatment System Hydraulics

CALCULATIONS

WETLAND PROCESS

Madison, Mark INC00003001

Digitally signed by Madison, Mark INC00003001
Date: 2020.05.06 12:16:37 -07'00'

MARK MADISON
22457

Digitally Signed on

May 5, 2020

Mark Madison

JACOBS™

CALCULATION COVER SHEET

PROJECT:
Kaiser Mead Groundwater Remediation Interim Action

LOCATION:
Mead Washington

CLIENT: Kaiser Mead Custodial Trust

JOB No.
KMCT2019

TITLE:
Final Design Report for Extraction, Treatment, and Discharge Systems

Enhanced Wetland Treatment System Calculations

EQUIP./DWG. NO.:
Reference Drawings - 002-C-006

CALCULATION NUMBER:
Final

OBJECTIVE:
Document Design Criteria to obtain modeled treatment performance calibrated with pilot test data

INPUTS:
Treatment performance targets, Hydraulic Retention Time, Hydraulic Loading Rate, Media Specs, Aerobic/Anaerobic Cycling Regime

ASSUMPTIONS:
Flow rates can be varied from 50 gpm to 100 gpm by adjusting the rate of recycled flow.

ASSUMPTIONS REQUIRING CONFIRMATION:
Pilot test performance data can be scaled up to full scale with similar results

BASIS OF CALCULATION, METHOD, OR SOFTWARE TO BE USED:
Excel Spreadsheet

CONCLUSION:
The design provides operational flexibility to achieve performance targets.

Revision	0	1	2	3	4	5	6
Prepared Date	5/6/2020 Mark Madison						
Checker Date	Jim Bays						

JACOBS™ CALCULATION TABLE OF CONTENTS	PROJECT: Kaiser Mead Groundwater Remediation Interim Action	J.O. NUMBER: KMCT2019
	CALCULATION NUMBER: Final	PAGE: 2 OF 10

JACOBS™

CALCULATION SHEET

	PROJECT: Kaiser Mead Custodial Trust	LOCATION: Mead Washington
	CLIENT:: Kaiser Mead Groundwater Remediation Interim Action	JOB No. KMCT2019
TITLE: Preliminary (90%) Design Report for Extraction, Treatment, and Discharge Systems Enhanced Wetland Treatment System Calculations	EQUIP./DWG. NO.: Reference Drawings - 11-4-2019_KMCT-2019_90% pdf	CALCULATION NUMBER: Preliminary (90%)

Project No.	Document / Item Reference

TABLE 1 HYDRAULIC CALCULATIONS FOR NATURAL TREATMENT SYSTEM Page 3 of 10

Made/Revised by; Mark Madison/PDX Date: 1/13/2020

Checked by; Jim Bays/TPA

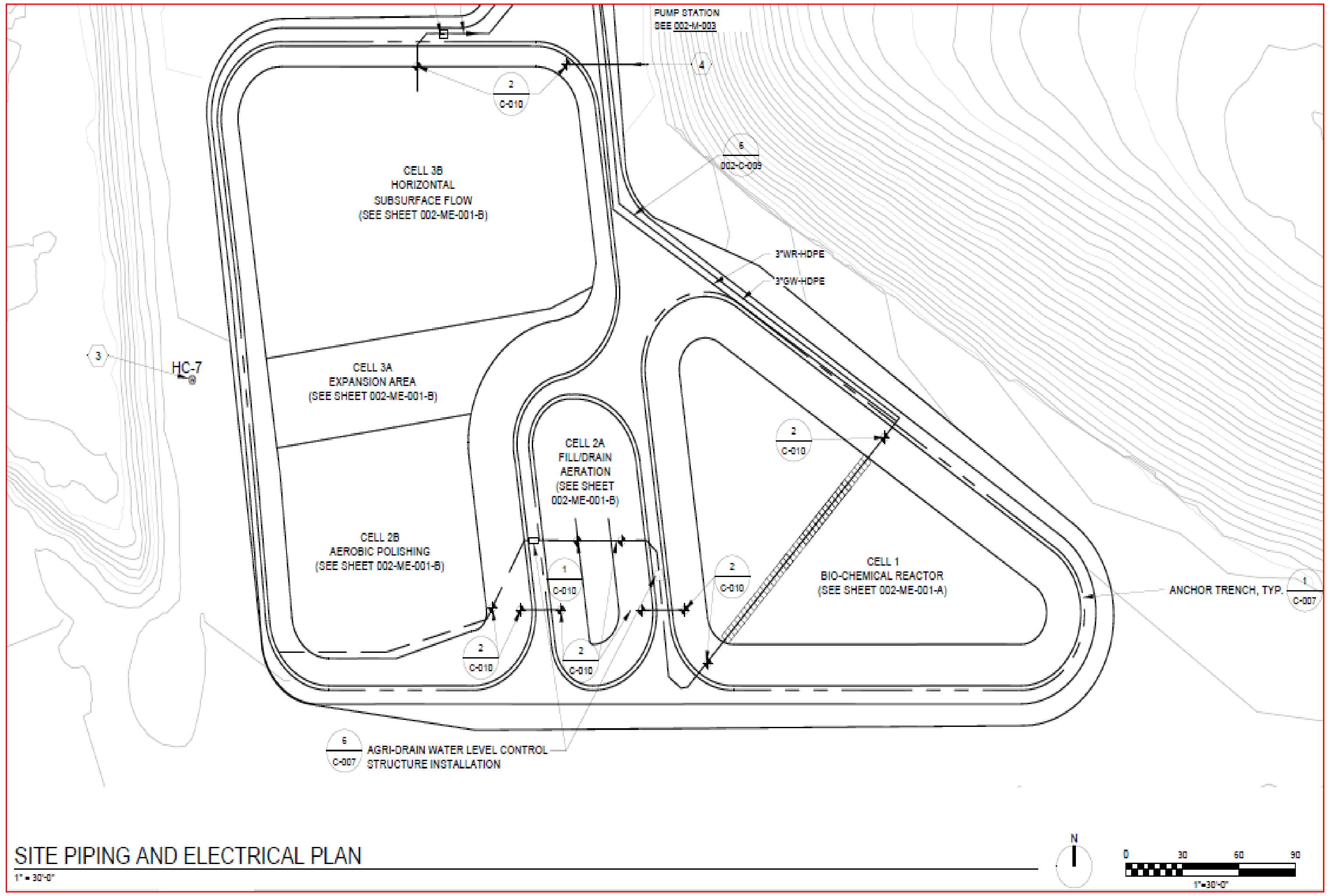
Approved

TABLE 1 HYDRAULIC CALCULATIONS FOR NATURAL TREATMENT SYSTEM

	Flow			Elevation			Volume		Area		Hydraulic		Range of Adjustment		
Operational Scenario	from wells (gpm)	from recycle (gpm)	Total (gpm)	Cell Bottom (ft)	Normal Water (ft)	Bypass Spillway (ft)	Water in pore spaces at Spillway Elev. (gallons)	Water in pore spaces at Normal Water Elev. (gallons)	at Normal Water Surface (ft2)	at Top of Berm (ft2)	Residence Time (hrs)	Loading Rate (cm/day)	Residence Time (hrs)	Loading Rate (cm/day)	
50 Gallons per Minute from Wells no Recycle with 4 Cycles per day in Cell 2A	50	0	50												
Cell 1 Bio-Chemical Reactor				1940	1944	1945	584,118	445625	22196	26044	149	13.2	74.3	26	one side of membrane isolated
Cell 2A Tidal Flow Aeration				1940	1942.8	1945	104976	21192	3431	6172	2.8	85.5			
Cell 2B Aerobic Polishing with Plants				1938	1939.3	1941	253005	26483	11061	14347	12.1	26.5			
Cell 3 Horizontal Subsurface Flow with Plants				1937	1939	1940	345126	106684	22029	25534	35.6	13.3			
Total							1287225	599983	58718	72097	199				
											8.3	days			
50 Gallons per Minute from Wells plus 50 gpm from Recycle with 5 Cycles per day in Cell 2A	50	50	100												
Cell 1 Bio-Chemical Reactor				1940	1944	1945	584,118	445625	22196	26044	74	26.4	37.1	53	one side of membrane isolated
Cell 2A Tidal Flow Aeration				1940	1943.9	1945	104976	31992	4286	6172	2.2	136.9			
Cell 2B Aerobic Polishing with Plants				1938	1939.5	1941	253005	26483	11256	14347	6.9	52.1			
Cell 3 Horizontal Subsurface Flow with Plants				1937	1939	1940	345126	106684	22029	25534	17.8	26.6			
Total							1287225	610783	59767	72097	101				
											4.2	days			
50 gpm from wells and no recycle for 6 tidal cycles per day in Cell 2A	50	0	50												
Cell 1 Bio-Chemical Reactor				1940	1944	1945	584,118	445625	22196	26044	149	13.2	74.3	26	one side of membrane isolated
Cell 2A Tidal Flow Aeration				1940	1942.1	1945	104976	15192	2896	6172	1.8	101.3			
Cell 2B Aerobic Polishing with Plants				1938	1939.3	1941	253005	26483	11061	14347	12.1	26.1			
Cell 3 Horizontal Subsurface Flow with Plants				1937	1939	1940	345126	106684	22029	25534	35.6	13.3			
Total							1287225	593983	58183	72097	198				
											8.2	days			
50 gpm from wells and 50 gpm from recycle for 6 tidal cycles per day in Cell 2A	50	50	100												
Cell 1 Bio-Chemical Reactor				1940	1944	1945	584,118	445625	22196	26044	74	26.4	37.1	53	one side of membrane isolated
Cell 2A Tidal Flow Aeration				1940	1943.4	1945	104976	27192	3915	6172	1.8	149.9			
Cell 2B Aerobic Polishing with Plants				1938	1939.5	1941	253005	26483	11256	14347	6.9	52.1			
Cell 3 Horizontal Subsurface Flow with Plants				1937	1939	1940	345126	106684	22029	25534	17.8	26.6			
Total							1287225	641568	60453	72097	101				
											4.2	days			
50 gpm from wells and no recycle for 8 tidal cycles per day in Cell 2A	50	0	50												
Cell 1 Bio-Chemical Reactor				1940	1944	1945	584,118	445625	22196	26044	149	13.2	74.3	26	one side of membrane isolated
Cell 2A Tidal Flow Aeration				1940	1941.6	1945	104976	12192	2590	6172	1.3	113.3			
Cell 2B Aerobic Polishing with Plants				1938	1939.3	1941	253005	26483	11061	14347	12.1	26.1			
Cell 3 Horizontal Subsurface Flow with Plants				1937	1939	1940	345126	106684	22029	25534	35.6	13.3			
Total							1287225	590983	57876	72097	197				
											8.2	days			
50 gpm from wells and 50 gpm from recycle for 8 tidal cycles per day in Cell 2A	50	50	100												
Cell 1 Bio-Chemical Reactor				1940	1944	1945	584,118	445625	22196	26044	74	26.4	37.1	53	one side of membrane isolated
Cell 2A Tidal Flow Aeration				1940	1942.8	1945	104976	21192	3431	6172	1.3	171.0			
Cell 2B Aerobic Polishing with Plants				1938	1939.5	1941	253005	26483	11256	14347	6.9	52.1			
Cell 3 Horizontal Subsurface Flow with Plants				1937	1939	1940	345126	106684	22029	25534	17.8	26.6			
Total							1287225	641568	60453	72097	100				
											4.2	days			

Notes: 1.)Porosity of 1.5", 1", and 3/4" rock is 35%, Porosity of Mix 2 organic media and wood chip insulation layer is 80%,

2.)The wetlands design is capable of a range of aeration pulses and flow rates from 4 cycles per day in Cell 2A at 50 gpm up to 8 cycles per day at 100 gpm. Any number of cycles between 5 and 8 will work with any flow rate into Cell 1 of between 50 and 100 gpm. To have as few as 4 cycles per day only works with 50 gpm at the cell sizes as designed .



SITE PIPING AND ELECTRICAL PLAN

1" = 30'-0"

JACOBS™

CALCULATION SHEET

	PROJECT: Kaiser Mead Groundwater Remediation Interim Action	LOCATION: Mead Washington
	CLIENT: Kaiser Mead Custodial Trust	JOB No. KMCT2019
TITLE: Final Design Report for Extraction, Treatment, and Discharge Systems Enhanced Wetland Treatment System Calculations	EQUIP./DWG. NO.: Reference Drawings - 002-C-006	CALCULATION NUMBER: Final

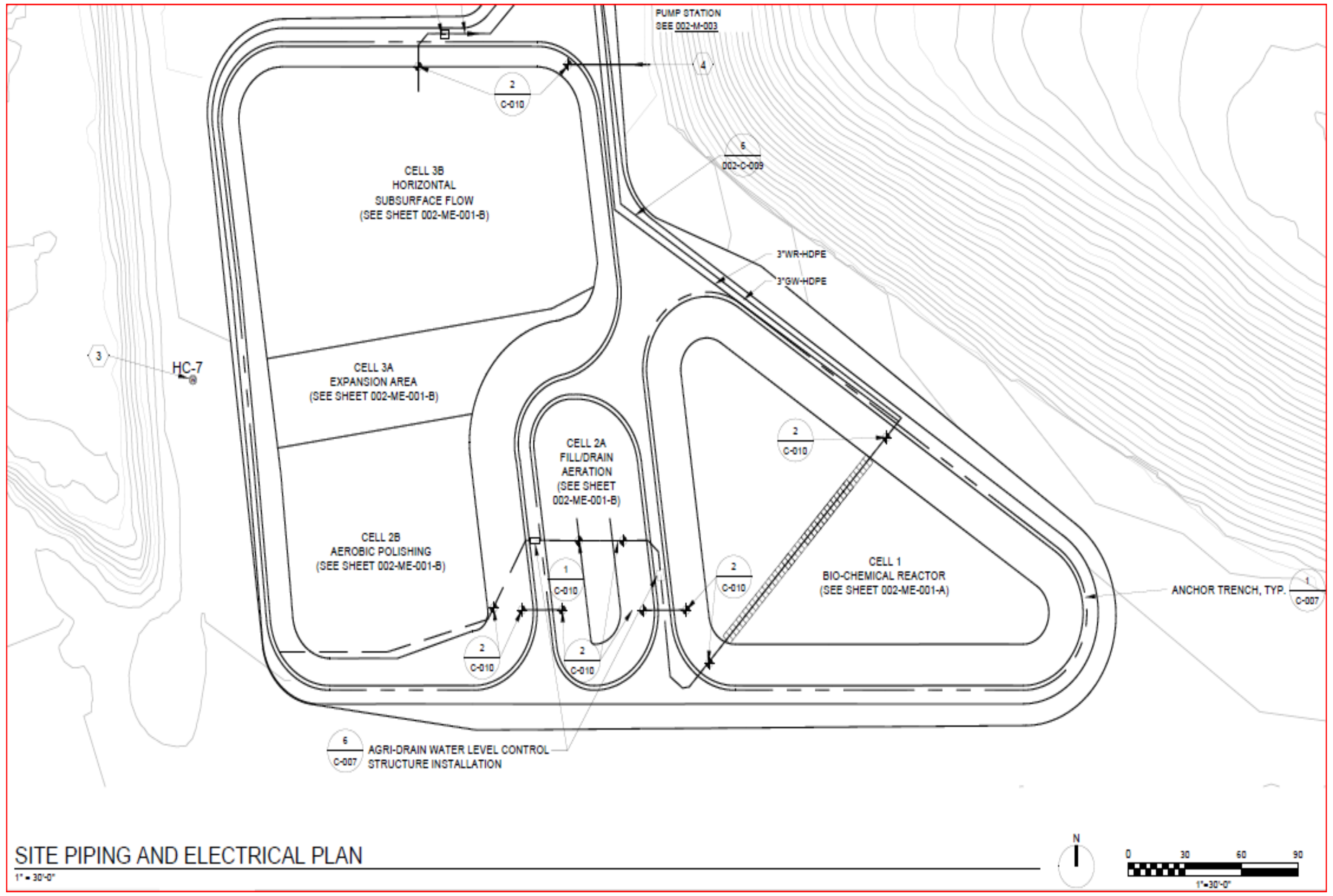
TABLE 2 PIPELINE HYDRAULICS

Made/Revised by; Mark Madison/PDX	Date: 5/6/2020	
Checked by; Jim Bays/TPA		
Approved		

TABLE 2 PIPELINE HYDRAULICS

	FLOW RATE in gpm						
	25	50	100	150	600	900	1000
	VELOCITY OF FLOW in ft/sec						
12" bypass spillway pipes	0.07	0.14	0.28	0.43			
12" Cell 1 outlet		0.14	0.28	0.43	1.70	2.55	
12" Cell 2A outlet					1.70	2.55	2.84
10" Agri-Drain inlet and outlet		0.20	0.41	0.61			
6" drain line header to fill Cell 1	0.28	0.57	1.13				
3" pumped from wells and recycle		2.27	4.54				
3" drain lines average (flow split 10 ways)		0.23	0.45				
3" drain lines average (flow split 5 ways with 1/2 of Cell 1 Isolated)		0.45	0.91				
8" tall x 24" wide standard Infiltrators		0.08	0.16	0.24	0.96	1.44	1.60

Notes: 1.) all gravity pipelines have less than 1 ft of total head loss
2.) spillway pipes flow as partially full culverts with drop inlets



JACOBS™ CALCULATION SHEET	PROJECT: Kaiser Mead Custodial Trust	LOCATION: Mead Washington
	CLIENT:: Kaiser Mead Groundwater Remediation Interim Action	JOB No. KMCT2019
TITLE: Final Design Report for Extraction, Treatment, and Discharge Systems Enhanced Wetland Treatment System Calculations	EQUIP./DWG. NO.: Reference Drawings - 002-C-006	CALCULATION NUMBER: Final

4 Cycles at 50 GPM

Page 5 of 10

Made/Revised by; Mark Madison/PDX	Date: 5/6/2020	
Checked by; Jim Bays/TPA		
Approved		

50 gpm from wells and no recycle for 4 tidal cycles per day in Cell 2A ***72000 gallons per day total flow***

Cell 1 ***FINAL Design Specs***
Project: ***Kaiser Mead Natural Treatment System***
Basin Description: ***Bio-Chemical Reactor***

From CAD Earthwork Model

For all cells wood chip layer has 80% porosity

Contour Elevation (ft)	Contour Area (sq. ft)	Depth Avg. End (ft)	Incremental Volume (cu. ft)	Cumulative Volume (cu. ft)	Cumulative Volume of Water at Porosity (gallons)	Cell Profile	
1940	15,180	N/A	N/A	0		Bottom	
1941	16,849	1	16,014	16,014	41,926	12" of Drain Rock + 6" of 3/4" Rock	35% porosity
1942	18,575	1	17,712	33,726	145,057	2.75' of Organic Media	80% porosity
1943	20,357	1	19,466	53,193	318,304		
1944	22,196	1	21,277	74,469	445,625		
1944.25	23,144	0.25	5,786	80,255	480,248	Normal Water Level	
1945	24,092	1	23,144	97,613	584,118	Maximum Water Level with 1 ft of Freeboard	
1946	26,044	1	25,068	122,681	825,888	Top of Berm	

Hydrualic Loading (cm3/day) 272520000 cm3 1 gal = 3785 cm3
Hydraulic Surface Area 21,500,730 cm2 1 ft2 = 929 cm2
Hydraulic Loading Rate (cm/day) 12.7 cm/day

HRT at 50 gpm forward flow rate = 160 hours 6.7 days
Time from normal water level to maximum water level at 50 gpm in and 0 gpm out = 35 hours (assumes no recycle and well pumping and plugged outlet)
at maximum water level the emergency bypass begins to flow to Cell 2A
During Cell 2A fill cycle Cell 1 receives 50 gpm for 120 minutes or 6000 gallons in and 9000 gallons out
Maximum water level drop is 0.007 ft below normal water level 0.080785477 inches

During Cell 2A drain cycle Cell 1 stops discharging for 1 hour but receives 50 gpm for 3000 gallons accumulation
Maximum water level rise is 0.007 ft above normal water level 0.080785477 inches

Maximum Volume that could discharge if the outlet control slide gate fails open when Cell 1 is at normal water elevation 335191 gallons
Maximum Drain Down 1944.25-1942

Cell 2A ***Final Design Specs***
Project: ***Kaiser Mead***
Basin Description: ***Tidal Flow Aeration***

From CAD Earthwork Model

Contour Elevation (ft)	Contour Area (sq. ft)	Depth Avg. End (ft)	Incremental Volume (cu. ft)	Cumulative Volume (cu. ft)	Cumulative Volume of Water at Porosity (gallons)	Cell Profile	
1939	931	N/A	N/A	0		Bottom	
1940	1508	1	1219	1219	3192	12" of Drain Rock	35% porosity
1941	2142	1	1825	3044	7969	4.25' of 3/4" Angular Basalt Media	35% porosity
1942	2833	1	2487	5531	14480		
1943	3582	1	3207	8738	22877	Normal Water = 1944.25	for 4 equal cycles
1944	4388	1	3985	12723	33309		
1,944.25	4,820	0.25	1,205	13,928	36464	Hydraulic Profile elevation	
1945	5251	1	4820	17543	104976	Maximum Water Level with 1 ft of Freeboard	
1946	6172	1	5712	23255	156551	Top of Berm	

fill level		gal/fill	# of cycles/day
1941.8	1 at max plus 3 at min	36000 +3*12000	4
1942.8	1 at max plus 2 at min	36000 + 2* 18000	3
1944.25	2 equal at max elev	36000 gal	2
	50 gpm =	72000 gal avail.	
	4 equal at max elev	91509 gal demand	
1944.25	4 equal at avaiablel elev	18000 gal	4

Hydrualic Loading (cm3/day) 272520000 cm3 1 gal = 3785 cm3
Hydraulic Surface Area 2,238,704 cm2 1 ft2 = 929 cm2 empty 50% of time
Hydraulic Loading Rate (cm/day) 121.7 cm/day

HRT = 3.81 hours average 0.16 days empty 50% of time
Normal low water is 1940 (BOTTOM 1 FT DOESN'T DRAIN)
4 cycles per day uses 30 minutes to drain, 30 minutes to remain empty, and 30 minutes to refill cycling every 6 hours. 360 minutes per cycle
Rate of Drainage for 30 minute draining time = 600 gpm
(30 minutes empty with no flow) Rate of Filling for 30 minute filling time = 600 gpm
4 cycles/day Volume of forward flow into and out of Cell 1 in 360 minutes at 50 gpm = 18000 gallons

time to reach spillway from normal high water with 50 gpm inflow and no discharge 23 hours

Cell 2b ***Final Design Specs*** ***0.5 ft contours***
Project: ***Kaiser Mead***
Basin Description: ***Aerobic Polishing with Plants***

From CAD Earthwork Model

Contour Elevation (ft)	Contour Area (sq. ft)	Depth Avg. End	Incremental Volume (cu. ft)	Cumulative Volume (cu. ft)	Cumulative Volume of Water at Porosity (gallons)	Cell Profile	
1,938.00	9,797	N/A	N/A	0.0		Bottom	
1,938.50	10,221	0.5	5004.36	5004.4	13101	1.5' of Drain Rock	35% porosity
1,939.00	10,652	0.5	5218.17	10222.5	26763		
1,939.50	11,090	0.5	5435.54	15658.1	40993	Normal water level is 1940 with breif drain down to 1939.5	
1,940.00	11,536	0.5	5656.46	21314.5	55801	0.5'' of 3/4" Angular Basalt Media	35% porosity
1,940.50	11,988	0.5	5880.95	27195.5	162738	Maximum Water Level 1940 with 1 ft of Freeboard with 6" wood chips	
1,941.00	12,448	0.5	6109	33304.5	249118	Top of Berm at Cell 3B outlet	
1,941.50	12,915	0.5	6340.62	39645.1	296545		
1,942.00	12,605	0.5	6379.86	46025.0	344267	Top of Berm at Cell 2B	

Hydrualic Loading (cm3/day) 272520000 cm3 1 gal = 3785 cm3
Hydraulic Surface Area 10,302,796 cm2 1 ft2 = 929 cm2
Hydraulic Loading Rate (cm/day) 26.5 cm/day

HRT = 13.7 hours average
Normal Low Water Level = 1939.5 near Cell 3 or just before a fill surge
Normal High Water Level = 1940 near fill point just after a fill surge
flow through rock and plant roots dampens level changes caused by siphon discharge
Maximum Drain Down 1940 to 1939.5 14809 gallons
Assume discharge to cell 3 at 500 gpm during fill cycle 18000 gallons enters from Cell 2A in 30 minutes while discharge to Cell 3 is 50 gpm or 1500 gallons
flow accumulated is 16500 gallons which causes a rise of 0.62 ft average over the total cell for 30 minutes
actual rise is expected to be 1 ft at the input location and insignificant at the outlet weir. Root density will dampen rise with growth.
Time to reach spillway from normal low water with no discharge and full inflow 4.9 hours

Cell 3A ***Final Design Specs***
Project: ***Kaiser Mead***
Basin Description: ***Horizontal Subsurface Flow with Plants***

From CAD Earthwork Model

Contour Elevation (ft)	Contour Area Avg. End (sq. ft)	Depth Avg. End (ft)	Incremental Volume (cu. ft)	Cumulative Volume (cu. ft)	Cumulative Volume of Water at Porosity (gallons)	Cell Profile	
1,938.00	5,006	N/A	N/A	0		Bottom	
1,938.50	5,199	0.5	2551.23	2551.23	6,679	2' drain gravel	
1,939.00	5,393	0.5	2648.05	5199.28	13,612		35% porosity
1,939.50	5,587	0.5	2745.03	7944.31	20,798	normal water level near cell 3B	80% porosity
1,940.00	5,782	0.5	2842.14	10786.45	28,239	maximum water level near cell 2B	
1,940.50	5,976	0.5	2939.39	13725.84	102,669		
1,941.00	6,171	0.5	3036.79	16762.63	125,384	Top of Berm	

Hydrualic Loading (cm3/day)	272520000	cm3
Hydraulic Surface Area	5,190,416	cm2
Hydraulic Loading Rate (cm/day)	52.5	cm/day

HRT = 6.9 hours average

time to reach maximum water level from normal water level with 50 gpm in and 0 out 149 minutes or 2 hours
(assumes failed recycle and EC pumps and no discharge with 50 gpm from wells causing forward flow through all cells)

Cell 3B ***Final Design Specs***
Project: ***Kaiser Mead***
Basin Description: ***Horizontal Subsurface Flow with Plants***

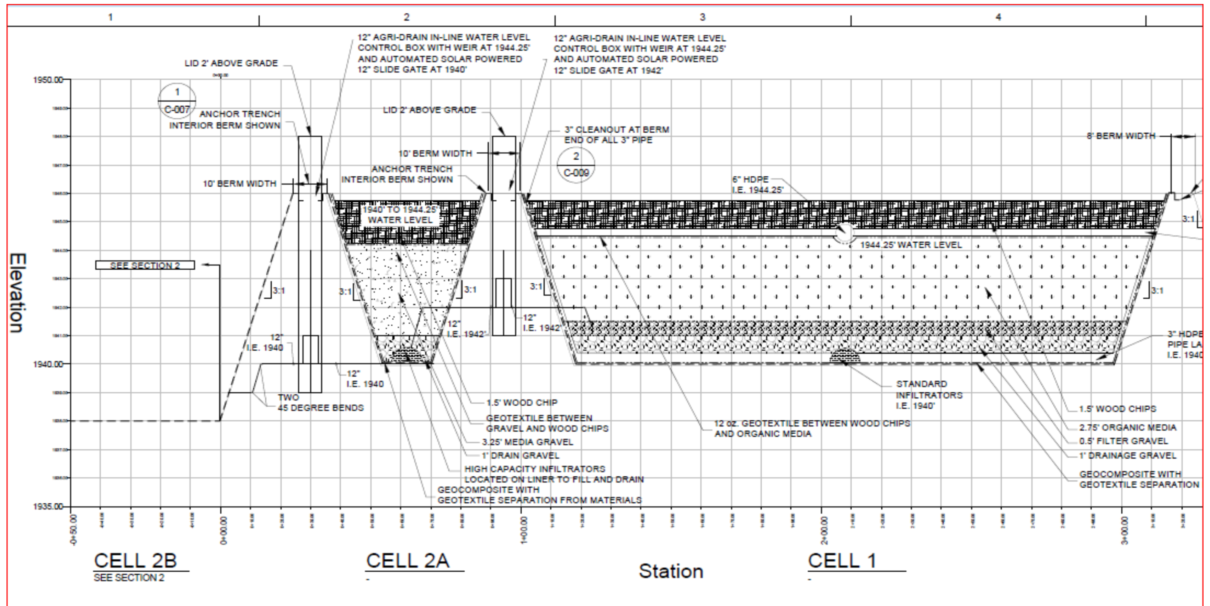
From CAD Earthwork Model

Contour Elevation (ft)	Contour Area Avg. End (sq. ft)	Depth Avg. End (ft)	Incremental Volume (cu. ft)	Cumulative Volume (cu. ft)	Cumulative Volume of Water at Porosity (gallons)	Cell Profile	
1,938.00	20,061	N/A	N/A	0		Bottom	
1,938.50	20,607	0.5	10166.94	10166.94	26,617	2' drain gravel	35% porosity
1,939.00	21,158	0.5	10441.08	20608.03	53,952		
1,939.50	21,715	0.5	10718.07	31326.1	82,012	maximum water level	
1,940.00	22,277	0.5	10997.9	42324	284,925	Woodchips	80% porosity
1,940.50	22,845	0.5	11280.58	53604.58	400,962		
1,941.00	23,419	0.5	11566.04	65170.62	487,476	Top of Berm	

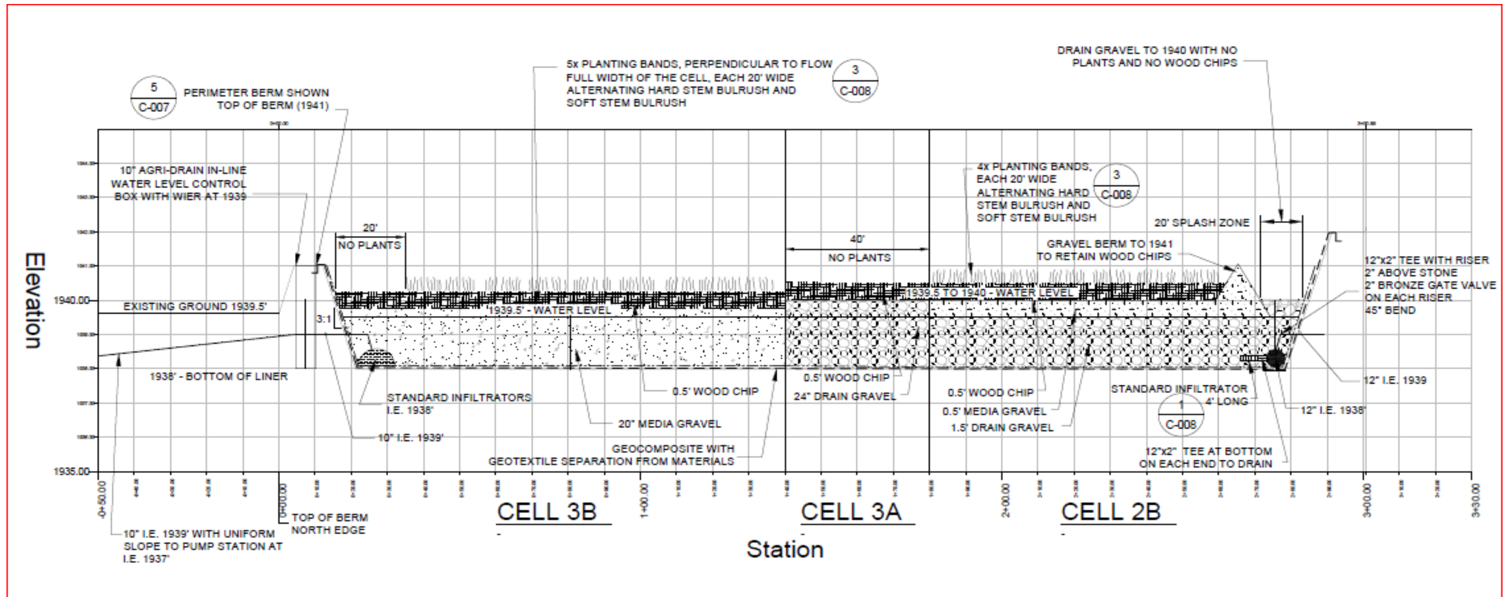
Hydrualic Loading (cm3/day)	272520000	cm3
Hydraulic Surface Area	20,172,863	cm2
Hydraulic Loading Rate (cm/day)	13.5	cm/day

HRT = 27.3 hours average

time to reach maximum water level from normal water level with 50 gpm in and 0 out 4058 minutes or 68 hours
(assumes failed recycle and EC pumps and no discharge with 50 gpm from wells causing forward flow through all cells)


1
2
3
4
LID 2' ABOVE GRADE
12" AGRI-DRAIN IN-LINE WATER LEVEL CONTROL BOX WITH WEIR AT 1944.25' AND AUTOMATED SOLAR POWERED 12" SLIDE GATE AT 1940'
12" AGRI-DRAIN IN-LINE WATER LEVEL CONTROL BOX WITH WEIR AT 1944.25' AND AUTOMATED SOLAR POWERED 12" SLIDE GATE AT 1942'
1 C-007
ANCHOR TRENCH INTERIOR BERM SHOWN
LID 2' ABOVE GRADE
3" CLEANOUT AT BERM END OF ALL 3" PIPE
2 C-009
10' BERM WIDTH
ANCHOR TRENCH INTERIOR BERM SHOWN
10' BERM WIDTH
1940' TO 1944.25' WATER LEVEL
6" HDPE I.E. 1944.25'
8' BERM WIDTH
1944.25' WATER LEVEL
SEE SECTION 2
3:1
12" I.E. 1940
12" I.E. 1942'
12" I.E. 1942'
12" I.E. 1940
TWO 45 DEGREE BENDS
3" HDPE PIPE LA I.E. 1940
1.5' WOOD CHIP
GEOTEXTILE BETWEEN GRAVEL AND WOOD CHIPS
3.25' MEDIA GRAVEL
1' DRAIN GRAVEL
HIGH CAPACITY INFILTRATORS LOCATED ON LINER TO FILL AND DRAIN
GEOCOMPOSITE WITH GEOTEXTILE SEPARATION FROM MATERIALS
12 oz. GEOTEXTILE BETWEEN WOOD CHIPS AND ORGANIC MEDIA
STANDARD INFILTRATORS I.E. 1940'
1.5' WOOD CHIPS
2.75' ORGANIC MEDIA
0.5' FILTER GRAVEL
1' DRAINAGE GRAVEL
GEOCOMPOSITE WITH GEOTEXTILE SEPARATION
Elevation
1950.00
1940.00
1935.00
-0+50.00
0+00.00
1+00.00
2+00.00
3+00.00
CELL 2B
SEE SECTION 2
CELL 2A
Station
CELL 1

1 CELL 1-2A CROSS SECTION DETAIL
BIO-CHEMICAL REACTOR (BCR) - NTS


5 C-007
PERIMETER BERM SHOWN TOP OF BERM (1941)
5x PLANTING BANDS, PERPENDICULAR TO FLOW FULL WIDTH OF THE CELL, EACH 20' WIDE ALTERNATING HARD STEM BULRUSH AND SOFT STEM BULRUSH
3 C-008
DRAIN GRAVEL TO 1940 WITH NO PLANTS AND NO WOOD CHIPS
10" AGRI-DRAIN IN-LINE WATER LEVEL CONTROL BOX WITH WIER AT 1939
4x PLANTING BANDS, EACH 20' WIDE ALTERNATING HARD STEM BULRUSH AND SOFT STEM BULRUSH
3 C-008
20' SPLASH ZONE
20'
NO PLANTS
40'
NO PLANTS
GRAVEL BERM TO 1941 TO RETAIN WOOD CHIPS
12"x2" TEE WITH RISER 2" ABOVE STONE 2" BRONZE GATE VALVE ON EACH RISER 45° BEND
EXISTING GROUND 1939.5'
3:1
1939.5' - WATER LEVEL
1939.5 TO 1940 - WATER LEVEL
1938' - BOTTOM OF LINER
STANDARD INFILTRATORS I.E. 1938'
10" I.E. 1939'
0.5' WOOD CHIP
20" MEDIA GRAVEL
GEOCOMPOSITE WITH GEOTEXTILE SEPARATION FROM MATERIALS
0.5' WOOD CHIP
24" DRAIN GRAVEL
0.5' WOOD CHIP
0.5' MEDIA GRAVEL
1.5' DRAIN GRAVEL
STANDARD INFILTRATOR 4' LONG
1 C-008
12"x2" TEE AT BOTTOM ON EACH END TO DRAIN
12" I.E. 1938'
12" I.E. 1939
Elevation
1940.00
1935.00
-0+50.00
0+00.00
1+00.00
2+00.00
3+00.00
3+30.00
TOP OF BERM NORTH EDGE
10" I.E. 1939' WITH UNIFORM SLOPE TO PUMP STATION AT I.E. 1937'
CELL 3B
CELL 3A
CELL 2B
Station

2 CELL 3-2B CROSS SECTION DETAIL
HORIZONTAL SUBSURFACE FLOW WETLAND (SSF) - NTS

JACOBS™ CALCULATION SHEET	PROJECT: Kaiser Mead Custodial Trust	LOCATION: Mead Washington
	CLIENT:: Kaiser Mead Groundwater Remediation Interim Action	JOB No. KMCT2019
TITLE: Final Design Report for Extraction, Treatment, and Discharge Systems Enhanced Wetland Treatment System Calculations	EQUIP./DWG. NO.: Reference Drawings - 002-C-006	CALCULATION NUMBER: Final

5 Cycles at 100 GPM

Made/Revised by; Mark Madison/PDX	Date: 5/6/2020	
Checked by; Jim Bays/TPA		
Approved		

50 Gallons per Minute from Wells plus 50 gpm from Recycle with 5 Cycles per day in Cell 2A ***144000 gallons per day total flow***

Cell 1 ***Final Design Specs***
Project: ***Kaiser Mead Natural Treatment System***
Basin Description: ***Bio-Chemical Reactor***

From CAD Earthwork Model

For all cells wood chip layer has 80% porosity

Contour Elevation (ft)	Contour Area (sq. ft)	Depth Avg. End (ft)	Incremental Volume (cu. ft)	Cumulative Volume (cu. ft)	Cumulative Volume of Water at Porosity (gallons)	Cell Profile	
1940	15,180	N/A	N/A	0		Bottom	
1941	16,849	1	16,014	16,014	41,926	12" of Drain Rock + 6" of 3/4" Rock	35% porosity
1942	18,575	1	17,712	33,726	145,057	2.75' of Organic Media	80% porosity
1943	20,357	1	19,466	53,193	318,304	Maximum Drain Down 1944.25-1942	335191 gallons
1944	22,196	1	21,277	74,469	445,625		
1944.25	23,144	0.25	5,786	80,255	480,248	Normal Water Level	
1945	24,092	1	23,144	97,613	584,118	Maximum Water Level with 1 ft of Freeboard	
1946	26,044	1	25,068	122,681	825,888	Top of Berm	

Hydrualic Loading (cm3/day) 545040000 cm3 — 1 gal = 3785 cm3
Hydraulic Surface Area 21,500,730 cm2 — 1 ft2 = 929 cm2
Hydraulic Loading Rate (cm/day) 25.3 cm/day
only possible if Cell 2B slide gate also failed open. Cell 2B can hold
HRT at 100 gpm forward flow rate = 80 hours 3.3 days

Time from normal water level to maximum water level at 100 gpm in and 0 gpm out = 17 hours (assumes maximum recycle and well pumping and plugged outlet)
at maximum water level the emergency bypass begins to flow to Cell 2A

During Cell 2A fill cycle Cell 1 a receives 100 gpm for 120 minutes or 12000 gallons in and 18000 gallons out
Maximum water level drop is 0.012 ft below normal water level 0.149923 inches

During Cell 2A drain cycle Cell 1 stops discharging for 1 hour but receives 100 gpm for 6000 gallons accumulation
Maximum water level rise is 0.012 ft above normal water level 0.149923 inches

Maximum Volume that could discharge if the outlet control slide gate fails open when Cell 1 is at normal water elevation 335,191 gallons

Cell 2A ***Final Design Specs***
Project: ***Kaiser Mead***
Basin Description: ***Tidal Flow Aeration***

From CAD Earthwork Model

Contour Elevation (ft)	Contour Area (sq. ft)	Depth Avg. End (ft)	Incremental Volume (cu. ft)	Cumulative Volume (cu. ft)	Cumulative Volume of Water at Porosity (gallons)	Cell Profile	
1939	931	N/A	N/A	0		Bottom	
1940	1508	1	1219	1219	3192	9" of Drain Rock	35% porosity
1941	2142	1	1825	3044	7969	4.25' of 3/4" Angular Basalt Media	35% porosity
1942	2833	1	2487	5531	14480	Maximum Drain Down 1944.25-1940	21983 gallons
1943	3582	1	3207	8738	22877		
1944	4388	1	3985	12723	33309	Normal High Water Level = 1944	
1,944.25	4,820	0.25	1,205	13,928	36464	Hydraulic Profile elevation	
1945	5251	1	4820	17543	104976	Maximum Water Level with 1 ft of Freeboard	
1946	6172	1	5712	23255	156551	Top of Berm	

4 CYCLES DOESN'T QUITE WORK - USE 5 OR 4+ PER DAY
5 cycles per day uses 30 minutes to drain, 30 minutes to remain empty, and 3.8 hours to refill. 288 minutes per cycle
Hydrualic Loading (cm3/day) 545040000 cm3
Hydraulic Surface Area 3,981,718 cm2
Hydraulic Loading Rate (cm/day) 136.9 cm/day 28800 gallons per cycle

HRT = 2.78 hours average empty 50% of time
Rate of Drainage for 30 minute draining time = 733 gpm (30 minutes empty with no flow)
Rate of Filling for 228 minute filling time = 96 gpm
Volume of forward flow into and out of Cell 1 in 288 minutes at 100 gpm 28800 gallons

time to reach spillway with full inflow and no discharge 12 hours
Normal low water is 1940 (BOTTOM 1 FT DOESN'T DRAIN)
Normal high water level is contour that holds 31992 gallons = 1943.874 FT
1043.21 gal/tenth
Normal water area 4286 9115 delta
0.87 additional tenths of ft to add above 1943

Cell 2b ***Final Design Specs***
Project: ***Kaiser Mead***
Basin Description: ***Aerobic Polishing with Plants***

From CAD Earthwork Model

Contour Elevation (ft)	Contour Area (sq. ft)	Depth Avg. End (ft)	Incremental Volume (cu. ft)	Cumulative Volume (cu. ft)	Cumulative Volume of Water at Porosity (gallons)	Cell Profile	
1,938.0	9,797	N/A	N/A	0.0		Bottom	
1,938.5	10,221	0.5	5004.36	5004.4	13101	1.5' of Drain Rock	35% porosity
1,939.0	10,652	0.5	5218.17	10222.5	26763	0.5'' of 3/4" Angular Basalt Media	35% porosity
1,939.5	11,090	0.5	5435.54	15658.1	40993		
1,940.0	11,536	0.5	5656.46	21314.5	55801	Maximum Water Level with 1 ft of Freeboard	
1,940.5	11,988	0.5	5880.95	27195.5	203422		
1,941.0	12,448	0.5	6109	33304.5	199294	Top of Berm	
1,941.5	12,915	0.5	6340.62	39645.1	237236		
1,942.0	12,605	0.5	6379.86	46025.0	275413		

Hydrualic Loading (cm3/day) 545040000 cm3
Hydraulic Surface Area 10,302,796 cm2
Hydraulic Loading Rate (cm/day) 52.9 cm/day

HRT = 6.8 hours average
Normal Low Water Level = 1939 near outlet weir
Normal High Water Level = 1940 near fill point
flow through rock and plant roots dampens level changes caused by siphon discharge
Maximum Drain Down 1940 to 1939.5 14809
Assume discharge to cell 3 at 100 gpm during fill cycle 28800 gallons enters from Cell 2A in 30 minutes while discharge to Cell 3 is 100 gpm or 3000 gallons
flow accumulated is 25800 gallons which causes a rise of 0.96 ft.
actual rise is expected to be 1 ft at the input location and insignificant at the outlet weir. Root density will dampen rise with growth.
time to reach spillway with full inflow and no discharge 5 hrs

Cell 3A *Final Design Specs*
Project: ***Kaiser Mead***
Basin Description: ***Horizontal Subsurface Flow with Plants***

From CAD Earthwork Model							
Contour Elevation (ft)	Contour Area Avg. End (sq. ft)	Depth Avg. End (ft)	Incremental Volume (cu. ft)	Cumulative Volume (cu. ft)	Cumulative Volume of Water at Porosity (gallons)	Cell Profile	
1,938.00	5,005.70	N/A	N/A	0		Bottom	
1,938.50	5,199.20	0.5	2551.23	2551.23	6,679	2' of drain gravel	35% porosity
1,939.00	5,393.00	0.5	2648.05	5199.28	13,612		
1,939.50	5,587.10	0.5	2745.03	7944.31	20,798	normal water level	
1,940.00	5,781.50	0.5	2842.14	10786.45	28,239	maximum water level with 1 ft of freeboard	
1,940.50	5,976.10	0.5	2939.39	13725.84	102,669		
1,941.00	6,171.00	0.5	3036.79	16762.63	125,384	Top of Berm	

Hydraulic Loading (cm3/day)	545040000	cm3
Hydraulic Surface Area	5,190,416	cm2
Hydraulic Loading Rate (cm/day)	105.0	cm/day

HRT = 3.5 hours average

time to reach maximum water level from normal water level with 100 gpm in and 0 out 74 minutes

water level rise if Cell 1 slide gate fails open and all flow passes through other cells 0.00 ft rise in Cell 3 (1939.79 ft.)
(slide gate invert is at elevation 142)

TOTAL NTS SYSTEM HRT = 3.5 hours average 0.1 DAYS

Cell 3B *Final Design Specs*
Project: ***Kaiser Mead***
Basin Description: ***Horizontal Subsurface Flow with Plants***

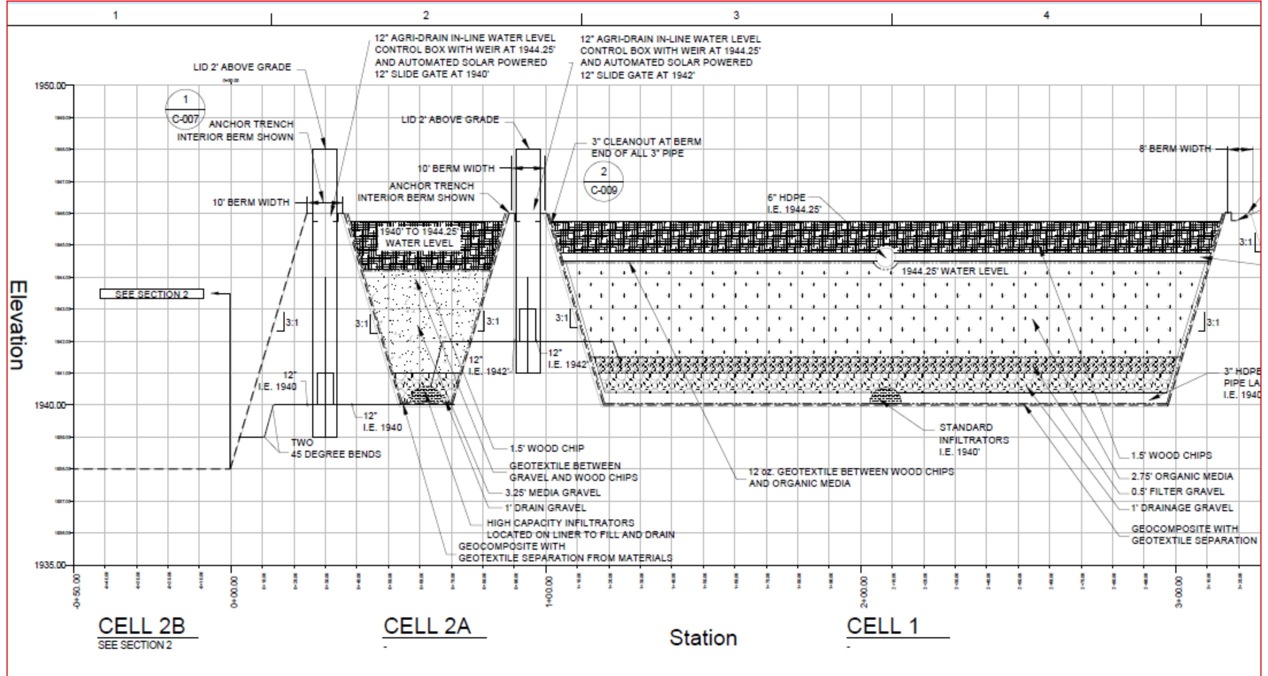
From CAD Earthwork Model							
Contour Elevation (ft)	Contour Area Avg. End (sq. ft)	Depth Avg. End (ft)	Incremental Volume (cu. ft)	Cumulative Volume (cu. ft)	Cumulative Volume of Water at Porosity (gallons)	Cell Profile	
1,938.00	20,061.20	N/A	N/A	0		Bottom	
1,938.50	20,606.60	0.5	10166.94	10166.94	26,617	20"' of 3/4" Angular Basalt Media	35% porosity
1,939.00	21,157.70	0.5	10441.08	20608.03	53,952		
1,939.50	21,714.60	0.5	10718.07	31326.1	82,012	normal water level	80% porosity
1,940.00	22,277.10	0.5	10997.9	42324	229,523	maximum water level with 1 ft of freeboard	
1,940.50	22,845.30	0.5	11280.58	53604.58	400,962		
1,941.00	23,418.90	0.5	11566.04	65170.62	487,476	Top of Berm	

Hydraulic Loading (cm3/day)	545040000	cm3
Hydraulic Surface Area	20,172,863	cm2
Hydraulic Loading Rate (cm/day)	27.0	cm/day

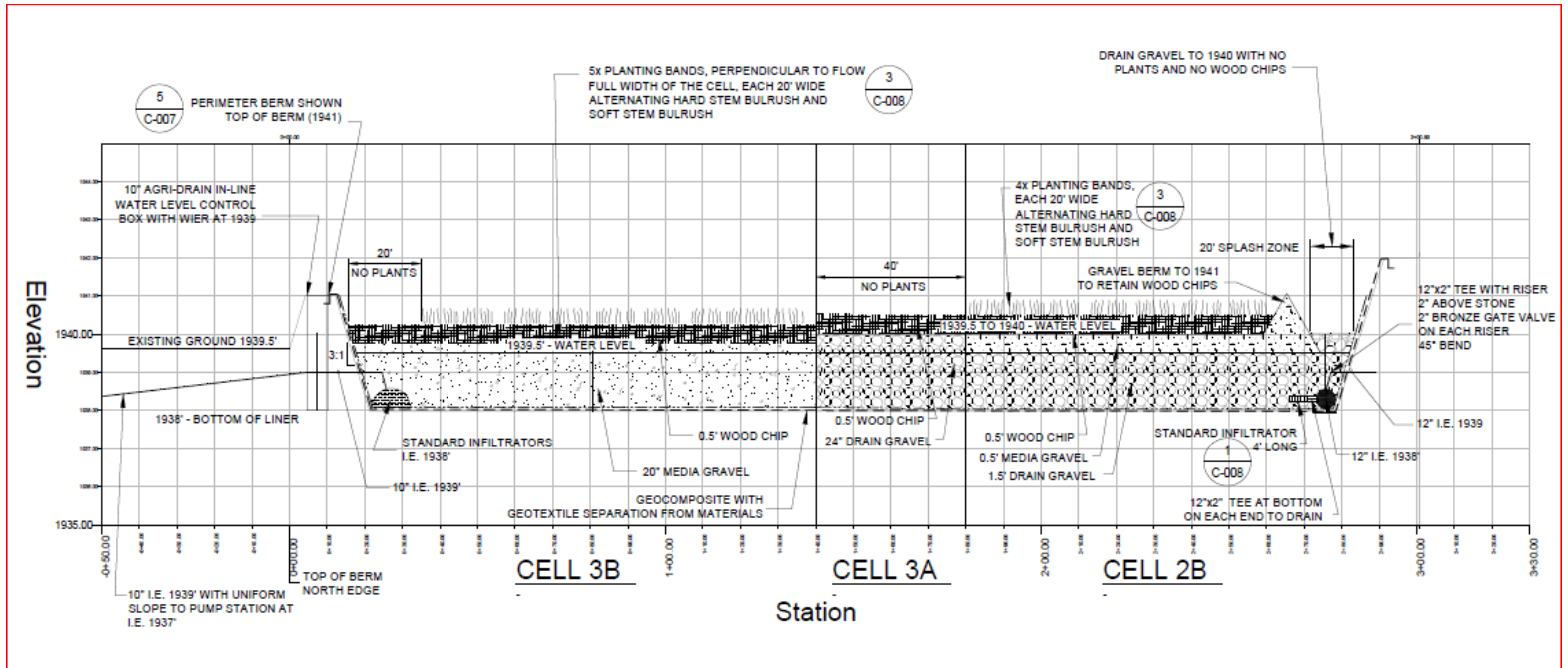
HRT = 13.7 hours average

time to reach maximum water level from normal water level with 100 gpm in and 0 out 281 minutes or 5 hours

water level rise if Cell 1 slide gate fails open and all flow passes through other cells 4.09 ft rise in Cell 3 (1939.79 ft.)
(slide gate invert is at elevation 142)


1
2
3
4
Elevation
1950.00
1940.00
1935.00
LID 2' ABOVE GRADE
1
C-007
ANCHOR TRENCH INTERIOR BERM SHOWN
12" AGRI-DRAIN IN-LINE WATER LEVEL CONTROL BOX WITH WEIR AT 1944.25' AND AUTOMATED SOLAR POWERED 12" SLIDE GATE AT 1940'
12" AGRI-DRAIN IN-LINE WATER LEVEL CONTROL BOX WITH WEIR AT 1944.25' AND AUTOMATED SOLAR POWERED 12" SLIDE GATE AT 1942'
LID 2' ABOVE GRADE
3" CLEANOUT AT BERM END OF ALL 3" PIPE
2
C-009
10' BERM WIDTH
ANCHOR TRENCH INTERIOR BERM SHOWN
10' BERM WIDTH
1940' TO 1944.25' WATER LEVEL
6" HDPE I.E. 1944.25'
8' BERM WIDTH
1944.25' WATER LEVEL
SEE SECTION 2
3:1
3:1
3:1
3:1
3:1
3:1
12" I.E. 1940
12" I.E. 1942'
12" I.E. 1942'
12" I.E. 1940
TWO 45 DEGREE BENDS
3" HDPE PIPE LA I.E. 1940
STANDARD INFILTRATORS I.E. 1940'
1.5' WOOD CHIP
GEOTEXTILE BETWEEN GRAVEL AND WOOD CHIPS
3.25' MEDIA GRAVEL
1' DRAIN GRAVEL
HIGH CAPACITY INFILTRATORS LOCATED ON LINER TO FILL AND DRAIN
GEOCOMPOSITE WITH GEOTEXTILE SEPARATION FROM MATERIALS
12 oz. GEOTEXTILE BETWEEN WOOD CHIPS AND ORGANIC MEDIA
1.5' WOOD CHIPS
2.75' ORGANIC MEDIA
0.5' FILTER GRAVEL
1' DRAINAGE GRAVEL
GEOCOMPOSITE WITH GEOTEXTILE SEPARATION
-0+50.00
0+00.00
1+00.00
2+00.00
3+00.00
CELL 2B
SEE SECTION 2
CELL 2A
Station
CELL 1

1 CELL 1-2A CROSS SECTION DETAIL
BIO-CHEMICAL REACTOR (BCR) - NTS


Elevation
1940.00
1935.00
5
C-007
PERIMETER BERM SHOWN TOP OF BERM (1941)
5x PLANTING BANDS, PERPENDICULAR TO FLOW FULL WIDTH OF THE CELL, EACH 20' WIDE ALTERNATING HARD STEM BULRUSH AND SOFT STEM BULRUSH
3
C-008
DRAIN GRAVEL TO 1940 WITH NO PLANTS AND NO WOOD CHIPS
10" AGRI-DRAIN IN-LINE WATER LEVEL CONTROL BOX WITH WIER AT 1939
20'
NO PLANTS
40'
NO PLANTS
4x PLANTING BANDS, EACH 20' WIDE ALTERNATING HARD STEM BULRUSH AND SOFT STEM BULRUSH
3
C-008
20' SPLASH ZONE
GRAVEL BERM TO 1941 TO RETAIN WOOD CHIPS
12"x2" TEE WITH RISER 2" ABOVE STONE 2" BRONZE GATE VALVE ON EACH RISER 45° BEND
EXISTING GROUND 1939.5'
3:1
1939.5' - WATER LEVEL
1939.5 TO 1940 - WATER LEVEL
1938' - BOTTOM OF LINER
STANDARD INFILTRATORS I.E. 1938'
10" I.E. 1939'
0.5' WOOD CHIP
20" MEDIA GRAVEL
GEOCOMPOSITE WITH GEOTEXTILE SEPARATION FROM MATERIALS
0.5' WOOD CHIP
24" DRAIN GRAVEL
0.5' WOOD CHIP
0.5' MEDIA GRAVEL
1.5' DRAIN GRAVEL
STANDARD INFILTRATOR 4' LONG
1
C-008
12"x2" TEE AT BOTTOM ON EACH END TO DRAIN
12" I.E. 1938'
12" I.E. 1939
10" I.E. 1939' WITH UNIFORM SLOPE TO PUMP STATION AT I.E. 1937'
TOP OF BERM NORTH EDGE
-0+50.00
0+00.00
1+00.00
2+00.00
3+00.00
3+30.00
CELL 3B
CELL 3A
CELL 2B
Station

2 CELL 3-2B CROSS SECTION DETAIL
HORIZONTAL SUBSURFACE FLOW WETLAND (SSF) - NTS

JACOBS™ CALCULATION SHEET	PROJECT: Kaiser Mead Custodial Trust	LOCATION: Mead Washington
	CLIENT:: Kaiser Mead Groundwater Remediation Interim Action	JOB No. KMCT2019
TITLE: Final Design Report for Extraction, Treatment, and Discharge Systems Enhanced Wetland Treatment System Calculations	EQUIP./DWG. NO.: Reference Drawings - 002-C-006	CALCULATION NUMBER: Final

6 Cycles at 50 GPM

Made/Revised by; Mark Madison/PDX	Date: 5/6/2020	
Checked by; Jim Bays/TPA		
Approved		

50 gpm from wells and no recycle for 6 tidal cycles per day in Cell 2A ***72000 gallons per day total flow***

Cell 1 Final Design Specs
Project: Kaiser Mead Natural Treatment System
Basin Description: Bio-Chemical Reactor

For all cells wood chip layer has 80% porosity

From CAD Earthwork Model								
Contour Elevation (ft)	Contour Area (sq. ft)	Depth Avg. End (ft)	Incremental Volume (cu. ft)	Cumulative Volume (cu. ft)	Cumulative Volume of Water at Porosity (gallons)	Cell Profile		
1940	15,180	N/A	N/A	0		Bottom		
1941	16,849	1	16,014	16,014	41,926	12" of Drain Rock + 6" of 3/4" Rock	35% porosity	
1942	18,575	1	17,712	33,726	145,057	2.75' of Organic Media	80% porosity	
1943	20,357	1	19,466	53,193	318,304	Maximum Drain Down 1944-1942	335191	gallons
1944	22,196	1	21,277	74,469	445,625	Normal Water Level		
1944.25	23,144	0.25	5,786	80,255	480,248			
1945	24,092	1	23,144	97,613	584,118	Maximum Water Level with 1 ft of Freeboard		
1946	26,044	1	25,068	122,681	825,888	Top of Berm		

Hydrualic Loading (cm3/day)	272520000	cm3		1 gal = 3785 cm3
Hydraulic Surface Area	21,500,730	cm2		1 ft2 = 929 cm2
Hydraulic Loading Rate (cm/day)		12.7	cm/day	

HRT at 100 gpm forward flow rate = 160 hours 6.7 days
Time from normal water level to maximum water level at 100 gpm in and 0 gpm out = 17 hours (assumes maximum recycle and well pumping and plugged outlet)
at maximum water level the emergency bypass begins to flow to Cell 2A

During Cell 2A fill cycle Cell 1 a receives 100 gpm for 180 minutes or 18000 gallons in and 24000 gallons out
Maximum water level drop is 0.012 ft below normal water level 0.149923 inches

During Cell 2A drain cycle Cell 1 stops discharging for 1 hour but receives 100 gpm for 6000 gallons accumulation
Maximum water level rise is 0.012 ft above normal water level 0.149923 inches

Maximum Volume that could discharge if the outlet control slide gate fails open when Cell 1 is at normal water elevation 335191

Cell 2A Final Design Specs
Project: Kaiser Mead
Basin Description: Tidal Flow Aeration

From CAD Earthwork Model							
Contour Elevation (ft)	Contour Area (sq. ft)	Depth Avg. End (ft)	Incremental Volume (cu. ft)	Cumulative Volume (cu. ft)	Cumulative Volume of Water at Porosity (gallons)	Cell Profile	
1939	931	N/A	N/A	0		Bottom	
1940	1508	1	1219	1219	3192	9" of Drain Rock	35% porosity
1941	2142	1	1825	3044	7969	4.25' of 3/4" Angular Basalt Media	35% porosity
1942	2833	1	2487	5531	14480	Normal High Water Level = 1942.08	
1943	3582	1	3207	8738	22877		
1944	4388	1	3985	12723	33309		
1945	5251	1	4820	17543	104976	Maximum Water Level with 1 ft of Freeboard	
1946	6172	1	5712	23255	156551	Top of Berm	

Hydrualic Loading (cm3/day)	272520000	cm3		1 gal = 3785 cm3
Hydraulic Surface Area	2,690,724	cm2		1 ft2 = 929 cm2
Hydraulic Loading Rate (cm/day)		101.3	cm/day	

HRT = 2.4 hours average per cycle empty 50% of the time
Normal low water is 1940 (BOTTOM 1 FT DOESN'T DRAIN)
Rate of Drainage for 30 minute draining time = 400 gpm (30 minutes empty with no flow)
Rate of Filling for 180 minute filling time = 67 gpm
6 cycles/da Volume of forward flow into and out of Cell 1 in 240 minutes at 100 gpm 12000 gallons

Maximum Drain Down 1942.08-1940 12000 gallons
Normal high water level is contour that holds 15192 gallons = 1942.085 FT
839.67 gal/tenth
Normal water area 2896.4 712 delta
0.08 additional tenths of ft to add

Cell 2b Final Design Specs
Project: Kaiser Mead
Basin Description: Aerobic Polishing with Plants

From CAD Earthwork Model							
Contour Elevation (ft)	Contour Area (sq. ft)	Depth Avg. End (ft)	Incremental Volume (cu. ft)	Cumulative Volume (cu. ft)	Cumulative Volume of Water at Porosity (gallons)	Cell Profile	
1,938.00	9,797	N/A	N/A	0.0		Bottom	
1,938.50	10,221	0.5	5004.36	5004.4	13101	1.5' of Drain Rock	35% porosity
1,939.00	10,652	0.5	5218.17	10222.5	26763	0.5'' of 3/4" Angular Basalt Media	35% porosity
1,939.50	11,090	0.5	5435.54	15658.1	40993		
1,940.00	11,536	0.5	5656.46	21314.5	55801	Maximum Water Level with 1 ft of Freeboard	
1,940.50	11,988	0.5	5880.95	27195.5	203422		
1,941.00	12,448	0.5	6109	33304.5	199294	Top of Berm	
1,941.50	12,915	0.5	6340.62	39645.1	237236		

Hydrualic Loading (cm3/day)	272520000	cm3		1 gal = 3785 cm3
Hydraulic Surface Area	10,302,796	cm2		1 ft2 = 929 cm2
Hydraulic Loading Rate (cm/day)		26.5	cm/day	

HRT = 13.7 hours average
Normal Low Water Level = 1939 near outlet weir
Normal High Water Level = 1940 near fill point
flow through rock and plant roots dampens level changes caused by siphon discharge
Maximum Drain Down 1940 to 1939 13661 gallons
Assume discharge to cell 3 at 100 gpm during fill cycle 12000 gallons enters from Cell 2A in 30 minutes while discharge to Cell 3 is 100 gpm or 3000 gallons
flow accumulated is 9000 gallons which causes a rise of =9000 0.34 ft average over the total cell
actual rise is expected to be 1 ft at the input location and insignificant at the outlet weir. Root density will dampen rise with growth.

1,942.00	12,605	0.5	6379.86	46025.0	275413

Cell 3A *Final Design Specs*
Project: *Kaiser Mead*
Basin Description: *Horizontal Subsurface Flow with Plants*

From CAD Earthwork Model

Contour Elevation (ft)	Contour Area Avg. End (sq. ft)	Depth Avg. End (ft)	Incremental Volume (cu. ft)	Cumulative Volume (cu. ft)	Cumulative Volume of Water at Porosity (gallons)	Cell Profile	
1,938.00	5,006	N/A	N/A	0		Bottom	
1,938.50	5,199	0.5	2551.23	2551.23	6,679	2' drain gravel	35% porosity
1,939.00	5,393	0.5	2648.05	5199.28	13,612		
1,939.50	5,587	0.5	2745.03	7944.31	20,798	normal water level near cell 3B	
1,940.00	5,782	0.5	2842.14	10786.45	28,239	maximum water level near cell 2B	
1,940.50	5,976	0.5	2939.39	13725.84	102,669		
1,941.00	6,171	0.5	3036.79	16762.63	125,384	Top of Berm	

Hydraulic Loading (cm3/day)	272520000 cm3		1 gal = 3785 cm3
Hydraulic Surface Area	5,190,416 cm2		1 ft2 = 929 cm2
Hydraulic Loading Rate (cm/day)		52.5 cm/day	

HRT = 6.9 hours average

time to reach maximum water level from normal water level with 50 gpm in and 0 out 144 minutes or 2 hours
(assumes failed recycle and EC pumps and no discharge with 50 gpm from wells causing forward flow through all cells)

water level rise if Cell 1 slide gate fails open and all flow passes through other cells 16.12 ft rise in Cell 3 (1939.79 ft.)
(slide gate invert is at elevation 142)

Cell 3B *Final Design Specs*
Project: *Kaiser Mead*
Basin Description: *Horizontal Subsurface Flow with Plants*

From CAD Earthwork Model

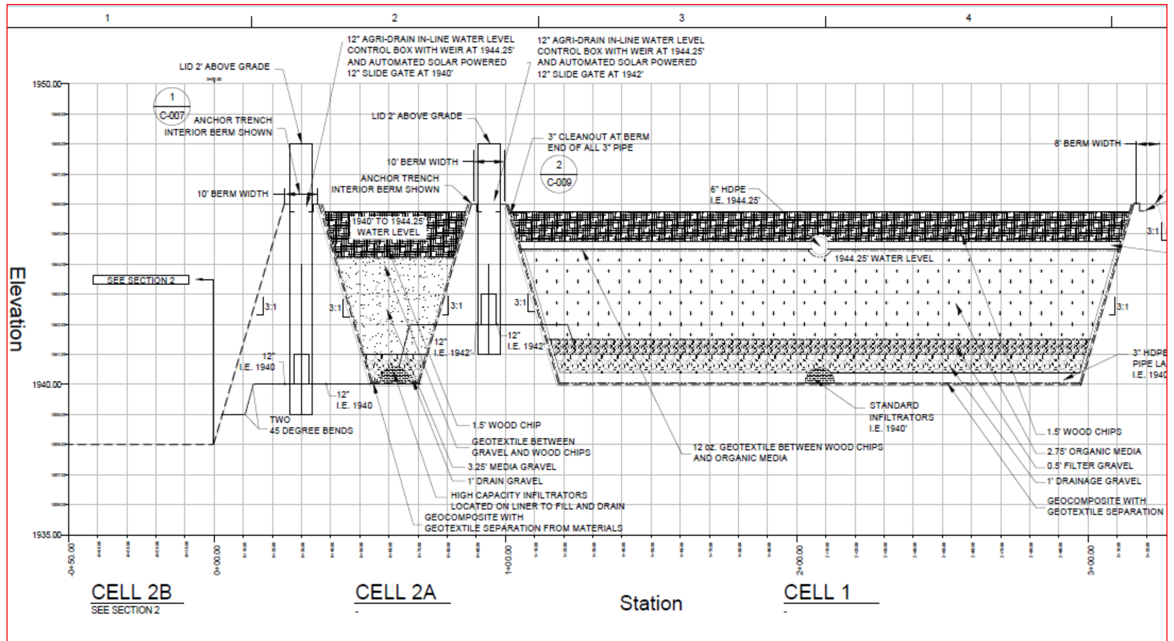
Contour Elevation (ft)	Contour Area Avg. End (sq. ft)	Depth Avg. End (ft)	Incremental Volume (cu. ft)	Cumulative Volume (cu. ft)	Cumulative Volume of Water at Porosity (gallons)	Cell Profile
1,938.00	20,061	N/A	N/A	0		Bottom
1,938.50	20,607	0.5	10166.94	10166.94	26,617	20" media gravel
1,939.00	21,158	0.5	10441.08	20608.03	53,952	
1,939.50	21,715	0.5	10718.07	31326.1	82,012	maximum water level
1,940.00	22,277	0.5	10997.9	42324	253,267	Woodchips
1,940.50	22,845	0.5	11280.58	53604.58	400,962	
1,941.00	23,419	0.5	11566.04	65170.62	487,476	Top of Berm

Hydraulic Loading (cm3/day)	272520000 cm3		1 gal = 3785 cm3
Hydraulic Surface Area	20,172,863 cm2		1 ft2 = 929 cm2
Hydraulic Loading Rate (cm/day)		13.5 cm/day	

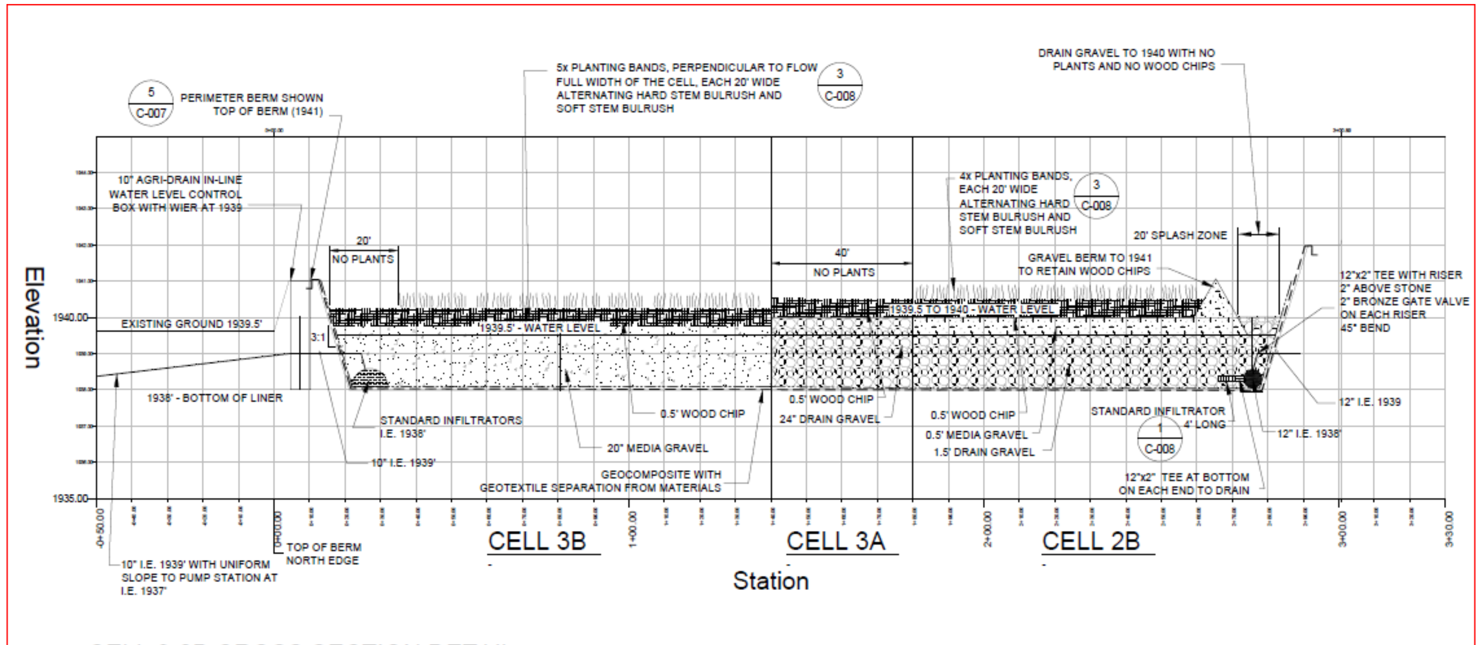
HRT = 27.3 hours average

time to reach maximum water level from normal water level with 50 gpm in and 0 out 561 minutes or 9 hours
(assumes failed recycle and EC pumps and no discharge with 50 gpm from wells causing forward flow through all cells)

water level rise if Cell 1 slide gate fails open and all flow passes through other cells 0.00 ft rise in Cell 3 (1939.79 ft.)
(slide gate invert is at elevation 142)


1
2
3
4
12" AGRI-DRAIN IN-LINE WATER LEVEL CONTROL BOX WITH WEIR AT 1944.25' AND AUTOMATED SOLAR POWERED 12" SLIDE GATE AT 1940'
12" AGRI-DRAIN IN-LINE WATER LEVEL CONTROL BOX WITH WEIR AT 1944.25' AND AUTOMATED SOLAR POWERED 12" SLIDE GATE AT 1942'
LID 2' ABOVE GRADE
1950.00
1
C-007
ANCHOR TRENCH INTERIOR BERM SHOWN
LID 2' ABOVE GRADE
3" CLEANOUT AT BERM END OF ALL 3" PIPE
10' BERM WIDTH
2
C-009
ANCHOR TRENCH INTERIOR BERM SHOWN
10' BERM WIDTH
6" HDPE I.E. 1944.25'
8' BERM WIDTH
1940' TO 1944.25' WATER LEVEL
1944.25' WATER LEVEL
SEE SECTION 2
3:1
12" I.E. 1942'
12" I.E. 1940
3" HDPE PIPE LA I.E. 1940
1940.00
12" I.E. 1940
TWO 45 DEGREE BENDS
1.5' WOOD CHIP
GEOTEXTILE BETWEEN GRAVEL AND WOOD CHIPS
3.25' MEDIA GRAVEL
1' DRAIN GRAVEL
HIGH CAPACITY INFILTRATORS LOCATED ON LINER TO FILL AND DRAIN
GEOCOMPOSITE WITH GEOTEXTILE SEPARATION FROM MATERIALS
STANDARD INFILTRATORS I.E. 1940'
12 oz. GEOTEXTILE BETWEEN WOOD CHIPS AND ORGANIC MEDIA
1.5' WOOD CHIPS
2.75' ORGANIC MEDIA
0.5' FILTER GRAVEL
1' DRAINAGE GRAVEL
GEOCOMPOSITE WITH GEOTEXTILE SEPARATION
1935.00
Elevation
0+50.00
0+00.00
1+00.00
2+00.00
3+00.00
CELL 2B
SEE SECTION 2
CELL 2A
Station
CELL 1

1 CELL 1-2A CROSS SECTION DETAIL
BIO-CHEMICAL REACTOR (BCR) - NTS


5
C-007
PERIMETER BERM SHOWN TOP OF BERM (1941)
5x PLANTING BANDS, PERPENDICULAR TO FLOW FULL WIDTH OF THE CELL, EACH 20' WIDE ALTERNATING HARD STEM BULRUSH AND SOFT STEM BULRUSH
3
C-008
DRAIN GRAVEL TO 1940 WITH NO PLANTS AND NO WOOD CHIPS
10" AGRI-DRAIN IN-LINE WATER LEVEL CONTROL BOX WITH WIER AT 1939
4x PLANTING BANDS, EACH 20' WIDE ALTERNATING HARD STEM BULRUSH AND SOFT STEM BULRUSH
3
C-008
20'
NO PLANTS
40'
NO PLANTS
20' SPLASH ZONE
GRAVEL BERM TO 1941 TO RETAIN WOOD CHIPS
12"x2" TEE WITH RISER 2" ABOVE STONE 2" BRONZE GATE VALVE ON EACH RISER 45° BEND
1940.00
EXISTING GROUND 1939.5'
3:1
1939.5' - WATER LEVEL
1939.5 TO 1940 - WATER LEVEL
1938' - BOTTOM OF LINER
STANDARD INFILTRATORS I.E. 1938'
0.5' WOOD CHIP
0.5' WOOD CHIP
24" DRAIN GRAVEL
0.5' WOOD CHIP
0.5' MEDIA GRAVEL
1.5' DRAIN GRAVEL
STANDARD INFILTRATOR 4' LONG
1
C-008
12" I.E. 1939
12" I.E. 1938'
10" I.E. 1939'
20" MEDIA GRAVEL
GEOCOMPOSITE WITH GEOTEXTILE SEPARATION FROM MATERIALS
12"x2" TEE AT BOTTOM ON EACH END TO DRAIN
1935.00
Elevation
-0+50.00
0+00.00
TOP OF BERM NORTH EDGE
10" I.E. 1939' WITH UNIFORM SLOPE TO PUMP STATION AT I.E. 1937'
1+00.00
2+00.00
3+00.00
3+30.00
CELL 3B
CELL 3A
CELL 2B
Station

2 CELL 3-2B CROSS SECTION DETAIL
HORIZONTAL SUBSURFACE FLOW WETLAND (SSF) - NTS

JACOBS™ CALCULATION SHEET	PROJECT: Kaiser Mead Custodial Trust	LOCATION: Mead Washington
	CLIENT:: Kaiser Mead Groundwater Remediation Interim Action	JOB No. KMCT2019
TITLE: Final Design Report for Extraction, Treatment, and Discharge Systems Enhanced Wetland Treatment System Calculations	EQUIP./DWG. NO.: Reference Drawings - 002-C-006	CALCULATION NUMBER: Final

6 Cycles at 100 GPM
Page 8 of 10

Made/Revised by; Mark Madison/PDX	Date: 5/6/2020	
Checked by; Jim Bays/TPA		
Approved		

50 gpm from wells and 50 gpm from recycle for 6 tidal cycles per day in Cell 2A ***144000 gallons per day total flow***

Cell 1 ***Final Design Specs***
Project: ***Kaiser Mead Natural Treatment System***
Basin Description: ***Bio-Chemical Reactor***

From CAD Earthwork Model

Contour Elevation (ft)	Contour Area (sq. ft)	Depth Avg. End (ft)	Incremental Volume (cu. ft)	Cumulative Volume (cu. ft)	Cumulative Volume of Water at Porosity (gallons)	Cell Profile	
							For all cells wood chip layer has 80% porosity
1940	15,180	N/A	N/A	0		Bottom	
1941	16,849	1	16,014	16,014	41,926	12" of Drain Rock + 6" of 3/4" Rock	35% porosity
1942	18,575	1	17,712	33,726	145,057	2.75' of Organic Media	80% porosity
1943	20,357	1	19,466	53,193	318,304	Maximum Drain Down 1944-1942	335191 gallons
1944	22,196	1	21,277	74,469	445,625	Normal Water Level	
1944.25	23,144	0.25	5,786	80,255	480,248	Normal Water Level	
1945	24,092	1	23,144	97,613	584,118	Maximum Water Level with 1 ft of Freeboard	
1946	26,044	1	25,068	122,681	825,888	Top of Berm	

Hydrualic Loading (cm3/day) 545040000 cm3 — 1 gal = 3785 cm3
Hydraulic Surface Area 21,500,730 cm2 — 1 ft2 = 929 cm2
Hydraulic Loading Rate (cm/day) 25.3 cm/day

HRT at 100 gpm forward flow rate = 80 hours 3.3 days
Time from normal water level to maximum water level at 100 gpm in and 0 gpm out = 17 hours (assumes maximum recycle and well pumping and plugged outlet)
at maximum water level the emergency bypass begins to flow to Cell 2A

During Cell 2A fill cycle Cell 1 a receives 100 gpm for 180 minutes or 18000 gallons in and 24000 gallons out
Maximum water level drop is 0.012 ft below normal water level 0.149923 inches

During Cell 2A drain cycle Cell 1 stops discharging for 1 hour but receives 100 gpm for 6000 gallons accumulation
Maximum water level rise is 0.012 ft above normal water level 0.149923 inches

Maximum Volume that could discharge if the outlet control slide gate fails open when Cell 1 is at normal water elevation 335191

Cell 2A ***Final Design Specs***
Project: ***Kaiser Mead***
Basin Description: ***Tidal Flow Aeration***

From CAD Earthwork Model

Contour Elevation (ft)	Contour Area (sq. ft)	Depth Avg. End (ft)	Incremental Volume (cu. ft)	Cumulative Volume (cu. ft)	Cumulative Volume of Water at Porosity (gallons)	Cell Profile	
1939	931	N/A	N/A	0		Bottom	
1940	1508	1	1219	1219	3192	9" of Drain Rock	35% porosity
1941	2142	1	1825	3044	7969	4.25' of 3/4" Angular Basalt Media	35% porosity
1942	2833	1	2487	5531	14480	Maximum Drain Down 1943.41-1940	24000 gallons
1943	3582	1	3207	8738	22877		
1944	4388	1	3985	12723	33309	Normal High Water Level = 1943.82	
1945	5251	1	4820	17543	104976	Maximum Water Level with 1 ft of Freeboard	
1946	6172	1	5712	23255	156551	Top of Berm	

Hydrualic Loading (cm3/day) 545040000 cm3
Hydraulic Surface Area 3,637,151 cm2
Hydraulic Loading Rate (cm/day) 149.9 cm/day

HRT = 2.3 hours average per cycle empty 50% of the time
Normal low water is 1940 (BOTTOM 1 FT DOESN'T DRAIN)

Rate of Drainage for 30 minute draining time = 800 gpm (30 minutes empty with no flow)
Rate of Filling for 180 minute filling time = 133 gpm
6 cycles/day Volume of forward flow into and out of Cell 1 in 240 minutes at 100 gpm 24000 gallons

Normal high water level is contour that holds 27192 gallons = 1943.41 FT
1043.21 gal/tenth
4315 delta
0.41 additional tenths of ft to add

Normal water area 3915

Cell 2b ***Final Design Specs***
Project: ***Kaiser Mead***
Basin Description: ***Aerobic Polishing with Plants***

From CAD Earthwork Model

Contour Elevation (ft)	Contour Area (sq. ft)	Depth Avg. End (ft)	Incremental Volume (cu. ft)	Cumulative Volume (cu. ft)	Cumulative Volume of Water at Porosity (gallons)	Cell Profile	
1,938.0	9,797	N/A	N/A	0.0		Bottom	
1,938.5	10,221	0.5	5004.36	5004.4	13101	1.5' of Drain Rock	35% porosity
1,939.0	10,652	0.5	5218.17	10222.5	26763	0.5'' of 3/4" Angular Basalt Media	35% porosity
1,939.5	11,090	0.5	5435.54	15658.1	40993		
1,940.0	11,536	0.5	5656.46	21314.5	55801	Maximum Water Level with 1 ft of Freeboard	
1,940.5	11,988	0.5	5880.95	27195.5	203422		
1,941.0	12,448	0.5	6109	33304.5	199294	Top of Berm	
1,941.5	12,915	0.5	6340.62	39645.1	237236		

Hydrualic Loading (cm3/day) 545040000 cm3
Hydraulic Surface Area 10,302,796 cm2
Hydraulic Loading Rate (cm/day) 52.9 cm/day

HRT = 6.8 hours average
Normal Low Water Level = 1939 near outlet weir
Normal High Water Level = 1940 near fill point
flow through rock and plant roots dampens level changes caused by siphon discharge
Maximum Drain Down 1940 to 1939 13661 gallons
during fill cycle 24000 gallons enters from Cell 2A in 30 minutes while discharge to Cell 3 is 100 gpm or 3000 gallons
flow accumulated is 21000 gallons which causes a rise of 0.78 ft average over the total cell
actual rise is expected to be 1 ft at the input location and insignificant at the outlet weir. Root density will dampen rise with growth.

1,942.0	12,605	0.5	6379.86	46025.0	275413

Cell 3A ***Final Design Specs***
Project: ***Kaiser Mead***
Basin Description: ***Horizontal Subsurface Flow with Plants***

From CAD Earthwork Model

Contour Elevation (ft)	Contour Area Avg. End (sq. ft)	Depth Avg. End (ft)	Incremental Volume (cu. ft)	Cumulative Volume (cu. ft)	Cumulative Volume of Water at Porosity (gallons)	Cell Profile
1,938.00	5,005.70	N/A	N/A	0		Bottom
1,938.50	5,199.20	0.5	2551.23	2551.23	6,679	2' of drain gravel
1,939.00	5,393.00	0.5	2648.05	5199.28	13,612	
1,939.50	5,587.10	0.5	2745.03	7944.31	20,798	normal water level
1,940.00	5,781.50	0.5	2842.14	10786.45	28,239	maximum water level with 1 ft of freeboard
1,940.50	5,976.10	0.5	2939.39	13725.84	102,669	
1,941.00	6,171.00	0.5	3036.79	16762.63	125,384	Top of Berm

35% porosity

Hydraulic Loading (cm3/day)	545040000	cm3
Hydraulic Surface Area	5,190,416	cm2
Hydraulic Loading Rate (cm/day)	105.0	cm/day

HRT = 3.5 hours average

time to reach maximum water level from normal water level with 50 gpm in and 0 out 149 minutes or 2 hours
(assumes failed recycle and EC pumps and no discharge with 50 gpm from wells causing forward flow through all cells)

water level rise if Cell 1 slide gate fails open and all flow passes through other cells 11.87 ft rise in Cell 3 (1939.79 ft.)
(slide gate invert is at elevation 142)

TOTAL NTS SYSTEM HRT = 92.6 hours average 3.9 DAYS

Cell 3B ***Final Design Specs***
Project: ***Kaiser Mead***
Basin Description: ***Horizontal Subsurface Flow with Plants***

From CAD Earthwork Model

Contour Elevation (ft)	Contour Area Avg. End (sq. ft)	Depth Avg. End (ft)	Incremental Volume (cu. ft)	Cumulative Volume (cu. ft)	Cumulative Volume of Water at Porosity (gallons)	Cell Profile
1,938.00	20,061.20	N/A	N/A	0		Bottom
1,938.50	20,606.60	0.5	10166.94	10166.94	26,617	20"' of 3/4" Angular Basalt Media
1,939.00	21,157.70	0.5	10441.08	20608.03	53,952	
1,939.50	21,714.60	0.5	10718.07	31326.1	82,012	normal water level
1,940.00	22,277.10	0.5	10997.9	42324	229,523	maximum water level with 1 ft of freeboard
1,940.50	22,845.30	0.5	11280.58	53604.58	400,962	
1,941.00	23,418.90	0.5	11566.04	65170.62	487,476	Top of Berm

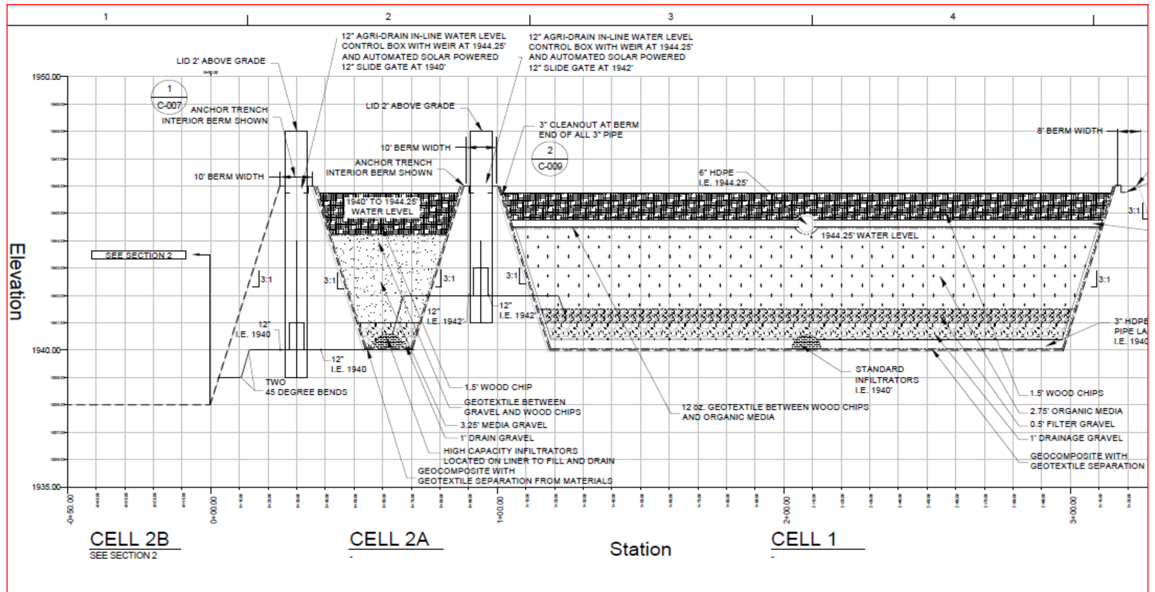
Hydraulic Loading (cm3/day)	545040000	cm3
Hydraulic Surface Area	20,172,863	cm2
Hydraulic Loading Rate (cm/day)	27.0	cm/day

HRT = 13.7 hours average

time to reach maximum water level from normal water level with 50 gpm in and 0 out 2950 minutes or 49 hours
(assumes failed recycle and EC pumps and no discharge with 50 gpm from wells causing forward flow through all cells)

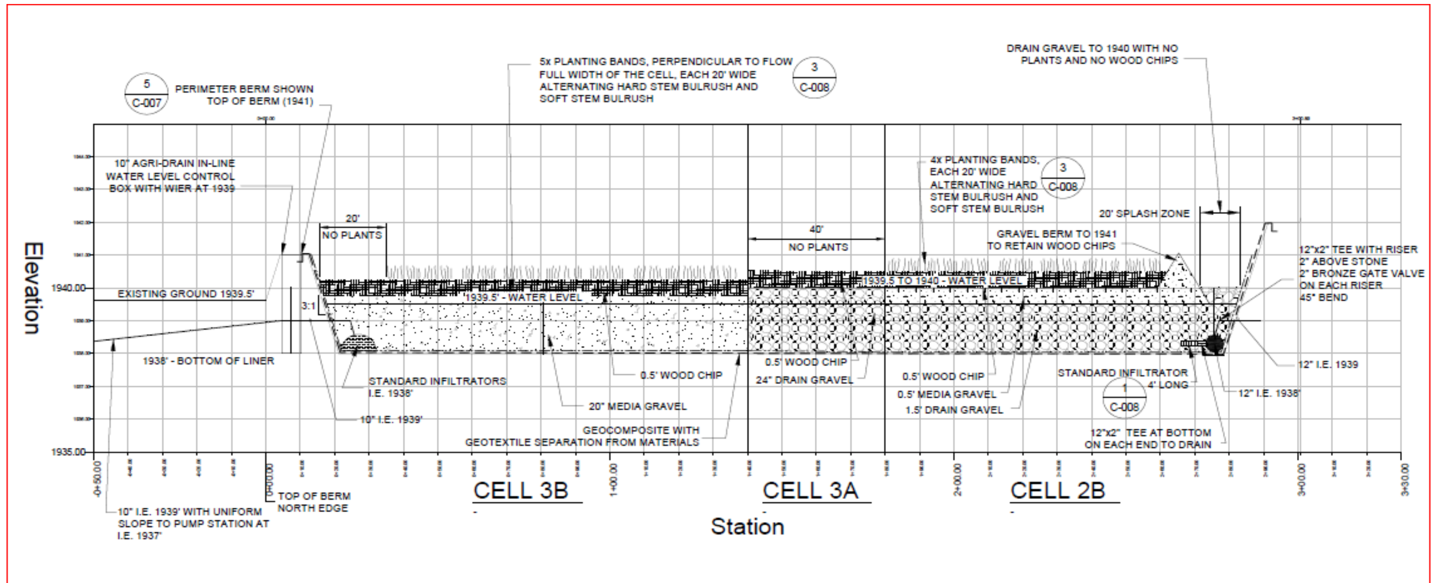
water level rise if Cell 1 slide gate fails open and all flow passes through other cells 0.00 ft rise in Cell 3 (1939.79 ft.)
(slide gate invert is at elevation 142)

TOTAL NTS SYSTEM HRT = 17.1 hours average 0.7 DAYS



1
2
3
4
LID 2' ABOVE GRADE
12" AGRI-DRAIN IN-LINE WATER LEVEL CONTROL BOX WITH WEIR AT 1944.25' AND AUTOMATED SOLAR POWERED 12" SLIDE GATE AT 1940'
12" AGRI-DRAIN IN-LINE WATER LEVEL CONTROL BOX WITH WEIR AT 1944.25' AND AUTOMATED SOLAR POWERED 12" SLIDE GATE AT 1942'
12" AGRI-DRAIN IN-LINE WATER LEVEL CONTROL BOX WITH WEIR AT 1944.25' AND AUTOMATED SOLAR POWERED 12" SLIDE GATE AT 1942'
1950.00
1 C-007
ANCHOR TRENCH INTERIOR BERM SHOWN
LID 2' ABOVE GRADE
3" CLEANOUT AT BERM END OF ALL 3" PIPE
2 C-009
10' BERM WIDTH
ANCHOR TRENCH INTERIOR BERM SHOWN
10' BERM WIDTH
8' BERM WIDTH
6" HDPE I.E. 1944.25'
1940' TO 1944.25' WATER LEVEL
1944.25' WATER LEVEL
SEE SECTION 2
Elevation
3:1
12" I.E. 1942'
12" I.E. 1942'
12" I.E. 1940
1940.00
12" I.E. 1940
TWO 45 DEGREE BENDS
3" HDPE PIPE LA I.E. 1940
STANDARD INFILTRATORS I.E. 1940'
1.5' WOOD CHIP
GEOTEXTILE BETWEEN GRAVEL AND WOOD CHIPS
3.25' MEDIA GRAVEL
1' DRAIN GRAVEL
HIGH CAPACITY INFILTRATORS LOCATED ON LINER TO FILL AND DRAIN
GEOCOMPOSITE WITH GEOTEXTILE SEPARATION FROM MATERIALS
12 oz. GEOTEXTILE BETWEEN WOOD CHIPS AND ORGANIC MEDIA
1.5' WOOD CHIPS
2.75' ORGANIC MEDIA
0.5' FILTER GRAVEL
1' DRAINAGE GRAVEL
GEOCOMPOSITE WITH GEOTEXTILE SEPARATION
1935.00
-0+50.00
0+00.00
1+00.00
2+00.00
3+00.00
CELL 2B
SEE SECTION 2
CELL 2A
Station
CELL 1

① CELL 1-2A CROSS SECTION DETAIL
BIO-CHEMICAL REACTOR (BCR) - NTS



5 C-007
PERIMETER BERM SHOWN TOP OF BERM (1941)
5x PLANTING BANDS, PERPENDICULAR TO FLOW FULL WIDTH OF THE CELL, EACH 20' WIDE ALTERNATING HARD STEM BULRUSH AND SOFT STEM BULRUSH
3 C-008
DRAIN GRAVEL TO 1940 WITH NO PLANTS AND NO WOOD CHIPS
10" AGRI-DRAIN IN-LINE WATER LEVEL CONTROL BOX WITH WIER AT 1939
20'
NO PLANTS
40'
NO PLANTS
4x PLANTING BANDS, EACH 20' WIDE ALTERNATING HARD STEM BULRUSH AND SOFT STEM BULRUSH
3 C-008
20' SPLASH ZONE
GRAVEL BERM TO 1941 TO RETAIN WOOD CHIPS
12"x2" TEE WITH RISER 2" ABOVE STONE 2" BRONZE GATE VALVE ON EACH RISER 45° BEND
Elevation
1940.00
EXISTING GROUND 1939.5'
3:1
1939.5' - WATER LEVEL
1939.5 TO 1940 - WATER LEVEL
1938' - BOTTOM OF LINER
STANDARD INFILTRATORS I.E. 1938'
0.5' WOOD CHIP
24" DRAIN GRAVEL
0.5' WOOD CHIP
0.5' WOOD CHIP
0.5' MEDIA GRAVEL
1.5' DRAIN GRAVEL
STANDARD INFILTRATOR 4' LONG
1 C-008
12" I.E. 1939
12" I.E. 1938'
20" MEDIA GRAVEL
10" I.E. 1939'
GEOCOMPOSITE WITH GEOTEXTILE SEPARATION FROM MATERIALS
12"x2" TEE AT BOTTOM ON EACH END TO DRAIN
1935.00
-0+50.00
0+00.00
1+00.00
2+00.00
3+00.00
3+30.00
TOP OF BERM NORTH EDGE
10" I.E. 1939' WITH UNIFORM SLOPE TO PUMP STATION AT I.E. 1937'
CELL 3B
CELL 3A
CELL 2B
Station

② CELL 3-2B CROSS SECTION DETAIL
HORIZONTAL SUBSURFACE FLOW WETLAND (SSF) - NTS

CALCULATION SHEET

TITLE: Final Design Report for Extraction, Treatment, and Discharge Systems Enhanced Wetland Treatment System Calculations	PROJECT: Kaiser Mead Custodial Trust	LOCATION: Mead Washington
	CLIENT:: Kaiser Mead Groundwater Remediation Interim Action	JOB No. KMCT2019
	EQUIP./DWG. NO.: Reference Drawings - 002-C-006	CALCULATION NUMBER: Final

8 Cycles at 50 GPM Page 9 of 10

Made/Revised by; Mark Madison/PDX	Date: 5/6/2020	
Checked by; Jim Bays/TPA		
Approved		

50 gpm from wells and no recycle for 8 tidal cycles per day in Cell 2A ***72000 gallons per day total flow***

Cell 1 ***Final Design Specs***
Project: ***Kaiser Mead Natural Treatment System***
Basin Description: ***Bio-Chemical Reactor***

For all cells wood chip layer has 80% porosity

From CAD Earthwork Model							
Contour Elevation (ft)	Contour Area (sq. ft)	Depth Avg. End (ft)	Incremental Volume (cu. ft)	Cumulative Volume (cu. ft)	Cumulative Volume of Water at Porosity (gallons)	Cell Profile	
1940	15,180	N/A	N/A	0		Bottom	
1941	16,849	1	16,014	16,014	41,926	12" of Drain Rock + 6" of 3/4" Rock	35% porosity
1942	18,575	1	17,712	33,726	145,057	2.75' of Organic Media	80% porosity
1943	20,357	1	19,466	53,193	318,304	Maximum Drain Down 1944-1942	335191 gallons
1944	22,196	1	21,277	74,469	445,625	Normal Water Level	
1944.25	23,144	0.25	5,786	80,255	480,248	Normal Water Level	
1945	24,092	1	23,144	97,613	584,118	Maximum Water Level with 1 ft of Freeboard	
1946	26,044	1	25,068	122,681	825,888	Top of Berm	

Hydrualic Loading (cm3/day) 272520000 cm3 1 gal = 3785 cm3
Hydraulic Surface Area 21,500,730 cm2 1 ft2 = 929 cm2
Hydraulic Loading Rate (cm/day) 12.7 cm/day

HRT at 50 gpm forward flow rate = 160 hours 6.7 days
Time from normal water level to maximum water level at 50 gpm in and 0 gpm out = 35 hours (assumes maximum recycle and well pumping and plugged outlet)
at maximum water level the emergency bypass begins to flow to Cell 2A

During Cell 2A fill cycle Cell 1 a receives 50 gpm for 120 minutes or 6000 gallons in and 9000 gallons out
Maximum water level drop is 0.006 ft below normal water level 0.075 inches

During Cell 2A drain cycle Cell 1 stops discharging for 1 hour but receives 50 gpm for 3000 gallons accumulation
Maximum water level rise is 0.006 ft above normal water level 0.075 inches

Maximum Volume that could discharge if the outlet control slide gate fails open when Cell 1 is at normal water elevation 335,191 gallons

Cell 2A ***Final Design Specs***
Project: ***Kaiser Mead***
Basin Description: ***Tidal Flow Aeration***

From CAD Earthwork Model							
Contour Elevation (ft)	Contour Area (sq. ft)	Depth Avg. End (ft)	Incremental Volume (cu. ft)	Cumulative Volume (cu. ft)	Cumulative Volume of Water at Porosity (gallons)	Cell Profile	
1939	931	N/A	N/A	0		Bottom	
1940	1508	1	1219	1219	3192	9" of Drain Rock	35% porosity
1941	2142	1	1825	3044	7969	4.25' of 3/4" Angular Basalt Media	35% porosity
1942	2833	1	2487	5531	14480	Maximum Drain Down 1941.53-1940	
1943	3582	1	3207	8738	22877		
1944	4388	1	3985	12723	33309	Normal High Water Level = 1941.53	
1945	5251	1	4820	17543	104976	Maximum Water Level with 1 ft of Freeboard	
1946	6172	1	5712	23255	156551	Top of Berm	

Hydrualic Loading (cm3/day) 272520000 cm3
Hydraulic Surface Area 2,406,074 cm2
Hydraulic Loading Rate (cm/day) 113.3 cm/day

HRT = 2.0 hours average (1/2 of fill time plus 1/2 of drain time)
Normal low water is 1940 (BOTTOM 1 FT DOESN'T DRAIN)
8 cycles per day uses 30 minutes to drain, 30 minutes to remain empty, and 2 hours to refill. 180 minutes per cycle
Rate of Drainage for 30 minute draining time = 300 gpm (30 minutes empty with no flow)
Rate of Filling for 120 minute filling time = 75 gpm 9000 gallons
Volume of forward flow into and out of Cell 1 in 180 minutes at 50 gpm 9000 gallons

Normal high water level is contour that holds 12192 gallons = 1941.649 FT
651.16 gal/tenth
4223 delta
0.65 additional tenths of ft to add

Normal water area 2590

Cell 2b ***Final Design Specs***
Project: ***Kaiser Mead***
Basin Description: ***Aerobic Polishing with Plants***

From CAD Earthwork Model							
Contour Elevation (ft)	Contour Area (sq. ft)	Depth Avg. End (ft)	Incremental Volume (cu. ft)	Cumulative Volume (cu. ft)	Cumulative Volume of Water at Porosity (gallons)	Cell Profile	
1,938.00	9,797	N/A	N/A	0.0		Bottom	
1,938.50	10,221	0.5	5004.36	5004.4	13101	1.5' of Drain Rock	35% porosity
1,939.00	10,652	0.5	5218.17	10222.5	26763	0.5'' of 3/4" Angular Basalt Media	35% porosity
1,939.50	11,090	0.5	5435.54	15658.1	40993		
1,940.00	11,536	0.5	5656.46	21314.5	55801	Maximum Water Level with 1 ft of Freeboard	
1,940.50	11,988	0.5	5880.95	27195.5	203422		
1,941.00	12,448	0.5	6109	33304.5	199294	Top of Berm	
1,941.50	12,915	0.5	6340.62	39645.1	237236		

Hydrualic Loading (cm3/day) 272520000 cm3
Hydraulic Surface Area 10,302,796 cm2
Hydraulic Loading Rate (cm/day) 26.5 cm/day

HRT = 13.7 hours average
Normal Low Water Level = 1939 near outlet weir
Normal High Water Level = 1940 near fill point
flow through rock and plant roots dampens level changes caused by siphon discharge
Maximum Drain Down 1940 to 1939 13661 gallons
during fill cycle 9000 gallons enters from Cell 2A in 30 minutes while discharge to Cell 3 is 50 gpm or 1500 gallons
flow accumulated is 7500 gallons which causes a rise of 0.28 ft average over the total cell for 30 minutes
actual rise is expected to be <1 ft at the input location and insignificant at the outlet weir. Root density will dampen rise with growth.

1,942.00	12,605	0.5	6379.86	46025.0	275413

Cell 3A* *Final Design Specs
Project: ***Kaiser Mead***
Basin Description: ***Horizontal Subsurface Flow with Plants***

From CAD Earthwork Model

Contour Elevation (ft)	Contour Area Avg. End (sq. ft)	Depth Avg. End (ft)	Incremental Volume (cu. ft)	Cumulative Volume (cu. ft)	Cumulative Volume of Water at Porosity (gallons)	Cell Profile
1,938.00	5,006	N/A	N/A	0		bottom
1,938.50	5,199	0.5	2551.23	2551.23	6,679	2' Drain Gravel
1,939.00	5,393	0.5	2648.05	5199.28	13,612	
1,939.50	5,587	0.5	2745.03	7944.31	20,798	normal water level
1,940.00	5,782	0.5	2842.14	10786.45	28,239	maximum water level with 1 ft of freeboard
1,940.50	5,976	0.5	2939.39	13725.84	102,669	
1,941.00	6,171	0.5	3036.79	16762.63	125,384	Top of Berm

media porosity	0.35
woodchip porosity	0.8

35% porosity

Hydraulic Loading (cm3/day) 272520000 cm3
Hydraulic Surface Area 5,190,416 cm2
Hydraulic Loading Rate (cm/day) 52.5 cm/day

HRT = 6.9 hours average
time to reach maximum water level from normal water level with 50 gpm in and 0 out 144 minutes or 2 hours
(assumes failed recycle and EC pumps and no discharge with 50 gpm from wells causing forward flow through all cells)

water level rise if Cell 1 slide gate fails open and all flow passes through other cells 16.12 ft rise in Cell 3 (1939.79 ft.)
(slide gate invert is at elevation 142)

TOTAL NTS SYSTEM HRT = 182.7 hours average 7.6 DAYS

Cell 3B* *Final Design Specs
Project: ***Kaiser Mead***
Basin Description: ***Horizontal Subsurface Flow with Plants***

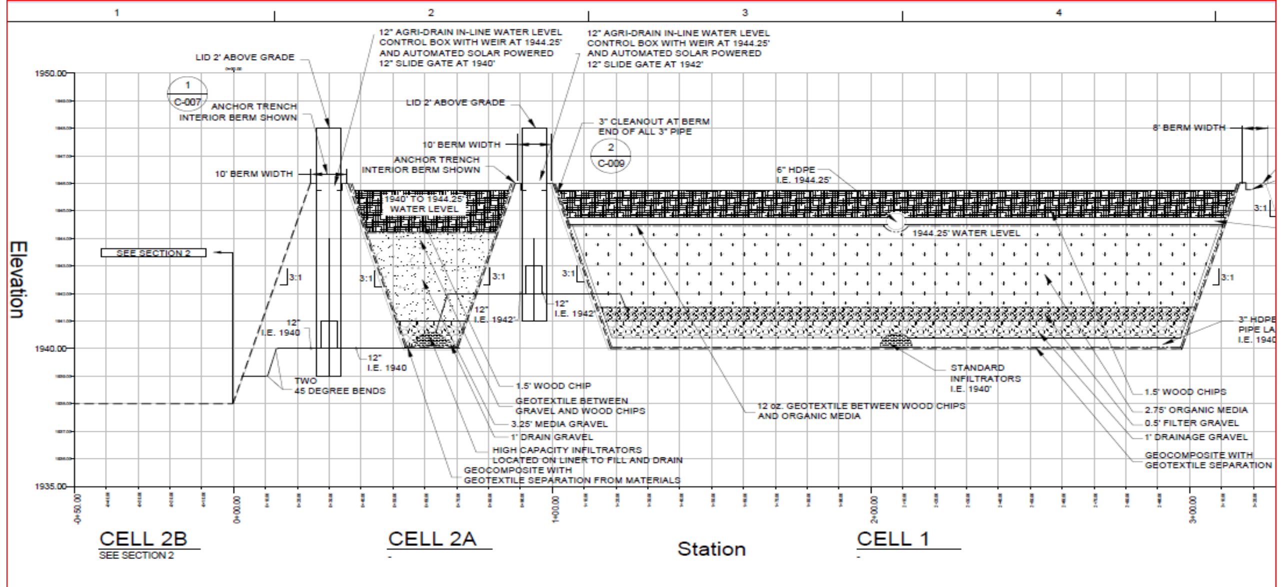
From CAD Earthwork Model

Contour Elevation (ft)	Contour Area Avg. End (sq. ft)	Depth Avg. End (ft)	Incremental Volume (cu. ft)	Cumulative Volume (cu. ft)	Cumulative Volume of Water at Porosity (gallons)
1,938.00	20,061	N/A	N/A	0	
1,938.50	20,607	0.5	10166.94	10166.94	26,617
1,939.00	21,158	0.5	10441.08	20608.03	53,952
1,939.50	21,715	0.5	10718.07	31326.1	82,012
1,940.00	22,277	0.5	10997.9	42324	253,267
1,940.50	22,845	0.5	11280.58	53604.58	400,962
1,941.00	23,419	0.5	11566.04	65170.62	487,476

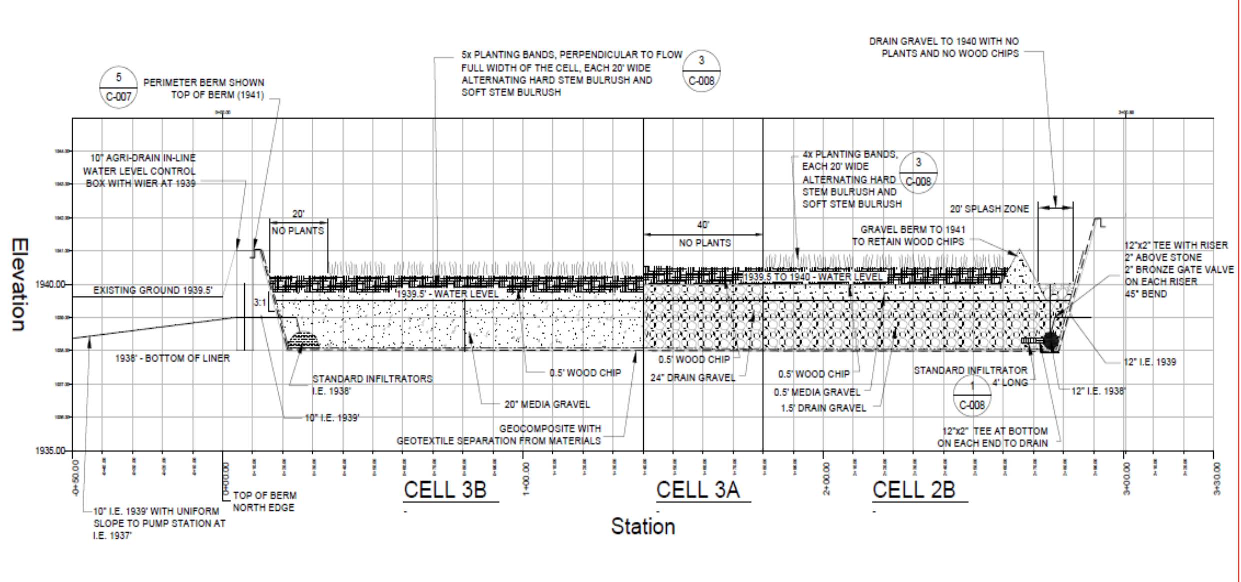
Hydraulic Loading (cm3/day) 272520000 cm3
Hydraulic Surface Area 20,172,863 cm2
Hydraulic Loading Rate (cm/day) 13.5 cm/day

HRT = 27.3 hours average
time to reach maximum water level from normal water level with 50 gpm in and 0 out 561 minutes or 9 hours
(assumes failed recycle and EC pumps and no discharge with 50 gpm from wells causing forward flow through all cells)

water level rise if Cell 1 slide gate fails open and all flow passes through other cells 0.00 ft rise in Cell 3 (1939.79 ft.)
(slide gate invert is at elevation 142)


1
2
3
4
12" AGRI-DRAIN IN-LINE WATER LEVEL CONTROL BOX WITH WEIR AT 1944.25' AND AUTOMATED SOLAR POWERED 12" SLIDE GATE AT 1940'
12" AGRI-DRAIN IN-LINE WATER LEVEL CONTROL BOX WITH WEIR AT 1944.25' AND AUTOMATED SOLAR POWERED 12" SLIDE GATE AT 1942'
LID 2' ABOVE GRADE
1950.00
1 C-007
ANCHOR TRENCH INTERIOR BERM SHOWN
LID 2' ABOVE GRADE
3" CLEANOUT AT BERM END OF ALL 3" PIPE
8' BERM WIDTH
10' BERM WIDTH
2 C-009
ANCHOR TRENCH INTERIOR BERM SHOWN
10' BERM WIDTH
6" HDPE I.E. 1944.25'
1940' TO 1944.25' WATER LEVEL
1944.25' WATER LEVEL
Elevation
SEE SECTION 2
3:1
12" I.E. 1942'
12" I.E. 1942'
12" I.E. 1940
1940.00
12" I.E. 1940
3" HDPE PIPE LA I.E. 1940
TWO 45 DEGREE BENDS
STANDARD INFILTRATORS I.E. 1940'
1.5' WOOD CHIP
GEOTEXTILE BETWEEN GRAVEL AND WOOD CHIPS
3.25' MEDIA GRAVEL
1' DRAIN GRAVEL
HIGH CAPACITY INFILTRATORS LOCATED ON LINER TO FILL AND DRAIN
GEOCOMPOSITE WITH GEOTEXTILE SEPARATION FROM MATERIALS
12 oz. GEOTEXTILE BETWEEN WOOD CHIPS AND ORGANIC MEDIA
1.5' WOOD CHIPS
2.75' ORGANIC MEDIA
0.5' FILTER GRAVEL
1' DRAINAGE GRAVEL
GEOCOMPOSITE WITH GEOTEXTILE SEPARATION
1935.00
-0+50.00
0+00.00
1+00.00
2+00.00
3+00.00
CELL 2B
SEE SECTION 2
CELL 2A
Station
CELL 1

① CELL 1-2A CROSS SECTION DETAIL
BIO-CHEMICAL REACTOR (BCR) - NTS


5 C-007
PERIMETER BERM SHOWN TOP OF BERM (1941)
5x PLANTING BANDS, PERPENDICULAR TO FLOW FULL WIDTH OF THE CELL, EACH 20' WIDE ALTERNATING HARD STEM BULRUSH AND SOFT STEM BULRUSH
3 C-008
DRAIN GRAVEL TO 1940 WITH NO PLANTS AND NO WOOD CHIPS
10" AGRI-DRAIN IN-LINE WATER LEVEL CONTROL BOX WITH WIER AT 1939
4x PLANTING BANDS, EACH 20' WIDE ALTERNATING HARD STEM BULRUSH AND SOFT STEM BULRUSH
3 C-008
20'
NO PLANTS
40'
NO PLANTS
20' SPLASH ZONE
GRAVEL BERM TO 1941 TO RETAIN WOOD CHIPS
12"x2" TEE WITH RISER 2" ABOVE STONE 2" BRONZE GATE VALVE ON EACH RISER 45° BEND
1940.00
EXISTING GROUND 1939.5'
1939.5' - WATER LEVEL
1939.5 TO 1940 - WATER LEVEL
Elevation
3:1
1938' - BOTTOM OF LINER
0.5' WOOD CHIP
24" DRAIN GRAVEL
0.5' WOOD CHIP
0.5' WOOD CHIP
STANDARD INFILTRATOR 4' LONG
12" I.E. 1939
STANDARD INFILTRATORS I.E. 1938'
0.5' MEDIA GRAVEL
1.5' DRAIN GRAVEL
1 C-008
12" I.E. 1938'
20" MEDIA GRAVEL
10" I.E. 1939'
GEOCOMPOSITE WITH GEOTEXTILE SEPARATION FROM MATERIALS
12"x2" TEE AT BOTTOM ON EACH END TO DRAIN
1935.00
-0+50.00
0+00.00
1+00.00
2+00.00
3+00.00
3+30.00
TOP OF BERM NORTH EDGE
10" I.E. 1939' WITH UNIFORM SLOPE TO PUMP STATION AT I.E. 1937'
CELL 3B
CELL 3A
CELL 2B
Station

② CELL 3-2B CROSS SECTION DETAIL
HORIZONTAL SUBSURFACE FLOW WETLAND (SSF) - NTS

JACOBS™ CALCULATION SHEET	PROJECT: Kaiser Mead Custodial Trust	LOCATION: Mead Washington
	CLIENT:: Kaiser Mead Groundwater Remediation Interim Action	JOB No. KMCT2019
TITLE: Final Design Report for Extraction, Treatment, and Discharge Systems Enhanced Wetland Treatment System Calculations	EQUIP./DWG. NO.: Reference Drawings - 002-C-006	CALCULATION NUMBER: Final

8 Cycles at 100 GPM   Page 10 of 10

Made/Revised by; Mark Madison/PDX	Date: 5/6/2019	
Checked by		
Approved		

50 gpm from wells and 50 gpm from recycle for 8 tidal cycles per day in Cell 2A   ***144000 gallons per day total flow***

Cell 1 ***Final Design Specs***
Project: ***Kaiser Mead Natural Treatment System***
Basin Description: ***Bio-Chemical Reactor***

From CAD Earthwork Model

Contour Elevation (ft)	Contour Area (sq. ft)	Depth Avg. End (ft)	Incremental Volume (cu. ft)	Cumulative Volume (cu. ft)	Cumulative Volume of Water at Porosity (gallons)	Cell Profile	
1940	15,180	N/A	N/A	0		Bottom	
1941	16,849	1	16,014	16,014	41,926	12" of Drain Rock + 6" of 3/4" Rock	35% porosity
1942	18,575	1	17,712	33,726	145,057	2.75' of Organic Media	80% porosity
1943	20,357	1	19,466	53,193	318,304	Maximum Drain Down 1944-1942	335191 gallons
1944	22,196	1	21,277	74,469	445,625	Normal Water Level	
1944.25	23,144	0.25	5,786	80,255	480,248	Normal Water Level	
1945	24,092	1	23,144	97,613	584,118	Maximum Water Level with 1 ft of Freeboard	
1946	26,044	1	25,068	122,681	825,888	Top of Berm	

For all cells wood chip layer has 80% porosity

Hydrualic Loading (cm3/day) 545040000 cm3   1 gal = 3785 cm3
Hydraulic Surface Area 21,500,730 cm2   1 ft2 = 929 cm2
Hydraulic Loading Rate (cm/day) 25.3 cm/day

HRT at 100 gpm forward flow rate = 80 hours 3.3 days
Time from normal water level to maximum water level at 100 gpm in and 0 gpm out = 17 hours (assumes maximum recycle and well pumping and plugged outlet)
at maximum water level the emergency bypass begins to flow to Cell 2A

During Cell 2A fill cycle Cell 1 a receives 100 gpm for 120 minutes or 12000 gallons in and 18000 gallons out
Maximum water level drop is 0.012 ft below normal water level 0.149923 inches

During Cell 2A drain cycle Cell 1 stops discharging for 1 hour but receives 100 gpm for 6000 gallons accumulation
Maximum water level rise is 0.012 ft above normal water level 0.149923 inches

Maximum Volume that could discharge if the outlet control slide gate fails open when Cell 1 is at normal water elevation 335,191 gallons

Cell 2A ***Final Design Specs***
Project: ***Kaiser Mead***
Basin Description: ***Tidal Flow Aeration***

From CAD Earthwork Model

Contour Elevation (ft)	Contour Area (sq. ft)	Depth Avg. End (ft)	Incremental Volume (cu. ft)	Cumulative Volume (cu. ft)	Cumulative Volume of Water at Porosity (gallons)	Cell Profile	
1939	931	N/A	N/A	0		Bottom	
1940	1508	1	1219	1219	3192	9" of Drain Rock	35% porosity
1941	2142	1	1825	3044	7969	4.25' of 3/4" Angular Basalt Media	35% porosity
1942	2833	1	2487	5531	14480	Maximum Drain Down 1942.8-1940	18000 gallons
1943	3582	1	3207	8738	22877		
1944	4388	1	3985	12723	33309	Normal High Water Level = 1942.8	
1945	5251	1	4820	17543	104976	Maximum Water Level with 1 ft of Freeboard	
1946	6172	1	5712	23255	156551	Top of Berm	

Hydrualic Loading (cm3/day) 545040000 cm3
Hydraulic Surface Area 3,187,803 cm2
Hydraulic Loading Rate (cm/day) 171.0 cm/day

HRT = 1.8 hours average (1/2 of fill time plus 1/2 of drain time)
Normal low water is 1942.8 (BOTTOM 1 FT DOESN'T DRAIN)
8 cycles per day uses 30 minutes to drain, 30 minutes to remain empty, and 2 hours to refill. 180 minutes per cycle
Rate of Drainage for 30 minute draining time = 600 gpm (30 minutes empty with no flow)
Rate of Filling for 120 minute filling time = 150 gpm
Volume of forward flow into and out of Cell 1 in 180 minutes at 100 gpm 18000 gallons

Normal high water level is contour that holds 21192 gallons = 1942.8 FT
839.7 gal/tenth
6712 delta
0.80 additional tenths of ft to add

Normal water area 3431

Cell 2b ***Final Design Specs***
Project: ***Kaiser Mead***
Basin Description: ***Aerobic Polishing with Plants***

From CAD Earthwork Model

Contour Elevation (ft)	Contour Area (sq. ft)	Depth Avg. End (ft)	Incremental Volume (cu. ft)	Cumulative Volume (cu. ft)	Cumulative Volume of Water at Porosity (gallons)	Cell Profile	
1,938.0	9,797	N/A	N/A	0.0		Bottom	
1,938.5	10,221	0.5	5004.36	5004.4	13101	1.5' of Drain Rock	35% porosity
1,939.0	10,652	0.5	5218.17	10222.5	26763	0.5'' of 3/4" Angular Basalt Media	35% porosity
1,939.5	11,090	0.5	5435.54	15658.1	40993		
1,940.0	11,536	0.5	5656.46	21314.5	55801	Maximum Water Level with 1 ft of Freeboard	
1,940.5	11,988	0.5	5880.95	27195.5	162738		
1,941.0	12,448	0.5	6109	33304.5	199294	Top of Berm	
1,941.5	12,915	0.5	6340.62	39645.1	237236		

Hydrualic Loading (cm3/day) 545040000 cm3
Hydraulic Surface Area 10,302,796 cm2
Hydraulic Loading Rate (cm/day) 52.9 cm/day

HRT = 6.8 hours average
Normal Low Water Level = 1939 near outlet weir
Normal High Water Level = 1940 near fill point
flow through rock and plant roots dampens level changes caused by siphon discharge
Maximum Drain Down 1940 to 1939 13661 gallons
during fill cycle 18000 gallons enters from Cell 2A in 30 minutes while discharge to Cell 3 is 100 gpm or 3000 gallons
flow accumulated is 15000 gallons which causes a rise of 0.56 ft average over the total cell for 30 minutes
actual rise is expected to be 1 ft at the input location and insignificant at the outlet weir. Root density will dampen rise with growth.

1,942.0	12,605	0.5	6379.86	46025.0	275413

Cell 3A ***Final Design Specs***
Project: ***Kaiser Mead***
Basin Description: ***Horizontal Subsurface Flow with Plants***

From CAD Earthwork Model

Contour Elevation (ft)	Contour Area Avg. End (sq. ft)	Depth Avg. End (ft)	Incremental Volume (cu. ft)	Cumulative Volume (cu. ft)	Cumulative Volume of Water at Porosity (gallons)	Cell Profile
1,938.00	5,005.70	N/A	N/A	0		
1,938.50	5,199.20	0.5	2551.23	2551.23	6,679	bottom
1,939.00	5,393.00	0.5	2648.05	5199.28	13,612	2' and 2" of 3/4" Angular Basalt Media
1,939.50	5,587.10	0.5	2745.03	7944.31	20,798	normal water level
1,940.00	5,781.50	0.5	2842.14	10786.45	28,239	maximum water level with 1 ft of freeboard
1,940.50	5,976.10	0.5	2939.39	13725.84	102,669	Top of Berm
1,941.00	6,171.00	0.5	3036.79	16762.63	125,384	

media porosity	0.35
woodchip porosity	0.8

35% porosity

Hydraulic Loading (cm3/day)	545040000	cm3
Hydraulic Surface Area	5,190,416	cm2
Hydraulic Loading Rate (cm/day)	105.0	cm/day

HRT = 3.5 hours average

time to reach maximum water level from normal water level with 50 gpm in and 0 out 149 minutes or 2 hours
(assumes failed recycle and EC pumps and no discharge with 50 gpm from wells causing forward flow through all cells)

water level rise if Cell 1 slide gate fails open and all flow passes through other cells 11.87 ft rise in Cell 3 (1939.79 ft.)
(slide gate invert is at elevation 142)

TOTAL NTS SYSTEM HRT = 92.1 hours average 3.8 DAYS

Cell 3B ***Final Design Specs***
Project: ***Kaiser Mead***
Basin Description: ***Horizontal Subsurface Flow with Plants***

From CAD Earthwork Model

Contour Elevation (ft)	Contour Area Avg. End (sq. ft)	Depth Avg. End (ft)	Incremental Volume (cu. ft)	Cumulative Volume (cu. ft)	Cumulative Volume of Water at Porosity (gallons)
1,938.00	20,061.20	N/A	N/A	0	
1,938.50	20,606.60	0.5	10166.94	10166.94	26,617
1,939.00	21,157.70	0.5	10441.08	20608.03	53,952
1,939.50	21,714.60	0.5	10718.07	31326.1	82,012
1,940.00	22,277.10	0.5	10997.9	42324	229,523
1,940.50	22,845.30	0.5	11280.58	53604.58	400,962
1,941.00	23,418.90	0.5	11566.04	65170.62	487,476

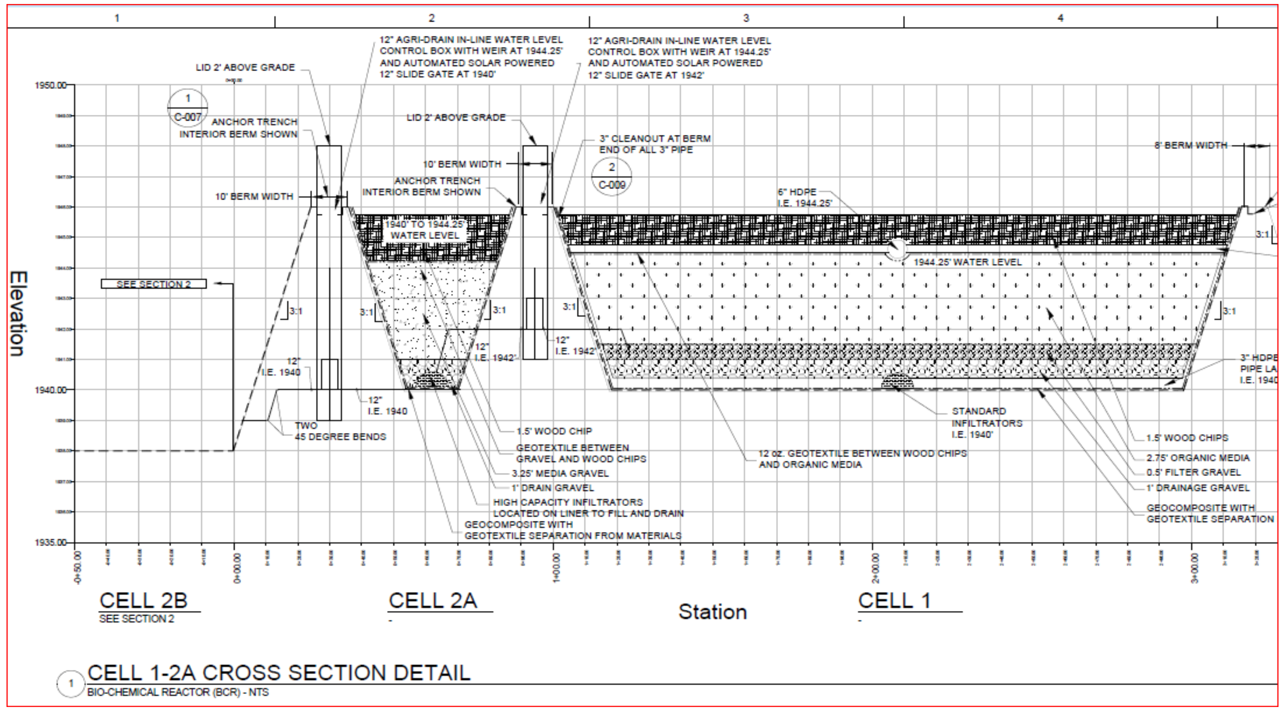
Hydraulic Loading (cm3/day)	545040000	cm3
Hydraulic Surface Area	20,172,863	cm2
Hydraulic Loading Rate (cm/day)	27.0	cm/day

HRT = 13.7 hours average

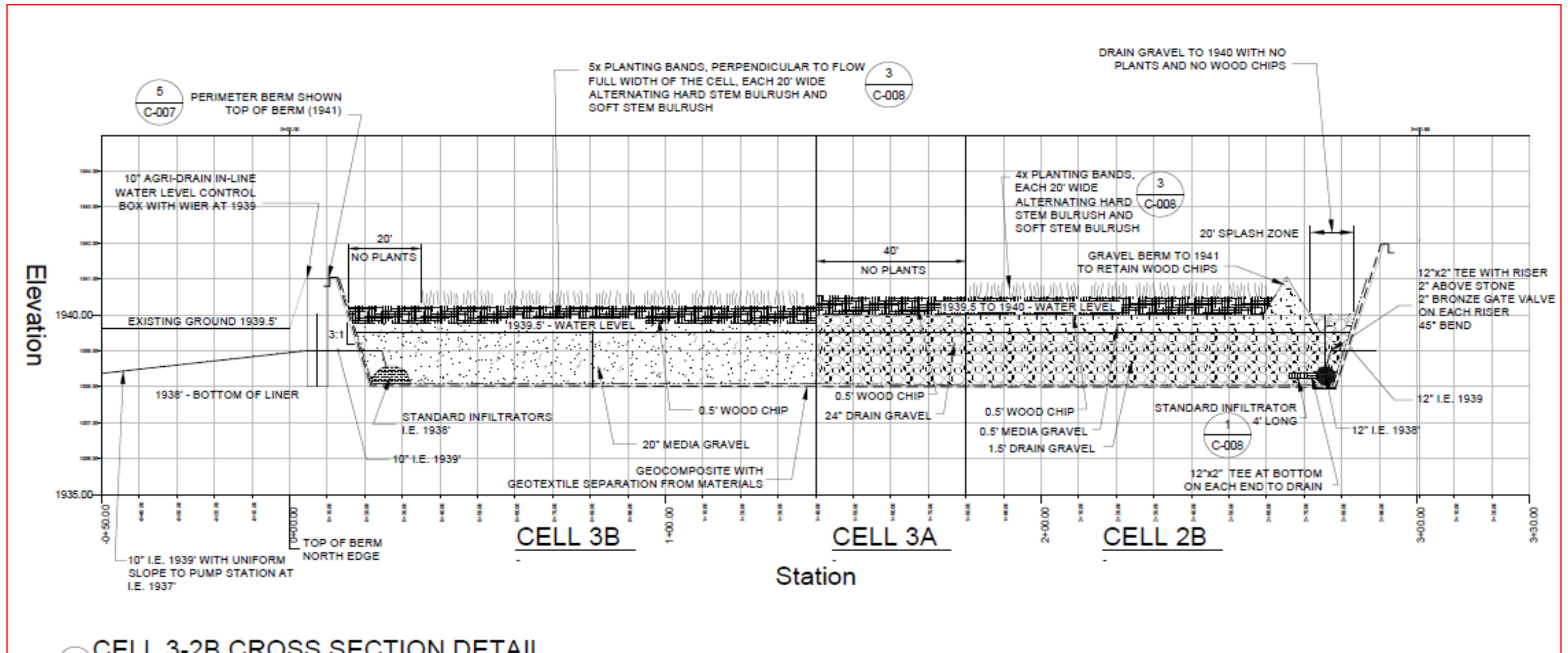
time to reach maximum water level from normal water level with 50 gpm in and 0 out 2950 minutes or 49 hours
(assumes failed recycle and EC pumps and no discharge with 50 gpm from wells causing forward flow through all cells)

water level rise if Cell 1 slide gate fails open and all flow passes through other cells 0.00 ft rise in Cell 3 (1939.79 ft.)
(slide gate invert is at elevation 142)

TOTAL NTS SYSTEM HRT = 17.1 hours average 0.7 DAYS


1
2
3
4
12" AGRI-DRAIN IN-LINE WATER LEVEL CONTROL BOX WITH WEIR AT 1944.25' AND AUTOMATED SOLAR POWERED 12" SLIDE GATE AT 1940'
12" AGRI-DRAIN IN-LINE WATER LEVEL CONTROL BOX WITH WEIR AT 1944.25' AND AUTOMATED SOLAR POWERED 12" SLIDE GATE AT 1942'
LID 2' ABOVE GRADE
1 C-007
ANCHOR TRENCH INTERIOR BERM SHOWN
LID 2' ABOVE GRADE
3" CLEANOUT AT BERM END OF ALL 3" PIPE
2 C-009
10' BERM WIDTH
10' BERM WIDTH
ANCHOR TRENCH INTERIOR BERM SHOWN
8' BERM WIDTH
6" HDPE I.E. 1944.25'
1940' TO 1944.25' WATER LEVEL
1944.25' WATER LEVEL
SEE SECTION 2
3:1
12" I.E. 1940
12" I.E. 1942'
12" I.E. 1942'
12" I.E. 1940
3" HDPE PIPE LA I.E. 1940
TWO 45 DEGREE BENDS
1.5' WOOD CHIP
GEOTEXTILE BETWEEN GRAVEL AND WOOD CHIPS
3.25' MEDIA GRAVEL
1' DRAIN GRAVEL
HIGH CAPACITY INFILTRATORS LOCATED ON LINER TO FILL AND DRAIN
GEOCOMPOSITE WITH GEOTEXTILE SEPARATION FROM MATERIALS
STANDARD INFILTRATORS I.E. 1940'
12 oz. GEOTEXTILE BETWEEN WOOD CHIPS AND ORGANIC MEDIA
1.5' WOOD CHIPS
2.75' ORGANIC MEDIA
0.5' FILTER GRAVEL
1' DRAINAGE GRAVEL
GEOCOMPOSITE WITH GEOTEXTILE SEPARATION
Elevation
1950.00
1940.00
1935.00
0-50.00
0+00.00
1+00.00
2+00.00
3+00.00
CELL 2B
SEE SECTION 2
CELL 2A
Station
CELL 1

1 CELL 1-2A CROSS SECTION DETAIL
BIO-CHEMICAL REACTOR (BCR) - NTS


5 C-007
PERIMETER BERM SHOWN TOP OF BERM (1941)
5x PLANTING BANDS, PERPENDICULAR TO FLOW FULL WIDTH OF THE CELL, EACH 20' WIDE ALTERNATING HARD STEM BULRUSH AND SOFT STEM BULRUSH
3 C-008
DRAIN GRAVEL TO 1940 WITH NO PLANTS AND NO WOOD CHIPS
10" AGRI-DRAIN IN-LINE WATER LEVEL CONTROL BOX WITH WIER AT 1939
4x PLANTING BANDS, EACH 20' WIDE ALTERNATING HARD STEM BULRUSH AND SOFT STEM BULRUSH
3 C-008
20' SPLASH ZONE
20'
NO PLANTS
40'
NO PLANTS
GRAVEL BERM TO 1941 TO RETAIN WOOD CHIPS
12"x2" TEE WITH RISER 2" ABOVE STONE
2" BRONZE GATE VALVE ON EACH RISER
45° BEND
EXISTING GROUND 1939.5'
3:1
1939.5' - WATER LEVEL
1939.5 TO 1940 - WATER LEVEL
1938' - BOTTOM OF LINER
STANDARD INFILTRATORS I.E. 1938'
10" I.E. 1939'
0.5' WOOD CHIP
20" MEDIA GRAVEL
GEOCOMPOSITE WITH GEOTEXTILE SEPARATION FROM MATERIALS
0.5' WOOD CHIP
24" DRAIN GRAVEL
0.5' WOOD CHIP
0.5' MEDIA GRAVEL
1.5' DRAIN GRAVEL
STANDARD INFILTRATOR 4' LONG
1 C-008
12"x2" TEE AT BOTTOM ON EACH END TO DRAIN
12" I.E. 1939
12" I.E. 1938'
Elevation
1940.00
1935.00
0-50.00
0+00.00
1+00.00
2+00.00
3+00.00
3+30.00
10" I.E. 1939' WITH UNIFORM SLOPE TO PUMP STATION AT I.E. 1937'
TOP OF BERM NORTH EDGE
CELL 3B
CELL 3A
CELL 2B
Station

2 CELL 3-2B CROSS SECTION DETAIL
HORIZONTAL SUBSURFACE FLOW WETLAND (SSF) - NTS

Enhanced Wetland Treatment System Process

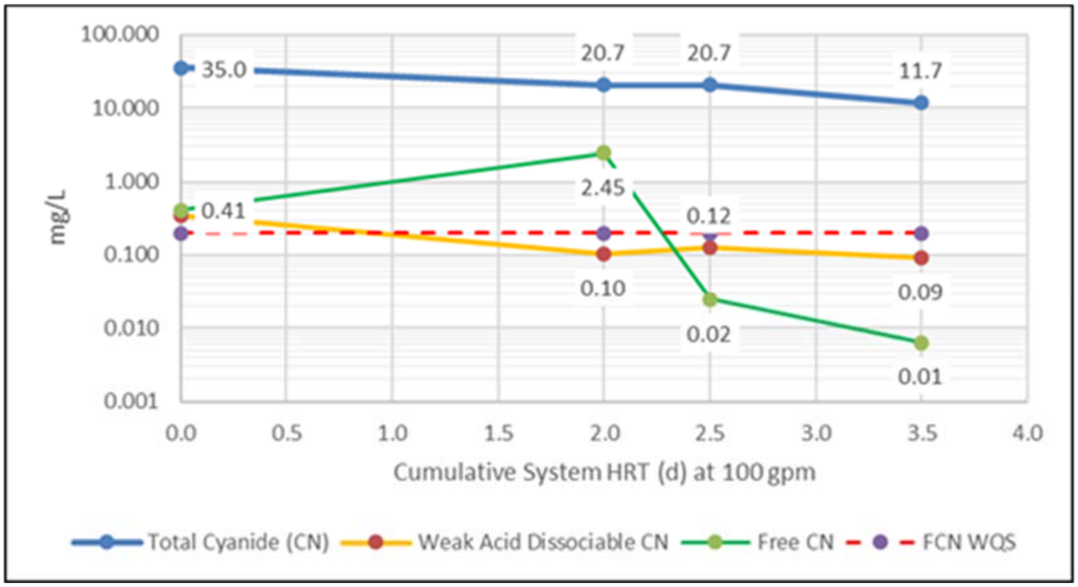
Kaiser Mead Enhanced Treatment Wetland Pre-Design
Water Quality Performance Estimates
p-k-C* Model (Kadlec and Wallace 2009)
Calibrated to Continuous Flow Pilot Study (Jacobs 2020)
Prepared by Jim Bays/Jacobs Engineering Group
Revised March 31 2020

The expected performance results provided in the Pre-Final Design Report have been revised and are presented in Table 1.

Table 1. Treatment Profile Summary

Station	Nominal HRT	Cumulative HRT	Total Cyanide (CN)	Weak Acid Dissociable CN	Free CN	FCN WQS
	d	d	mg/L	mg/L	mg/L	mg/L
Inlet	0.0	0.0	35.0	0.35	0.41	0.2
Cell 1	2.0	2.0	20.7	0.10	2.45	0.2
Cell 2	0.5	2.5	20.7	0.12	0.02	0.2
Cell 3	1.0	3.5	11.7	0.09	0.01	0.2
Concentration Reduction			66%	74%	98%	

Input values for total cyanide (TCN), weak acid dissociable cyanide (WAD CN) and free cyanide were selected from the average inflow values measured during the pilot system operation. First-order model removal rate constants calibrated from the final four data pairs of pilot data from each treatment cell were utilized to project performance under the design assumptions. Figure 2 presents the expected performance along the treatment profile based on cumulative hydraulic residence time. A total flow rate of 100 gpm (50 gpm forward flow, 50 gpm recirculation flow) was assumed. Total cyanide is projected to be discharged from the Enhanced Treatment Wetland at approximately 12 mg/L.



Model assumptions, parameter values and performance results are summarized in Table 2. The model hydraulic characterization (P) reflects the typical number of tanks in series for each type of system (i.e., Biochemical Reactor, Aerobic Polishing Cell, Horizontal Subsurface Flow).

Table 2. Model Assumptions, Parameter Values, and Performance for 100 gpm Flow.

		Cell 1			**Cell 2**			**Cell 3**		
Parameter	**Unit**	**TCN**	**WAD**	**FCN**	**TCN**	**WAD**	**FCN**	**TCN**	**WAD**	**FCN**
Ci	mg/L	35	0.35	0.41	20.7	0.10	2.45	20.7	0.12	0.02
Co	mg/L	20.73	0.10	2.45	20.7	0.12	0.02	11.7	0.09	0.01
C*	mg/L	1.5	0	0	1.5	0	0	1.5	0	0
kv	1/d	0.31	0.76	-0.67	0.00	-0.37	31.7	0.66	0.33	1.5
T	d	2	2	2	0.5	0.5	0.5	1	1	1
P	TIS	3	3	3	2	2	2	6	6	6
C-C*	mg/L	19.2	0.10	2.45	19.2	0.12	0.02	10.2	0.09	0.01
Ci-C*	mg/L	33.5	0.35	0.41	19.2	0.10	2.45	19.2	0.12	0.02
LH	unitless	0.57	0.29	5.96	1	1.21	0.01	0.533	0.73	0.26
RH	unitless	0.57	0.29	5.96	1.00	1.21	0.01	0.53	0.73	0.26

Note: Model formulation "C" selected for calibration and analysis from Equation 15.7 (Kadlec and Wallace 2009).
Model Source: Kadlec, R.H. and S. Wallace. 2009. Treatment Wetlands 2nd Ed. CRC Press, Boca Raton FL.

Kaiser Mead Enhanced Treatment Wetland
Pre-Design Water Quality Performance Estimates
p-k-C* Model (Kadlec and Wallace 2009) Calibrated to Continuous Flow Pilot Study (Jacobs 2020)
Prepared by Jim Bays/Jacobs Engineering Group
February 11 2020

Horizontal Subsurface Flow Wetland Simple PkC* Design Model (Wastewater Parameters)

User inputs indicated by white boxes.
Pop-up notes indicated by red triangles.

Project Name	KAISER MEAD DESIGN 100 GPM CELL 1 N SERIES
Project Number	KMCT.2200

General Inflow Data

Parameter	**Value**	**Units**
Annual Average Daily Flow	100	gpm
Converted Flow	545	m^3/d
Wastewater Temperature	5	°C

Water Quality Characteristics

Parameter		**BOD5**	**TSS**	**Organic N**	**NH4-N**	**NO2/3-N**	**TN**	**TP**	**FC**
Influent Concentration, mg/L	C_i =			13.0	3.0	34.4	50		
Average Target Effluent Conc., mg/L	C_e =						0		
Desired Confidence Percentile		0.5		0.5	0.5	0.5	0.5	0.5	0.5
Max Month/Annual Factor		1.7	1.9	1	1	1	1.6	1.8	2.6
Design Target Conc., mg/L	C_d =								
Wetland Background Limit, mg/L	C^* =	1	3.03	1.5	0	0	1.5	0.02	0
Reduction fraction to target	$F_e = 1 - C_e/C_i$=	No Value	No Value	1.000	1.000	1.000	1.000	No Value	No Value
Reduction fraction to background	$F_b = 1 - C^*/C_i$ =			0.885	1.000	1.000	0.970		
Areal Rate Constant, 20°C, m/y	k_{20} =	86	1000	34.6	208	8458	18	12	103
Temperature Factor	θ =	1.00	1.065	1.01	1.01	1.09	1.01	1.00	1.00
P-Factor	P =	3	3	3	3	3	6	3	3
Areal Rate Constant, m/y	k_T =	86	1000	30.2	168.6	2322.1	16.7	12	103
Area required for each parameter, ac		C*>Cd	C*>Cd	C*>Cd	-0.6	0.0	C*>Cd	C*>Cd	C*>Cd

☐ **Use Aeration Design**

Required Treatment Wetland Area

Required Treatment Wetland Area	A_{max} =	**0.000034**	acres	Displays minimum wetland area to treat all pollutants down to desired targets
		0.000014	ha	
User Defined Area	A_{user} =	**0.509555**	acres	User specified wetland area; leave blank if you wish to use A_{max} (above) for effluent calculations below.
		0.206297	ha	

Final Effluent Concentrations and Percent Removal

Area (ha) used for Calculations = **0.2**		**BOD5**	**TSS**	**Organic N**	**NH4-N**	**NO2/3-N**	**TN**	**TP**	**FC**
Design Target Conc., mg/L	C_d =						0.0		
Influent concentrations, mg/L	C_i =			13.0	3.000	34.400	50.4		
Effluent concentrations, mg/L				10.0	1.988	0.193	12.2		0.0
Percent Reduction (by concentration)				23%	34%	99%			
Mass Loading (lb/day)				16	4	41			
Mass Loading (kg/ha/d)				34.3	7.9	90.9			
Mass Out (lb/day)				12	2	0			
Mass Out (kg/ha/d)				26.5	5.3	0.5			
Percent Reduction (by mass)				23%	34%	99%			

Hydraulic Properties Based on Area and Flow

Gravel Diameter (cm)		Approx Aspect Ratio (L:W) = (1:1)	1
Bed Depth (m)	1.1	Length (m)	45
Porosity e (%)	75%	Width (m)	45
Volume Water (m3)	1477	Bottom Slope (m/m)	0
Volume Media (m3)	1969	**Hydraulic Constraints**	
Bed Conductivity k (m/d)	10500	G_1, Drainability	0.00
Design Outlet Water Depth h_0 (m)	0.99	G_3, Distance Thickening/Thinning	0.53

Hydraulic Loading Rate, q (cm/d)	HLR =	26.4	cm/d
Nominal Hydraulic Residence Time (d)	HRT =	2.7	days

Aeration Requirements

	Zone 1	**Zone 2**
AOR = Actual Oxygen Transfer Requirement, kg/hr	#VALUE!	10.5

Kaiser Mead Enhanced Treatment Wetland
Pre-Design Water Quality Performance Estimates
p-k-C* Model (Kadlec and Wallace 2009) Calibrated to Continuous Flow Pilot Study (Jacobs 2020)
Prepared by Jim Bays/Jacobs Engineering Group
February 11 2020

SOTR = Standardized Oxygen Transfer Req, kg O2/hr	#VALUE!	22.2
SOTR, lb O2/hr	#VALUE!	48.9
SOTE = Standard Oxygen Transfer Efficiency, %	9.6%	9.6%
eair, lb/ft3	0.07	0.07
Air Flow, SCFM	#VALUE!	527
Mass Air Flow, lb/s	#VALUE!	0.676
Blower Efficiency, %	67.9%	67.9%
Working Pressure, psig	6	6
PD Power Requirement, HP	#VALUE!	23.4
Air Flow, SCFM	**#VALUE!**	
PD Power Requirement, HP	**#VALUE!**	

Nitrogen Species Calculations

DO NOT CHANGE		
$(1+k_{ON}/Nq)$^-N	$(1+k_{AN}/Nq)$^-N	$(1+k_{NN}/Nq)$^-N
0.742	0.252	0.001
$k_{ON}/(k_{NH3}-k_{ON})$	kAN/(kNN-kAN)	kA/(kN-kO)
0.2	0.078	0.074

Nitrogen Models
per K&K Eqns 13-28. 13-29, 13-39:
Adapted for TIS model
Organic Nitrogen (ON)

$$C_{ON_{OUT}} = C^*_{ON} + (C_{ON_{IN}} - C^*_{ON})\left[1+\frac{k_{ON}A}{NQ}\right]^{-N}$$

Ammonia Nitrogen (AN)

$$C_{AN_{OUT}} = C^*_{AN} + (C_{AN_{IN}} - C^*_{AN})\left[1+\frac{k_{AN}A}{NQ}\right]^{-N} + \left(\frac{k_{ON}}{k_{AN}-k_{ON}}\right)(C_{ON_{IN}} - C^*_{ON})\left(\left[1+\frac{k_{ON}A}{NQ}\right]^{-N} - \left[1+\frac{k_{AN}A}{NQ}\right]^{-N}\right)$$

Nitrate Nitrogen (NN)

$$C_{NN_{OUT}} = C_{NN_{IN}}\left[1+\frac{k_{NN}A}{NQ}\right]^{-N} + \Psi\left[\begin{array}{l} \left(\frac{k_{AN}}{k_{NN}-k_{AN}}\right)C_{AN_{IN}}\left(\left[1+\frac{k_{AN}A}{NQ}\right]^{-N} - \left[1+\frac{k_{NN}A}{NQ}\right]^{-N}\right) \\ +\left(\frac{k_{ON}}{k_{AN}-k_{ON}}\right)\left(\frac{k_{AN}}{k_{NN}-k_{ON}}\right)(C_{ON_{IN}} - C^*_{ON})\left(\left[1+\frac{k_{ON}A}{NQ}\right]^{-N} - \left[1+\frac{k_{NN}A}{NQ}\right]^{-N}\right) \\ -\left(\frac{k_{ON}}{k_{AN}-k_{ON}}\right)\left(\frac{k_{AN}}{k_{NN}-k_{AN}}\right)(C_{ON_{IN}} - C^*_{ON})\left(\left[1+\frac{k_{AN}A}{NQ}\right]^{-N} - \left[1+\frac{k_{NN}A}{NQ}\right]^{-N}\right) \end{array}\right]$$

where Ψ = fraction of ammonium nitrified, assumed to be 100% = 100%

Kaiser Mead Enhanced Treatment Wetland
Pre-Design Water Quality Performance Estimates
p-k-C* Model (Kadlec and Wallace 2009) Calibrated to Continuous Flow Pilot Study (Jacobs 2020)
Prepared by Jim Bays/Jacobs Engineering Group
February 11 2020

Horizontal Subsurface Flow Wetland Simple PkC* Design Model (Wastewater Parameters)

User inputs indicated by white boxes.
Pop-up notes indicated by red triangles.

Project Name	KAISER MEAD DESIGN 100 GPM CELL 2 N SERIES
Project Number	KMCT.2200

General Inflow Data

Parameter	**Value**	**Units**
Annual Average Daily Flow	100	gpm
Converted Flow	545	m^3/d
Wastewater Temperature	5	$^{\circ}C$

Water Quality Characteristics

Parameter		**BOD5**	**TSS**	**Organic N**	**NH4-N**	**NO2/3-N**	**TN**	**TP**	**FC**
Influent Concentration, mg/L	C_i =			10.0	2.0	0.2	12		
Average Target Effluent Conc., mg/L	C_e =						0		
Desired Confidence Percentile		0.5		0.5	0.5	0.5	0.5	0.5	0.5
Max Month/Annual Factor		1.7	1.9	1	1	1	1.6	1.8	2.6
Design Target Conc., mg/L	C_d =								
Wetland Background Limit, mg/L	C^* =	1	3.03	1.5	0	0	1.5	0.02	0
Reduction fraction to target	$F_e = 1 - C_e/C_i$=	No Value	No Value	1.000	1.000	1.000	1.000	No Value	No Value
Reduction fraction to background	$F_b = 1 - C^*/C_i$ =			0.851	1.000	1.000	0.877		
Areal Rate Constant, 20°C, m/y	k_{20} =	86	1000	4	193	4036	18	12	103
Temperature Factor	θ =	1.00	1.065	1.01	1.01	1.09	1.01	1.00	1.00
P-Factor	P =	3	3	2	2	2	6	3	3
Areal Rate Constant, m/y	k_T =	86	1000	3.9	156.7	1108.1	16.7	12	103
Area required for each parameter, ac		C*>Cd	C*>Cd	C*>Cd	-0.6	0.0	C*>Cd	C*>Cd	C*>Cd

☐ **Use Aeration Design**

Required Treatment Wetland Area

Required Treatment Wetland Area	A_{max} =	**0.000132**	acres	Displays minimum wetland area to treat all pollutants down to desired targets
		0.000053	ha	
User Defined Area	A_{user} =	**0.372640**	acres	User specified wetland area; leave blank if you wish to use A_{max} (above) for effluent calculations below.
		0.150866	ha	

Final Effluent Concentrations and Percent Removal

Area (ha) used for Calculations =	**0.2**	**BOD5**	**TSS**	**Organic N**	**NH4-N**	**NO2/3-N**	**TN**	**TP**	**FC**
Design Target Conc., mg/L	C_d =								
Influent concentrations, mg/L	C_i =			10.0	1.988	0.193	12.2		
Effluent concentrations, mg/L				9.8	0.907	0.140	10.8		0.0
Percent Reduction (by concentration)				2%	54%	28%	11%		
Mass Loading (lb/day)				12	2	0	15		
Mass Loading (kg/ha/d)				36.3	7.2	0.7	44.1		
Mass Out (lb/day)				12	1	0	13		
Mass Out (kg/ha/d)				35.4	3.3	0.5	39.2		
Percent Reduction (by mass)				2%	54%	28%	11%		

Hydraulic Properties Based on Area and Flow

Gravel Diameter (cm)		Approx Aspect Ratio (L:W) = (1:1)	1
Bed Depth (m)	0.6	Length (m)	39
Porosity e (%)	40%	Width (m)	39
Volume Water (m3)	589	Bottom Slope (m/m)	0
Volume Media (m3)	1472	**Hydraulic Constraints**	
Bed Conductivity k (m/d)	10500	G_1, Drainability	**0.00**
Design Outlet Water Depth h_0 (m)	0.54	G_3, Distance Thickening/Thinning	***1.78***

Hydraulic Loading Rate, q (cm/d)	HLR =	36.1	cm/d
Nominal Hydraulic Residence Time (d)	HRT =	1.1	days

Aeration Requirements

	Zone 1	**Zone 2**
AOR = Actual Oxygen Transfer Requirement, kg/hr	#VALUE!	10.5

Kaiser Mead Enhanced Treatment Wetland
Pre-Design Water Quality Performance Estimates
p-k-C* Model (Kadlec and Wallace 2009) Calibrated to Continuous Flow Pilot Study (Jacobs 2020)
Prepared by Jim Bays/Jacobs Engineering Group
February 11 2020

SOTR = Standardized Oxygen Transfer Req, kg O2/hr	#VALUE!	22.2
SOTR, lb O2/hr	#VALUE!	48.9
SOTE = Standard Oxygen Transfer Efficiency, %	9.6%	9.6%
eair, lb/ft3	0.07	0.07
Air Flow, SCFM	#VALUE!	527
Mass Air Flow, lb/s	#VALUE!	0.676
Blower Efficiency, %	67.9%	67.9%
Working Pressure, psig	6	6
PD Power Requirement, HP	#VALUE!	23.4
Air Flow, SCFM	**#VALUE!**	
PD Power Requirement, HP	**#VALUE!**	

Nitrogen Species Calculations

DO NOT CHANGE		
(1+k_{ON}/Nq)^-N	(1+k_{AN}/Nq)^-N	(1+k_{NN}/Nq)^-N
0.971	0.394	0.037
k_{ON}/(k_{NH3}-k_{ON})	kAN/(kNN-kAN)	kA/(kN-kO)
0.0	0.165	0.142

Nitrogen Models
per K&K Eqns 13-28. 13-29, 13-39:
Adapted for TIS model
Organic Nitrogen (ON)

$$C_{ON_{OUT}} = C^*_{ON} + (C_{ON_{IN}} - C^*_{ON})\left[1+\frac{k_{ON}A}{NQ}\right]^{-N}$$

Ammonia Nitrogen (AN)

$$C_{AN_{OUT}} = C^*_{AN} + (C_{AN_{IN}} - C^*_{AN})\left[1+\frac{k_{AN}A}{NQ}\right]^{-N} + \left(\frac{k_{ON}}{k_{AN}-k_{ON}}\right)(C_{ON_{IN}} - C^*_{ON})\left(\left[1+\frac{k_{ON}A}{NQ}\right]^{-N} - \left[1+\frac{k_{AN}A}{NQ}\right]^{-N}\right)$$

Nitrate Nitrogen (NN)

$$C_{NN_{OUT}} = C_{NN_{IN}}\left[1+\frac{k_{NN}A}{NQ}\right]^{-N} + \Psi\left[\begin{array}{l} \left(\frac{k_{AN}}{k_{NN}-k_{AN}}\right)C_{AN_{IN}}\left(\left[1+\frac{k_{AN}A}{NQ}\right]^{-N} - \left[1+\frac{k_{NN}A}{NQ}\right]^{-N}\right) \\ +\left(\frac{k_{ON}}{k_{AN}-k_{ON}}\right)\left(\frac{k_{AN}}{k_{NN}-k_{ON}}\right)(C_{ON_{IN}} - C^*_{ON})\left(\left[1+\frac{k_{ON}A}{NQ}\right]^{-N} - \left[1+\frac{k_{NN}A}{NQ}\right]^{-N}\right) \\ -\left(\frac{k_{ON}}{k_{AN}-k_{ON}}\right)\left(\frac{k_{AN}}{k_{NN}-k_{AN}}\right)(C_{ON_{IN}} - C^*_{ON})\left(\left[1+\frac{k_{AN}A}{NQ}\right]^{-N} - \left[1+\frac{k_{NN}A}{NQ}\right]^{-N}\right) \end{array}\right]$$

where Ψ = fraction of ammonium nitrified, assumed to be 100% = 100%

Kaiser Mead Enhanced Treatment Wetland
Pre-Design Water Quality Performance Estimates
p-k-C* Model (Kadlec and Wallace 2009) Calibrated to Continuous Flow Pilot Study (Jacobs 2020)
Prepared by Jim Bays/Jacobs Engineering Group
February 11 2020

Horizontal Subsurface Flow Wetland Simple PkC* Design Model (Wastewater Parameters)

User inputs indicated by white boxes.
Pop-up notes indicated by red triangles.

Project Name	KAISER MEAD DESIGN 100 GPM CELL 3 N SERIES
Project Number	KMCT.2200

General Inflow Data

Parameter	**Value**	**Units**
Annual Average Daily Flow	100	gpm ▼
Converted Flow	545	m^3/d
Wastewater Temperature	5	°C

Water Quality Characteristics

Parameter		**BOD5**	**TSS**	**Organic N**	**NH4-N**	**NO2/3-N**	**TN**	**TP**	**FC**
Influent Concentration, mg/L	C_i =			9.8	0.9	0.1	11		
Average Target Effluent Conc., mg/L	C_e =						0.0		
Desired Confidence Percentile		0.5		0.5	0.5	0.5	0.5	0.5	0.5
Max Month/Annual Factor		1.7	1.9	1	1	1	1.6	1.8	2.6
Design Target Conc., mg/L	C_d =								
Wetland Background Limit, mg/L	C^* =	1	3.03	1.5	0	0	1.5	0.02	0
Reduction fraction to target	$F_e = 1 - C_e/C_i$=	No Value	No Value	1.000	1.000	1.000	1.000	No Value	No Value
Reduction fraction to background	$F_b = 1 - C^*/C_i$ =			0.847	1.000	1.000	0.862		
Areal Rate Constant, 20°C, m/y	k_{20} =	86	1000	20	11	42	18	12	103
Temperature Factor	θ =	1.00	1.065	1.01	1.01	1.09	1.01	1.00	1.00
P-Factor	P =	3	3	6	6	6	6	3	3
Areal Rate Constant, m/y	k_T =	86	1000	17.5	8.9	11.5	16.7	12	103
Area required for each parameter, ac		C*>Cd	C*>Cd	C*>Cd	C*>Cd	C*>Cd	C*>Cd	C*>Cd	C*>Cd

☐ **Use Aeration Design**

Required Treatment Wetland Area

Required Treatment Wetland Area	A_{max} =	**0.000000**	acres	Displays minimum wetland area to treat all pollutants down to desired targets
		0.000000	ha	
User Defined Area	A_{user} =	**0.505714**	acres	User specified wetland area; leave blank if you wish to use A_{max} (above) for effluent calculations below.
		0.204742	ha	

Final Effluent Concentrations and Percent Removal

Area (ha) used for Calculations =	**0.2**	**BOD5**	**TSS**	**Organic N**	**NH4-N**	**NO2/3-N**	**TN**	**TP**	**FC**
Design Target Conc., mg/L	C_d =								
Influent concentrations, mg/L	C_i =			9.8	0.907	0.140	10.8		
Effluent concentrations, mg/L				8.4	2.104	0.266	10.8		0.0
System Concentration Reduction , %				35%	30%	99%	79%		
Percent Reduction (by concentration)				14%	-132%	-90%	0%		
Mass Loading (lb/day)				12	1	0	13		
Mass Loading (kg/ha/d)				26.1	2.4	0.4	28.9		
Mass Out (lb/day)				10	3	0	13		
Mass Out (kg/ha/d)				22.5	5.6	0.7	28.8		
Percent Reduction (by mass)				14%	-132%	-90%	0%		

Hydraulic Properties Based on Area and Flow

Gravel Diameter (cm)		Approx Aspect Ratio (L:W) = (2:1)	2
Bed Depth (m)	0.6	Length (m)	64
Porosity e (%)	40%	Width (m)	32
Volume Water (m3)	779	Bottom Slope (m/m)	0
Volume Media (m3)	1948	**Hydraulic Constraints**	
Bed Conductivity k (m/d)	10500	G_1, Drainability	**0.00**
Design Outlet Water Depth h_0 (m)	0.54	G_3, Distance Thickening/Thinning	***3.56***

Hydraulic Loading Rate, q (cm/d)	HLR =	26.6	cm/d
Nominal Hydraulic Residence Time (d)	HRT =	1.4	days

Aeration Requirements

	Zone 1	**Zone 2**
AOR = Actual Oxygen Transfer Requirement, kg/hr	#VALUE!	10.5

Kaiser Mead Enhanced Treatment Wetland
Pre-Design Water Quality Performance Estimates
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Prepared by Jim Bays/Jacobs Engineering Group
February 11 2020

SOTR = Standardized Oxygen Transfer Req, kg O2/hr	#VALUE!	22.2
SOTR, lb O2/hr	#VALUE!	48.9
SOTE = Standard Oxygen Transfer Efficiency, %	9.6%	9.6%
eair, lb/ft3	0.07	0.07
Air Flow, SCFM	#VALUE!	527
Mass Air Flow, lb/s	#VALUE!	0.676
Blower Efficiency, %	67.9%	67.9%
Working Pressure, psig	6	6
PD Power Requirement, HP	#VALUE!	23.4
Air Flow, SCFM	**#VALUE!**	
PD Power Requirement, HP	**#VALUE!**	

Nitrogen Species Calculations

Nitrogen Models
per K&K Eqns 13-28. 13-29, 13-39:
Adapted for TIS model
Organic Nitrogen (ON)

$$C_{ON_{OUT}} = C^*_{ON} + (C_{ON_{IN}} - C^*_{ON})\left[1+\frac{k_{ON}A}{NQ}\right]^{-N}$$

DO NOT CHANGE

$(1+k_{ON}/Nq)$^-N	$(1+k_{AN}/Nq)$^-N	$(1+k_{NN}/Nq)$^-N
0.838	0.913	0.889
$k_{ON}/(k_{NH3}-k_{ON})$	kAN/(kNN-kAN)	kA/(kN-kO)
-2.0	3.433	-1.500

Ammonia Nitrogen (AN)

$$C_{AN_{OUT}} = C^*_{AN} + (C_{AN_{IN}} - C^*_{AN})\left[1+\frac{k_{AN}A}{NQ}\right]^{-N} + \left(\frac{k_{ON}}{k_{AN}-k_{ON}}\right)(C_{ON_{IN}} - C^*_{ON})\left(\left[1+\frac{k_{ON}A}{NQ}\right]^{-N} - \left[1+\frac{k_{AN}A}{NQ}\right]^{-N}\right)$$

Nitrate Nitrogen (NN)

$$C_{NN_{OUT}} = C_{NN_{IN}}\left[1+\frac{k_{NN}A}{NQ}\right]^{-N} + \Psi\left[\begin{array}{l} \left(\frac{k_{AN}}{k_{NN}-k_{AN}}\right)C_{AN_{IN}}\left(\left[1+\frac{k_{AN}A}{NQ}\right]^{-N} - \left[1+\frac{k_{NN}A}{NQ}\right]^{-N}\right) \\ + \left(\frac{k_{ON}}{k_{AN}-k_{ON}}\right)\left(\frac{k_{AN}}{k_{NN}-k_{ON}}\right)(C_{ON_{IN}} - C^*_{ON})\left(\left[1+\frac{k_{ON}A}{NQ}\right]^{-N} - \left[1+\frac{k_{NN}A}{NQ}\right]^{-N}\right) \\ - \left(\frac{k_{ON}}{k_{AN}-k_{ON}}\right)\left(\frac{k_{AN}}{k_{NN}-k_{AN}}\right)(C_{ON_{IN}} - C^*_{ON})\left(\left[1+\frac{k_{AN}A}{NQ}\right]^{-N} - \left[1+\frac{k_{NN}A}{NQ}\right]^{-N}\right) \end{array}\right]$$

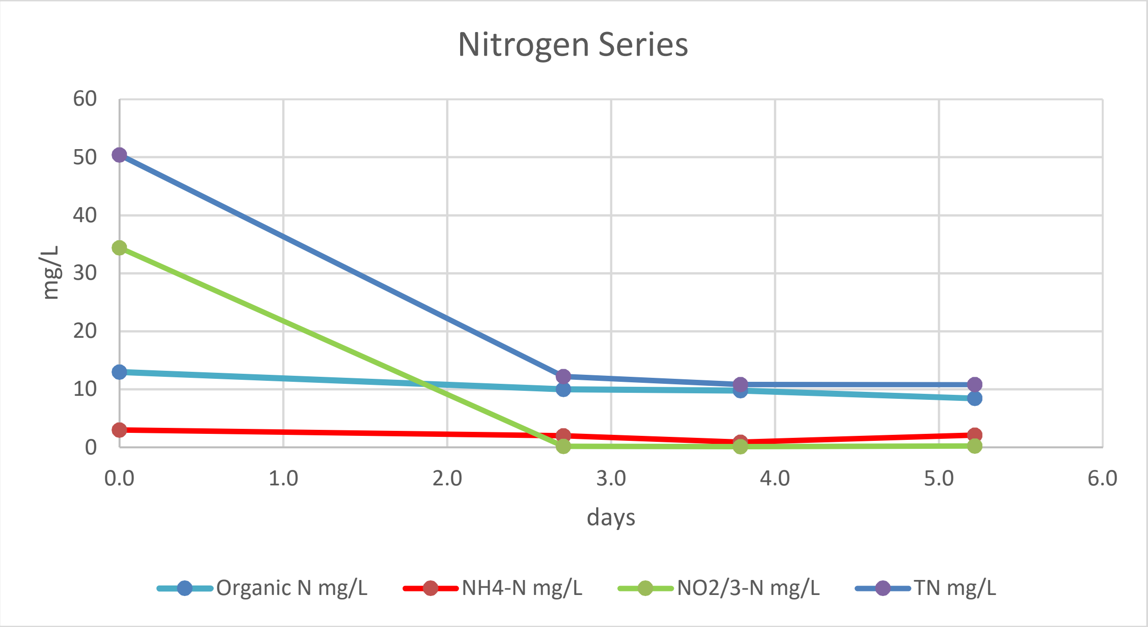
where Ψ = fraction of ammonium nitrified, assumed to be 100% = 100%

Kaiser Mead Enhanced Treatment Wetland
Pre-Design Water Quality Performance Estimates
p-k-C* Model (Kadlec and Wallace 2009) Calibrated to Continuous Flow Pilot Study (Jacobs 2020)
Prepared by Jim Bays/Jacobs Engineering Group
February 11 2020

Cell	Organic N mg/L	NH4-N mg/L	NO2/3-N mg/L	TN mg/L	TN CR	HRT d	Cumulative HRT d
Inflow	13.0	3.000	34.400	50.400	0%	0.0	0.0
Cell 1	10.0	1.988	0.193	12.216	76%	2.7	2.7
Cell 2	9.8	0.907	0.140	10.837	78%	1.1	3.8
Cell 3	8.4	2.104	0.266	10.813	79%	1.4	5.2

Note

100 gpm = 50 gpm inflow + 50 gpm recirc



Structural Calculations

KAISER MEAD GROUNDWATER
REMEDIATION INTERIM ACTION

CALCULATIONS

STRUCTURAL

LIAO YANG
STATE OF WASHINGTON
49264
REGISTERED
PROFESSIONAL ENGINEER
04-03-2020

Digitally Signed on

April 3, 2020

Liao Yang

STRUCTURAL CALCULATIONS

FOR

Kaiser Meads PEMB

Code Search

Code: International Building Code 2015

Occupancy:

Occupancy Group = U Utility & Miscellaneous

Risk Category & Importance Factors:

Risk Category = II

Wind factor = 1.00
Snow factor = 1.00
Seismic factor = 1.00

Type of Construction:

Fire Rating:

Roof = 0.0 hr
Floor = 0.0 hr

Building Geometry:

Roof angle (θ)	3.00 / 12	14.0 deg
Building length (L)	90.0 ft	
Least width (B)	44.0 ft	
Mean Roof Ht (h)	23.0 ft	
Parapet ht above grd	0.0 ft	
Minimum parapet ht	0.0 ft	

Live Loads:

Roof
0 to 200 sf: 20 psf
200 to 600 sf: 24 - 0.02Area, but not less than 12 psf
over 600 sf: 12 psf

Floor:

Typical Floor	250 psf
Partitions	15 psf
Lobbies & first floor corridors	100 psf
Corridors above first floor	80 psf
Balconies (exterior) - same as occupa	100 psf

JOB TITLE Kaiser Meads PEMB
JOB NO.
SHEET NO.
CALCULATED BY L.Yang
DATE 12/6/19
CHECKED BY
DATE

Enclosure Classification

Test for Enclosed Building: A building that does not qualify as open or partially enclosed.

Test for Open Building: All walls are at least 80% open.
Ao ≥ 0.8Ag

Test for Partially Enclosed Building: Predominately open on one side only

	Input			Test	
Ao	500.0	sf	Ao ≥ 1.1Aoi	NO	
Ag	600.0	sf	Ao > 4' or 0.01Ag	YES	
Aoi	1000.0	sf	Aoi / Agi ≤ 0.20	YES	Building is NOT Partially Enclosed
Agi	10000.0	sf			

Conditions to qualify as Partially Enclosed Building. Must satisfy all of the following:
Ao ≥ 1.1Aoi
Ao > smaller of 4' or 0.01 Ag
Aoi / Agi ≤ 0.20
Where:
Ao = the total area of openings in a wall that receives positive external pressure.
Ag = the gross area of that wall in which Ao is identified.
Aoi = the sum of the areas of openings in the building envelope (walls and roof) not including Ao.
Agi = the sum of the gross surface areas of the building envelope (walls and roof) not including Ag.

Reduction Factor for large volume partially enclosed buildings (Ri) :

If the partially enclosed building contains a single room that is unpartitioned , the internal pressure coefficient may be multiplied by the reduction factor Ri.

Total area of all wall & roof openings (Aog): 0 sf
Unpartitioned internal volume (Vi) : 0 cf
Ri = 1.00

Altitude adjustment to constant 0.00256 (caution - see code) :

Grd level above sea level = 0.0 ft
Constant = 0.00256
Adj Constant = 0.00256
Average Air Density = 0.0765 lbm/ft3

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1100 NE Circle Blvd
Corvallis
547683444

JOB TITLE Kaiser Meads PEMB
JOB NO.
SHEET NO.
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DATE 12/6/19
CHECKED BY
DATE

Wind Loads :

ASCE 7- 10

ASK Bldg do 115 mph

Ultimate Wind Speed	110 mph
Nominal Wind Speed	85.2 mph
Risk Category	II
Exposure Category	C
Enclosure Classif.	Enclosed Building
Internal pressure	+/-0.18
Directionality (Kd)	0.85
Kh case 1	0.929
Kh case 2	0.929
Type of roof	Gable

Topographic Factor (Kzt)

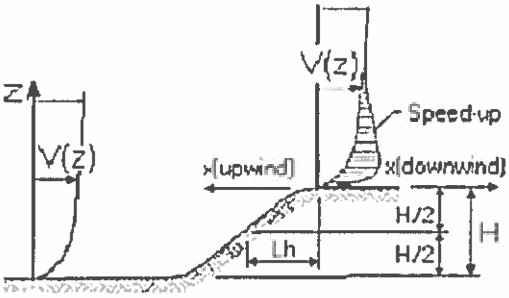
Topography		Flat
Hill Height	(H)	0.0 ft
Half Hill Length (Lh)		0.0 ft
Actual H/Lh	=	0.00
Use H/Lh	=	0.00
Modified Lh	=	0.0 ft
From top of crest: x =		200.0 ft
Bldg up/down wind?		downwind

H< 15ft;exp C
∴ Kzt=1.0

H/Lh= 0.00 K_1 = 0.000
x/Lh = 0.00 K_2 = 0.000
z/Lh = 0.00 K_3 = 1.000

At Mean Roof Ht:

$Kzt = (1+K_1K_2K_3)^2 = 1.00$



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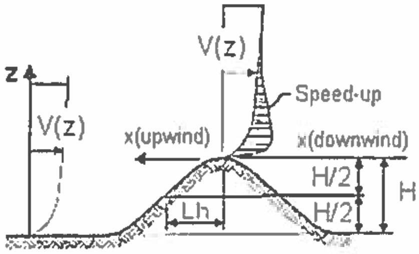

2D RIDGE or 3D AXISYMMETRICAL HILL

Gust Effect Factor

h = 23.0 ft
B = 44.0 ft
/z (0.6h) = 15.0 ft

Flexible structure if natural frequency < 1 Hz (T > 1 second).
If building h/B>4 then may be flexible and should be investigated.
h/B = 0.52 Rigid structure (low rise bldg)

G = 0.85 Using rigid structure default

Rigid Structure

ē = 0.20
ℓ = 500 ft
z_{min} = 15 ft
c = 0.20
g_Q, g_v = 3.4
L_z = 427.1 ft
Q = 0.91
I_z = 0.23
G = 0.88 use G = 0.85

Flexible or Dynamically Sensitive Structure

34 ıcy (η_1) = 0.0 Hz
Damping ratio (β) = 0
/b = 0.65
/α = 0.15
Vz = 92.9
N_1 = 0.00
K_n = 0.000
R_h = 28.282 η = 0.000 h = 23.0 ft
R_B = 28.282 η = 0.000
R_L = 28.282 η = 0.000
g_R = 0.000
R = 0.000
Gf = 0.000

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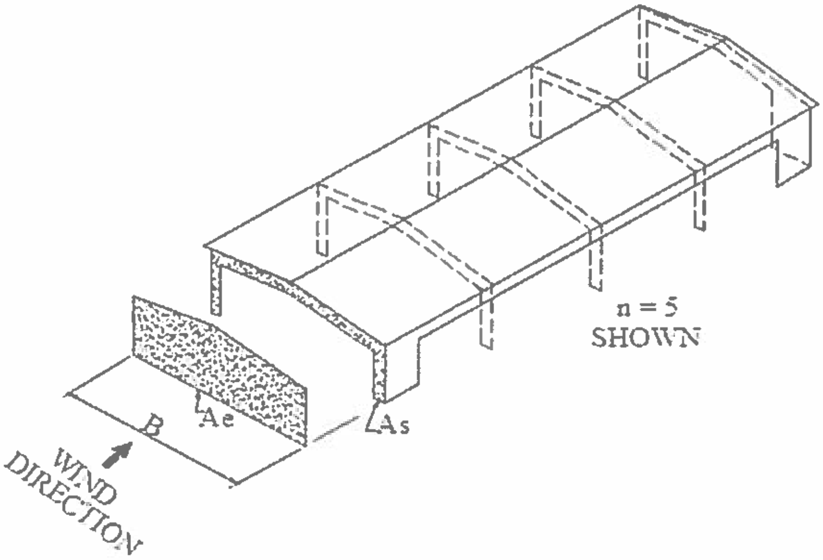
5.5E+08

JOB TITLE Kaiser Meads PEMB
JOB NO.
SHEET NO.
CALCULATED BY L.Yang
DATE 12/6/19
CHECKED BY
DATE

Wind Loads - h≤60' Longitudinal Direction MWFRS On Open or Partially Enclosed Buildings with Transverse Frames and Pitched Roofs

ASCE 7-16 procedure

Base pressure (qh) = **24.5 psf**
GCpi = +/-0.18 Enclosed bldg, procdure doesn't apply
Roof Angle (θ) = 14.0 deg



B= 44.0 ft
# of frames (n) = 5
Solid are of end wall including fascia (As) = 1,500.0 sf
Roof ridge height = 25.8 ft
Roof eave height = 20.3 ft
Total end wall area if soild (Ae) = 1,012.0 sf

Longidinal Directional Force (F) = pAe
p= qh [(GCpf)windward -(GCpf)leeward] $K_B K_S$
Solidarity ratio (Φ) = 1.482
n = 5
KB = 0.8
KS = 3.284
Zones 5 & 6 area = 916.9 sf
5E & 6E area = 95.2 sf
(GCpf) windward - (GCpf) leeward] = 0.723
p = 46.5 psf

Total force to be resisted by MWFRS (F) = **47.0 kips** applied at the centroid of the end wall area Ae

Note: The longidudinal force acts in combination with roof loads calculated elsewhere for an open or partially enclosed building.

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JOB TITLE Kaiser Meads PEMB
JOB NO.
SHEET NO.
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CHECKED BY
DATE

Wind Loads - MWFRS h≤60' (Low-rise Buildings) except for open buildings

Kz = Kh (case 1) = 0.93
Base pressure (qh) = **24.5 psf**
GCpi = +/-0.18

Edge Strip (a) = 4.4 ft
End Zone (2a) = 8.8 ft
Zone 2 length = 22.0 ft

Wind Pressure Coefficients

Surface	CASE A				CASE B		
	GCpf	θ = 14 deg w/-GCpi	w/+GCpi		GCpf	w/-GCpi	w/+GCpi
1	0.48	0.66	0.30		-0.45	-0.27	-0.63
2	-0.69	-0.51	-0.87		-0.69	-0.51	-0.87
3	-0.44	-0.26	-0.62		-0.37	-0.19	-0.55
4	-0.37	-0.19	-0.55		-0.45	-0.27	-0.63
5					0.40	0.58	0.22
6					-0.29	-0.11	-0.47
1E	0.72	0.90	0.54		-0.48	-0.30	-0.66
2E	-1.07	-0.89	-1.25		-1.07	-0.89	-1.25
3E	-0.63	-0.45	-0.81		-0.53	-0.35	-0.71
4E	-0.56	-0.38	-0.74		-0.48	-0.30	-0.66
5E					0.61	0.79	0.43
6E					-0.43	-0.25	-0.61

Ultimate Wind Surface Pressures (psf)

1		16.1	7.3			-6.6	-15.4
2		-12.5	-21.3			-12.5	-21.3
3		-6.3	-15.1			-4.6	-13.5
4		-4.8	-13.6			-6.6	-15.4
5						14.2	5.4
6						-2.7	-11.5
1E		22.1	13.3			-7.3	-16.1
2E		-21.8	-30.6			-21.8	-30.6
3E		-10.9	-19.7			-8.6	-17.4
4E		-9.2	-18.0			-7.3	-16.1
5E						19.3	10.5
6E						-6.1	-14.9

SEE FIGURES page 300 OF ASCE 7-10

Parapet

Windward parapet = 0.0 psf (GCpn = +1.5)
Leeward parapet = 0.0 psf (GCpn = -1.0)

Windward roof overhangs = 17.1 psf (upward) add to windward roof pressure

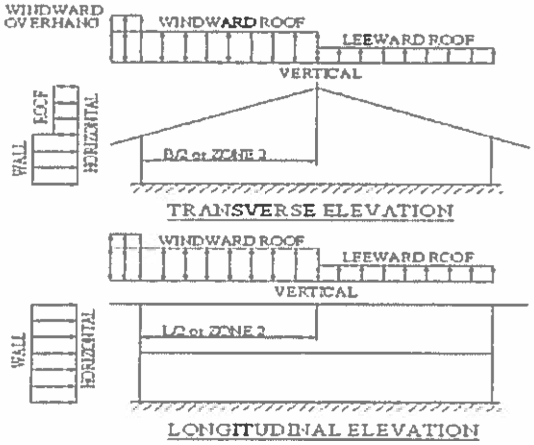
Horizontal MWFRS Simple Diaphragm Pressures (psf)

Transverse direction (normal to L)
Interior Zone: Wall 20.9 psf
Roof -6.2 psf **
End Zone: Wall 31.3 psf
Roof -10.8 psf **

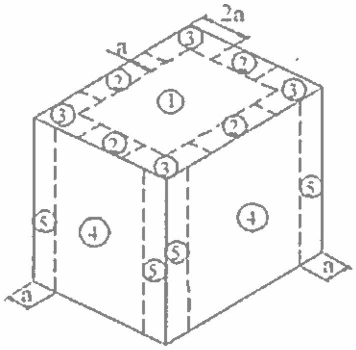
Longitudinal direction (parallel to L)
Interior Zone: Wall 16.9 psf
End Zone: Wall 25.4 psf

** NOTE: Total horiz force shall not be less than that determined by neglecting roof forces (except for MWFRS moment frames).

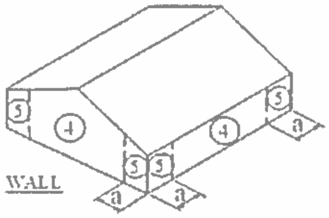
The code requires the MWFRS be designed for a min ultimate force of 16 psf multiplied by the wall area plus an 8 psf force applied to the vertical projection of the roof.



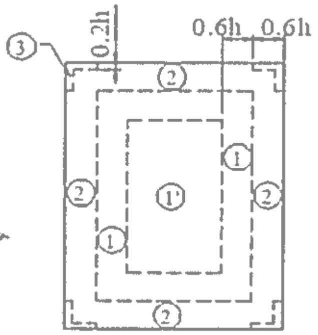
Location of C&C Wind Pressure Zones - ASCE 7-16



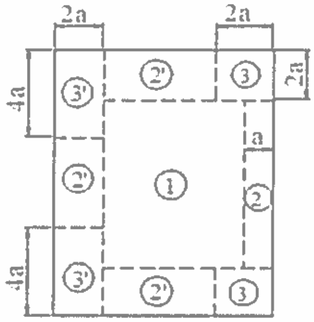
Roofs w/ θ ≤ 10°
and all walls
h > 60'



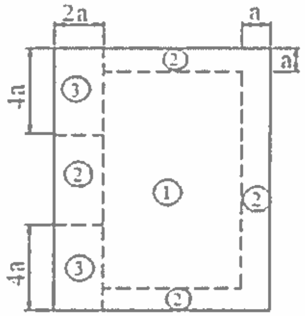
Walls h ≤ 60'
& alt design h<90'



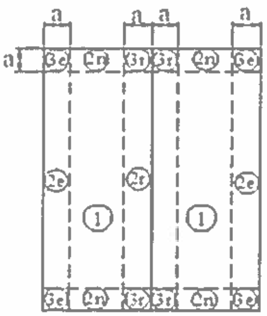
Gable, Sawtooth and
Multispan Gable θ ≤ 7 degrees &
Monoslope ≤ 3 degrees
h ≤ 60' & alt design h<90'



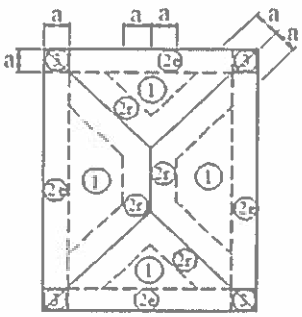
Monoslope roofs
3° < θ ≤ 10°
h ≤ 60' & alt design h<90'



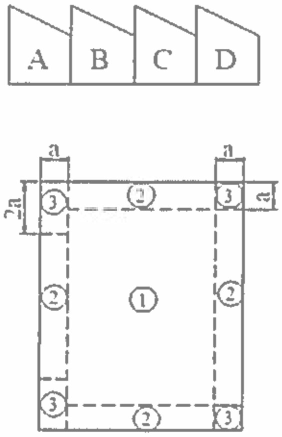
Monoslope roofs
10° < θ ≤ 30°
h ≤ 60' & alt design h<90'



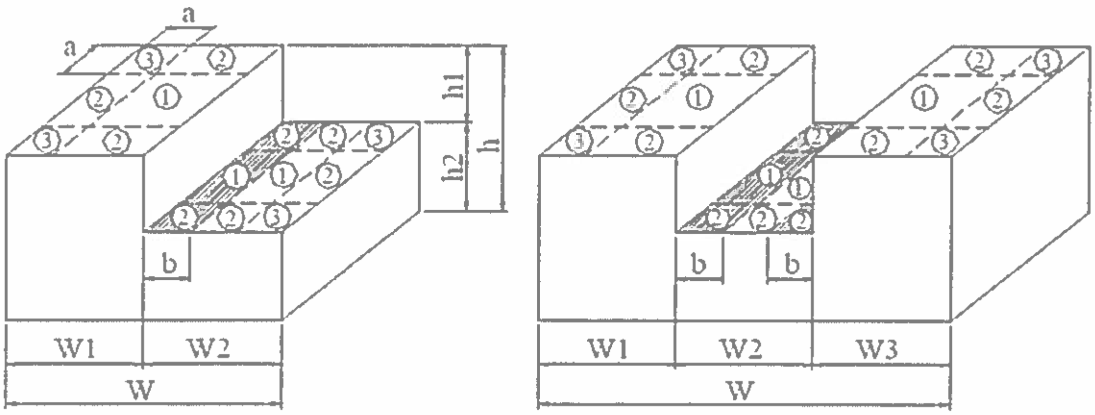
Multispan Gable &
Gable 7° < θ ≤ 45°



Hip 7° < θ ≤ 27°



Sawtooth 10° < θ ≤ 45°
h ≤ 60' & alt design h<90'



Stepped roofs θ ≤ 3°
h ≤ 60' & alt design h<90'

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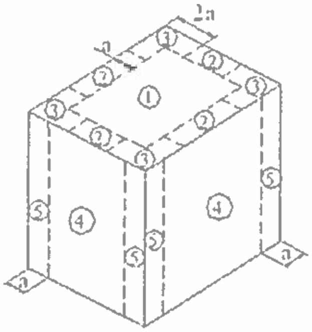
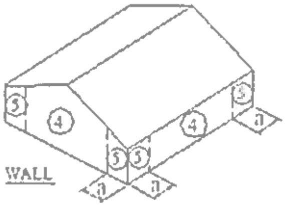
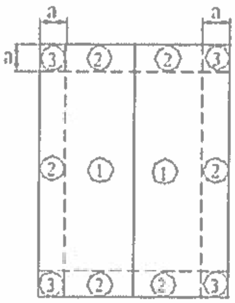
Location of C&C Wind Pressure Zones - ASCE 7-10 & earlier



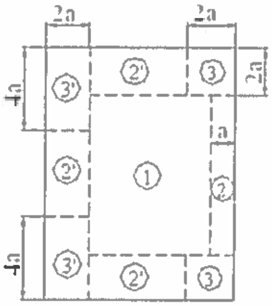
Roofs w/ θ ≤ 10°
and all walls
h > 60'



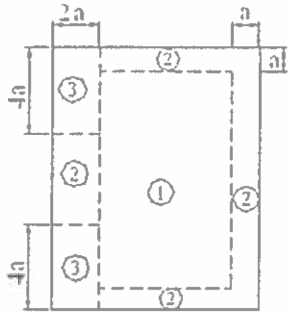
Walls h ≤ 60'
& alt design h<90'



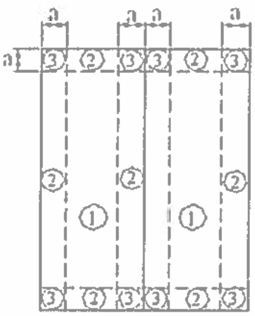
Gable, Sawtooth and
Multispan Gable θ ≤ 7 degrees &
Monoslope ≤ 3 degrees
h ≤ 60' & alt design h<90'



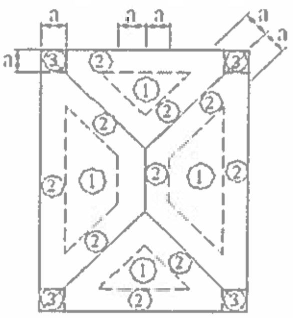
Monoslope roofs
3° < θ ≤ 10°
h ≤ 60' & alt design h<90'



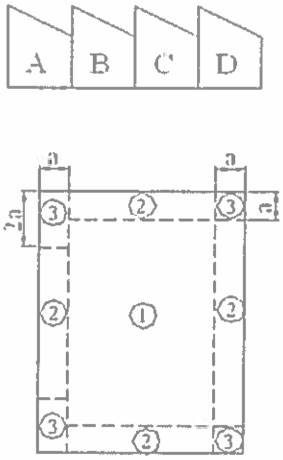
Monoslope roofs
10° < θ ≤ 30°
h ≤ 60' & alt design h<90'



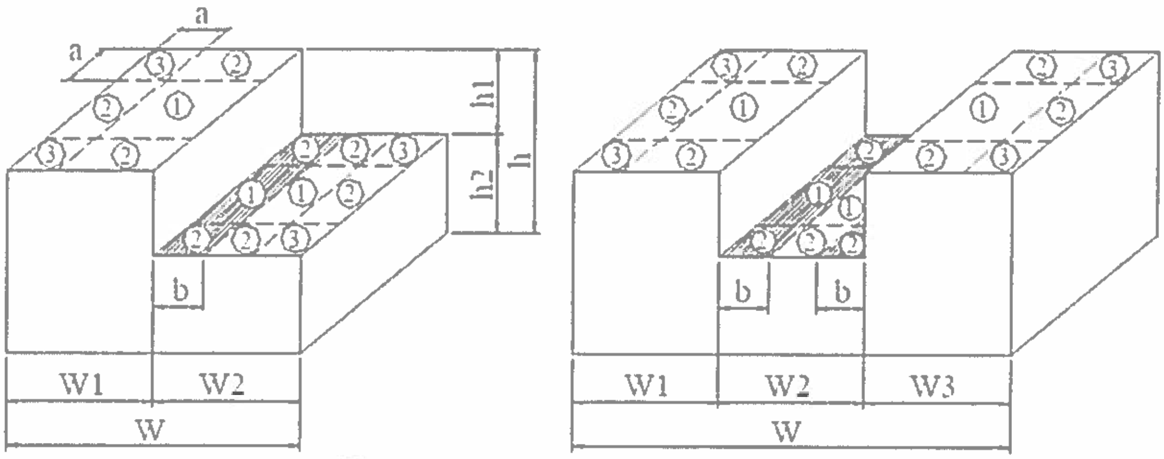
Multispan Gable &
Gable 7° < θ ≤ 45°



Hip 7° < θ ≤ 27°



Sawtooth 10° < θ ≤ 45°
h ≤ 60' & alt design h<90'



Stepped roofs θ ≤ 3°
h ≤ 60' & alt design h<90'

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Ultimate Wind Pressures

Wind Loads - Components & Cladding : h ≤ 60'

Kh (case 1) = 0.93
h = 23.0 ft
Base pressure (qh) = **24.5 psf**
a = 4.4 ft
Minimum parapet ht = 0.0 ft
GCpi = +/-0.18
Roof Angle (θ) = 14.0 deg
Type of roof = Gable

Roof

	GCp +/- GCpi				Surface Pressure (psf)				User input	
Area	10 sf	20 sf	50 sf	100 sf	10 sf	20 sf	50 sf	100 sf	75 sf	300 sf
Negative Zone 1	-1.08	-1.05	-1.01	-0.98	-26.4	-25.7	-24.7	-24.0	-24.3	-24.0
Negative Zone 2	-1.88	-1.73	-1.53	-1.38	-46.0	-42.3	-37.4	-33.7	-35.3	-33.7
Negative Zone 3	-2.78	-2.6	-2.36	-2.18	-68.0	-63.6	-57.7	-53.3	-55.1	-53.3
Positive All Zones	0.68	0.62	0.54	0.48	16.6	16.0	16.0	16.0	16.0	16.0
Overhang Zone 2	-2.2	-2.2	-2.2	-2.2	-53.8	-53.8	-53.8	-53.8	-53.8	-53.8
Overhang Zone 3	-3.7	-3.34	-2.86	-2.5	-90.5	-81.7	-69.9	-61.1	-64.8	-61.1

Overhang pressures in the table above assume an internal pressure coefficient (Gcpi) of 0.0
Overhang soffit pressure equals adj wall pressure (which includes internal pressure of 4.4 psf)

Parapet

qp = 0.0 psf

		Surface Pressure (psf)						User input
Solid Parapet Pressure		10 sf	20 sf	50 sf	100 sf	200 sf	500 sf	40 sf
CASE A:	Zone 2 :	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Zone 3 :	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CASE B:	Edge zones 2 :	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Corner zones 3 :	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Walls

	GCp +/- GCpi				Surface Pressure (psf)				User input	
Area	10 sf	100 sf	200 sf	500 sf	10 sf	100 sf	200 sf	500 sf	50 sf	200 sf
Negative Zone 4	-1.28	-1.10	-1.05	-0.98	-31.3	-27.0	-25.7	-24.0	-28.3	-25.7
Negative Zone 5	-1.58	-1.23	-1.12	-0.98	-38.6	-30.0	-27.4	-24.0	-32.6	-27.4
Positive Zone 4 & 5	1.18	1.00	0.95	0.88	28.9	24.5	23.2	21.5	25.8	23.2

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Snow Loads : ASCE 7-10

Nominal Snow Forces

Roof slope = 14.0 deg
Horiz. eave to ridge dist (W) = 22.0 ft
Roof length parallel to ridge (L) = 90.0 ft

Type of Roof Hip and gable w/ rafters
Ground Snow Load Pg = 39.0 psf
Risk Category = II
Importance Factor I = 1.0
Thermal Factor Ct = 1.00
Exposure Factor Ce = 1.2

Pf = 0.7*Ce*Ct*I*Pg = 32.8 psf
Unobstructed Slippery Surface no

Sloped-roof Factor Cs = 1.00
Balanced Snow Load = 32.8 psf

SPOKAN CODE 30psf

Near ground level surface balanced snow load = **39.0 psf**

Rain on Snow Surcharge Angle 0.44 deg
Code Maximum Rain Surcharge 5.0 psf
Rain on Snow Surcharge = 0.0 psf
Ps plus rain surcharge = 32.8 psf
Minimum Snow Load Pm = 20.0 psf

Uniform Roof Design Snow Load = **32.8 psf**

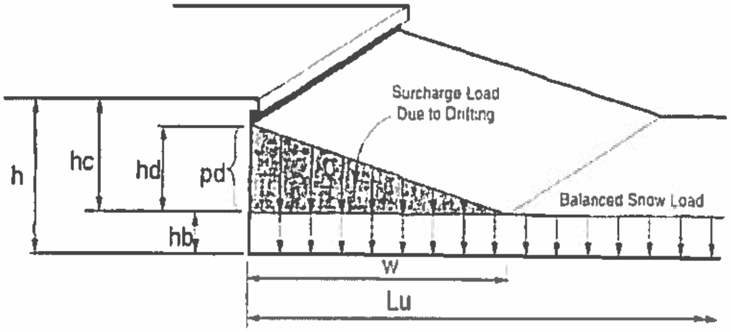
NOTE: Alternate spans of continuous beams shall be loaded with half the design roof snow load so as to produce the greatest possible effect - see code for loading diagrams and exceptions for gable roofs..

Unbalanced Snow Loads - for Hip & Gable roofs only

Required if slope is between 7 on 12 = 30.26 deg
and 2.38 deg = 2.38 deg **Unbalanced snow loads must be applied**
Windward snow load = 9.8 psf = 0.3Ps
Leeward snow load from ridge to 9' = 48.9 psf = hdγ / √S + Ps
Leeward snow load from 9' to the eave = 32.8 psf = Ps

Windward Snow Drifts 1 - Against walls, parapets, etc

Upwind fetch lu = 220.0 ft
Projection height h = 5.2 ft
Snow density g = 19.1 pcf
Balanced snow height hb = 1.72 ft
hd = 4.03 ft
hc = 3.48 ft
hc/hb >0.2 = 2.0 **Therefore, design for drift**
Drift height (hc) = 3.48 ft
Drift width w = 18.62 ft
Surcharge load: pd = γ*hd = **66.4 psf**
Balanced Snow load: = 32.8 psf
99.2 psf



Windward Snow Drifts 2 - Against walls, parapets, etc

Upwind fetch lu = 160.0 ft
Projection height h = 4.0 ft
Snow density g = 19.1 pcf
Balanced snow height hb = 1.72 ft
hd = 3.51 ft
hc = 2.28 ft
hc/hb >0.2 = 1.3 **Therefore, design for drift**
Drift height (hc) = 2.28 ft
Drift width w = 18.26 ft
Surcharge load: pd = γ*hd = **43.5 psf**
Balanced Snow load: = 32.8 psf
76.3 psf

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Seismic Loads: IBC 2015 Strength Level Forces

Risk Category : II
Importance Factor (I) : 1.00
Site Class : D

Ss (0.2 sec) = 33.70 %g
S1 (1.0 sec) = 11.60 %g

Fa =	1.530	Sms =	0.516	S_{DS} =	0.344	Design Category =	C
Fv =	2.336	Sm1 =	0.271	S_{D1} =	0.181	Design Category =	C

Seismic Design Category = C

Redundancy Coefficient ρ = 1.30
Number of Stories: 1
Structure Type: Moment-resisting frame systems of steel
Horizontal Struct Irregularities: No plan Irregularity
Vertical Structural Irregularities: No vertical Irregularity
Flexible Diaphragms: No
Building System: **Moment-resisting Frame Systems**
Seismic resisting system: **Steel ordinary moment frames**
System Structural Height Limit: **Height not limited**
Actual Structural Height (hn) = 25.8 ft

DESIGN COEFFICIENTS AND FACTORS

Response Modification Coefficient (R) = 3.5
Over-Strength Factor (Ωo) = 3
Deflection Amplification Factor (Cd) = 3
S_{DS} = 0.344
S_{D1} = 0.181

Seismic Load Effect (E) = Eh +/-Ev = $\rho Q_E \pm 0.2S_{DS} D$ = 1.3Qe +/- 0.069D
Special Seismic Load Effect (Em) = Emh +/- Ev = $\Omega o\, Q_E \pm 0.2S_{DS} D$ = 3Qe +/- 0.069D

Q_E = horizontal seismic force
D = dead load

PERMITTED ANALYTICAL PROCEDURES

Simplified Analysis - Use Equivalent Lateral Force Analysis

Equivalent Lateral-Force Analysis - Permitted
Building period coef. (C_T) = 0.028
Approx fundamental period (Ta) = $C_T h_n^x$ = 0.377 sec x= 0.80
User calculated fundamental period (T) = sec
Long Period Transition Period (TL) = ASCE7 map = 8
Seismic response coef. (Cs) = $S_{DS}I/R$ = 0.098
need not exceed Cs = Sd1 I /RT = 0.137
but not less than Cs = 0.044SdsI = 0.015
USE Cs = 0.098
Design Base Shear V = 0.098W

Cu = 1.54
Tmax = CuTa = 0.580
Use T = 0.377

Model & Seismic Response Analysis - Permitted (see code for procedure)

ALLOWABLE STORY DRIFT

Structure Type: All other structures
Allowable story drift Δa = 0.020hsx where hsx is the story height below level x

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Seismic Loads - cont. :

Strength Level Forces

Seismic Design Category (SDC)= C
Ie = 1.00
Sds = 0.344

CONNECTIONS

Force to connect smaller portions of structure to remainder of structure

$Fp = 0.133Sdsw_p =$ 0.046 w_p
or $Fp = 0.05w_p =$ 0.05 w_p Use Fp = 0.05 w_p w_p = weight of smaller portion

Beam, girder or truss connection for resisting horizontal force parallel to member

F_P = no less than 0.05 times dead plus live load vertical reaction

Anchorage of Structural Walls to elements providing lateral support

Fp = not less than 0.2KaIeWp
Enter Lf to calculate Fp for flexible diaphragm
Fp =0.4SdskaIeWp = 0.138 Wp, but not less than 0.2Wp (rigid diaphragm)

Flexible diaphragm span Lf =
ka= 1 Fp = 0.200 Wp
but Fp shall not be less than 5 psf

MEMBER DESIGN

Bearing Walls and Shear Walls (out of plane force)

$Fp = 0.4SdsIeWw =$ 0.138 w_w
but not less than 0.10 w_w Use Fp = 0.14 w_w

Diaphragms

Fp = 0.2ISdsWp + Vpx = 0.069 Wp + Vpx

ARCHITECTURAL COMPONENTS SEISMIC COEFFICIENTS

Architectural Component : Cantilever Elements (Unbraced or Braced to Structural Frame Below Its Center of Mass): Parapets and cantilever interior nonstructural walls

Importance Factor (Ip) : 1.0
Component Amplification Factor (a_p) = 2.5 h= 25.8 feet
Comp Response Modification Factor (R_p) = 2.5 z= 50.0 feet z/h = 1.00

$Fp = 0.4a_pSdsIpWp(1+2z/h)/Rp =$ 0.413 Wp
not greater than Fp = 1.6SdsIpWp = 0.550 Wp
but not less than Fp = 0.3SdsIpWp = 0.103 Wp use Fp = 0.413 Wp

MECH AND ELEC COMPONENTS SEISMIC COEFFICIENTS

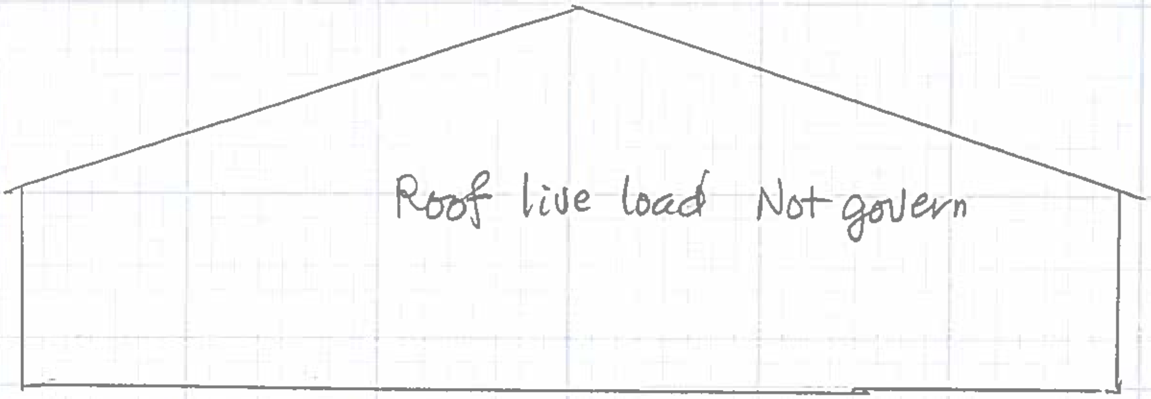
Mech or Electrical Component : Skirt-supported pressure vessels not within the scope of Chapter 15.

Importance Factor (Ip) : 1.5
Component Amplification Factor (a_p) = 2.5 h= 25.8 feet
Comp Response Modification Factor (R_p) = 2.5 z= 0.0 feet z/h = 0.00

$Fp = 0.4a_pSdsIpWp(1+2z/h)/Rp =$ 0.206 Wp
not greater than Fp = 1.6SdsIpWp = 0.825 Wp
but not less than Fp = 0.3SdsIpWp = 0.155 Wp use Fp = 0.206 Wp

Subject PEMB FOUNDATION REACTION Project Kaiser Meads
Sheet No. 1 of
Authored by L.YANG Date 12/6/2019 Checked by Date

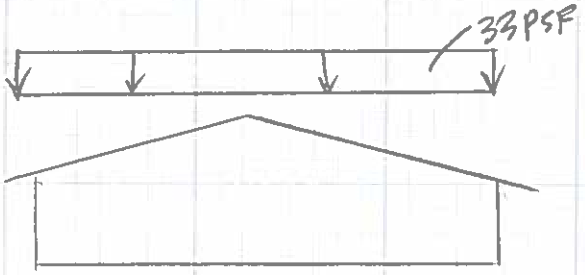
Kaiser Meads Pre-Engineered Bldg Calc



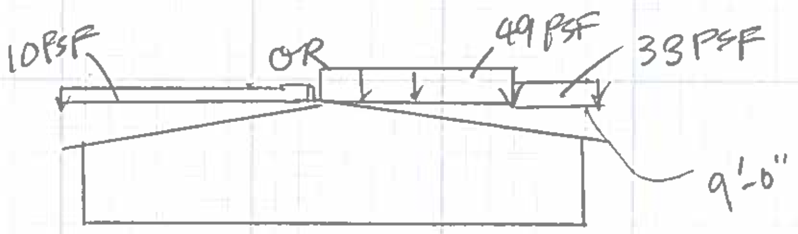
Roof live load Not govern

Loads: (SEE CRITERIA & FROM STRUCTWARE RESULTS)

1) Snow load: per Spokane Code, Flat Roof Snow
$P_f = 30$ PSF, USE $P_f = 33$ for foundation Calc



Balanced



unbalanced

Snow load → Spokane use 30PSF Roof load
Even w/ $I_{snow} = 1.1$ → 33 PSF okay

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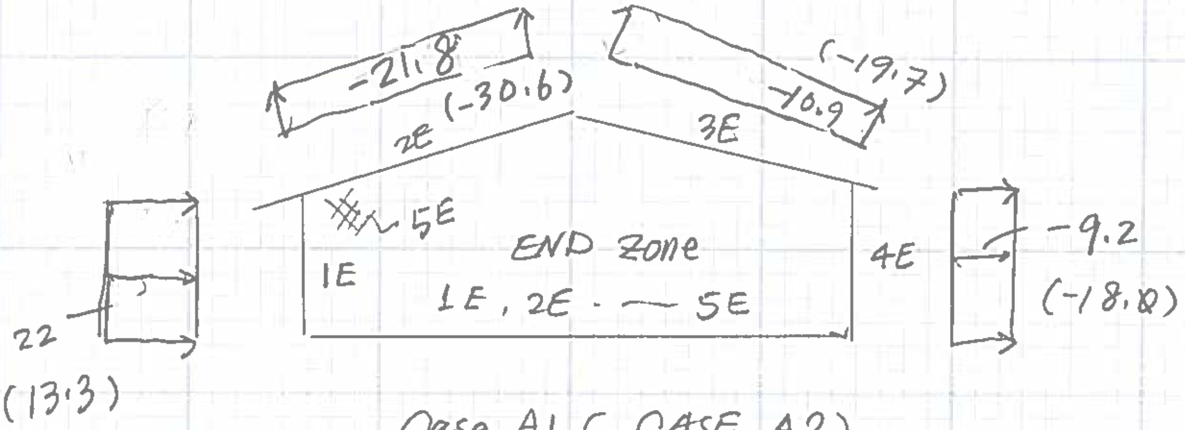
2) Wind load (SEE CRITERIA & STRUCTWARE RESULTS)



Case A1 (CASE A2)

CASE B1 & B2, SEE Table

LOADS WILL BE INPUT TO STAAD MODEL for Foundation Reaction Calculations

3) Collateral Load - use 10 PSF

4) DL load — use 20 PSF

} 0.03 ksf

LOAD Combination — USE ASCE 7-10

IF Cat III IS USED Basic Wind Pressure 29.1 w/ 120 mph

$$\alpha = \frac{29.1 \text{ PSF}}{24.5 \text{ PSF}} = 1.187 \sim 1.2 \text{ factor}$$

3). SEISMIC LOADS

Seismic loads don't govern bldg design by inspection. However, Tank and EQuipment Anchor Design will be governed by E.

USE $F_p = 0.206 W_p$ (Conservatively use $I = 1.5$, No Info about contents)

If Not Harzard

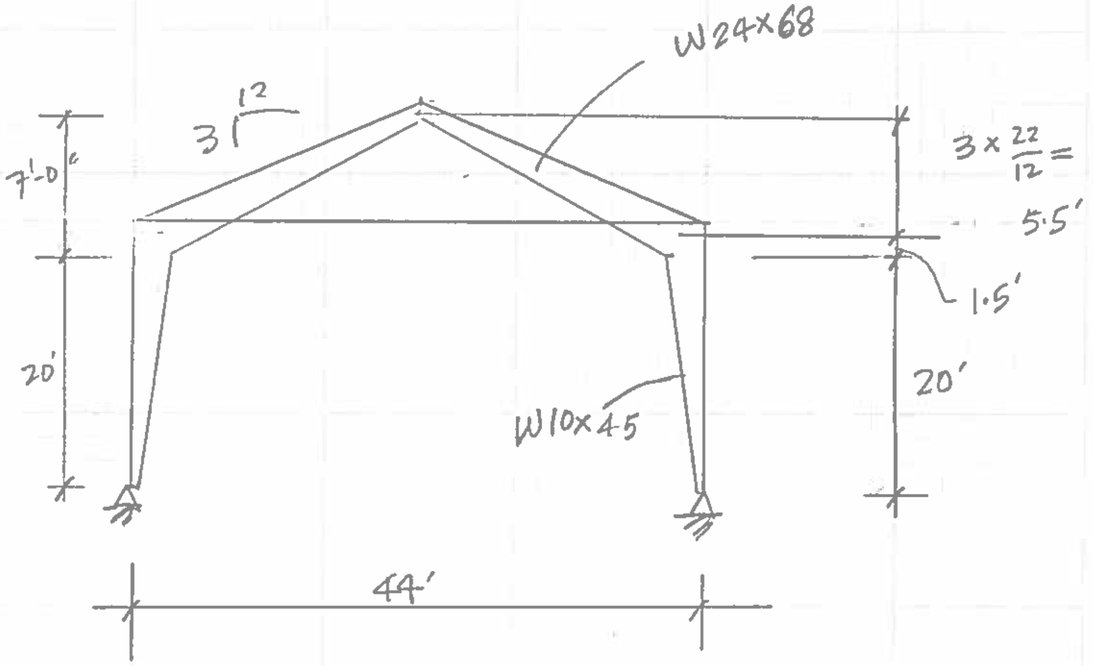
$$F_p = 0.206/1.5 = 0.137 W_p$$

Foundation Design Can resist Cat III facility.

but need deside if Cat III should be specified !

Reactins from PEMB Columns

Bay ≙ 22'-0"   Roof. span 44'-0"



STAAD Mode —

1) 22' × Results = Col Reactin

2) 0.6DL + 0.6W

∵ 10 PSF Collateral load & 20 PSF = DL

use 1/2 of them w/o Beam frame Weight

0.3DL + 0.6W.

STAAD RESULTS

1) Col uplifting load

Cat III

$P_y = 0.233^{k} \times 22' = 5.12^{k} \times 1.2 = 6.144^{k}$

Footing. Size $6' \times 8' \times 1.5 \times 150\,\#/_{3} = 10.8^{k}$

$0.6\,DL = 6.48^{k}$ okay

Try $6' \times 6' \times 1.5 \times 0.15 \times 0.6 = 4.86^{k}$

$+$ 2.5' Soil $= 2.5 \times 6' \times 6' \times 0.11^{k}/ft^{3} \times 0.6 = 5.94^{k}$ NG.

∴ use $6' \times 8' \times 1.5'$ Col FTG okay

2) Thrust forces

$T = 0.283^{k/'} \times 22' = 6.22^{k}$

Assume $f_s = 24\ ksi$ $\quad A_s = \frac{6.22}{24} = 0.26\ in^2$

Use (3) #6 okay — in Case some cannot pass thru trenches...

3) Downward $P_Y = 1.454^{k/'} \times 22' = 32^{k}$

$q = \frac{32^{k}}{6' \times 6'} = 889$ PSF. bearing is okay

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$C_s = 0.206$ → Cat III facility

PADS Supporting EQ, DEFORM, FLOC & Sludg TANKS

Tank NAME	EQ	DEFORM	FLOC	SLUDGE
Weight	47.3^k	47.3^k	34^k	23.6^k
HEIGHT	132"	132"	120"	160"
Shear $V = 0.206W$	$9.7^k \sim 10^k$	10^k	7^k	$4.86 \sim 5^k$
Moment $M = V(\frac{h}{2}+6")$ =	$720^{k\text{-}in}$	$720^{k\text{-}"}$	$462^{k\text{-}"}$	$430^{k\text{-}"}$
$e = 0.7M/P\,(\text{Weight})$	0.89'	0.89'	0.79'	1.06'
d = Diameter of Tank	108" $A = 63.61'^2$	108" $63.61\ ft^2$	96" $50\ ft^2$	90" $44\ ft^2$
Pressure w/o Moment $= P/A$	743 PSF	743 PSF	680 PSF	536 PSF
$S = \frac{\pi}{32}d^3$	$71.56\ ft^3$	$71.56\ ft^3$	$50\ ft^3$	$41.41\ ft^3$
$0.7M/S =$	±586	±586	±539	±605
Max Pressure pluss 8"+6" CONC	+175 PSF ~1500	~1500	1394	1316
Min Pressure	330	330	316	106

Okay!

```
STAAD SPACE
START JOB INFORMATION
ENGINEER DATE 09-Dec-19
END JOB INFORMATION
INPUT WIDTH 79
UNIT FEET KIP
JOINT COORDINATES
1 0 0 0; 2 22 27 0; 3 44 20 0; 4 44 0 0; 5 0 20 0;
MEMBER INCIDENCES
1 1 5; 2 5 2; 3 2 3; 4 3 4;
DEFINE MATERIAL START
ISOTROPIC STEEL
E 4.176e+06
POISSON 0.3
DENSITY 0.489024
ALPHA 6.5e-06
DAMP 0.03
TYPE STEEL
STRENGTH RY 1.5 RT 1.2
END DEFINE MATERIAL
MEMBER PROPERTY AMERICAN
2 3 TABLE ST W24X68
1 4 TABLE ST W10X45
CONSTANTS
MATERIAL STEEL ALL
SUPPORTS
1 4 PINNED
DEFINE REFERENCE LOADS
LOAD R1 LOADTYPE Dead  TITLE ROOF DEAD LOAD
MEMBER LOAD
2 3 UNI GY -0.03
LOAD R2 LOADTYPE Wind  TITLE WIND LOAD A1
MEMBER LOAD
1 UNI GX 0.022
4 UNI GX 0.0092
2 UNI GY 0.0218
3 UNI GY 0.0197
LOAD R3 LOADTYPE Wind  TITLE WIND LOAD A2
MEMBER LOAD
1 UNI GX 0.0133
4 UNI GX 0.018
2 UNI GY 0.0306
3 UNI GY 0.0109
LOAD R4 LOADTYPE Wind  TITLE WIND LOAD B1
MEMBER LOAD
1 UNI GX -0.0073
4 UNI GX 0.0073
```

```
2 UNI GY 0.0218
3 UNI GY 0.0086
LOAD R5 LOADTYPE Wind  TITLE WIND LOAD B2
MEMBER LOAD
1 UNI GX -0.0161
4 UNI GX 0.0161
2 UNI GY 0.0306
3 UNI GY 0.0174
LOAD R6 LOADTYPE Snow  TITLE SNOW LOAD BALANCED
MEMBER LOAD
2 3 UNI GY -0.033
LOAD R7 LOADTYPE Snow  TITLE SNOW LOAD UNBALANCED
MEMBER LOAD
3 UNI GY -0.033 9 22
2 UNI GY -0.01
3 UNI GY -0.049 0 9
END DEFINE REFERENCE LOADS
LOAD 1 LOADTYPE None  TITLE DL + SBALANCED
REFERENCE LOAD
R1 1.0 R6 1.0
LOAD 2 LOADTYPE None  TITLE DL + S-UNBALANCED
REFERENCE LOAD
R1 1.0 R7 1.0
LOAD 3 LOADTYPE None  TITLE DL + 0.6 WA1
REFERENCE LOAD
R1 1.0 R2 0.6
LOAD 4 LOADTYPE None  TITLE DL + 0.6WA2
REFERENCE LOAD
R1 1.0 R3 0.6
LOAD 5 LOADTYPE None  TITLE DL + 0.6WB1
REFERENCE LOAD
R1 1.0 R4 0.6
LOAD 6 LOADTYPE None  TITLE DL + 0.6WB2
REFERENCE LOAD
R1 1.0 R5 0.6
LOAD 7 LOADTYPE None  TITLE DL + 0.75 (SBAL + 0.6WA1)
REFERENCE LOAD
R1 1.0 R6 0.75 R2 0.45
LOAD 8 LOADTYPE None  TITLE DL + 0.75 (SBAL + 0.6WA2)
REFERENCE LOAD
R1 1.0 R6 0.75 R3 0.45
LOAD 9 LOADTYPE None  TITLE DL + 0.75 (SBAL + 0.6WB1)
REFERENCE LOAD
R1 1.0 R6 0.75 R4 0.45
LOAD 10 LOADTYPE None  TITLE DL + 0.75 (SBAL + 0.6WB2)
REFERENCE LOAD
R1 1.0 R6 0.75 R5 0.45
```

```
****
LOAD 11 LOADTYPE None  TITLE DL + 0.75 (SUNBAL + 0.6WA1)
REFERENCE LOAD
R1 1.0 R7 0.75 R2 0.45
LOAD 12 LOADTYPE None  TITLE DL + 0.75 (SUNBAL + 0.6WA2)
REFERENCE LOAD
R1 1.0 R7 0.75 R3 0.45
LOAD 13 LOADTYPE None  TITLE DL + 0.75 (SUNBAL + 0.6WB1)
REFERENCE LOAD
R1 1.0 R7 0.75 R4 0.45
LOAD 14 LOADTYPE None  TITLE DL + 0.75 (SUNBAL + 0.6WB2)
REFERENCE LOAD
R1 1.0 R7 0.75 R5 0.45
LOAD 15 LOADTYPE None  TITLE 0.6DL + 0.6WA1
REFERENCE LOAD
R1 0.3 R2 0.6
LOAD 16 LOADTYPE None  TITLE 0.6DL + 0.6WA2
REFERENCE LOAD
R1 0.3 R3 0.6
LOAD 17 LOADTYPE None  TITLE 0.6DL + 0.6WB1
REFERENCE LOAD
R1 0.3 R4 0.6
LOAD 18 LOADTYPE None  TITLE 0.6DL + 0.6WB2
REFERENCE LOAD
R1 0.3 R5 0.6
PERFORM ANALYSIS
DEFINE ENVELOPE
1 TO 18 ENVELOPE 1 TYPE COLUMN
END DEFINE ENVELOPE
FINISH
```

Process Mechanical Calculations

CALCULATIONS

MECHANICAL

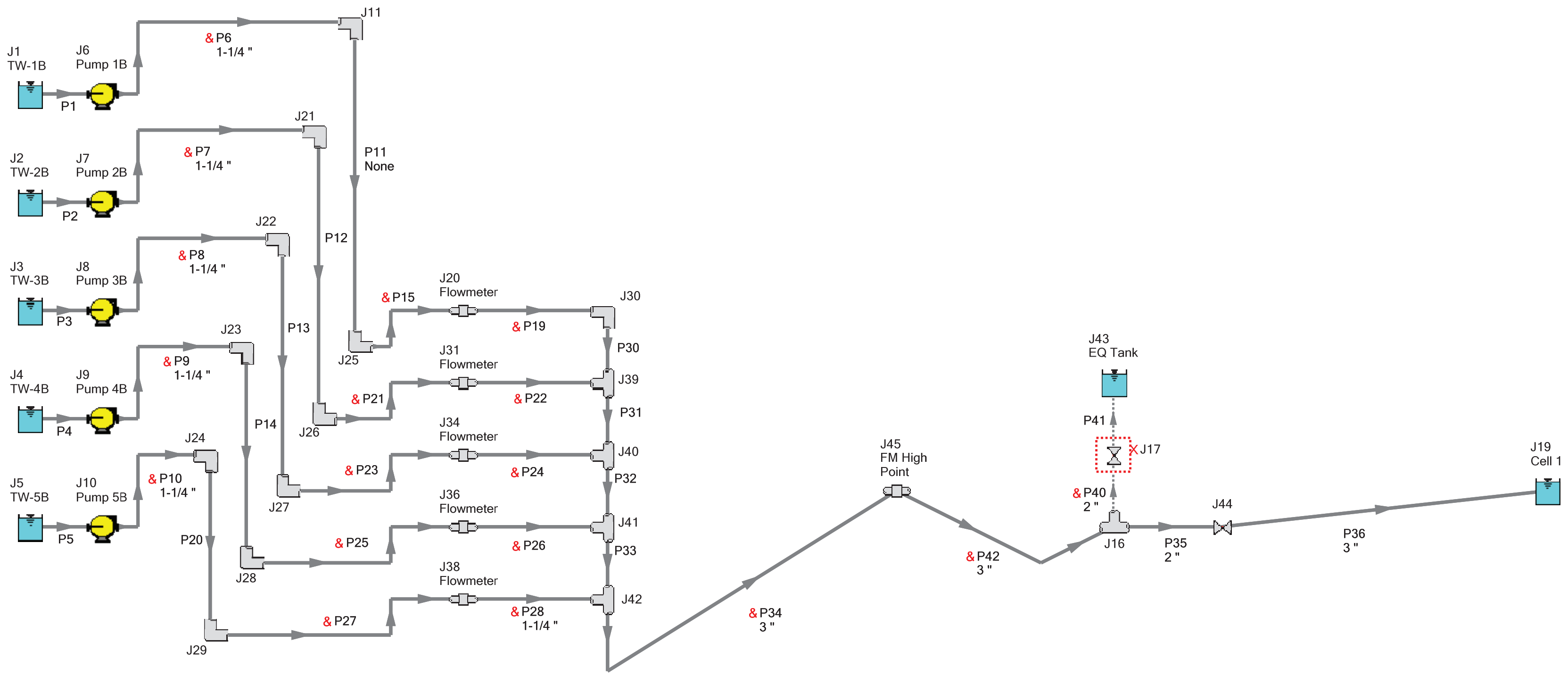
WILLIAM S. FARMER
STATE OF WASHINGTON
28512
REGISTERED PROFESSIONAL ENGINEER
4-3-20

Digitally Signed

on April 3, 2020

Bill Farmer

Extraction Well Pumps Hydraulics including Pipe Sizing



AFT Fathom 10 (Workspace)
1/12/2020
Page 1 of 1

AFT Fathom Model
GW Extraction System
Well Pumps Model

Model Reference Information

General

Title: AFT Fathom Model
Analysis run on: 1/12/2020 8:04:12 PM
Application version: AFT Fathom Version 10 (2019.03.28)
Input File: C:\Kaiser Mead GWTS\Mechanical\Fathom\GW_to_Cell1_v6_high point added.fth
Scenario: Base Scenario - HDPE Force Main/50 gpm total - 3" and 1.25"
Output File: C:\Kaiser Mead GWTS\Mechanical\Fathom\GW_to_Cell1_v6_high point added_F4.out

Execution Time= 0.17 seconds
Total Number Of Head/Pressure Iterations= 0
Total Number Of Flow Iterations= 2
Total Number Of Temperature Iterations= 0
Number Of Pipes= 35
Number Of Junctions= 36
Matrix Method= Gaussian Elimination

Pressure/Head Tolerance= 0.0001 relative change
Flow Rate Tolerance= 0.0001 relative change
Temperature Tolerance= 0.0001 relative change
Flow Relaxation= (Automatic)
Pressure Relaxation= (Automatic)

Constant Fluid Property Model
Fluid Database: AFT Standard
Fluid: Water at 1 atm
Max Fluid Temperature Data= 212 deg. F
Min Fluid Temperature Data= 32 deg. F
Temperature= 60 deg. F
Density= 62.37215 lbm/ft3
Viscosity= 2.72848 lbm/hr-ft
Vapor Pressure= 0.25024 psia
Viscosity Model= Newtonian
Apply laminar and non-Newtonian correction to: Pipe Fittings & Losses, Junction K factors, Junction Special Losses, Junction Polynomials
Corrections applied to the following junctions: Branch, Reservoir, Assigned Flow, Assigned Pressure, Area Change, Bend, Tee or Wye, Spray Discharge, Relief Valve

Ambient Pressure (constant)= 1 atm
Gravitational Acceleration= 1 g
Turbulent Flow Above Reynolds Number= 4000
Laminar Flow Below Reynolds Number= 2300
Total Inflow= 50.00 gal/min
Total Outflow= 50.00 gal/min
Maximum Static Pressure is 115.2 psia at Pipe 8 Inlet
Minimum Static Pressure is 14.66 psia at Pipe 36 Outlet

Warnings

For an explanation of Warnings, click an item in this list and press F1 or search for 'Warnings' in the Help system.

CAUTION The performance of Pump Junction 6 (Pump 1B) may be affected by the fluid viscosity. Apply the Viscosity Correction on the Pump Property window and rerun the model to assess the impact of the fluid viscosity.
CAUTION The performance of Pump Junction 7 (Pump 2B) may be affected by the fluid viscosity. Apply the Viscosity Correction on the Pump Property window and rerun the model to assess the impact of the fluid viscosity.

CAUTION The performance of Pump Junction 8 (Pump 3B) may be affected by the fluid viscosity. Apply the Viscosity Correction on the Pump Property window and rerun the model to assess the impact of the fluid viscosity.
CAUTION The performance of Pump Junction 9 (Pump 4B) may be affected by the fluid viscosity. Apply the Viscosity Correction on the Pump Property window and rerun the model to assess the impact of the fluid viscosity.
CAUTION The performance of Pump Junction 10 (Pump 5B) may be affected by the fluid viscosity. Apply the Viscosity Correction on the Pump Property window and rerun the model to assess the impact of the fluid viscosity.

Pump Summary

Jct	Results Diagram	Name	Vol. Flow (gal/min)	dH (feet)	Speed (Percent)	Ideal Power (hp)	Pump Efficiency (Percent)	Shaft Power (hp)	Motor Efficiency (Percent)	Motor Input Power (hp)	NPSHA (feet)
6	Show	Pump 1B	3.000	203.9	74.76	0.1545	62.05	0.2491	95.00	0.2622	41.35
7	Show	Pump 2B	4.000	204.4	75.86	0.2065	63.86	0.3234	95.00	0.3404	41.35
8	Show	Pump 3B	20.000	224.4	91.68	1.1337	65.12	1.7409	95.00	1.8325	41.35
9	Show	Pump 4B	20.000	219.4	91.05	1.1085	65.06	1.7038	95.00	1.7934	41.35
10	Show	Pump 5B	3.000	203.2	74.63	0.1540	62.06	0.2481	95.00	0.2612	41.35

Jct	NPSHR (feet)
6	N/A
7	N/A
8	N/A
9	N/A
10	N/A

Valve Summary

Jct	Name	Valve Type	Vol. Flow (gal/min)	Mass Flow (lbm/sec)	dP Stag. (psid)	dH (feet)	P Static In (psia)	Cv	K	Valve State
X17	Valve	REGULAR	0.00	0.000	N/A	N/A	22.66	N/A	N/A	Closed By User
44	Valve	REGULAR	50.00	6.948	6.376E-04	1.472E-03	24.74	1,980	0.02000	Open

Reservoir Summary

Jct	Name	Type	Liq. Height (feet)	Liq. Elevation (feet)	Surface Pressure (psia)	Liquid Volume (feet3)	Liquid Mass (lbm)	Net Vol. Flow (gal/min)	Net Mass Flow (lbm/sec)
1	TW-1B	Infinite	N/A	1,773	14.70	N/A	N/A	-3.000	-0.4169
2	TW-2B	Infinite	N/A	1,773	14.70	N/A	N/A	-4.000	-0.5559
3	TW-3B	Infinite	N/A	1,773	14.70	N/A	N/A	-20.000	-2.7793
4	TW-4B	Infinite	N/A	1,773	14.70	N/A	N/A	-20.000	-2.7793
5	TW-5B	Infinite	N/A	1,773	14.70	N/A	N/A	-3.000	-0.4169
19	Cell 1	Infinite	N/A	1,944	14.70	N/A	N/A	50.000	6.9483
43	EQ Tank	Infinite	N/A	1,953	14.70	N/A	N/A	0.000	0.0000

Pipe Output Table

Pipe	Name	Vol. Flow Rate (gal/min)	Pipe Nominal Size	Velocity (feet/sec)	P Static Max (psia)	P Static Min (psia)	Elevation Inlet (feet)	Elevation Outlet (feet)	dP Stag. Total (psid)	dP Static Total (psid)
1	Pipe	3.000	12 inch	0.008599	18.16	18.16	1,765	1,765	5.724E-09	5.724E-09
2	Pipe	4.000	12 inch	0.011465	18.16	18.16	1,765	1,765	1.330E-08	1.330E-08
3	Pipe	20.000	12 inch	0.057327	18.16	18.16	1,765	1,765	4.068E-07	4.068E-07
4	Pipe	20.000	12 inch	0.057327	18.16	18.16	1,765	1,765	4.068E-07	4.068E-07
5	Pipe	3.000	12 inch	0.008599	18.16	18.16	1,765	1,765	5.724E-09	5.724E-09
6	Pipe	3.000	1-1/4 inch	0.643506	106.48	40.07	1,765	1,918	6.641E+01	6.641E+01
7	Pipe	4.000	1-1/4 inch	0.858008	106.68	40.18	1,765	1,918	6.650E+01	6.650E+01
8	Pipe	20.000	1-1/4 inch	4.290043	115.23	44.98	1,765	1,918	7.025E+01	7.025E+01
9	Pipe	20.000	1-1/4 inch	4.290043	113.06	42.81	1,765	1,918	7.025E+01	7.025E+01
10	Pipe	3.000	1-1/4 inch	0.643506	106.17	39.76	1,765	1,918	6.641E+01	6.641E+01
11	Pipe	3.000	None	0.682498	40.07	39.81	1,918	1,918	2.566E-01	2.566E-01
12	Pipe	4.000	None	0.909997	40.18	39.82	1,918	1,918	3.567E-01	3.567E-01
13	Pipe	20.000	None	4.549987	44.93	40.28	1,918	1,918	4.648E+00	4.648E+00
14	Pipe	20.000	None	4.549987	42.76	40.30	1,918	1,918	2.461E+00	2.461E+00
15	Pipe	3.000	1-1/4 inch	0.643506	39.81	33.73	1,918	1,932	6.078E+00	6.078E+00
19	Pipe	3.000	1-1/4 inch	0.643506	33.73	33.73	1,932	1,932	4.406E-03	4.406E-03
20	Pipe	3.000	None	0.682498	39.76	39.71	1,918	1,918	4.934E-02	4.934E-02
21	Pipe	4.000	1-1/4 inch	0.858008	39.82	33.73	1,918	1,932	6.087E+00	6.087E+00
22	Pipe	4.000	1-1/4 inch	0.858008	33.73	33.73	1,932	1,932	7.257E-03	7.257E-03
23	Pipe	20.000	1-1/4 inch	4.290043	40.26	33.79	1,918	1,932	6.465E+00	6.465E+00
24	Pipe	20.000	1-1/4 inch	4.290043	33.79	33.67	1,932	1,932	1.237E-01	1.237E-01
25	Pipe	20.000	1-1/4 inch	4.290043	40.27	33.81	1,918	1,932	6.465E+00	6.465E+00
26	Pipe	20.000	1-1/4 inch	4.290043	33.81	33.69	1,932	1,932	1.237E-01	1.237E-01
27	Pipe	3.000	1-1/4 inch	0.643506	39.71	33.63	1,918	1,932	6.078E+00	6.078E+00
28	Pipe	3.000	1-1/4 inch	0.643506	33.63	33.63	1,932	1,932	4.408E-03	4.408E-03
30	Pipe	3.000	1-1/4 inch	0.643506	33.73	33.73	1,932	1,932	8.635E-04	8.635E-04
31	Pipe	7.000	2 inch	0.669279	33.72	33.72	1,932	1,932	5.493E-04	5.493E-04
32	Pipe	27.000	2 inch	2.581503	33.66	33.65	1,932	1,932	5.866E-03	5.866E-03
33	Pipe	47.000	2-1/2 inch	3.149527	33.60	33.59	1,932	1,932	6.716E-03	6.716E-03
34	Pipe	50.000	3 inch	2.176285	33.62	19.51	1,932	1,954	1.411E+01	1.411E+01
35	Pipe	50.000	3 inch	2.176285	24.80	24.74	1,938	1,938	5.343E-02	5.343E-02
36	Pipe	50.000	3 inch	2.176285	24.74	14.66	1,938	1,944	1.008E+01	1.008E+01
40	Pipe	0.000	3 inch	0.000000	24.83	22.66	1,938	1,943	2.166E+00	2.166E+00
41	Pipe	0.000	3 inch	0.000000	18.81	18.81	1,943	1,943	0.000E+00	0.000E+00
42	Pipe	50.000	3 inch	2.176285	24.80	19.51	1,954	1,938	-5.287E+00	-5.287E+00

Pipe	dP Gravity (psid)	dH (feet)	P Static In (psia)	P Static Out (psia)	P Stag. In (psia)	P Stag. Out (psia)
1	0.000	1.321E-08	18.16	18.16	18.16	18.16
2	0.000	3.072E-08	18.16	18.16	18.16	18.16
3	0.000	9.391E-07	18.16	18.16	18.16	18.16
4	0.000	9.391E-07	18.16	18.16	18.16	18.16
5	0.000	1.321E-08	18.16	18.16	18.16	18.16
6	66.270	3.265E-01	106.48	40.07	106.48	40.07
7	66.270	5.376E-01	106.68	40.18	106.69	40.19
8	66.270	9.185E+00	115.23	44.98	115.35	45.11
9	66.270	9.185E+00	113.06	42.81	113.19	42.94
10	66.270	3.265E-01	106.17	39.76	106.18	39.76
11	0.000	5.924E-01	40.07	39.81	40.07	39.81
12	0.000	8.236E-01	40.18	39.82	40.18	39.83
13	0.000	1.073E+01	44.93	40.28	45.07	40.42
14	0.000	5.681E+00	42.76	40.30	42.90	40.44
15	6.064	3.209E-02	39.81	33.73	39.81	33.74
19	0.000	1.017E-02	33.73	33.73	33.74	33.73
20	0.000	1.139E-01	39.76	39.71	39.76	39.71
21	6.064	5.303E-02	39.82	33.73	39.83	33.74
22	0.000	1.675E-02	33.73	33.73	33.74	33.73
23	6.064	9.269E-01	40.26	33.79	40.38	33.91
24	0.000	2.857E-01	33.79	33.67	33.91	33.79
25	6.064	9.269E-01	40.27	33.81	40.40	33.93
26	0.000	2.857E-01	33.81	33.69	33.93	33.81
27	6.064	3.209E-02	39.71	33.63	39.71	33.64
28	0.000	1.018E-02	33.63	33.63	33.64	33.63
30	0.000	1.994E-03	33.73	33.73	33.73	33.73
31	0.000	1.268E-03	33.72	33.72	33.73	33.73
32	0.000	1.354E-02	33.66	33.65	33.70	33.69
33	0.000	1.551E-02	33.60	33.59	33.66	33.66
34	9.529	1.058E+01	33.62	19.51	33.65	19.54
35	0.000	1.234E-01	24.80	24.74	24.83	24.78
36	2.599	1.727E+01	24.74	14.66	24.78	14.70
40	2.166	0.000E+00	24.83	22.66	24.83	22.66
41	0.000	0.000E+00	18.81	18.81	18.81	18.81
42	-6.930	3.793E+00	19.51	24.80	19.54	24.83

All Junction Table

Jct	Name	P Static In (psia)	P Static Out (psia)	P Stag. In (psia)	P Stag. Out (psia)	Vol. Flow Rate Thru Jct (gal/min)	Mass Flow Rate Thru Jct (lbm/sec)	Loss Factor (K)
1	TW-1B	14.70	18.16	14.70	18.16	3.000	0.4169	6.08297
2	TW-2B	14.70	18.16	14.70	18.16	4.000	0.5559	4.56223
3	TW-3B	14.70	18.16	14.70	18.16	20.000	2.7793	0.50000
4	TW-4B	14.70	18.16	14.70	18.16	20.000	2.7793	0.50000
5	TW-5B	14.70	18.16	14.70	18.16	3.000	0.4169	6.08297
6	Pump 1B	18.16	106.48	18.16	106.48	3.000	0.4169	0.00000
7	Pump 2B	18.16	106.68	18.16	106.69	4.000	0.5559	0.00000
8	Pump 3B	18.16	115.23	18.16	115.35	20.000	2.7793	0.00000
9	Pump 4B	18.16	113.06	18.16	113.19	20.000	2.7793	0.00000
10	Pump 5B	18.16	106.17	18.16	106.18	3.000	0.4169	0.00000
11	Bend	40.07	40.07	40.07	40.07	3.000	0.4169	0.30072
16	Tee or Wye	24.82	24.82	24.83	24.83	N/A	N/A	See Mult. Losses
X17	Valve	22.66	18.81	22.66	18.81	0.000	0.0000	0.00000
19	Cell 1	14.70	14.70	14.70	14.70	50.000	6.9483	0.00000
20	Flowmeter	33.73	33.73	33.74	33.74	3.000	0.4169	0.00000
21	Bend	40.18	40.18	40.19	40.18	4.000	0.5559	0.30072
22	Bend	44.98	44.93	45.11	45.07	20.000	2.7793	0.30072
23	Bend	42.81	42.76	42.94	42.90	20.000	2.7793	0.30072
24	Bend	39.76	39.76	39.76	39.76	3.000	0.4169	0.30072
25	Bend	39.81	39.81	39.81	39.81	3.000	0.4169	0.30296
26	Bend	39.82	39.82	39.83	39.83	4.000	0.5559	0.30296
27	Bend	40.28	40.26	40.42	40.38	20.000	2.7793	0.30296
28	Bend	40.30	40.27	40.44	40.40	20.000	2.7793	0.30296
29	Bend	39.71	39.71	39.71	39.71	3.000	0.4169	0.30296
30	Bend	33.73	33.73	33.73	33.73	3.000	0.4169	0.30072
31	Flowmeter	33.73	33.73	33.74	33.74	4.000	0.5559	0.00000
34	Flowmeter	33.79	33.79	33.91	33.91	20.000	2.7793	0.00000
36	Flowmeter	33.81	33.81	33.93	33.93	20.000	2.7793	0.00000
38	Flowmeter	33.63	33.63	33.64	33.64	3.000	0.4169	0.00000
39	Tee or Wye	33.72	33.72	33.73	33.73	N/A	N/A	See Mult. Losses
40	Tee or Wye	33.66	33.66	33.70	33.70	N/A	N/A	See Mult. Losses
41	Tee or Wye	33.59	33.59	33.66	33.66	N/A	N/A	See Mult. Losses
42	Tee or Wye	33.63	33.63	33.65	33.65	N/A	N/A	See Mult. Losses
43	EQ Tank	14.70	18.81	14.70	18.81	0.000	0.0000	0.00000
44	Valve	24.74	24.74	24.78	24.78	50.000	6.9483	0.02000
45	FM High Point	19.51	19.51	19.54	19.54	50.000	6.9483	0.00000

Model Reference Information

General

Title: AFT Fathom Model
Analysis run on: 2/10/2020 8:47:38 AM
Application version: AFT Fathom Version 10 (2019.03.28)
Input File: C:\Kaiser Mead GWTS\Mechanical\Fathom\Well Pumps Model\GW_to_Cell1_v6_high point added.fth
Scenario: Base Scenario - HDPE Force Main/75 gpm total - thru EC Bldg with 2" pipe/75% effic pumps
Output File: C:\Kaiser Mead GWTS\Mechanical\Fathom\Well Pumps Model\GW_to_Cell1_v6_high point added_F2.out

Execution Time= 0.10 seconds
Total Number Of Head/Pressure Iterations= 0
Total Number Of Flow Iterations= 2
Total Number Of Temperature Iterations= 0
Number Of Pipes= 35
Number Of Junctions= 36
Matrix Method= Gaussian Elimination

Pressure/Head Tolerance= 0.0001 relative change
Flow Rate Tolerance= 0.0001 relative change
Temperature Tolerance= 0.0001 relative change
Flow Relaxation= (Automatic)
Pressure Relaxation= (Automatic)

Constant Fluid Property Model
Fluid Database: AFT Standard
Fluid: Water at 1 atm
Max Fluid Temperature Data= 212 deg. F
Min Fluid Temperature Data= 32 deg. F
Temperature= 60 deg. F
Density= 62.37215 lbm/ft3
Viscosity= 2.72848 lbm/hr-ft
Vapor Pressure= 0.25024 psia
Viscosity Model= Newtonian
Apply laminar and non-Newtonian correction to: Pipe Fittings & Losses, Junction K factors, Junction Special Losses, Junction Polynomials
Corrections applied to the following junctions: Branch, Reservoir, Assigned Flow, Assigned Pressure, Area Change, Bend, Tee or Wye, Spray Discharge, Relief Valve

Ambient Pressure (constant)= 1 atm
Gravitational Acceleration= 1 g
Turbulent Flow Above Reynolds Number= 4000
Laminar Flow Below Reynolds Number= 2300
Total Inflow= 75.00 gal/min
Total Outflow= 75.00 gal/min
Maximum Static Pressure is 130.5 psia at Pipe 8 Inlet
Minimum Static Pressure is 14.62 psia at Pipe 36 Outlet

Warnings

For an explanation of Warnings, click an item in this list and press F1 or search for 'Warnings' in the Help system.

CAUTION The performance of Pump Junction 6 (Pump 1B) may be affected by the fluid viscosity. Apply the Viscosity Correction on the Pump Property window and rerun the model to assess the impact of the fluid viscosity.
CAUTION The performance of Pump Junction 7 (Pump 2B) may be affected by the fluid viscosity. Apply the Viscosity Correction on the Pump Property window and rerun the model to assess the impact of the fluid viscosity.

CAUTION The performance of Pump Junction 8 (Pump 3B) may be affected by the fluid viscosity. Apply the Viscosity Correction on the Pump Property window and rerun the model to assess the impact of the fluid viscosity.
CAUTION The performance of Pump Junction 9 (Pump 4B) may be affected by the fluid viscosity. Apply the Viscosity Correction on the Pump Property window and rerun the model to assess the impact of the fluid viscosity.
CAUTION The performance of Pump Junction 10 (Pump 5B) may be affected by the fluid viscosity. Apply the Viscosity Correction on the Pump Property window and rerun the model to assess the impact of the fluid viscosity.

Pump Summary

Jct	Results Diagram	Name	Vol. Flow (gal/min)	dH (feet)	Speed (Percent)	Ideal Power (hp)	Pump Efficiency (Percent)	Shaft Power (hp)	Motor Efficiency (Percent)	Motor Input Power (hp)	NPSHA (feet)
6	Show	Pump 1B	10.00	246.2	93.04	0.6220	74.76	0.8319	85.00	0.9788	41.35
7	Show	Pump 2B	15.00	253.0	97.68	0.9587	69.18	1.3859	85.00	1.6305	41.35
8	Show	Pump 3B	20.00	259.6	96.00	1.3116	75.49	1.7375	85.00	2.0441	41.35
9	Show	Pump 4B	20.00	254.5	95.39	1.2857	75.44	1.7042	85.00	2.0050	41.35
10	Show	Pump 5B	10.00	241.9	92.42	0.6110	74.70	0.8180	85.00	0.9623	41.35

Jct	NPSHR (feet)
6	N/A
7	N/A
8	N/A
9	N/A
10	N/A

Valve Summary

Jct	Name	Valve Type	Vol. Flow (gal/min)	Mass Flow (lbm/sec)	dP Stag. (psid)	dH (feet)	P Static In (psia)	Cv	K	Valve State
X17	Valve	REGULAR	0.00	0.00	N/A	N/A	31.25	N/A	N/A	Closed By User
44	Valve	REGULAR	75.00	10.42	6.766E-03	0.01562	32.37	911.7	0.02000	Open

Reservoir Summary

Jct	Name	Type	Liq. Height (feet)	Liq. Elevation (feet)	Surface Pressure (psia)	Liquid Volume (feet3)	Liquid Mass (lbm)	Net Vol. Flow (gal/min)	Net Mass Flow (lbm/sec)
1	TW-1B	Infinite	N/A	1,773	14.70	N/A	N/A	-10.00	-1.390
2	TW-2B	Infinite	N/A	1,773	14.70	N/A	N/A	-15.00	-2.084
3	TW-3B	Infinite	N/A	1,773	14.70	N/A	N/A	-20.00	-2.779
4	TW-4B	Infinite	N/A	1,773	14.70	N/A	N/A	-20.00	-2.779
5	TW-5B	Infinite	N/A	1,773	14.70	N/A	N/A	-10.00	-1.390
19	Cell 1	Infinite	N/A	1,944	14.70	N/A	N/A	75.00	10.422
43	EQ Tank	Infinite	N/A	1,953	14.70	N/A	N/A	0.00	0.000

Pipe Output Table

Pipe	Name	Vol. Flow Rate (gal/min)	Pipe Nominal Size	Velocity (feet/sec)	P Static Max (psia)	P Static Min (psia)	Elevation Inlet (feet)	Elevation Outlet (feet)	dP Stag. Total (psid)	dP Static Total (psid)
1	Pipe	10.00	12 inch	0.02866	18.16	18.16	1,765	1,765	6.125E-08	6.125E-08
2	Pipe	15.00	12 inch	0.04299	18.16	18.16	1,765	1,765	2.114E-07	2.114E-07
3	Pipe	20.00	12 inch	0.05733	18.16	18.16	1,765	1,765	4.068E-07	4.068E-07
4	Pipe	20.00	12 inch	0.05733	18.16	18.16	1,765	1,765	4.068E-07	4.068E-07
5	Pipe	10.00	12 inch	0.02866	18.16	18.16	1,765	1,765	6.125E-08	6.125E-08
6	Pipe	10.00	1-1/4 inch	2.14502	124.77	57.34	1,765	1,918	6.743E+01	6.743E+01
7	Pipe	15.00	1-1/4 inch	3.21753	127.68	59.02	1,765	1,918	6.865E+01	6.865E+01
8	Pipe	20.00	1-1/4 inch	4.29004	130.48	60.23	1,765	1,918	7.025E+01	7.025E+01
9	Pipe	20.00	1-1/4 inch	4.29004	128.26	58.01	1,765	1,918	7.025E+01	7.025E+01
10	Pipe	10.00	1-1/4 inch	2.14502	122.89	55.45	1,765	1,918	6.743E+01	6.743E+01
11	Pipe	10.00	None	2.27499	57.32	55.24	1,918	1,918	2.086E+00	2.086E+00
12	Pipe	15.00	None	3.41249	58.99	55.38	1,918	1,918	3.610E+00	3.610E+00
13	Pipe	20.00	None	4.54999	60.18	55.53	1,918	1,918	4.648E+00	4.648E+00
14	Pipe	20.00	None	4.54999	57.96	55.50	1,918	1,918	2.461E+00	2.461E+00
15	Pipe	10.00	1-1/4 inch	2.14502	55.23	49.05	1,918	1,932	6.180E+00	6.180E+00
19	Pipe	10.00	1-1/4 inch	2.14502	49.05	49.02	1,932	1,932	3.612E-02	3.612E-02
20	Pipe	10.00	None	2.27499	55.44	55.04	1,918	1,918	4.012E-01	4.012E-01
21	Pipe	15.00	1-1/4 inch	3.21753	55.37	49.07	1,918	1,932	6.303E+00	6.303E+00
22	Pipe	15.00	1-1/4 inch	3.21753	49.07	48.99	1,932	1,932	7.411E-02	7.411E-02
23	Pipe	20.00	1-1/4 inch	4.29004	55.50	49.04	1,918	1,932	6.465E+00	6.465E+00
24	Pipe	20.00	1-1/4 inch	4.29004	49.04	48.91	1,932	1,932	1.237E-01	1.237E-01
25	Pipe	20.00	1-1/4 inch	4.29004	55.47	49.01	1,918	1,932	6.465E+00	6.465E+00
26	Pipe	20.00	1-1/4 inch	4.29004	49.01	48.88	1,932	1,932	1.237E-01	1.237E-01
27	Pipe	10.00	1-1/4 inch	2.14502	55.03	48.85	1,918	1,932	6.180E+00	6.180E+00
28	Pipe	10.00	1-1/4 inch	2.14502	48.85	48.82	1,932	1,932	3.612E-02	3.612E-02
30	Pipe	10.00	1-1/4 inch	2.14502	49.01	49.00	1,932	1,932	6.988E-03	6.988E-03
31	Pipe	25.00	2 inch	2.39028	48.97	48.97	1,932	1,932	5.118E-03	5.118E-03
32	Pipe	45.00	2 inch	4.30250	48.82	48.80	1,932	1,932	1.456E-02	1.456E-02
33	Pipe	65.00	2-1/2 inch	4.35573	48.75	48.74	1,932	1,932	1.198E-02	1.198E-02
34	Pipe	75.00	3 inch	3.26443	48.78	29.81	1,932	1,954	1.897E+01	1.897E+01
35	Pipe	75.00	2 inch	7.08950	33.08	32.37	1,938	1,938	7.075E-01	7.075E-01
36	Pipe	75.00	3 inch	3.26443	32.63	14.62	1,938	1,944	1.801E+01	1.801E+01
40	Pipe	0.00	2 inch	0.00000	33.42	31.25	1,938	1,943	2.166E+00	2.166E+00
41	Pipe	0.00	2 inch	0.00000	19.24	18.81	1,943	1,942	-4.331E-01	-4.331E-01
42	Pipe	75.00	3 inch	3.26443	33.35	29.81	1,954	1,938	-3.538E+00	-3.538E+00

Pipe	dP Gravity (psid)	dH (feet)	P Static In (psia)	P Static Out (psia)	P Stag. In (psia)	P Stag. Out (psia)
1	0.0000	1.414E-07	18.16	18.16	18.16	18.16
2	0.0000	4.880E-07	18.16	18.16	18.16	18.16
3	0.0000	9.391E-07	18.16	18.16	18.16	18.16
4	0.0000	9.391E-07	18.16	18.16	18.16	18.16
5	0.0000	1.414E-07	18.16	18.16	18.16	18.16
6	66.2704	2.680E+00	124.77	57.34	124.80	57.37
7	66.2704	5.499E+00	127.68	59.02	127.75	59.09
8	66.2704	9.185E+00	130.48	60.23	130.60	60.35
9	66.2704	9.185E+00	128.26	58.01	128.39	58.14
10	66.2704	2.680E+00	122.89	55.45	122.92	55.49
11	0.0000	4.817E+00	57.32	55.24	57.36	55.27
12	0.0000	8.335E+00	58.99	55.38	59.07	55.46
13	0.0000	1.073E+01	60.18	55.53	60.32	55.67
14	0.0000	5.681E+00	57.96	55.50	58.10	55.64
15	6.0640	2.677E-01	55.23	49.05	55.26	49.08
19	0.0000	8.338E-02	49.05	49.02	49.08	49.05
20	0.0000	9.263E-01	55.44	55.04	55.48	55.07
21	6.0640	5.526E-01	55.37	49.07	55.44	49.14
22	0.0000	1.711E-01	49.07	48.99	49.14	49.06
23	6.0640	9.269E-01	55.50	49.04	55.63	49.16
24	0.0000	2.857E-01	49.04	48.91	49.16	49.04
25	6.0640	9.269E-01	55.47	49.01	55.60	49.13
26	0.0000	2.857E-01	49.01	48.88	49.13	49.01
27	6.0640	2.677E-01	55.03	48.85	55.06	48.88
28	0.0000	8.340E-02	48.85	48.82	48.88	48.85
30	0.0000	1.613E-02	49.01	49.00	49.04	49.03
31	0.0000	1.182E-02	48.97	48.97	49.01	49.00
32	0.0000	3.361E-02	48.82	48.80	48.94	48.93
33	0.0000	2.767E-02	48.75	48.74	48.88	48.87
34	9.5291	2.181E+01	48.78	29.81	48.85	29.88
35	0.0000	1.634E+00	33.08	32.37	33.42	32.71
36	2.5988	3.557E+01	32.63	14.62	32.70	14.70
40	2.1657	0.000E+00	33.42	31.25	33.42	31.25
41	-0.4331	0.000E+00	18.81	19.24	18.81	19.24
42	-6.9302	7.831E+00	29.81	33.35	29.88	33.42

All Junction Table

Jct	Name	P Static In (psia)	P Static Out (psia)	P Stag. In (psia)	P Stag. Out (psia)	Vol. Flow Rate Thru Jct (gal/min)	Mass Flow Rate Thru Jct (lbm/sec)	Loss Factor (K)
1	TW-1B	14.70	18.16	14.70	18.16	10.00	1.390	1.84618
2	TW-2B	14.70	18.16	14.70	18.16	15.00	2.084	1.04880
3	TW-3B	14.70	18.16	14.70	18.16	20.00	2.779	0.50000
4	TW-4B	14.70	18.16	14.70	18.16	20.00	2.779	0.50000
5	TW-5B	14.70	18.16	14.70	18.16	10.00	1.390	1.84618
6	Pump 1B	18.16	124.77	18.16	124.80	10.00	1.390	0.00000
7	Pump 2B	18.16	127.68	18.16	127.75	15.00	2.084	0.00000
8	Pump 3B	18.16	130.48	18.16	130.60	20.00	2.779	0.00000
9	Pump 4B	18.16	128.26	18.16	128.39	20.00	2.779	0.00000
10	Pump 5B	18.16	122.89	18.16	122.92	10.00	1.390	0.00000
11	Bend	57.34	57.32	57.37	57.36	10.00	1.390	0.30072
16	Tee or Wye	33.34	33.34	33.42	33.42	N/A	N/A	See Mult. Losses
X17	Valve	31.25	18.81	31.25	18.81	0.00	0.000	0.00000
19	Cell 1	14.70	14.70	14.70	14.70	75.00	10.422	0.00000
20	Flowmeter	49.05	49.05	49.08	49.08	10.00	1.390	0.00000
21	Bend	59.02	58.99	59.09	59.07	15.00	2.084	0.30072
22	Bend	60.23	60.18	60.35	60.32	20.00	2.779	0.30072
23	Bend	58.01	57.96	58.14	58.10	20.00	2.779	0.30072
24	Bend	55.45	55.44	55.49	55.48	10.00	1.390	0.30072
25	Bend	55.24	55.23	55.27	55.26	10.00	1.390	0.30296
26	Bend	55.38	55.37	55.46	55.44	15.00	2.084	0.30296
27	Bend	55.53	55.50	55.67	55.63	20.00	2.779	0.30296
28	Bend	55.50	55.47	55.64	55.60	20.00	2.779	0.30296
29	Bend	55.04	55.03	55.07	55.06	10.00	1.390	0.30296
30	Bend	49.02	49.01	49.05	49.04	10.00	1.390	0.30072
31	Flowmeter	49.07	49.07	49.14	49.14	15.00	2.084	0.00000
34	Flowmeter	49.04	49.04	49.16	49.16	20.00	2.779	0.00000
36	Flowmeter	49.01	49.01	49.13	49.13	20.00	2.779	0.00000
38	Flowmeter	48.85	48.85	48.88	48.88	10.00	1.390	0.00000
39	Tee or Wye	48.96	48.96	49.01	49.01	N/A	N/A	See Mult. Losses
40	Tee or Wye	48.85	48.85	48.94	48.94	N/A	N/A	See Mult. Losses
41	Tee or Wye	48.75	48.75	48.88	48.88	N/A	N/A	See Mult. Losses
42	Tee or Wye	48.78	48.78	48.85	48.85	N/A	N/A	See Mult. Losses
43	EQ Tank	14.70	19.24	14.70	19.24	0.00	0.000	0.00000
44	Valve	32.37	32.63	32.71	32.70	75.00	10.422	0.02000
45	FM High Point	29.81	29.81	29.88	29.88	75.00	10.422	0.00000

Model Reference Information

General

Title: AFT Fathom Model
Analysis run on: 2/10/2020 8:42:07 AM
Application version: AFT Fathom Version 10 (2019.03.28)
Input File: C:\Kaiser Mead GWTS\Mechanical\Fathom\Well Pumps Model\GW_to_Cell1_v6_high point added.fth
Scenario: Base Scenario - HDPE Force Main/75 gpm total - to EQ with 2" pipe
Output File: C:\Kaiser Mead GWTS\Mechanical\Fathom\Well Pumps Model\GW_to_Cell1_v6_high point added_F3.out

Execution Time= 0.13 seconds
Total Number Of Head/Pressure Iterations= 0
Total Number Of Flow Iterations= 2
Total Number Of Temperature Iterations= 0
Number Of Pipes= 35
Number Of Junctions= 36
Matrix Method= Gaussian Elimination

Pressure/Head Tolerance= 0.0001 relative change
Flow Rate Tolerance= 0.0001 relative change
Temperature Tolerance= 0.0001 relative change
Flow Relaxation= (Automatic)
Pressure Relaxation= (Automatic)

Constant Fluid Property Model
Fluid Database: AFT Standard
Fluid: Water at 1 atm
Max Fluid Temperature Data= 212 deg. F
Min Fluid Temperature Data= 32 deg. F
Temperature= 60 deg. F
Density= 62.37215 lbm/ft3
Viscosity= 2.72848 lbm/hr-ft
Vapor Pressure= 0.25024 psia
Viscosity Model= Newtonian
Apply laminar and non-Newtonian correction to: Pipe Fittings & Losses, Junction K factors, Junction Special Losses, Junction Polynomials
Corrections applied to the following junctions: Branch, Reservoir, Assigned Flow, Assigned Pressure, Area Change, Bend, Tee or Wye, Spray Discharge, Relief Valve

Ambient Pressure (constant)= 1 atm
Gravitational Acceleration= 1 g
Turbulent Flow Above Reynolds Number= 4000
Laminar Flow Below Reynolds Number= 2300
Total Inflow= 75.00 gal/min
Total Outflow= 75.00 gal/min
Maximum Static Pressure is 121.8 psia at Pipe 8 Inlet
Minimum Static Pressure is 16.00 psia at Pipe 36 Outlet

Warnings

For an explanation of Warnings, click an item in this list and press F1 or search for 'Warnings' in the Help system.

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CAUTION The performance of Pump Junction 10 (Pump 5B) may be affected by the fluid viscosity. Apply the Viscosity Correction on the Pump Property window and rerun the model to assess the impact of the fluid viscosity.

Pump Summary

Jct	Results Diagram	Name	Vol. Flow (gal/min)	dH (feet)	Speed (Percent)	Ideal Power (hp)	Pump Efficiency (Percent)	Shaft Power (hp)	Motor Efficiency (Percent)	Motor Input Power (hp)	NPSHA (feet)
6	Show	Pump 1B	10.00	226.2	90.14	0.5715	79.43	0.7195	85.00	0.8464	41.35
7	Show	Pump 2B	15.00	233.0	95.83	0.8830	73.57	1.2003	85.00	1.4121	41.35
8	Show	Pump 3B	20.00	239.6	93.57	1.2107	80.30	1.5077	85.00	1.7738	41.35
9	Show	Pump 4B	20.00	234.5	92.94	1.1848	80.24	1.4766	85.00	1.7371	41.35
10	Show	Pump 5B	10.00	221.9	89.50	0.5605	79.35	0.7064	85.00	0.8310	41.35

Jct	NPSHR (feet)
6	N/A
7	N/A
8	N/A
9	N/A
10	N/A

Valve Summary

Jct	Name	Valve Type	Vol. Flow (gal/min)	Mass Flow (lbm/sec)	dP Stag. (psid)	dH (feet)	P Static In (psia)	Cv	K	Valve State
17	Valve	REGULAR	75.00	10.42	6.766E-03	0.01562	19.01	911.7	0.02000	Open
X44	Valve	REGULAR	0.00	0.00	N/A	N/A	24.77	N/A	N/A	Closed By User

Reservoir Summary

Jct	Name	Type	Liq. Height (feet)	Liq. Elevation (feet)	Surface Pressure (psia)	Liquid Volume (feet3)	Liquid Mass (lbm)	Net Vol. Flow (gal/min)	Net Mass Flow (lbm/sec)
1	TW-1B	Infinite	N/A	1,773	14.70	N/A	N/A	-10.00	-1.390
2	TW-2B	Infinite	N/A	1,773	14.70	N/A	N/A	-15.00	-2.084
3	TW-3B	Infinite	N/A	1,773	14.70	N/A	N/A	-20.00	-2.779
4	TW-4B	Infinite	N/A	1,773	14.70	N/A	N/A	-20.00	-2.779
5	TW-5B	Infinite	N/A	1,773	14.70	N/A	N/A	-10.00	-1.390
19	Cell 1	Infinite	N/A	1,944	14.70	N/A	N/A	0.00	0.000
43	EQ Tank	Infinite	N/A	1,953	14.70	N/A	N/A	75.00	10.422

Pipe Output Table

Pipe	Name	Vol. Flow Rate (gal/min)	Pipe Nominal Size	Velocity (feet/sec)	P Static Max (psia)	P Static Min (psia)	Elevation Inlet (feet)	Elevation Outlet (feet)	dP Stag. Total (psid)	dP Static Total (psid)
1	Pipe	10.00	12 inch	0.02866	18.16	18.16	1,765	1,765	6.125E-08	6.125E-08
2	Pipe	15.00	12 inch	0.04299	18.16	18.16	1,765	1,765	2.114E-07	2.114E-07
3	Pipe	20.00	12 inch	0.05733	18.16	18.16	1,765	1,765	4.068E-07	4.068E-07
4	Pipe	20.00	12 inch	0.05733	18.16	18.16	1,765	1,765	4.068E-07	4.068E-07
5	Pipe	10.00	12 inch	0.02866	18.16	18.16	1,765	1,765	6.125E-08	6.125E-08
6	Pipe	10.00	1-1/4 inch	2.14502	116.12	48.69	1,765	1,918	6.743E+01	6.743E+01
7	Pipe	15.00	1-1/4 inch	3.21753	119.02	50.37	1,765	1,918	6.865E+01	6.865E+01
8	Pipe	20.00	1-1/4 inch	4.29004	121.83	51.58	1,765	1,918	7.025E+01	7.025E+01
9	Pipe	20.00	1-1/4 inch	4.29004	119.61	49.36	1,765	1,918	7.025E+01	7.025E+01
10	Pipe	10.00	1-1/4 inch	2.14502	114.23	46.80	1,765	1,918	6.743E+01	6.743E+01
11	Pipe	10.00	None	2.27499	48.67	46.59	1,918	1,918	2.086E+00	2.086E+00
12	Pipe	15.00	None	3.41249	50.34	46.73	1,918	1,918	3.610E+00	3.610E+00
13	Pipe	20.00	None	4.54999	51.52	46.88	1,918	1,918	4.648E+00	4.648E+00
14	Pipe	20.00	None	4.54999	49.31	46.85	1,918	1,918	2.461E+00	2.461E+00
15	Pipe	10.00	1-1/4 inch	2.14502	46.58	40.40	1,918	1,932	6.180E+00	6.180E+00
19	Pipe	10.00	1-1/4 inch	2.14502	40.40	40.36	1,932	1,932	3.612E-02	3.612E-02
20	Pipe	10.00	None	2.27499	46.79	46.39	1,918	1,918	4.012E-01	4.012E-01
21	Pipe	15.00	1-1/4 inch	3.21753	46.72	40.41	1,918	1,932	6.303E+00	6.303E+00
22	Pipe	15.00	1-1/4 inch	3.21753	40.41	40.34	1,932	1,932	7.411E-02	7.411E-02
23	Pipe	20.00	1-1/4 inch	4.29004	46.85	40.38	1,918	1,932	6.465E+00	6.465E+00
24	Pipe	20.00	1-1/4 inch	4.29004	40.38	40.26	1,932	1,932	1.237E-01	1.237E-01
25	Pipe	20.00	1-1/4 inch	4.29004	46.82	40.36	1,918	1,932	6.465E+00	6.465E+00
26	Pipe	20.00	1-1/4 inch	4.29004	40.36	40.23	1,932	1,932	1.237E-01	1.237E-01
27	Pipe	10.00	1-1/4 inch	2.14502	46.38	40.20	1,918	1,932	6.180E+00	6.180E+00
28	Pipe	10.00	1-1/4 inch	2.14502	40.20	40.17	1,932	1,932	3.612E-02	3.612E-02
30	Pipe	10.00	1-1/4 inch	2.14502	40.35	40.35	1,932	1,932	6.988E-03	6.988E-03
31	Pipe	25.00	2 inch	2.39028	40.32	40.31	1,932	1,932	5.118E-03	5.118E-03
32	Pipe	45.00	2 inch	4.30250	40.17	40.15	1,932	1,932	1.456E-02	1.456E-02
33	Pipe	65.00	2-1/2 inch	4.35573	40.10	40.09	1,932	1,932	1.198E-02	1.198E-02
34	Pipe	75.00	3 inch	3.26443	40.13	21.16	1,932	1,954	1.897E+01	1.897E+01
35	Pipe	0.00	2 inch	0.00000	24.77	24.77	1,938	1,938	0.000E+00	0.000E+00
36	Pipe	0.00	3 inch	0.00000	17.29	16.00	1,938	1,941	1.299E+00	1.299E+00
40	Pipe	75.00	2 inch	7.08950	24.18	19.01	1,938	1,943	5.174E+00	5.174E+00
41	Pipe	75.00	2 inch	7.17084	19.24	18.99	1,943	1,942	-2.515E-01	-2.515E-01
42	Pipe	75.00	3 inch	3.26443	24.69	21.16	1,954	1,938	-3.538E+00	-3.538E+00

Pipe	dP Gravity (psid)	dH (feet)	P Static In (psia)	P Static Out (psia)	P Stag. In (psia)	P Stag. Out (psia)
1	0.0000	1.414E-07	18.16	18.16	18.16	18.16
2	0.0000	4.880E-07	18.16	18.16	18.16	18.16
3	0.0000	9.391E-07	18.16	18.16	18.16	18.16
4	0.0000	9.391E-07	18.16	18.16	18.16	18.16
5	0.0000	1.414E-07	18.16	18.16	18.16	18.16
6	66.2704	2.680E+00	116.12	48.69	116.15	48.72
7	66.2704	5.499E+00	119.02	50.37	119.09	50.44
8	66.2704	9.185E+00	121.83	51.58	121.95	51.70
9	66.2704	9.185E+00	119.61	49.36	119.73	49.49
10	66.2704	2.680E+00	114.23	46.80	114.26	46.83
11	0.0000	4.817E+00	48.67	46.59	48.71	46.62
12	0.0000	8.335E+00	50.34	46.73	50.42	46.81
13	0.0000	1.073E+01	51.52	46.88	51.66	47.02
14	0.0000	5.681E+00	49.31	46.85	49.45	46.99
15	6.0640	2.677E-01	46.58	40.40	46.61	40.43
19	0.0000	8.338E-02	40.40	40.36	40.43	40.40
20	0.0000	9.263E-01	46.79	46.39	46.82	46.42
21	6.0640	5.526E-01	46.72	40.41	46.79	40.48
22	0.0000	1.711E-01	40.41	40.34	40.48	40.41
23	6.0640	9.269E-01	46.85	40.38	46.97	40.51
24	0.0000	2.857E-01	40.38	40.26	40.51	40.39
25	6.0640	9.269E-01	46.82	40.36	46.95	40.48
26	0.0000	2.857E-01	40.36	40.23	40.48	40.36
27	6.0640	2.677E-01	46.38	40.20	46.41	40.23
28	0.0000	8.340E-02	40.20	40.17	40.23	40.20
30	0.0000	1.613E-02	40.35	40.35	40.39	40.38
31	0.0000	1.182E-02	40.32	40.31	40.36	40.35
32	0.0000	3.361E-02	40.17	40.15	40.29	40.28
33	0.0000	2.767E-02	40.10	40.09	40.23	40.22
34	9.5291	2.181E+01	40.13	21.16	40.20	21.23
35	0.0000	0.000E+00	24.77	24.77	24.77	24.77
36	1.2994	0.000E+00	17.29	16.00	17.29	16.00
40	2.1657	6.946E+00	24.18	19.01	24.52	19.35
41	-0.4331	4.194E-01	18.99	19.24	19.34	19.59
42	-6.9302	7.831E+00	21.16	24.69	21.23	24.77

All Junction Table

Jct	Name	P Static In (psia)	P Static Out (psia)	P Stag. In (psia)	P Stag. Out (psia)	Vol. Flow Rate Thru Jct (gal/min)	Mass Flow Rate Thru Jct (lbm/sec)	Loss Factor (K)
1	TW-1B	14.70	18.16	14.70	18.16	10.00	1.390	1.84618
2	TW-2B	14.70	18.16	14.70	18.16	15.00	2.084	1.04880
3	TW-3B	14.70	18.16	14.70	18.16	20.00	2.779	0.50000
4	TW-4B	14.70	18.16	14.70	18.16	20.00	2.779	0.50000
5	TW-5B	14.70	18.16	14.70	18.16	10.00	1.390	1.84618
6	Pump 1B	18.16	116.12	18.16	116.15	10.00	1.390	0.00000
7	Pump 2B	18.16	119.02	18.16	119.09	15.00	2.084	0.00000
8	Pump 3B	18.16	121.83	18.16	121.95	20.00	2.779	0.00000
9	Pump 4B	18.16	119.61	18.16	119.73	20.00	2.779	0.00000
10	Pump 5B	18.16	114.23	18.16	114.26	10.00	1.390	0.00000
11	Bend	48.69	48.67	48.72	48.71	10.00	1.390	0.30072
16	Tee or Wye	24.69	24.69	24.77	24.77	N/A	N/A	See Mult. Losses
17	Valve	19.01	18.99	19.35	19.34	75.00	10.422	0.02000
19	Cell 1	14.70	16.00	14.70	16.00	0.00	0.000	0.00000
20	Flowmeter	40.40	40.40	40.43	40.43	10.00	1.390	0.00000
21	Bend	50.37	50.34	50.44	50.42	15.00	2.084	0.30072
22	Bend	51.58	51.52	51.70	51.66	20.00	2.779	0.30072
23	Bend	49.36	49.31	49.49	49.45	20.00	2.779	0.30072
24	Bend	46.80	46.79	46.83	46.82	10.00	1.390	0.30072
25	Bend	46.59	46.58	46.62	46.61	10.00	1.390	0.30296
26	Bend	46.73	46.72	46.81	46.79	15.00	2.084	0.30296
27	Bend	46.88	46.85	47.02	46.97	20.00	2.779	0.30296
28	Bend	46.85	46.82	46.99	46.95	20.00	2.779	0.30296
29	Bend	46.39	46.38	46.42	46.41	10.00	1.390	0.30296
30	Bend	40.36	40.35	40.40	40.39	10.00	1.390	0.30072
31	Flowmeter	40.41	40.41	40.48	40.48	15.00	2.084	0.00000
34	Flowmeter	40.38	40.38	40.51	40.51	20.00	2.779	0.00000
36	Flowmeter	40.36	40.36	40.48	40.48	20.00	2.779	0.00000
38	Flowmeter	40.20	40.20	40.23	40.23	10.00	1.390	0.00000
39	Tee or Wye	40.31	40.31	40.36	40.36	N/A	N/A	See Mult. Losses
40	Tee or Wye	40.20	40.20	40.29	40.29	N/A	N/A	See Mult. Losses
41	Tee or Wye	40.10	40.10	40.23	40.23	N/A	N/A	See Mult. Losses
42	Tee or Wye	40.13	40.13	40.20	40.20	N/A	N/A	See Mult. Losses
43	EQ Tank	14.70	19.24	14.70	19.24	75.00	10.422	1.00000
X44	Valve	24.77	17.29	24.77	17.29	0.00	0.000	0.00000
45	FM High Point	21.16	21.16	21.23	21.23	75.00	10.422	0.00000

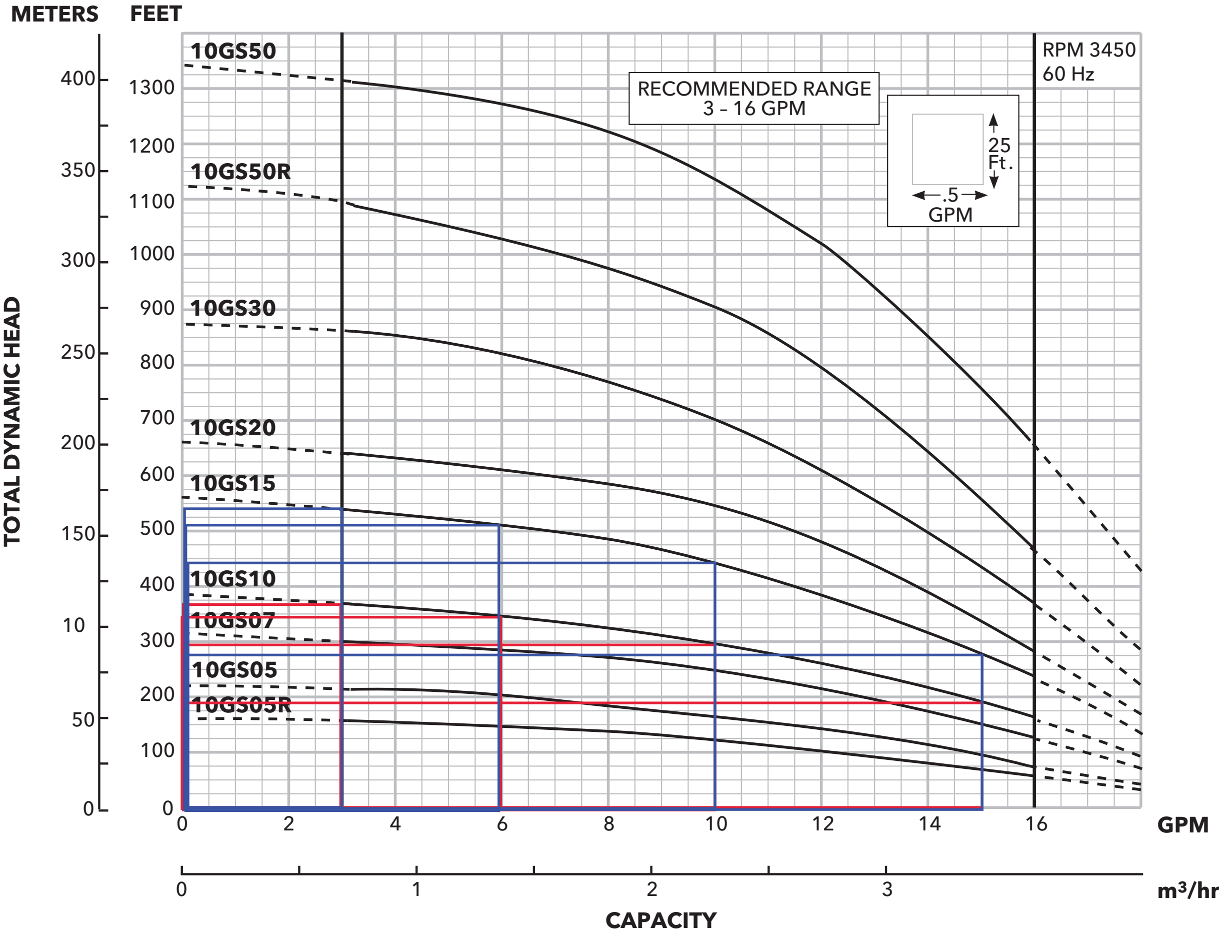
Model 10GS

1.0 HP

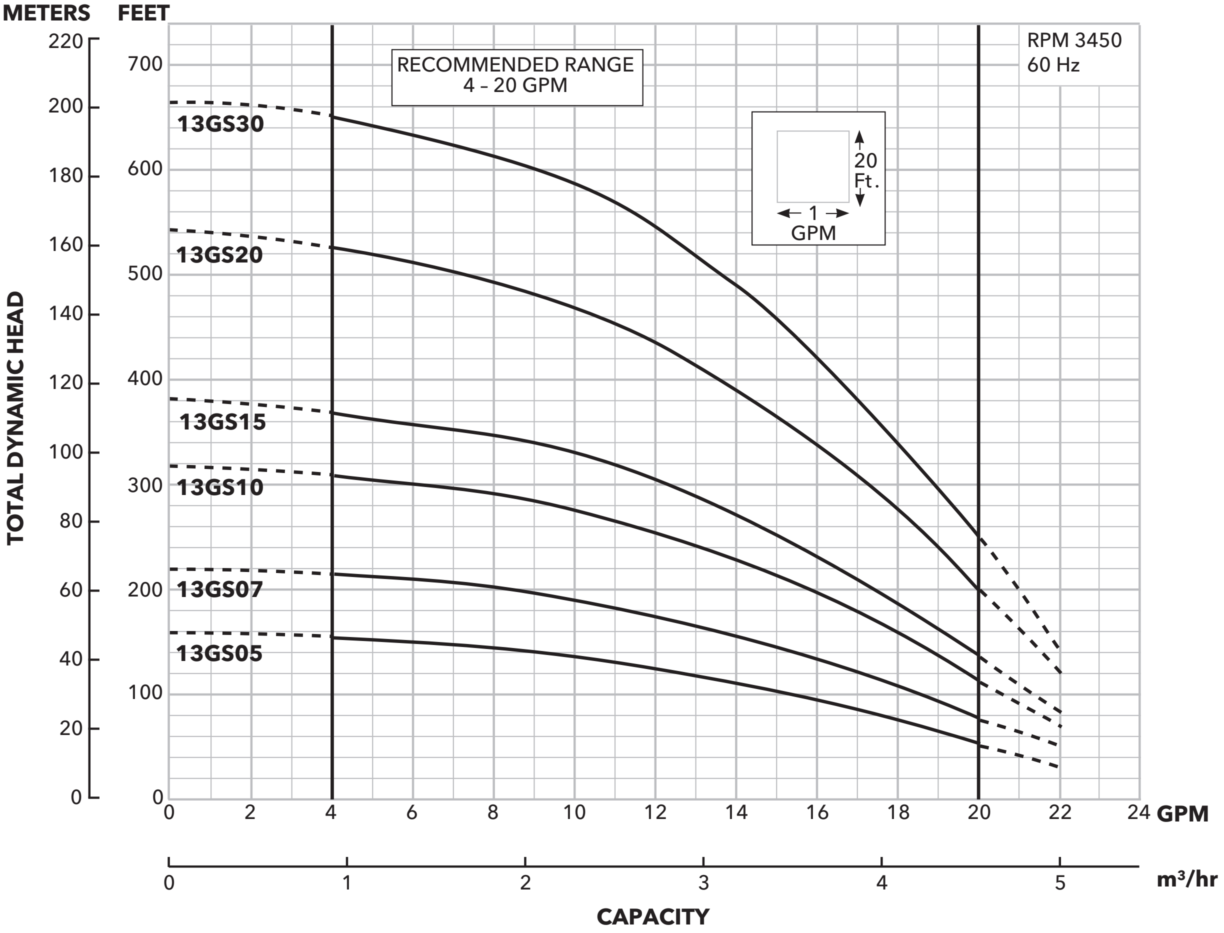
Q	TDH
0	385
3	370
6	345
10	300
15	190

1.5 HP

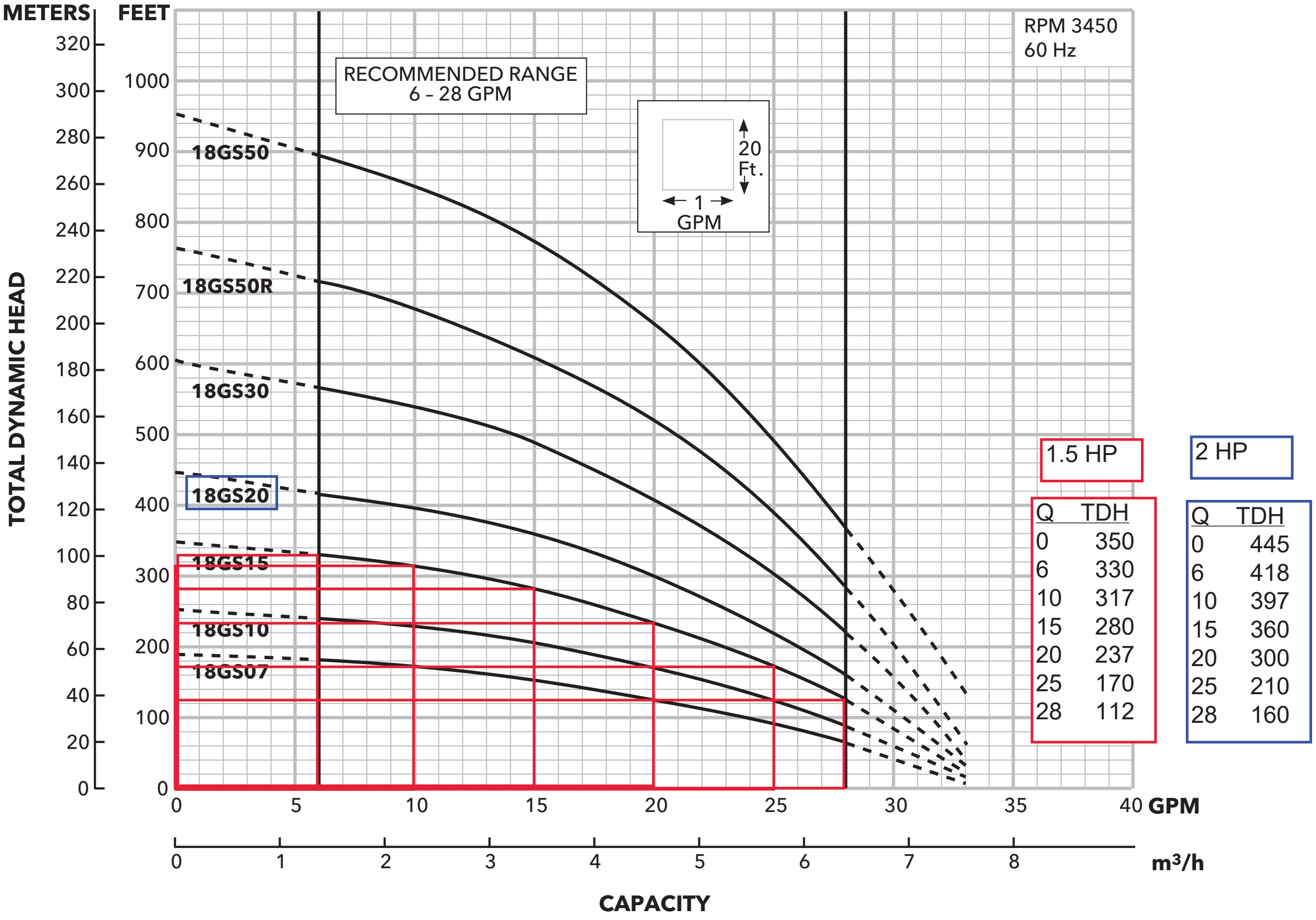
Q	TDH
0	565
3	540
6	510
10	445
15	275



Model 13GS



Model 18GS



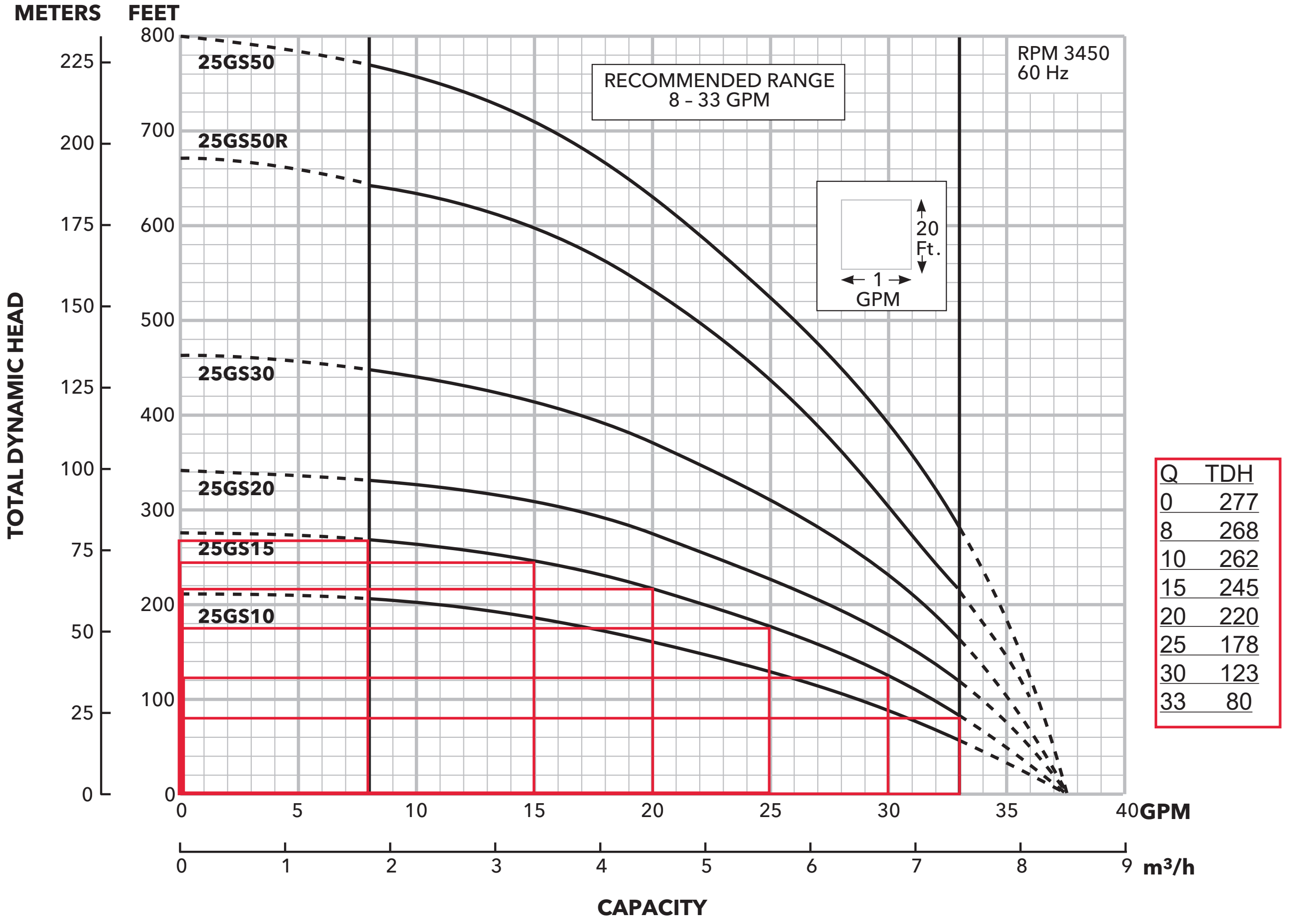
1.5 HP

Q	TDH
0	350
6	330
10	317
15	280
20	237
25	170
28	112

2 HP

Q	TDH
0	445
6	418
10	397
15	360
20	300
25	210
28	160

Model 25GS

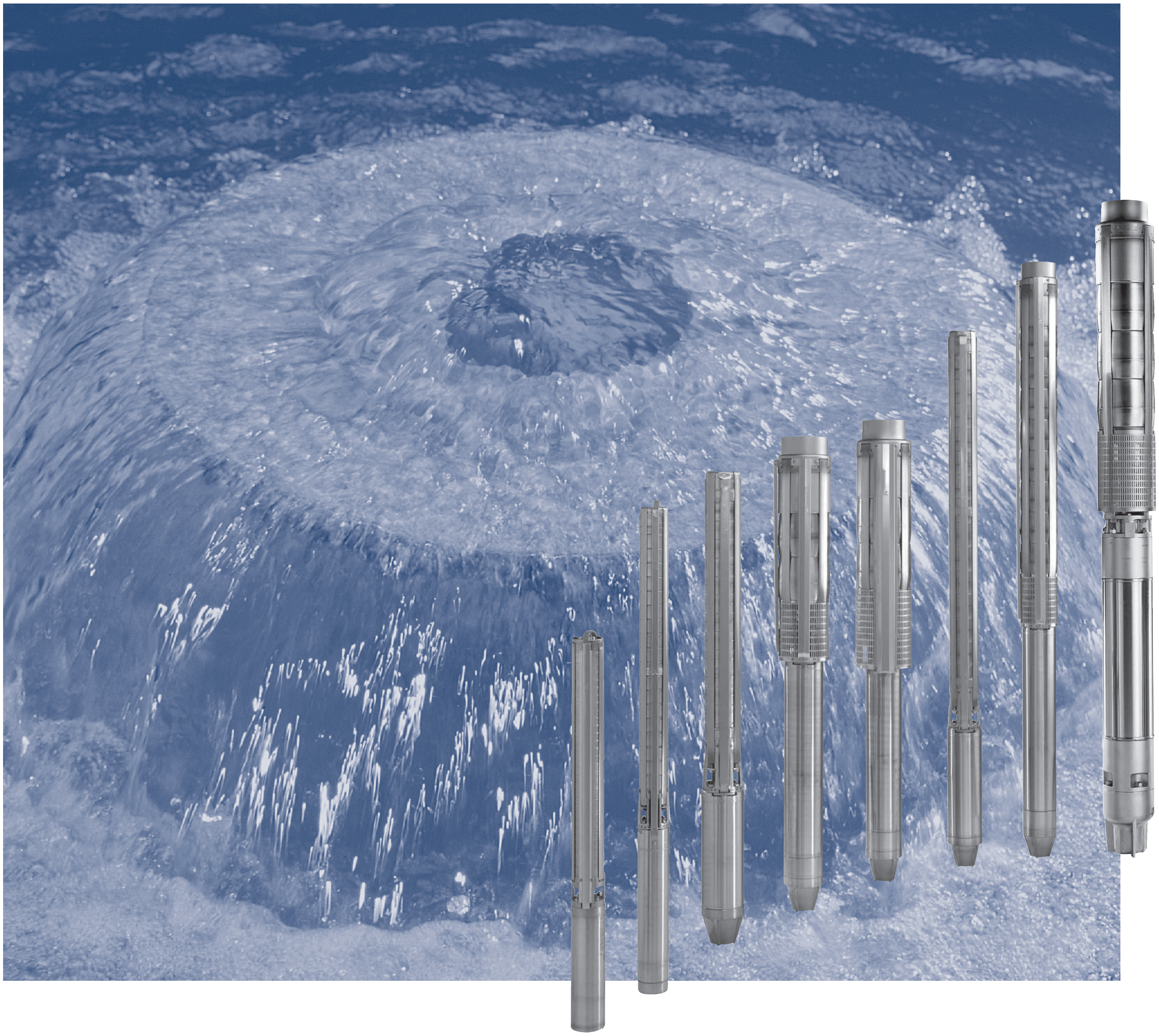


Q	TDH
0	277
8	268
10	262
15	245
20	220
25	178
30	123
33	80

GRUNDFOS **PRODUCT GUIDE**

SP

Submersible pumps, motors, and accessories
60 Hz



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GRUNDFOS®

1. Product introduction

Introduction

The Grundfos SP range of submersible pumps is renowned for high efficiency and reliability. Made entirely of corrosion resistant stainless steel, SP pumps are ideal for a wide variety of applications.

Grundfos SP pumps represent state-of-the-art hydraulic design. Built to deliver optimum efficiency during periods of high demand, SP pumps provide low long-term costs and high operating reliability regardless of the application.

The SP range offers high efficiency, high resistance to sand and other abrasives, motor burnout protection, and easy maintenance. A complete monitoring and control system is available for constant optimization of the pumping system.

TM05 0051 0611

Fig. 1 Grundfos SP pumps

Applications

Grundfos Large SP submersible pumps are suitable for:

- Groundwater supply to waterworks
- Irrigation in horticulture and agriculture
- Groundwater lowering (dewatering)
- Pressure boosting
- Industrial applications
- Domestic water supply.

Pumped liquids

Grundfos SP pumps are suitable for pumping clean, thin, non-aggressive liquids without solid particles or fibers.

SP offers stainless steel construction which ensures good wear resistance and a reduced risk of corrosion where the water has minor chloride content.

Optional, upgraded stainless steel construction is available for pumping more aggressive liquids:

A complete range of zinc anodes for cathodic protection is available; see p. 97 for applications (for example, sea water applications).

For slightly polluted liquids (for example, containing oil), Grundfos offers a complete range of stainless steel SP NE pumps with all rubber parts made of FKM.

Features and benefits

Grundfos SP submersible pumps offer these features and benefits:

- State-of-the-art hydraulics provide high efficiency and low operating costs
- 100 % stainless steel components inside and outside for long service life
- Sand resistant
- Resistant to aggressive water
- Dry-running protection
- Monitoring, protection and communication via protection unit MP204, and remote control, R100.

A wide pump range

Grundfos offers energy-efficient SP submersible pumps with a performance range of up to 1,400 gpm and 2,100 ft of head.

The pump range consists of many pump sizes, and each pump size is available with an optional number of stages to match any duty point.

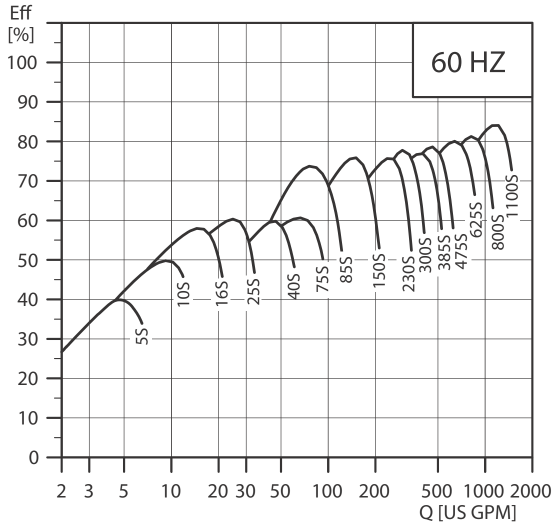
High pump efficiency

Often pump efficiency is given less consideration than the price of a pump; however, owners who choose efficiency will find substantial savings in energy costs over time. See fig. 2 for an illustration of SP efficiencies in relation to flow.

Example

For example, a pump and motor with a 10 % higher efficiency than a cheaper, less efficient pump, can save its owner more than $80,000.00 over 10 years*.

* If producing 880 gpm at 325 ft of head for 10 years @ 13.8 cents per kWh. U.S. kWh costs range from 6 cents to more than 20 cents, depending on region.



TM05 0057 0711

Fig. 2 SP pump/motor efficiencies in relation to flow

Pump design

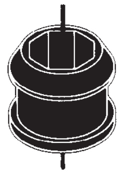
Grundfos SP submersible pumps feature components that contribute to the superior performance and durability of the range.

Lower installation costs

Stainless steel means low weight for ease in the handling of pumps, resulting in lower equipment costs and reduced installation and service time.

Bearings with sand channels

All bearings are water-lubricated and have a squared shape enabling sand particles, if any, to leave the pump together with the pumped liquid.

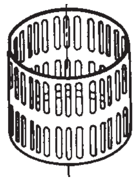


TM00 7301 1096

Fig. 3 Bearing

Inlet strainer

The inlet strainer prevents particles over a certain size from entering the pump.



TM00 7302 1096

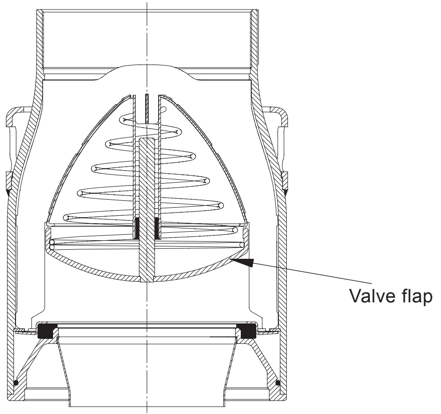
Fig. 4 Fig. Inlet strainer

Non-return valve

All pumps are equipped with a reliable check valve in the valve casing preventing back flow in connection with pump stoppage.

Furthermore, the short closing time of the check valve means that the risk of destructive water hammer is reduced to a minimum.

The valve casing is designed for optimum hydraulic properties to minimize the pressure loss across the valve and thus to contribute to the high efficiency of the pump.



TM01 2499 1798

Fig. 5 Check valve

Priming screw

All Grundfos 4" pumps are fitted with a priming screw. Consequently, dry running is prevented, because the priming screw will make sure that pump bearings are always lubricated.

Due to the semi-axial impellers of large SP pumps this priming is provided automatically.

However, it applies to all pump types that if the water table is lowered to a level below the pump inlet neither pump nor motor will be protected against dry running.

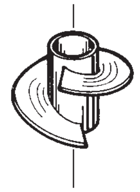

TM00 7304 1096

Fig. 6 Priming screw

Stop ring

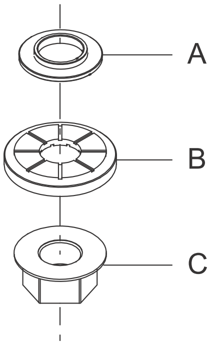
The stop ring prevents damage to the pump during transport and in case of up-thrust in connection with start-up.

The stop ring, which is designed as a thrust bearing, limits axial movements of the pump shaft.

Example: SP 385S

The stationary part of the stop ring (A) is secured in the upper intermediate chamber.

The rotating part (B) is fitted above the split cone (C).



TM01 3327 0412

Fig. 7 Stop ring (rotating and stationary part) and the split cone

Grundfos submersible motors

A complete motor range

Grundfos offers a complete submersible motor range in different voltages. For an overview of motor types, sizes and voltages, see page 85.

MS 402 is designed for the domestic ground water market and covers outputs. The MS 4000 and MS6 series are designed for use in a variety of applications in water supply. When equipped with features like oversized motor, temperature measurement, cooling jacket, and SiC/SiC mechanical shaft seals, these motors are suitable for heavy-duty industrial applications such as dewatering operations.

As a standard, all external surfaces of the Grundfos MS motors in contact with water are made of AISI 304 stainless steel. For aggressive water, such as seawater or brackish water, R-versions made of AISI 904 are available.

Grundfos rewindable MMS motor range

Grundfos MMS motors are suitable for any submersible installation, including heavy-duty industrial applications and dewatering operations (when equipped with temperature control, oversized motor, cooling jacket, and SiC/ SiC mechanical shaft seals).

As a standard the MMS motors are supplied with black cast-iron end-bells. Optionally, the range is available in all-stainless steel AISI 316 or AISI 904 versions.

The 2-pole Grundfos MMS submersible motors are all easy to rewind. The windings of the stator are made of a special water-proof wire of pure electrolytic copper sheathed with special non-hydroscopic thermoplastic material. The fine dielectric properties of this material allow direct contact between the windings and the liquid for efficient cooling of the windings.

TM00 7305 1096 - GrA4011 - GrA4013

Fig. 8 Grundfos MS motors

Fig. 9 Grundfos MMS motors

Industrial submersible motors and MS6 T60-versions

For heavy-duty applications Grundfos offers a complete motor range of industrial motors with up to 5 % higher efficiency than that of Grundfos' standard motors. The industrial motors are available in sizes as from 3 Hp up to 30 Hp.

The cooling of the motor is very efficient due to the large motor surface. The efficient cooling makes it possible to increase the liquid temperature to 140 °F (60 °C) at a minimum flow of 0.49 ft/s (0.15 m/s) past the motor.

The industrial motors are for customers who value low operating costs and long life higher than price.

Grundfos industrial motors are developed for difficult operating conditions. These motors will stand a higher thermal load than standard motors and thus have a longer life when subjected to high load. This applies whether the high load is caused by bad power supply, hot water, bad cooling conditions, high pump load etc.

Please note that heavy duty motors are longer than motors for standard conditions.

Overtemperature protection

Accessories for protection against overtemperature are available for both Grundfos MS and MMS submersible motors. When the temperature becomes too high, the protection device will cut out and damage to the pump and motor be avoided.

Restart of the motor after cut-out can be achieved in two ways:

- manual restart
- automatic restart.

Automatic restart means that the MP 204 attempts to restart the motor after 15 minutes. If the first attempt is not successful, restarting will be reattempted at 30-minute intervals.

MS

The Grundfos MS submersible motors (with the exception of MS 402) are available with a built-in Tempcon temperature transmitter for protection against overtemperature. By means of the transmitter, it is possible to read out and/or monitor the motor temperature via an MP 204 or a PR 5714 relay.

The Grundfos MS6 submersible motors can be fitted with a Pt100. The Pt100 is fitted in the motor and connected directly to the MP 204 or monitored by the PR 5714 relay.

MMS

For the protection of the Grundfos MMS submersible motors against overtemperature Grundfos offers the Pt100 temperature sensor as an optional extra.

The Pt100 is fitted in the motor and connected directly to the MP 204 or monitored by the PR 5714 relay.

Protection against upthrust

In case of a very low counter pressure in connection with start-up there is a risk that the entire chamber stack may rise. This is called upthrust. Upthrust may damage both pump and motor. Both Grundfos pumps and motors are protected against upthrust as standard, preventing upthrust from occurring during the critical start-up phase. The protection consists of either a built-in stop ring or hydraulic balancing.

Built-in cooling chambers

In all Grundfos MS submersible motors, efficient cooling is ensured by cooling chambers at the top and at the bottom of the motor, and by an internal circulation of motor liquid.

See fig. 10. As long as the required flow velocity past the motor is maintained, cooling of the motor will be efficient.

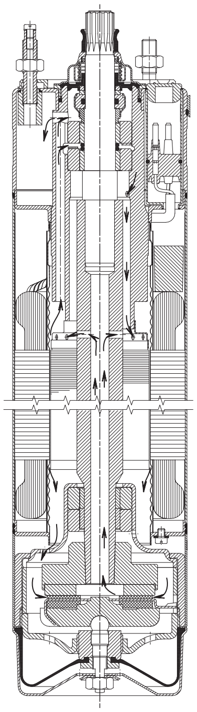


Fig. 10 MS 4000

Lightning protection

The smallest Grundfos submersible motors, such as the MS 402, are all insulated in order to minimize the risk of motor burnout caused by lightning strike.

Reduced risk of short-circuit

The embedded stator winding in the Grundfos MS submersible motor is hermetically enclosed in stainless steel. The result is high mechanical stability and optimum cooling. Also, this eliminates the risk of short-circuit of the windings caused by water condensation.

Shaft seal

MS 402

The shaft seal is of the lip seal type characterized by low friction against the rotor shaft.

The rubber material offers good wear resistance, good elasticity and resistance to particles, and it is approved for use in drinking water.

MS 4000, MS6

The material is ceramic/tungsten carbide providing optimum sealing, optimum wear resistance and long life.

The spring loaded shaft seal is designed with a large surface and a sand shield. The result is a minimum exchange of pumped and motor liquids and no penetration of particles.

Motors, version R, are supplied with a SiC/SiC shaft seal. Other combinations are available request. See fig. 11 and fig. 12 for an illustration of shaft seal components and configuration.

MMS rewindable motors

The standard shaft seal is a ceramic/carbon mechanical shaft seal. The shaft seal is replaceable.

The material features good wear resistance and resistance to particles.

Together with the shaft seal housing, the sand shield forms a labyrinth seal, which during normal operating conditions prevents penetration of sand particles into the shaft seal.

On request, motors can be supplied with a SiC/SiC seal.

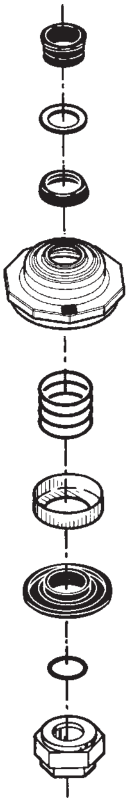


Fig. 11 Shaft seal, MS 4000

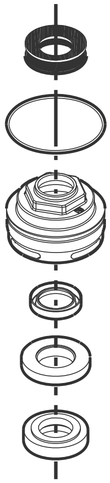


Fig. 12 Shaft seal, MS6

Identification

Type key, SP pumps

Example 475 S 500 - 5 - A B

Rated flow rate in gpm

Type range
Stainless steel parts of material
S= AISI 304
N= AISI 316
R= AISI 904L

Hp of motor

Number of impellers

First reduced-diameter impeller (A, B or C)

Second reduced-diameter impeller (A, B or C)

Type key, MS 4000 motors

Example MS 4 000 R

Motor submersible

Min. borehole
diameter in inches

Generation

- = Stainless steel AISI 304
R = Stainless steel AISI 904L
I = Stainless steel AISI 304 + De-rated
RE = Stainless steel AISI 904 L + FKM
EI = Stainless steel AISI 304 + De-rated + FKM

Type key, MS 402 motors

Example MS 4 02

Motor submersible

Min. borehole
diameter in inches

Generation

- = Stainless steel AISI 304

Type key, MMS motors

Example MMS 6 000 N

Type range

Min. borehole
diameter in inches

Generation

Material:
= Cast iron EN-JL1040
N = DIN/EN 1.4401 (AISI 316)

Type key, MS6 motors

Example MS 6 R E S W D T60

Type range
(**M**otor **S**ubmersible)

Motor diameter in inches

Material
- Blank = stainless steel EN 1.4301 (AISI 304)
- R = stainless steel EN 1.4539 (AISI 904L)

Rubber parts
- Blank = NBR
- E = FKM

Shaft seal
- Blank = ceramics/carbon
- S = SiC/SiC

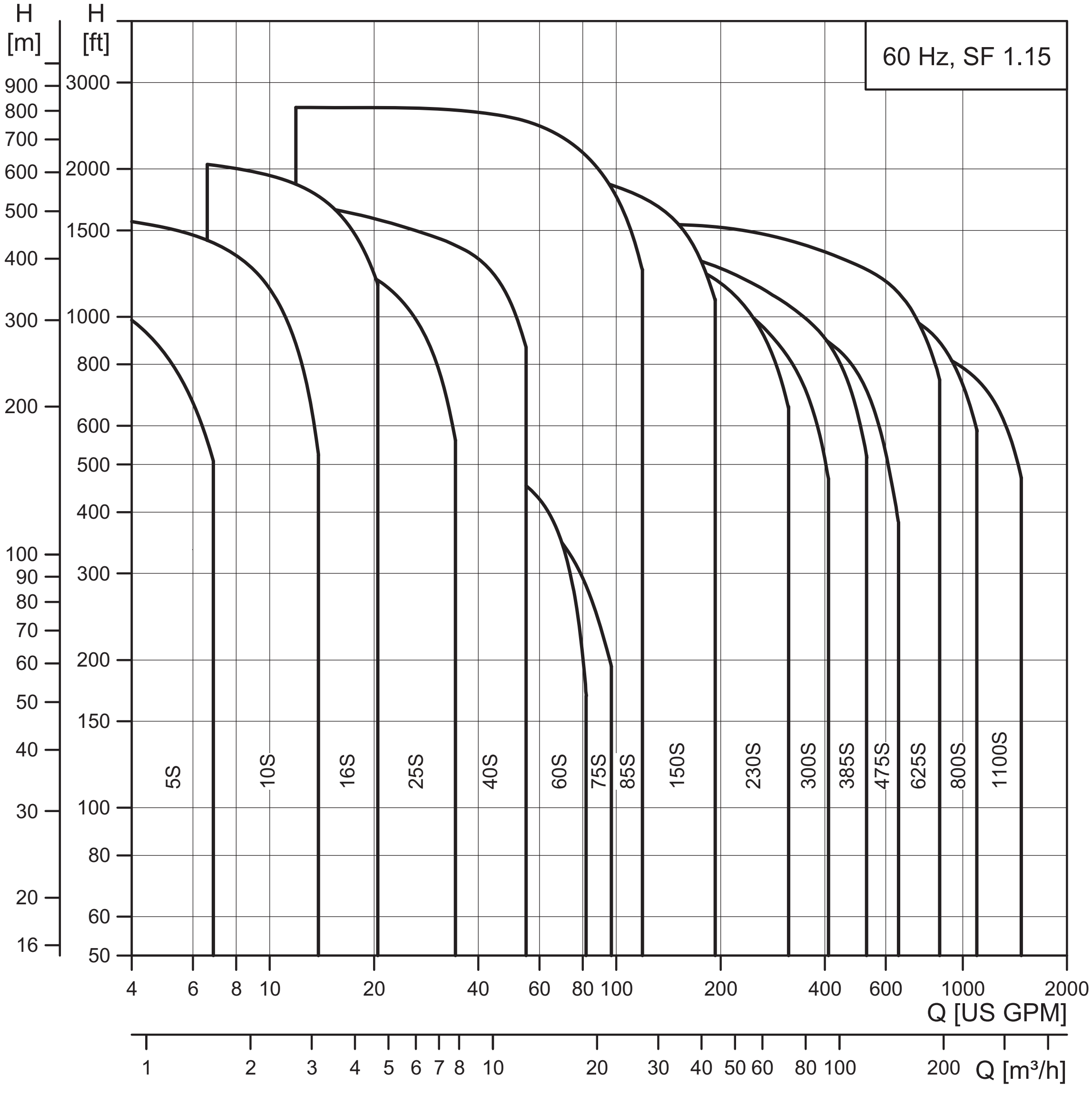
Radial bearings
- Blank = carbon/stainless steel
- W = SiC/tungsten carbide

Motor liquid
- Blank = SML-3
- D = demineralized water

Maximum liquid temperature
- T30 = 86 °F (30 °C)
- T60 = 140 °F (60 °C)

2. Product overview

Performance range 60 Hz



Pump range

Type		5S	10S	16S	25S	40S	60S	75S	85S	150S	230S	300S	385S	475S	625S	800S	1100S
AISI 304 stainless steel		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
AISI 316 stainless steel				●	●	●		●	●	●	●	●	●	●	●	●	●
AISI 904L stainless steel					●	●			●	●	●	●	●	●	●	●	●
Connection ★	NPT	1"	1.25"	1.25"	1.5"	2"	2"	2"	(3")	(3")	3" (4")	3" 4"	5"	5"	6"	6"	6"
Flange connection: Grundfos flange													5"	5"	6"	6"	6"

★ Figures in brackets ( ) indicate connection for pumps with sleeve.

Motor range

Motor output [hp]	0.5	0.75	1.0	1.5	1.5	3.0	5.0	7.5	10.0	15	20	25	30	40	50	60	75	100	125	150	175	200	250
Single-phase	●	●	●	●	●	●																	
Three-phase	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Industrial motor and MS6 T60-versions						●	●	●	●	●	●	●	●										
Rewindable motor							●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Steel: AISI 304	●	●	●	●	●	●	●	●	●	●	●	●	●	●									
Steel: AISI 304 and cast iron							●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Steel: AISI 316							●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Steel: AISI 904L			●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●			
Built-in temperature transmitter in motor			●	●	●	●	●	●	●	●	●	●	●	●									

Direct-on-line starting is recommended up to 100 hp.
Soft starter or autotransformer is recommended above 100 hp.
Motors with star/delta are available from 7.5 hp.

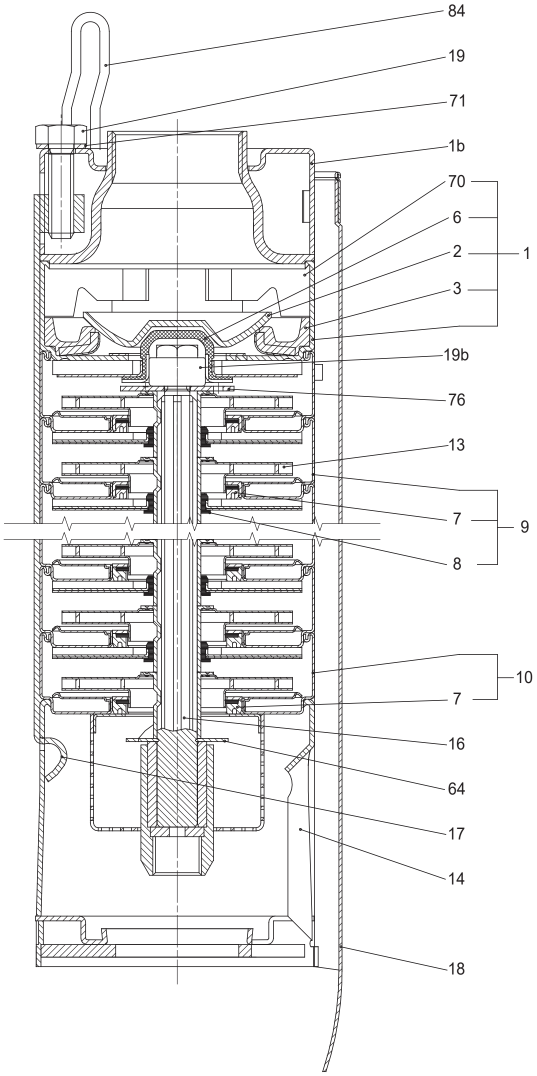
Motor protection and controllers

Motor output [hp]	0.5	0.75	1.0	1.5	1.5	3.0	5.0	7.5	10.0	15	20	25	30	40	50	60	75	100	125	150	175	200	250
MP 204	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Pt100							●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Zinc anode				●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Vertical flow sleeve	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Horizontal flow sleeve	●	●	●	●	●	●		●	●	●	●	●	●	●									
SA-SPM	●	●	●	●	●	●	●																
R100	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
RS-485 communication module	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
G100	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

Motor protection of single-phase motors, see page 85.

3. Construction

Sectional drawing, SP pump, 4"



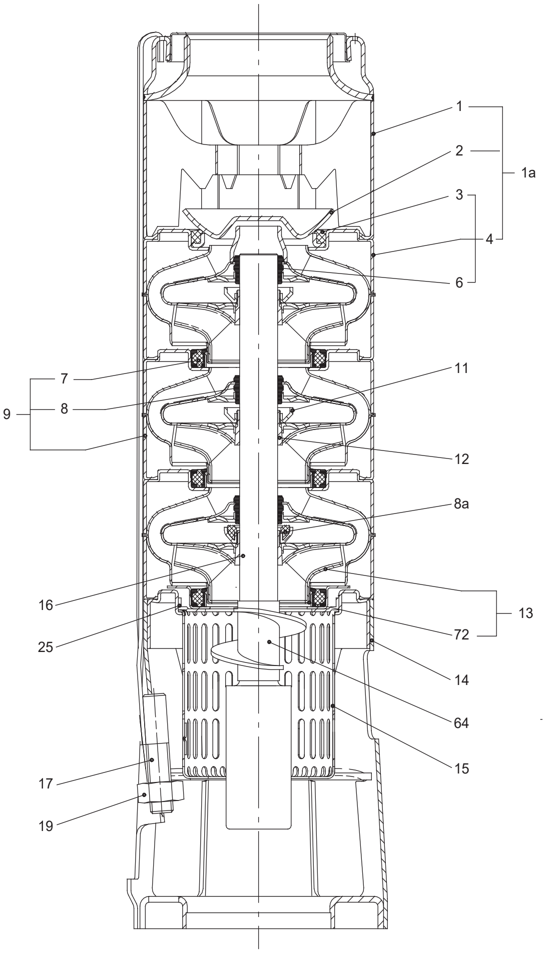
TM00 5606 1907

Fig. 13 SP pump, 4"

Material specification, SP pump, 4"

Pos.	Component	Materials	Standard
			AISI
1	Valve casing	Stainless steel	304
1b	Discharge piece	Stainless steel	304
2	Valve cup	Stainless steel	304
3	Valve seat	Stainless steel/NBR	304
6	Top bearing	NBR	
7	Neck ring	NBR/PBT	
8	Intermediate ring	NBR	
9	Intermediate chamber	Stainless steel	304
10	Bottom intermediate chamber	Stainless steel	304
13	Impeller	Stainless steel	304
14	Suction interconnector	Stainless steel	304
16	Shaft	Stainless steel	304
17	Strap	Stainless steel	304
18	Cable guard	Stainless steel	304
19	Hexagon screw	Stainless steel	304
19a	Nut	Stainless steel	316
19b	Nut	Stainless steel	304
20	Motor cable		
64	Priming disc	Stainless steel	304
70	Valve guide	Stainless steel	304
71	Washer for pos. 19	Stainless steel	316
76	Washer	Stainless steel	304
78	Nameplate	Stainless steel	316
84	Hook	Stainless steel	304

Sectional drawing, SP pump, 6"



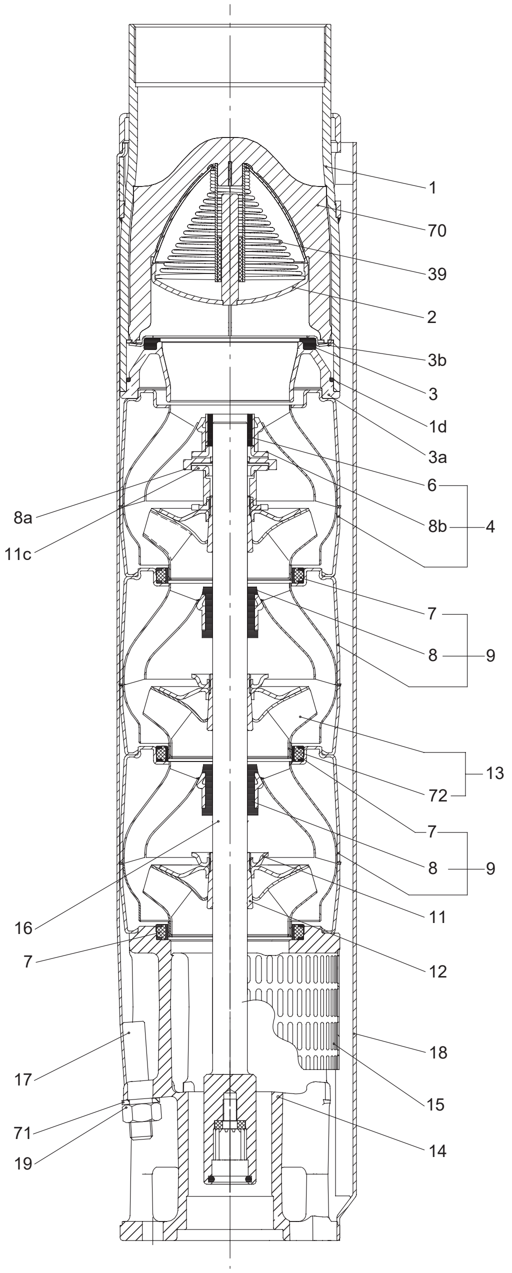
TM01 2258 2602

Fig. 14 SP pump, 6"

Material specification, SP pump, 6"

Pos.	Component	Materials	Standard	N-version	R-version
			AISI		
Valve casing					
1	Valve casing	Stainless steel	304	316	904 L
2	Valve cup	Stainless steel	304	316	904 L
3	Valve seat	Stainless steel	304	316	904 L
4	Top chamber	Stainless steel	304	316	904 L
Chamber stack					
7	Neck ring	NBR/PPS			
8	Bearing	NBR			
8a	Spacing washer	Carbon/ graphite HY22 in PTFE mass			
9	Chamber	Stainless steel	304	316	904 L
11	Nut for split cone	Stainless steel	304	316	904 L
12	Split cone	Stainless steel	304	316	904 L
13	Impeller	Stainless steel	304	316	904 L
16	Shaft with coupling	Stainless steel	431	329	Si 31 803
18	Cable guard	Stainless steel	304	316	904 L
23	Rubber guard	NBR			
25	Neck ring retainer	Stainless steel	304	316	904 L
64	Priming screw	Stainless steel	304	316	904 L
72	Wear ring	Stainless steel	304	316	904 L
Suction interconnector					
14	Suction interconnector	Stainless steel	304	316	904 L
	Intermediate piece for 6" motor over 40 Hp	Stainless steel	316	316	316
15	Strainer	Stainless steel	304	316	904 L
17	Strap	Stainless steel	304	316	904 L
19	Nut for strap	Stainless steel	304	316	904 L
19a	Nut	Stainless steel	316	316	316
20	Motor cable				
78	Nameplate	Stainless steel	316	316	316
Pumps in sleeve					
	Clamping flange (counter)	Stainless steel	304	316	904 L
	Clamping flange	Stainless steel	304	316	904 L
	Connecting piece	Stainless steel	304	316	904 L
	Sleeve	Stainless steel	304	316	904 L
	Stay bolt	Stainless steel	304	316	904 L
	Hexagon socket head screw	Stainless steel	304	316	904 L

Sectional drawing, SP pump, 8"



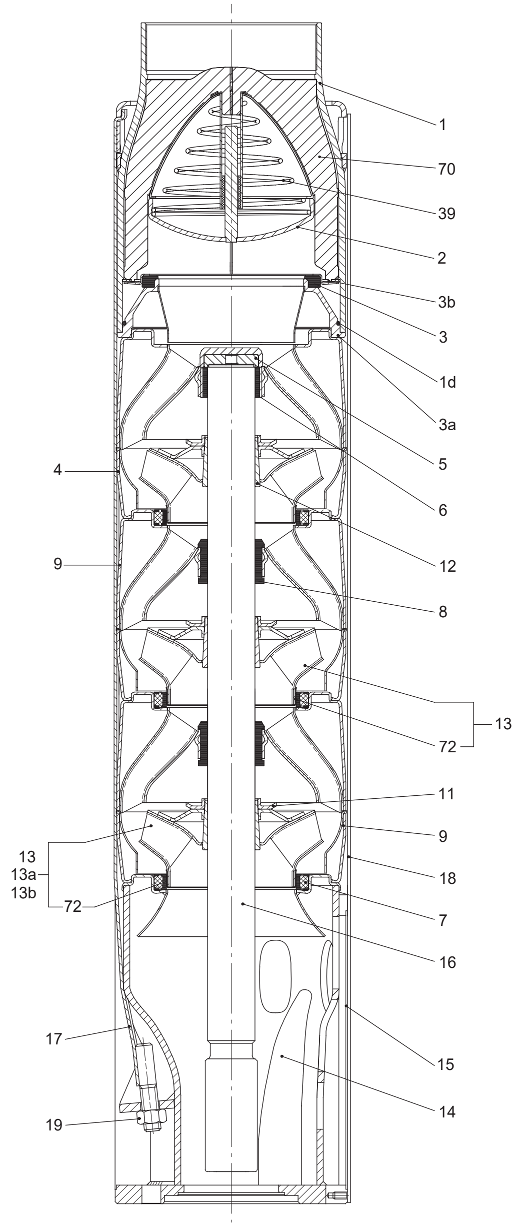
TM01 2359 2301

Fig. 15 SP pump, 8"

Material specification, SP pump, 8"

Pos.	Component	Materials	Standard	N-version	R-version
				AISI	
1	Valve casing	Stainless steel	304	316	904L
1d	O-ring	NBR			
2	Valve cup	Stainless steel	304	316	904L
3	Valve seat	Standard/ N- version: NBR R-version: FKM			
3a	Lower valve seat retainer	Stainless steel	316	316	(DIN 1.4517)
3b	Upper valve seat retainer	Stainless steel	304	316	904L
4	Top chamber	Stainless steel	304	316	904L
6	Upper bearing	Stainless steel/NBR	304	316	904L
7	Neck ring	NBR/PPS			
8	Bearing	NBR			
8a	Washer for stop ring	Carbon/ graphite HY22 in PTFE mass			
8b	Stop ring	Stainless steel	316	316	904L
9	Chamber	Stainless steel	304	316	904L
11	Split cone nut	Stainless steel	304	316	904L
11c	Nut for stop ring	Stainless steel	316	316	904L
12	Split cone	Stainless steel	304	316	904L
13	Impeller	Stainless steel	304	316	904L
14	Suction inter-connector	Stainless steel	CF8M	A744 CD4-MCu	(DIN 1.4517)
15	Strainer	Stainless steel	304	316	904L
16	Shaft complete	Stainless steel	431	329	329
17	Strap	Stainless steel	304	316	904L
18	Cable guard	Stainless steel	304	316	904L
19	Nut for strap	Stainless steel	304	316	904L
39	Spring for valve cup	Stainless steel	304	316	SAF 2205
70	Valve guide	Stainless steel	304	316	904L
71	Washer	Stainless steel	316	316	904L
72	Wear ring	Stainless steel	304	316	904L

Sectional drawing, SP pump, 10"



TM01 2363 2701

Fig. 16 SP pump, 10"

Material specification, SP pump, 10"

Pos.	Description	Material	Standard	N version
			AISI	
		Valve casing		
1	Valve casing	Stainless steel	304	316
1d	O-ring	NBR		
2	Valve cup	Stainless steel	304	316
3	Valve seat	Stainless steel	304	316
3a	Lower valve seat retainer	Stainless steel	304	316
3b	Upper valve seat retainer	Stainless steel	304	316
39	Spring for valve cup	Stainless steel	301	316
70	Valve guide	Stainless steel	304	316
78	Nameplate	Stainless steel	304	316
79	Rivet	Stainless steel	304	316
63	Connecting piece	Stainless steel	304	316
		Chamber stack		
4	Top chamber	Stainless steel	304	316
5	Upthrust disc	Carbon/ graphite HY22 in PTFE mass		
6	Top bearing	Stainless steel/ NBR	304	316
7	Neck ring	NBR/PPS		
8	Bearing	NBR		
9	Chamber	Stainless steel	304	316
11	Nut for split cone	Stainless steel	304	316
12	Split cone	Stainless steel	304	316
13	Impeller	Stainless steel	304	316
16	Shaft with coupling	Stainless steel	431	329
18	Cable guard	Stainless steel	304	316
18a, 18b	Screw for cable guard	Stainless steel	304	316
23	Rubber guard	NBR		
72	Wear ring	Stainless steel	304	316
		Suction interconnector		
14	Suction interconnector	Stainless steel	304	316
15	Strainer	Stainless steel	304	316
17	Strap	Stainless steel	304	316
19	Nut for strap	Stainless steel	304	316
19a	Nut	Stainless steel	316	316
20	Motor cable			
22	Bolts	Stainless steel	316	316
28, 28a	Lock for strainer	Stainless steel	329	329

Sectional drawing - MS motors

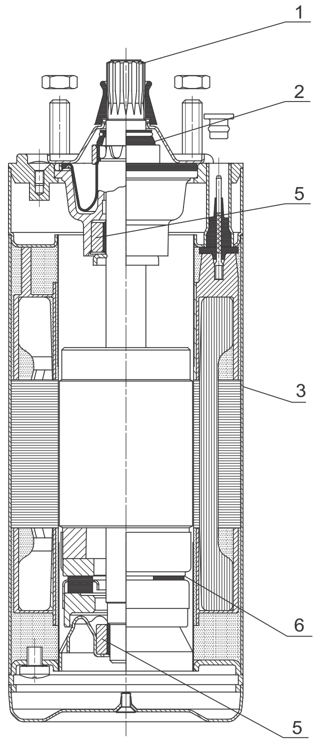


Fig. 17 MS 402 motor

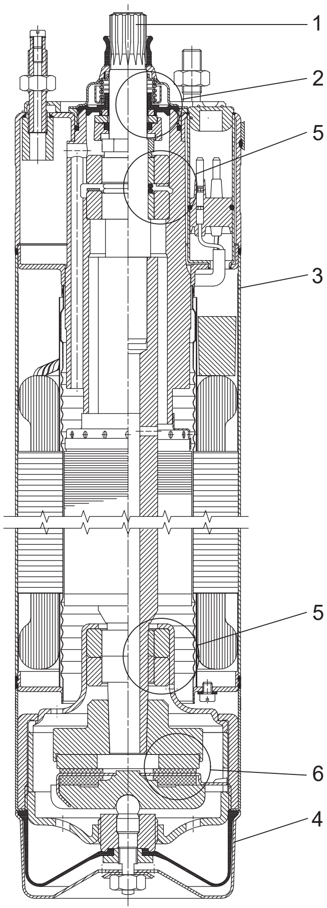


Fig. 18 MS 4000 motor

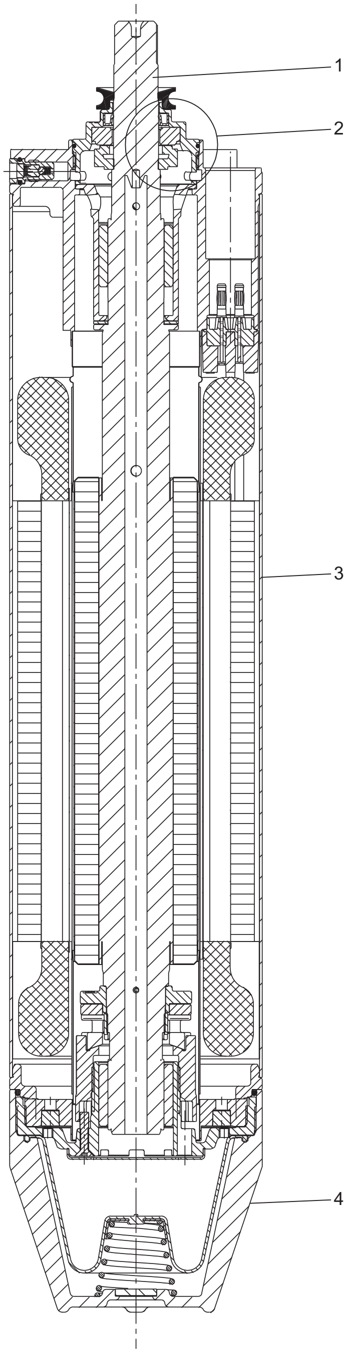
Material specification, MS 402 and MS 4000 motors

Pos.	Part	MS 402	MS 4000
		AISI	
1	Shaft	431	431
2	Shaft seal	NBR	Tungsten carbide/ ceramic
3	Motor sleeve	304	304
4	Motor end shield		304
5	Radial bearing	Ceramic	Ceramic/ tungsten carbide
6	Axial bearing	Ceramic/carbon	Ceramic/carbon
	Rubber parts	NBR	NBR

R-version motor

Pos.	Part	MS 4000
1	Shaft	318 LN
2	Shaft seal	NBR/ceramic
3	Motor sleeve	904L
4	Motor end shield	904L
5	Radial bearing	Ceramic/tungsten carbide
6	Thrust bearing	Ceramic/carbon
	Rubber parts	NBR

Sectional drawing - MS6 motors



TM03 9226 3607

Fig. 19 MS6 motor

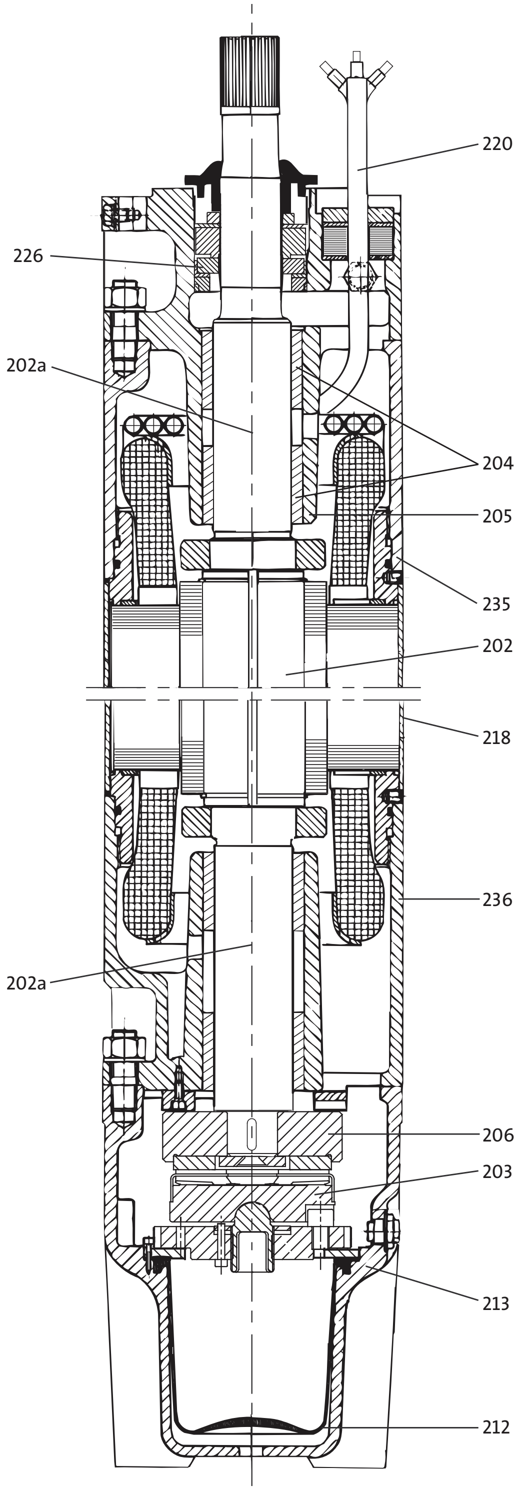
Material specification - MS6 motors

Pos.	Part	MS6
202	Shaft with rotor	318LN
2	Shaft seal	Ceramic/carbon
3	Motor sleeve	304
4	Motor end cover	304
	Rubber parts	NBR/FKM

R-version motor

Pos.	Part	MS6
1	Shaft	318LN
2	Shaft seal	SiC/SiC
3	Motor sleeve	904L
4	Motor end cover	(DIN 1.4517)
	Rubber parts	FKM

Sectional drawing - MMS motors



TM01 4985 0404

Fig. 20 MMS 10000

Material specification

MMS motors, submersible rewindable versions

Pos.	Component		Material	AISI
202	Shaft		Steel	(EN 1.0533)
202a	Shaft ends		Stainless steel	316/329
203/ 206	Thrust bearing Stationary/ rotating part	6", 0.5 - 20 Hp	Hardened steel/ EPDM	
		6", 25 - 50 Hp	Ceramic/ carbon	
		8" - 10"		
204	Bearing bush	6" - 10"	Carbon	
205	Bearing housing, upper		Cast iron	A126 Class B
212	Diaphragm		CR	
213	Motor end shield		Cast iron	A126 Class B
218	Motor sleeve		Stainless steel	304
220	Motor cable		EPDM	
226	Shaft seal		Ceramic/ carbon	
235	Intermediate housing		Cast iron	A126 Class B
236	Bearing housing, lower		Cast iron	A126 Class B

MMS motors, N- and R-versions

Pos.	Component		Material	Version	
				N	R*
				AISI	
202	Shaft		Steel	(EN 1.0533)	(EN 1.0533)
202a	Shaft ends		Stainless steel	316/329	318LN
203/ 206	Thrust bearing Stationary/ rotating part	6", 0.5 - 20 Hp	Hardened steel/EPDM		
		6", 25 - 50 Hp	Ceramic/ carbon		
		8"-10"			
204	Bearing bush	6"-10"	Carbon		
205	Bearing housing, upper		Stainless steel	316	904L
212	Diaphragm		CR		
213	Motor end shield		Stainless steel	316	904L
218	Motor sleeve		Stainless steel	316	904L
220	Motor cable		EPDM		
226	Shaft seal		Ceramic/ carbon		
235	Intermediate housing		Stainless steel	316	904L
236	Bearing housing, lower		Stainless steel	316	904L

* Only MMS 6000 and MMS 8000 are available in R-versions

4. Operating conditions

Operating conditions

Flow rate, Q:	0.44 - 1475 gpm (0.1-335 m^3/h).
Head, H:	Maximum 2657 ft (810 m).

Maximum liquid temperature

Motor	Installation		
	Flow velocity past motor	Vertical [°F (°C)]	Horizontal [°F (°C)]
Grundfos MS 4"and MS6 T30-versions	0.49 ft/s (0.15 m/s)	86 (30)	86 (30)
Grundfos 4" MS industry versions	0.49 ft/s (0.15 m/s)	140 (60)	140 (60)
Grundfos MS6 T60-versions	3.28 ft/s (1.0 m/s)	140 (60)	140 (60)
Grundfos MMS 6" to 12" rewindable with PVC in the windings	0.49 ft/s (0.15 m/s)	77 (25)	77 (25)
	1.64 ft/s (0.50 m/s)	86 (30)	86 (30)
Grundfos MMS 6" to 12" rewindable with PE/PA in the windings	0.49 ft/s (0.15 m/s)	104 (40)	104 (40)
	1.64 ft/s (0.50 m/s)	113 (45)	113 (45)

Note: Note: For MMS 6000, 0.5 hp; MMS 8000, 150 hp; the maximum liquid temperature is 9 °F (5 °C) lower than the values stated in the table. For MMS 10000, 250 hp, the temperature is 18 °F (10 °C) lower.

Operating pressure

Motor	Maximum operating pressure
Grundfos MS 4" and 6"	870 psi (6 Mpa) (60 bar)
Grundfos MMS 6" to 10" rewindable	

Curve conditions

The conditions below apply to the curves shown on pages 20 - 84:

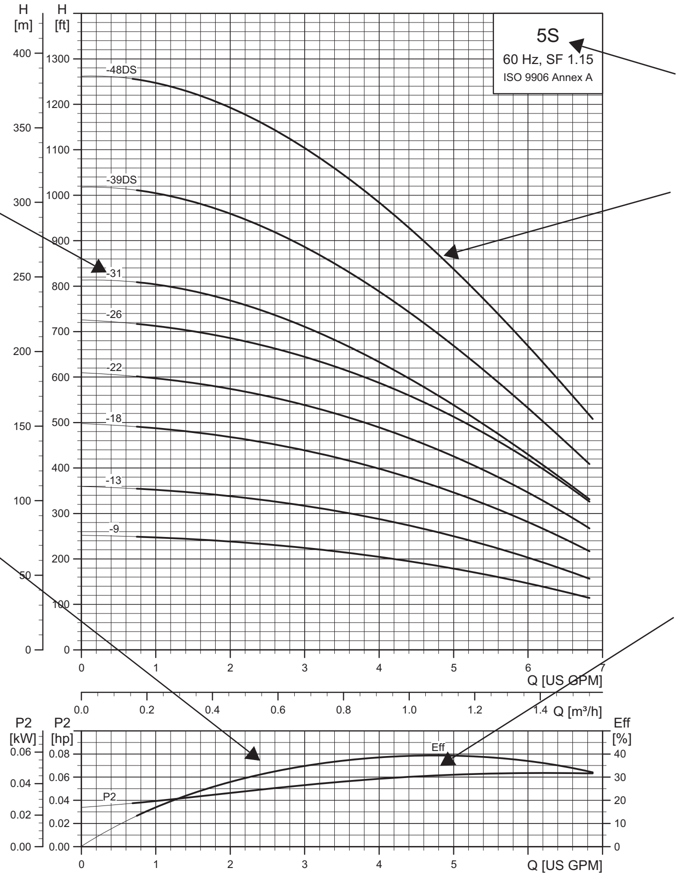
General

- Curve tolerances according to ISO 9906, Annex A.
- The performance curves show pump performance at actual speed, cf. standard motor range.
  The speeds of the motors are approximately these:

4" motors:	n = 3470 min^{-1}
6" motors:	n = 3460 min^{-1}
8" to 10" motors:	n = 3525 min^{-1}

- The measurements were made with airless water at a temperature of 68 °F (20 °C). The curves apply to a kinematic viscosity of 1 mm^2/s (1 cSt). When pumping liquids with a density higher than that of water, use motors with correspondingly higher outputs.
- The **bold** curves indicate the recommended performance range.
- The performance curves are inclusive of possible losses such as non-return valve loss.
- **Q/H:** The curves are inclusive of valve and inlet losses at the actual speed.
  Operation without non-return valve will increase the actual head at rated performance by 0.5 to 1.0 m.
- **NPSH:** The curve is inclusive of pressure loss in the suction interconnector and shows required inlet pressure.
- **Power curve:** P_2 shows pump power input at the actual speed of each individual pump size.
- **Efficiency curve:** Eta shows pump stage efficiency. If Eta for the actual pump size is needed, please consult WinCAPS or WebCAPS.

5. How to read the curve charts



Pump type, number of poles and frequency.

Number of stages.
First figure: number of stages; second figure: number of reduced-diameter impellers.

QH curve for the individual pump. The **bold** curves indicate the **recommended** performance range for best efficiency.

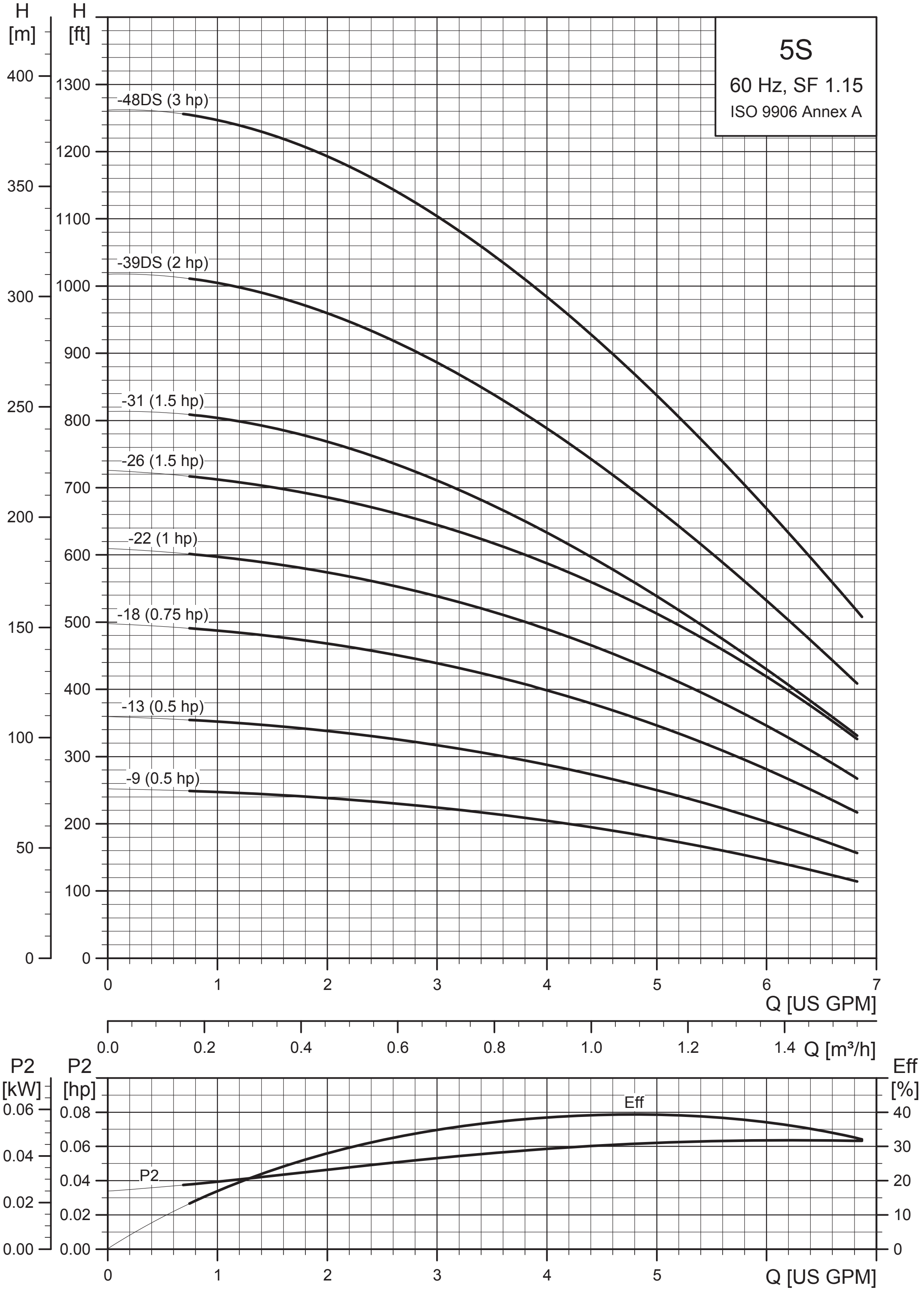
The efficiency curve shows the efficiency of the pump. The efficiency curve is an average curve of all the pump types shown in the chart. The efficiency of pumps with reduced-diameter impellers is approx. 2 % lower than the efficiency curve shown in the chart.

The power curves indicate pump input power **per stage**. Curves are shown for complete (1/1) and for reduced-diameter (2/3) impellers.

TM05 0229 10112

6. Curve charts and technical data

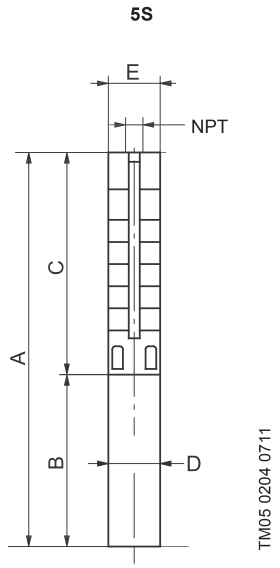
5S (5 gpm)



TM05 0229 2112

5S (5 gpm)

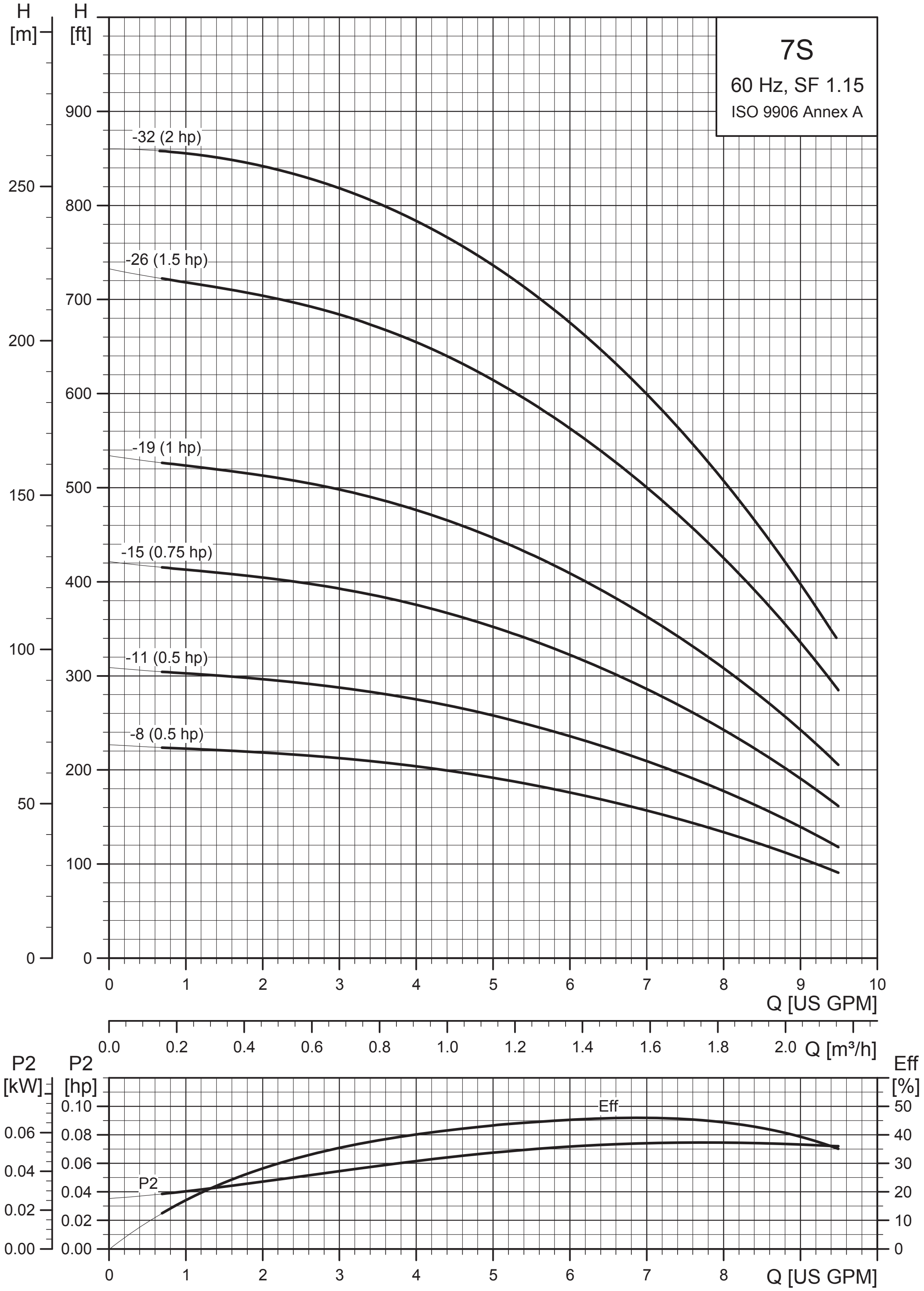
Pump model	Nom. head [ft]	Ph	Volts [V]	Motor [Hp]		Dimensions					Net weight (complete) [lb]
						A [in (mm)]	B [in (mm)]	C [in (mm)]	D [in (mm)]	E [in (mm)]	
5S, motor dia. 4 inch, 2 wire motor, 60 Hz - rated flow 5 gpm (1" NPT)											
5S05-9	171	1	230	0.5	■	24.57 (624)	11.03 (280)	13.55 (344)	3.74 (95)	3.97 (101)	21.6
5S05-13	247	1	115	0.5	■	27.88 (708)	11.03 (280)	16.86 (428)	3.74 (95)	3.97 (101)	26.9
			230	0.5	■	27.88 (708)	11.03 (280)	16.86 (428)	3.74 (95)	3.97 (101)	26.1
5S07-18	343	1	230	0.75	■	32.60 (828)	11.62 (295)	20.99 (533)	3.74 (95)	3.97 (101)	29.7
5S10-22	419	1	230	1	■	36.50 (927)	12.21 (310)	24.30 (617)	3.74 (95)	3.97 (101)	32.4
5S15-26	495	1	230	1.5	■	41.30 (1049)	13.71 (348)	27.60 (701)	3.74 (95)	3.97 (101)	41.4
5S15-31	527	1	230	1.5	■	47.21 (1199)	13.71 (348)	33.51 (851)	3.74 (95)	3.97 (101)	47.7
5S, motor dia. 4 inch, 3 wire motor, 60 Hz - rated flow 5 gpm (1" NPT)											
5S05-9	171	1	230	0.5	■	24.57 (624)	11.03 (280)	13.55 (344)	3.74 (95)	3.97 (101)	22.5
5S05-13	247	1	115	0.5	■	27.88 (708)	11.03 (280)	16.86 (428)	3.74 (95)	3.97 (101)	26.9
			230	0.5	■	27.88 (708)	11.03 (280)	16.86 (428)	3.74 (95)	3.97 (101)	25.2
5S07-18	343	1	230	0.75	■	32.60 (828)	11.62 (295)	20.99 (533)	3.74 (95)	3.97 (101)	28.8
5S10-22	419	1	230	1	■	36.50 (927)	12.21 (310)	24.30 (617)	3.74 (95)	3.97 (101)	32.4
5S15-26	495	1	230	1.5	■	41.30 (1049)	13.71 (348)	27.60 (701)	3.74 (95)	3.97 (101)	37.8
		3	230	1.5	■	39.81 (1011)	12.21 (310)	27.60 (701)	3.74 (95)	3.97 (101)	38.7
			460	1.5	■	39.81 (1011)	12.21 (310)	27.60 (701)	3.74 (95)	3.97 (101)	38.7
5S15-31	527	1	230	1.5	■	47.21 (1199)	13.71 (348)	33.51 (851)	3.74 (95)	3.97 (101)	47.7
		3	230	1.5	■	45.71 (1161)	12.21 (310)	33.51 (851)	3.74 (95)	3.97 (101)	45.0
			460	1.5	■	45.71 (1161)	12.21 (310)	33.51 (851)	3.74 (95)	3.97 (101)	45.0
5S20-39DS	663	1	230	2	●	59.61 (1514)	19.49 (495)	40.12 (1019)	3.74 (95)	3.97 (101)	57.6
		3	230	2	■	53.82 (1367)	13.71 (348)	40.12 (1019)	3.74 (95)	3.97 (101)	54.0
			460	2	■	53.82 (1367)	13.71 (348)	40.12 (1019)	3.74 (95)	3.97 (101)	54.0
5S30-48DS	816	1	230	3	●	70.16 (1782)	22.60 (574)	47.56 (1208)	3.74 (95)	3.97 (101)	77.4
		3	230	3	●	65.56 (1665)	18.00 (457)	47.56 (1208)	3.74 (95)	3.97 (101)	77.4
			460	3	●	65.56 (1665)	18.00 (457)	47.56 (1208)	3.74 (95)	3.97 (101)	77.4



E = Maximum diameter of pump including cable guard and motor.

Notes:
Control box is required for 3-wire, single-phase applications. Data does not include control box.
DS designation = Built into sleeve, 1-1/4" NPT, 6" minimum well diameter.
Performance conforms to ISO 9906. 1999 (E) Annex A. Minimum submergence is 2 feet.
■ MS402 motor.
● MS4000 motor.
▲ MS6 motor.
∧ MMS6000 motor.
★ MMS8000 motor.
♦ Takes MS6 motor; not available as complete.
☼ Takes MMS6000 motor; not available as complete.
* Takes MMS8000 motor; not available as complete.
† Takes MMS10000 motor; not available as complete.

7S (7 gpm)



TM05 0982 2112

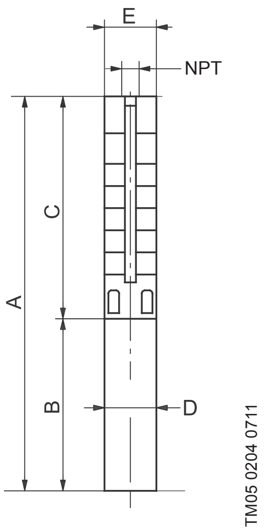
7S (7 gpm)

Pump model	Nom. head [ft]	Ph	Volts [V]	Motor [Hp]		Dimensions A [in (mm)]	B [in (mm)]	C [in (mm)]	D [in (mm)]	E [in (mm)]	Net weight (complete) [lb]
7S, motor dia. 4 inch, 2 wire motor, 60 Hz - rated flow 7 gpm (1" NPT)											
7S05-8	151	1	230	.5	■	23.75 (603)	11.03 (280)	12.72 (323)	3.74 (95)	3.97 (101)	21.6
7S05-11	208	1	115	.5	■	26.23 (666)	11.03 (280)	15.20 (386)	3.74 (95)	3.97 (101)	29.7
			230	.5	■	26.23 (666)	11.03 (280)	15.20 (386)	3.74 (95)	3.97 (101)	24.3
7S07-15	283	1	230	.75	■	30.12 (765)	11.62 (295)	18.51 (470)	3.74 (95)	3.97 (101)	29.7
7S10-19	358	1	230	1	■	34.02 (864)	12.21 (310)	21.82 (554)	3.74 (95)	3.97 (101)	32.4
7S15-26	491	1	230	1.5	■	41.3 (1049)	13.71 (348)	27.60 (701)	3.74 (95)	3.97 (101)	41.4
7S, motor dia. 4 inch, 3 wire motor, 60 Hz - rated flow 7 gpm (1" NPT)											
7S05-8	151	1	230	.5	■	23.75 (603)	11.03 (280)	12.72 (323)	3.74 (95)	3.97 (101)	21.6
7S05-11	208	1	115	.5	■	26.23 (666)	11.03 (280)	15.20 (386)	3.74 (95)	3.97 (101)	21.6
			230	.5	■	26.23 (666)	11.03 (280)	15.20 (386)	3.74 (95)	3.97 (101)	30.6
7S07-15	283	1	230	.75	■	30.12 (765)	11.62 (295)	18.51 (470)	3.74 (95)	3.97 (101)	27.9
7S10-19	358	1	230	1	■	34.02 (864)	12.21 (310)	21.82 (554)	3.74 (95)	3.97 (101)	39.6
7S15-26	491	1	230	1.5	■	41.30 (1049)	13.71 (348)	27.60 (701)	3.74 (95)	3.97 (101)	38.7
		3	230	1.5	■	39.81 (1011)	12.21 (310)	27.60 (701)	3.74 (95)	3.97 (101)	38.7
			460	1.5	■	39.81 (1011)	12.21 (310)	27.60 (701)	3.74 (95)	3.97 (101)	38.7
7S20-32	604	1	230	2	●	52.05 (1322)	19.49 (495)	32.56 (827)	3.74 (95)	3.97 (101)	48.5
		3	230	2	■	46.26 (1175)	13.71 (348)	32.56 (827)	3.74 (95)	3.97 (101)	48.5
			460	2	■	46.26 (1175)	13.71 (348)	32.56 (827)	3.74 (95)	3.97 (101)	48.5

Notes:
Control box is required for 3-wire, single-phase applications. Data does not include control box.
Performance conforms to ISO 9906. 1999 (E) Annex A. Minimum submergence is 2 feet.

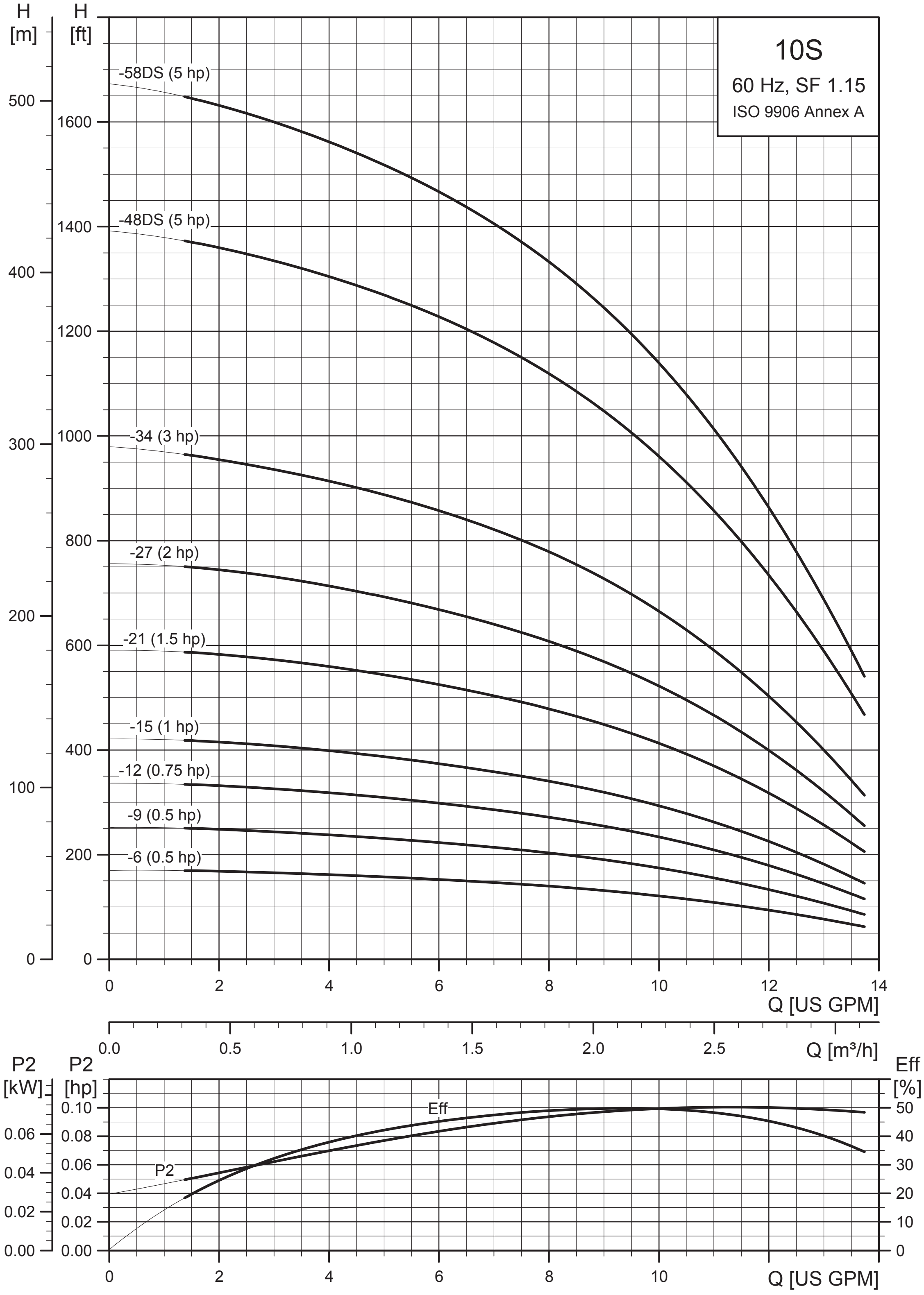
- ■ MS402 motor.
- ● MS4000 motor.
- ▲ MS6 motor.
- ʌ MMS6000 motor.
- ★ MMS8000 motor.
- ♦ Takes MS6 motor; not available as complete.
- ☼ Takes MMS6000 motor; not available as complete.
- * Takes MMS8000 motor; not available as complete.
- † Takes MMS10000 motor; not available as complete.

7S



E = Maximum diameter of pump including cable guard and motor.

10S (10 gpm)



TM05 0230 1812

10S (10 gpm)

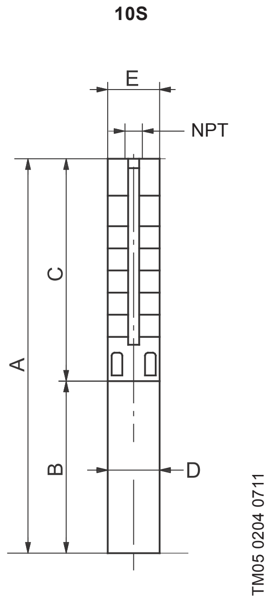
Pump model	Nom. head [ft]	Ph	Volts [V]	Motor [Hp]		Dimensions					Net weight (complete) [lb]
						A	B	C	D	E	
						[in (mm)]	[in (mm)]	[in (mm)]	[in (mm)]	[in (mm)]	

10S, motor dia. 4 inch, 2 wire motor, 60 Hz - rated flow 10 gpm (1.25" NPT)

Pump model	Nom. head [ft]	Ph	Volts [V]	Motor [Hp]		A [in (mm)]	B [in (mm)]	C [in (mm)]	D [in (mm)]	E [in (mm)]	Net weight (complete) [lb]
10S05-6	116	1	230	.5	■	22.05 (560)	10.99 (279)	11.07 (281)	3.74 (95)	3.97 (101)	20.7
10S05-9	174	1	115	.5	■	24.53 (623)	10.99 (279)	13.55 (344)	3.74 (95)	3.97 (101)	24.3
			230	.5	■	24.53 (623)	10.99 (279)	13.55 (344)	3.74 (95)	3.97 (101)	23.4
10S07-12	233	1	230	.75	■	27.60 (701)	11.58 (294)	16.03 (407)	3.74 (95)	3.97 (101)	24.3
10S10-15	291	1	230	1	■	30.67 (779)	12.17 (309)	18.51 (470)	3.74 (95)	3.97 (101)	29.7
10S15-21	407	1	230	1.5	■	37.17 (944)	13.71 (348)	23.47 (596)	3.74 (95)	3.97 (101)	35.1

10S, motor dia. 4 inch, 3 wire motor, 60 Hz - rated flow 10 gpm (1.25" NPT)

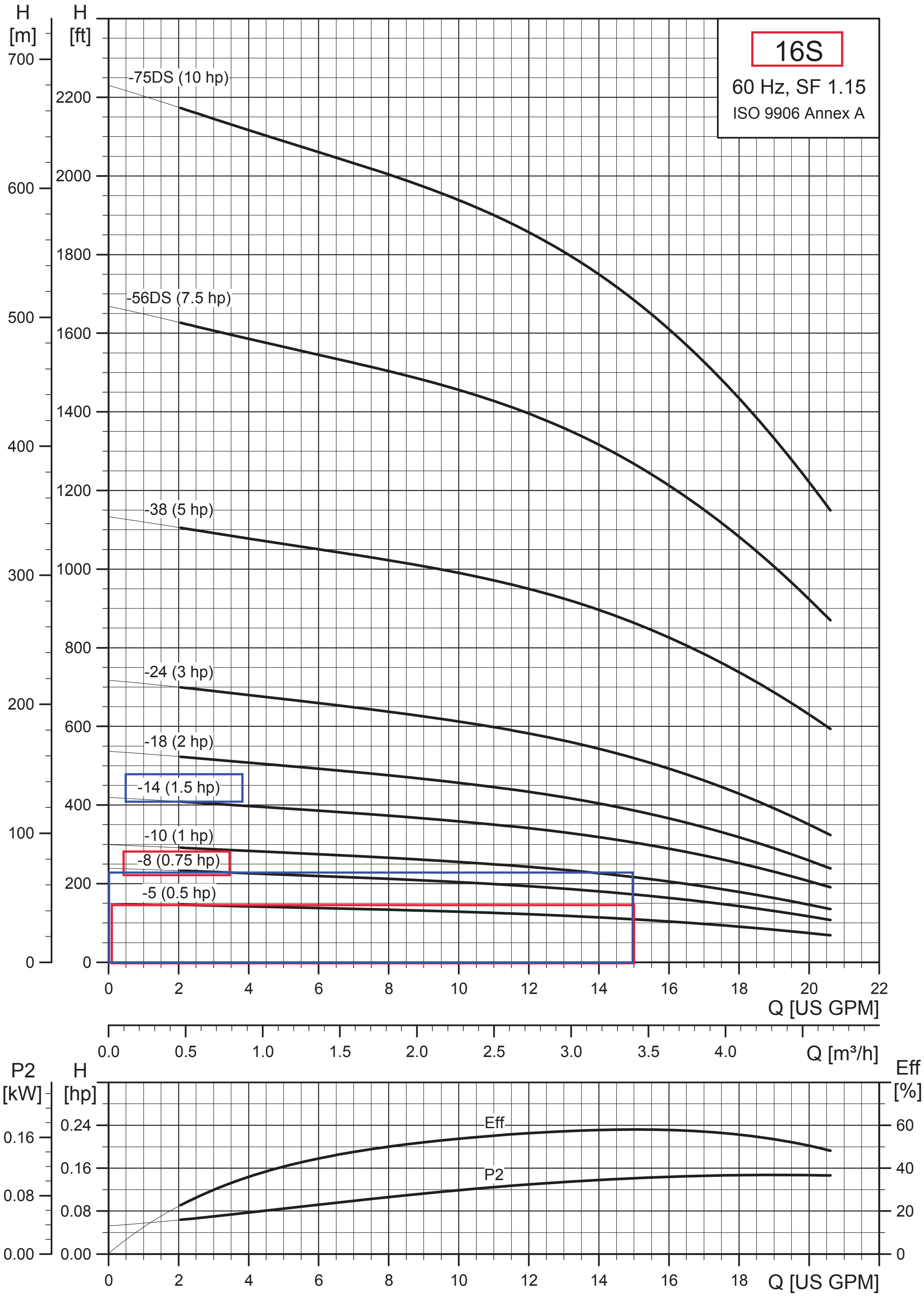
Pump model	Nom. head [ft]	Ph	Volts [V]	Motor [Hp]		A [in (mm)]	B [in (mm)]	C [in (mm)]	D [in (mm)]	E [in (mm)]	Net weight (complete) [lb]
10S05-6	116	1	230	.5	■	24.77 (629)	13.71 (348)	11.07 (281)	3.74 (95)	3.97 (101)	21.6
10S05-9	174	1	115	.5	■	24.53 (623)	10.99 (279)	13.55 (344)	3.74 (95)	3.97 (101)	25.4
			230	.5	■	24.53 (623)	10.99 (279)	13.55 (344)	3.74 (95)	3.97 (101)	24.3
10S07-12	233	1	230	.75	■	27.60 (701)	11.58 (294)	16.03 (407)	3.74 (95)	3.97 (101)	28.8
10S10-15	291	1	230	1	■	30.67 (779)	12.17 (309)	18.51 (470)	3.74 (95)	3.97 (101)	29.7
10S15-21	407	1	230	1.5	■	37.17 (944)	13.71 (348)	23.47 (596)	3.74 (95)	3.97 (101)	35.1
		3	230	1.5	■	35.63 (905)	12.17 (309)	23.47 (596)	3.74 (95)	3.97 (101)	32.4
			460	1.5	■	35.63 (905)	12.17 (309)	23.47 (596)	3.74 (95)	3.97 (101)	36.0
10S20-27	524	1	230	2	●	47.92 (1217)	19.49 (495)	28.43 (722)	3.74 (95)	3.97 (101)	45.9
		3	230	2	■	42.13 (1070)	13.71 (348)	28.43 (722)	3.74 (95)	3.97 (101)	44.1
			460	2	■	42.13 (1070)	13.71 (348)	28.43 (722)	3.74 (95)	3.97 (101)	44.1
10S30-34	659	1	230	3	●	58.59 (1488)	22.6 (574)	35.99 (914)	3.74 (95)	3.97 (101)	81.9
		3	230	3	●	53.98 (1371)	18.00 (457)	35.99 (914)	3.74 (95)	3.97 (101)	74.7
			460	3	●	53.98 (1371)	18.00 (457)	35.99 (914)	3.74 (95)	3.97 (101)	74.7
10S50-48DS	931	1	230	5	●	74.18 (1884)	26.62 (676)	47.56 (1208)	3.74 (95)	3.97 (101)	103.5
		3	230	5	●	70.16 (1782)	22.60 (574)	47.56 (1208)	3.74 (95)	3.97 (101)	103.5
			460	5	●	70.16 (1782)	22.60 (574)	47.56 (1208)	3.74 (95)	3.97 (101)	103.5
10S50-58DS	1124	1	230	5	●	89.49 (2272)	26.62 (676)	62.88 (1597)	3.74 (95)	4.25 (108)	132.3
		3	230	5	●	85.48 (2171)	22.60 (574)	62.88 (1597)	3.74 (95)	4.25 (108)	132.3
			460	5	●	85.48 (2171)	22.60 (574)	62.88 (1597)	3.74 (95)	4.25 (108)	132.3



E = Maximum diameter of pump including cable guard and motor.

Notes:
Control box is required for 3-wire, single-phase applications. Data does not include control box.
DS designation = Built into sleeve, 1-1/4" NPT, 6" minimum well diameter.
Performance conforms to ISO 9906. 1999 (E) Annex A. Minimum submergence is 2 feet.
■ MS402 motor.
● MS4000 motor.
▲ MS6 motor.
∧ MMS6000 motor.
★ MMS8000 motor.
♦ Takes MS6 motor; not available as complete.
☼ Takes MMS6000 motor; not available as complete.
* Takes MMS8000 motor; not available as complete.
† Takes MMS10000 motor; not available as complete.

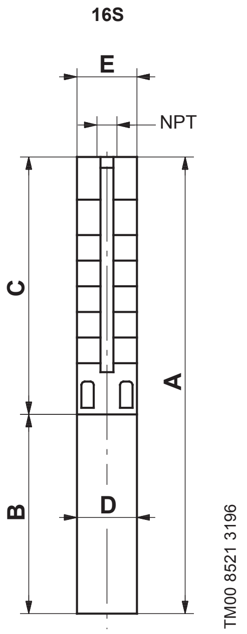
16S (16 gpm)



TM05 0231 0112

16S (16 gpm)

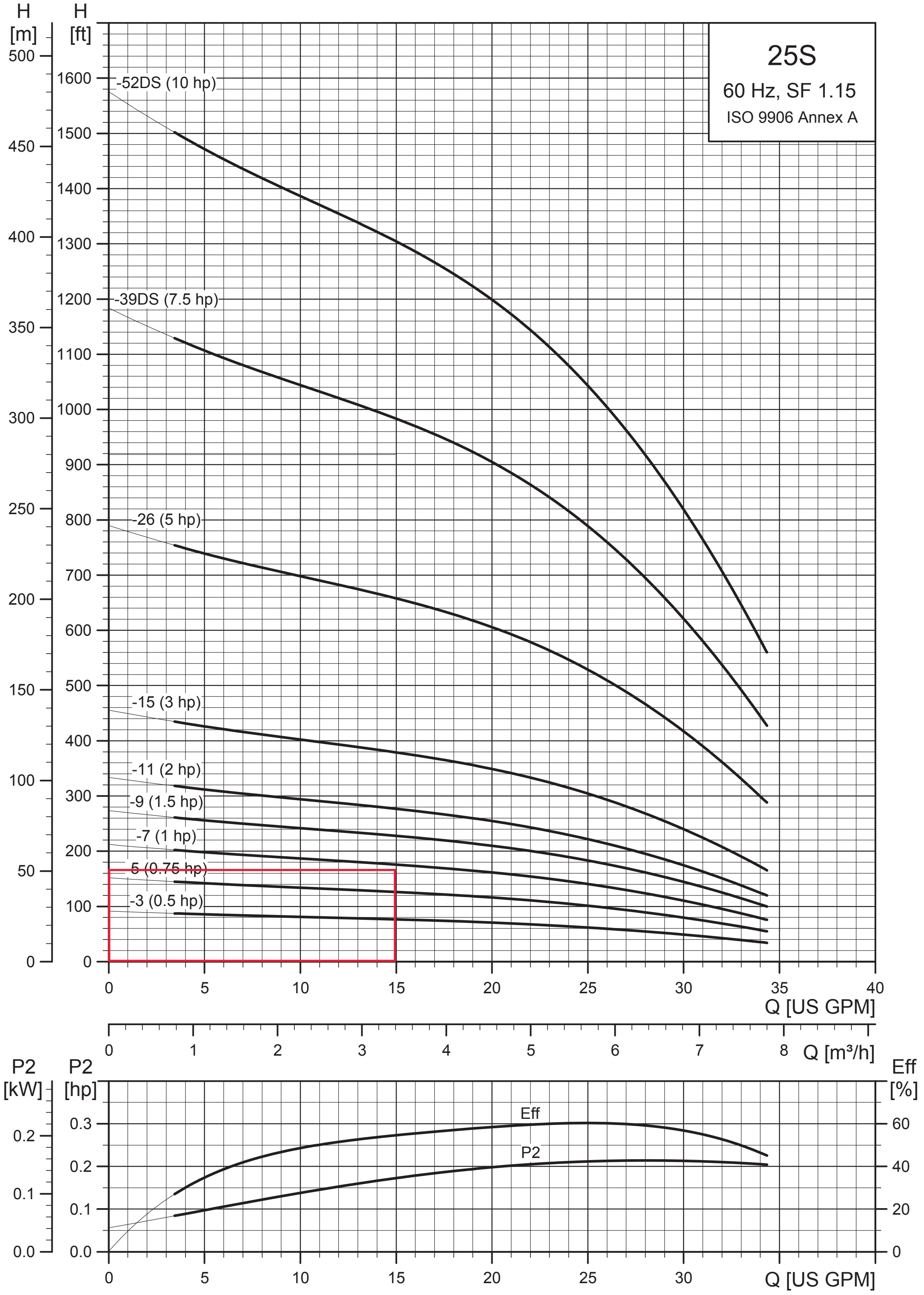
Pump model	Nom. head [ft]	Ph	Volts [V]	Motor [Hp]		Dimensions					Net weight (complete) [lb]
						A [in (mm)]	B [in (mm)]	C [in (mm)]	D [in (mm)]	E [in (mm)]	
16S, motor dia. 4 inch, 2 wire motor, 60 Hz - rated flow 16 gpm (1.25" NPT)											
16S05-5	102	1	115	.5	■	21.26 (540)	11.03 (280)	10.24 (260)	3.74 (95)	3.97 (101)	21.6
			230	.5	■	21.26 (540)	11.03 (280)	10.24 (260)	3.74 (95)	3.97 (101)	23.4
16S07-8	162	1	230	.75	■	24.34 (618)	11.62 (295)	12.72 (323)	3.74 (95)	3.97 (101)	24.3
16S10-10	203	1	230	1	■	26.58 (675)	12.21 (310)	14.38 (365)	3.74 (95)	3.97 (101)	27.9
16S15-14	284	1	230	1.5	■	31.38 (797)	13.71 (348)	17.68 (449)	3.74 (95)	3.97 (101)	36.0
16S, motor dia. 4 inch, 3 wire motor, 60 Hz - rated flow 16 gpm (1.25" NPT)											
16S05-5	102	1	115	.5	■	21.26 (540)	11.03 (280)	10.24 (260)	3.74 (95)	3.97 (101)	21.6
			230	.5	■	21.26 (540)	11.03 (280)	10.24 (260)	3.74 (95)	3.97 (101)	21.6
16S07-8	162	1	230	.75	■	24.34 (618)	11.62 (295)	12.72 (323)	3.74 (95)	3.97 (101)	27.0
16S10-10	203	1	230	1	■	26.58 (675)	12.21 (310)	14.38 (365)	3.74 (95)	3.97 (101)	27.9
16S15-14	284	1	230	1.5	●	31.38 (797)	13.71 (348)	17.68 (449)	3.74 (95)	3.97 (101)	32.4
		3	230	1.5	■	29.89 (759)	12.21 (310)	17.68 (449)	3.74 (95)	3.97 (101)	28.8
			460	1.5	■	29.89 (759)	12.21 (310)	17.68 (449)	3.74 (95)	3.97 (101)	28.8
16S20-18	366	1	230	2	●	40.48 (1028)	19.49 (495)	20.99 (533)	3.74 (95)	3.97 (101)	36.0
		3	230	2	■	34.69 (881)	13.71 (348)	20.99 (533)	3.74 (95)	3.97 (101)	36.0
			460	2	■	34.69 (881)	13.71 (348)	20.99 (533)	3.74 (95)	3.97 (101)	36.0
16S30-24	487	1	230	3	●	48.55 (1233)	22.60 (574)	25.95 (659)	3.74 (95)	3.97 (101)	62.1
		3	230	3	●	43.94 (1116)	18.00 (457)	25.95 (659)	3.74 (95)	3.97 (101)	57.6
			460	3	●	43.94 (1116)	18.00 (457)	25.95 (659)	3.74 (95)	3.97 (101)	57.6
16S50-38	814	1	230	5	●	65.91 (1674)	26.62 (676)	39.30 (998)	3.74 (95)	3.97 (101)	97.2
		3	230	5	●	62.01 (1575)	22.72 (577)	39.30 (998)	3.74 (95)	3.97 (101)	90.0
			460	5	●	62.01 (1575)	22.72 (577)	39.30 (998)	3.74 (95)	3.97 (101)	90.0
SP 16S, motor dia. 6 inch, 3 wire motor, 60 Hz - rated flow 16 gpm (1.25" NPT)											
16S75-56DS	1200	3	230	7.5	▲	95.40 (2423)	26.62 (676)	68.78 (1747)	5.63 (143)	5.51 (140)	165.1
			460	7.5	▲	95.40 (2423)	26.62 (676)	68.78 (1747)	5.63 (143)	5.51 (140)	165.1
16S100-75DS	1607	3	460	10	▲	115.08 (2923)	30.60 (777)	84.49 (2146)	5.63 (143)	5.51 (140)	190.0



E = Maximum diameter of pump including cable guard and motor.

Notes:
Control box is required for 3-wire, single-phase applications. Data does not include control box.
DS designation = Built into sleeve, 1-1/4" NPT, 6" minimum well diameter.
Performance conforms to ISO 9906. 1999 (E) Annex A. Minimum submergence is 2 feet.
■ MS402 motor.
● MS4000 motor.
▲ MS6 motor.
∧ MMS6000 motor.
★ MMS8000 motor.
♦ Takes MS6 motor; not available as complete.
☼ Takes MMS6000 motor; not available as complete.
* Takes MMS8000 motor; not available as complete.
† Takes MMS10000 motor; not available as complete.

25S (25 gpm)



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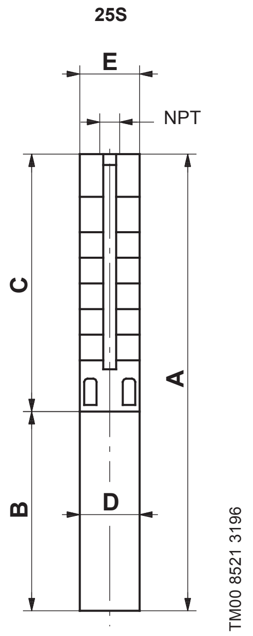
25S (25 gpm)

Pump model	Nom. head [ft]	Ph	Volts [V]	Motor [Hp]		Dimensions A [in (mm)]	B [in (mm)]	C [in (mm)]	D [in (mm)]	E [in (mm)]	Net weight (complete) [lb]
25S, motor dia. 4 inch, 2 wire motor, 60 Hz - rated flow 25 gpm (1.5" NPT)											
25S05-3	60	1	115	.5	■	19.61 (498)	11.03 (280)	8.59 (218)	3.74 (95)	3.97 (101)	21.6
			230	.5	■	19.61 (498)	11.03 (280)	8.59 (218)	3.74 (95)	3.97 (101)	21.6
25S07-5	99	1	230	.75	■	21.86 (555)	11.62 (295)	10.24 (260)	3.74 (95)	3.97 (101)	23.4
25S10-7	139	1	230	1	■	24.10 (612)	12.21 (310)	11.89 (302)	3.74 (95)	3.97 (101)	25.2
25S15-9	179	1	230	1.5	■	27.25 (692)	13.71 (348)	13.55 (344)	3.74 (95)	3.97 (101)	28.8
25S, motor dia. 4 inch, 3 wire motor, 60 Hz - rated flow 25 gpm (1.5" NPT)											
25S05-3	60	1	115	.5	■	19.61 (498)	11.03 (280)	8.59 (218)	3.74 (95)	3.97 (101)	21.6
			230	.5	■	19.61 (498)	11.03 (280)	8.59 (218)	3.74 (95)	3.97 (101)	21.6
25S07-5	99	1	230	.75	■	21.86 (555)	11.62 (295)	10.24 (260)	3.74 (95)	3.97 (101)	23.4
25S10-7	139	1	230	1	■	24.10 (612)	12.21 (310)	11.89 (302)	3.74 (95)	3.97 (101)	25.2
25S15-9	179	1	230	1.5	■	27.25 (692)	13.71 (348)	13.55 (344)	3.74 (95)	3.97 (101)	29.7
		3	230	1.5	■	25.75 (654)	12.21 (310)	13.55 (344)	3.74 (95)	3.97 (101)	27.0
			460	1.5	■	25.75 (654)	12.21 (310)	13.55 (344)	3.74 (95)	3.97 (101)	28.8
25S20-11	219	1	230	2	●	34.69 (881)	19.49 (495)	15.20 (386)	3.74 (95)	3.97 (101)	33.1
		3	230	2	■	28.90 (734)	13.71 (348)	15.20 (386)	3.74 (95)	3.97 (101)	37.0
			460	2	■	28.90 (734)	13.71 (348)	15.20 (386)	3.74 (95)	3.97 (101)	33.3
25S30-15	298	1	230	3	●	41.11 (1044)	22.60 (574)	18.51 (470)	3.74 (95)	3.97 (101)	61.2
		3	230	3	●	36.50 (927)	18.00 (457)	18.51 (470)	3.74 (95)	3.97 (101)	53.1
			460	3	●	36.50 (927)	18.00 (457)	18.51 (470)	3.74 (95)	3.97 (101)	53.1
25S50-26	517	1	230	5	●	54.22 (1377)	26.62 (676)	27.60 (701)	3.74 (95)	3.97 (101)	72.9
		3	230	5	●	50.32 (1278)	22.72 (577)	27.60 (701)	3.74 (95)	3.97 (101)	72.9
			460	5	●	50.32 (1278)	22.72 (577)	27.60 (701)	3.74 (95)	3.97 (101)	72.9
SP 25S, motor dia. 6 inch, 3 wire motor, 60 Hz - rated flow 25 gpm (1.5" NPT)											
25S75-39DS	775	3	230	7.5	▲	64.81 (1646)	22.25 (565)	42.56 (1081)	5.63 (143)	5.43 (138)	122.1
			460	7.5	▲	64.81 (1646)	22.25 (565)	42.56 (1081)	5.63 (143)	5.43 (138)	122.1
25S100-52DS	1034	3	460	10	▲	88.71 (2253)	23.23 (590)	65.48 (1663)	5.63 (143)	5.51 (140)	163.1



E = Maximum diameter of pump including cable guard and motor.

Notes:
Control box is required for 3-wire, single-phase applications. Data does not include control box.
DS designation = Built into sleeve, 1-1/2" NPT, 6" minimum well diameter.
Performance conforms to ISO 9906. 1999 (E) Annex A. Minimum submergence is 2 feet.

- ■ MS402 motor.
- ● MS4000 motor.
- ▲ MS6 motor.
- ∧ MMS6000 motor.
- ★ MMS8000 motor.
- ♦ Takes MS6 motor; not available as complete.
- ☼ Takes MMS6000 motor; not available as complete.
- * Takes MMS8000 motor; not available as complete.
- † Takes MMS10000 motor; not available as complete.

Electrical data

Grundfos submersible pump motors - 60 Hz

Grundfos submersible pump motors - 60 Hz

Hp	Ph	Volt [V]	S.F.	Circuit breaker		Amperage		Full load		Max. thrust [lbs]	Nameplate number	Product number
				Std.	Delay	Start [A]	Max. [A]	Eff. [%]	PF [%]			
4-inch, single-phase, 2-wire motors (control box not required)												
.5	1	115	1.60	35	15	55.0	12.0	62	76	900	79922102	96465574
.5	1	230	1.60	15	7	34.5	6.0	62	76	900	79952102	96465616
.75			1.50	20	9	40.5	8.4	62	75	900	79952103	96465618
1			1.40	25	12	48.4	9.8	63	82	900	79952104	96465620
1.5			1.30	35	15	62.0	13.1	64	85	900	79952105	96465622
4-inch, single-phase, 3-wire motors												
.5	1	115	1.60	35	15	42.5	12.0	61	76	900	79423102	96023039
.5	1	230	1.60	15	7	21.5	6.0	62	76	900	79453102	96465606
.75			1.50	20	9	31.4	8.4	62	75	900	79453103	96465608
1			1.40	25	12	37.0	9.8	63	82	900	79453104	96465610
1.5			1.30	35	15	45.9	11.6	69	89	900	79453105	96465612
2			1.25	35	20	57.0	13.2	72	86	1500	79454506	96449947
3			1.15	45	30	77.0	17.0	74	93	1500	79454507	96449948
5			1.15	70	45	110.0	27.5	77	92	1500	79454509	96449949
4-inch, three-phase, 3-wire motors												
1.5	3	230	1.30	15	8	40.3	7.3	75	72	900	79302005	96465629
		460	1.30	10	4	20.1	3.7	75	72	900	79362005	96465651
		575	1.30	10	4	16.1	2.9	75	72	900	79392005	96785912
2	3	230	1.25	20	10	48	8.7	76	75	900	79302006	96465630
		460	1.25	10	5	24	4.4	76	75	900	79362006	96465652
		575	1.25	10	4	19.2	3.5	76	75	900	79392006	96785917
3	3	230	1.15	30	15	56	12.2	77	75	1500	79304507	96405801
		460	1.15	15	7	28	6.1	77	75	1500	79354507	96405810
		575	1.15	15	6	22	4.8	77	75	1500	79394507	96405815
5	3	230	1.15	40	25	108	19.8	80	82	1500	79304509	96405802
		460	1.15	20	12	54	9.9	80	82	1500	79354509	96405811
		575	1.15	15	9	54	7.9	80	82	1500	79394509	96405816
7.5	3	230	1.15	60	30	130	25.0	81	82	1500	79305511	96405805
		460	1.15	35	15	67	13.2	81	82	1500	79355511	96405814
		575	1.15	30	15	67	10.6	81	82	1500	79395511	96405819
10	3	460	1.15	50	30	90	18	81	80	1500	79355512	96440318
6-inch, three-phase, 3-wire motors												
7.5	3	208-230	1.15	65	40	102-116	27-23.6	82-23	85	1686	78285541	96168843
		460	1.15	30	17	54	11.8	83	85	1686	78355541	96168823
10	3	208-230	1.15	90	50	142-162	35.5-32	82-84	86-84	1686	78285542	96168844
		460	1.15	40	25	75	16.0	84	85	1686	78355542	96168824
15	3	208-230	1.15	130	75	390-500	52-47	83-84	86-84	6182	78285544	96168846
		460	1.15	60	35	112	23.6	85	84	6182	78355544	96168826
20	3	208-230	1.15	175	100	265-305	70-63.5	83-85	86-84	6182	78285546	96168848
		460	1.15	80	45	154	32.0	85	84	6182	78355546	96168828
25	3	208-230	1.15	200	125	410-520	86-78	84-85	87-84	6182	78285547	96168849
		460	1.15	100	60	196	39	85	84	6182	78355547	96168829
30	3	208-230	1.15	250	150	405-475	102-92.5	84-85	87-85	6182	78285548	96168850
		460	1.15	125	70	238	46.0	85	85	6182	78355548	96168830
40	3	460	1.15	170	90	330	63.5	86	84	6182	78355550	96168832
50	3	460	1.15	225	125	470	68.7	84	83	6182	96476890	96023200
8-inch, three-phase, 3-wire motors												
40	3	460	1.15	175	100	380	55.7	83	85	13000	96530180	96023204
50	3	460	1.15	225	125	550	67.8	84	85	13000	96530182	96023205
60	3	460	1.15	250	150	640	80.4	86	85	13000	96476891	96023206
75	3	460	1.15	300	175	580	97.4	86	86	13000	96476892	96023207
100	3	460	1.15	400	225	570	130.4	87	86	13000	96476893	96023208
125	3	460	1.15	500	300	600	160.0	87	87	13000	96476894	96023209
150	3	460	1.15	600	350	580	191.3	86	87	13000	96511375	96023210
10-inch, three-phase, 3-wire motors												
175	3	460	1.15	700	400	570	230.4	88	85	13000	96521619	96937300
200	3	460	1.15	800	500	620	265.2	87	82	13000	96540302	96937302
250	3	460	1.15	1100	600	610	352.2	87	79	13000	96463669	96937316

.Other motor manufacturers

- Hitachi motors: Refer to the Hitachi submersible motors application maintenance manual.
- Franklin motors: Refer to the Franklin submersible motors application maintenance manual.

7. Accessories

MP 204

The MP 204 is an electronic motor protector, designed for the protection of an asynchronous motor or a pump.

The motor protector consists of:

- a cabinet incorporating transformers and electronics
- a control panel with operating buttons and display for reading of data.

The MP 204 operates with two sets of limits:

- a set of warning limits and
- a set of trip limits.

If one or more of the warning limits are exceeded, the motor continues to run, but the warnings will appear in the MP 204 display.

Some values only have a warning limit.

The warning can also be read out by means of the Grundfos R100 remote control.

If one of the trip limits is exceeded, the trip relay will stop the motor. At the same time, the signal relay is operating to indicate that the limit has been exceeded.

Applications

The MP 204 can be used as a stand-alone motor protector.

The MP 204 can be monitored via a Grundfos GENIbus.

The power supply to the MP 204 is in parallel with the supply to the motor. Motor currents up to 120 A are passed directly through the MP 204. The MP 204 protects the motor primarily by measuring the motor current by means of a true RMS measurement. The MP 204 disconnects the contactor if, for example, the current exceeds the preset value.

Secondarily, the motor is protected via temperature measuring by a Tempcon sensor, a Pt100/Pt1000 sensor and a PTC sensor/thermal switch.

The MP 204 is designed for single- and three-phase motors. In single-phase motors, the starting and run capacitors are also measured. Cos φ is measured in both single- and three-phase systems.

Benefits

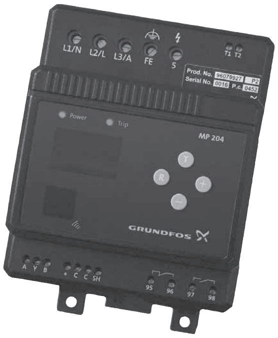
The MP 204 offers these benefits:

- Suitable for both single- and three-phase motors
- Dry-running protection
- Overload protection
- Very high accuracy
- Made for submersible pumps.

Many monitoring options

The MP 204 monitors the following parameters:

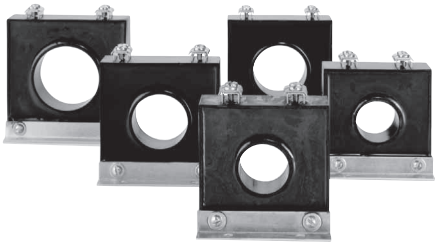
- Insulation resistance before start-up
- Temperature (Tempcon, Pt sensor and PTC/thermal switch)
- Overload/underload
- Overvoltage/undervoltage
- Phase sequence
- Phase failure
- Power factor
- Power consumption
- Harmonic distortion
- Operating hours and number of starts.



TM03 1471 2205

Fig. 21 MP 204

Five sizes of single-turn transformers, 120-999 A.
Note: Monitoring of motor temperature is not possible when single-turn transformers are used.



TM03 2033 3505

Fig. 22 Single-turn transformers

Product numbers

Product	Product number
MP 204	96079927
R100	625333

Functions

- Phase-sequence monitoring
- Indication of current or temperature (user selection)
- Indication of temperature in °F or °C (user selection)
- 4-digit, 7-segment display
- Setting and status reading with the R100
- Setting and status reading via the GENIbus.

Tripping conditions

- Overload
- Underload (dry running)
- Temperature (Tempcon sensor, PTC/thermal switch and Pt sensor)
- Phase failure
- Phase sequence
- Overvoltage
- Undervoltage
- Power factor (cos φ)
- Current unbalance.

Warnings

- Overload
- Underload
- Temperature (Tempcon and Pt sensor)
- Overvoltage
- Undervoltage
- Power factor (cos φ)
  Note: In connection with single- and three-phase connection.
- Run capacitor (single-phase operation)
- Starting capacitor (single-phase operation)
- Loss of communication in network
- Harmonic distortion.

Learning function

- Phase sequence (three-phase operation)
- Run capacitor (single-phase operation)
- Starting capacitor (single-phase operation)
- Identification and measurement of Pt100/Pt1000 sensor circuit.

External current transformers

When fitted with external current transformers, the MP 204 unit can handle currents from 120 to 999 A. Grundfos can supply approved current transformers from stock (200/5A, 300/5A, 500/5A, 750/5A, 1000/5A).

Remote control R100

The R100 remote control from Grundfos allows for wireless infrared remote control of your MP 204 unit.

With the R100, you get access to a full range of options such as factory setting adjustment, service and fault finding.

Ready for bus communication

The MP 204 allows for monitoring and communication via GENIbus — a Grundfos-designed bus for exchange of pump data, alarms, status information, and setpoints. This enables users to connect the MP 204 to, for instance, SCADA systems.

Technical data - MP 204

Enclosure class	IP 20
Ambient temperature	–4 °F to +140 °F (–20 °C to +60 °C)
Relative air humidity	99%
Voltage range	100-480 VAC
Current range	3-999 A
Frequency	50 to 60 Hz
IEC trip class	1-45
Special Grundfos trip class	0.1 to 30 s
Voltage variation	–25 %/+15 % of nominal voltage
Approvals	EN 60947, EN 60335, UL/CSA 508
Marking	CE, cUL, C-tick
Consumption	Max. 5 W
Plastic type	Black PC / ABS

	Measuring range	Accuracy	Resolution
Current without external current transformers	3-120 A	±1 %	0.1 A
Current with external current transformers	120-999 A	±1 %	1 A
Phase-to-phase voltage	80-610 VAC	±1 %	1 V
Frequency	47-63 Hz	±1 %	0.5 Hz
Power	0-1 MW	±2 %	1 W
Power factor	0-0.99	±2 %	0.01
Energy consumption	0-4x10^9 kWh	±5 %	1 kWh

IO 112	Description	Product number
	The IO 112 is a measuring module and a 1-channel protection unit for use in connection with the MP 204 motor protection unit. The module can be used for protection of pump against other factors than the electrical conditions, for instance dry-running. It can also be used as a stand-alone protection module. The IO 112 interface has three inputs for measured values one potentiometer for setting of limits indicator lights indicating the • measured value of the input • value of the limit set • alarm source • pump status. **Electrical data:** • Supply voltage: 24 VAC ±10% 50/60 Hz or 24 VDC ±10% • Supply current: Min. 2.4 A; max. 8 A • Power consumption:Max. 5 W Ambient temperature: –13 °F to+149 °F (–25 °C to +65 °C) • Enclosure class: IP 20	96651601

Control functions

This table describes the protection provided by MP 204.

Control parameters	Function	Problem	Advantages
Temperature	**MS** The motor temperature is measured by means of the built-in Tempcon temperature transmitter and a signal is sent to MP 204 via the phase leads. In MP 204 the measured temperature is compared with the factory-set value (167 °F (75 °C)). **MMS** The motor temperature is measured by means of the Pt100. The signal is sent to the MP 204 where the measured temperature is compared with the factory-set value. Temperature protection requires a submersible motor with a Pt100. The motor temperature must be monitored during frequency converter operation.	Overload, frequent starts/stops, operation against blocked discharge pipe, insufficient flow velocity past the motor.	Longer motor life, safe operating conditions, service indication.
Overvoltage/ undervoltage	If the set trip value is exceeded, the motor will stop.	The installation is close to a transformer. The mains do not absorb load variations.	Important installation parameter, possibility of improving operating conditions.
Overload	The motor power input is measured on each of the three phases. The registered power input is an average of these three values. If the factory-set value is exceeded, the motor will stop.	Incorrect sizing of pump/motor, voltage supply failure, defective cable, blocking, wear or corrosion.	Longer pump life, safe operating conditions, service indication.
Underload (dry running)	The motor power input is measured on each of the three phases. The registered power input is an average of these three values. If the average value is lower than the factory-set value, the motor will stop.	Pump exposed to dry running or underload, for example caused by wear.	Traditional dry-running protection is no longer necessary, no extra cables.
Current unbalance	The power input of the motor is measured on each of the three phases.	Mains load is uneven, incipient motor defect, phase voltages diverging.	Motor protection against overload, service indication.
Phase sequence	MP 204 and motor are installed so that the phase sequence corresponds to correct direction of rotation. MP 204 monitors changes in the phase sequence.	Two phases are wrongly connected.	Ensures correct pump performance.
Phase failure	MP 204 checks the phases connected, phase failure will cause an alarm.	Phase failure	Indication of phase failure, and alarm.

R100 menus

0. GENERAL

See the operating instructions for the R100.

1. OPERATION

- Operating mode
- Actual trip
- Actual warning 1
- Actual warning 2
- Alarm log 1
- Alarm log 2
- Alarm log 3
- Alarm log 4
- Alarm log 5.

2. STATUS

Display of

- Supply overview
- Average current
- Average voltage
- Tempcon sensor
- Pt100/Pt1000 sensor
- *Power input and energy consumption* (described in the following)
- Energy trip counter
- Phase sequence
- Current unbalance
- Operating hours and number of starts
- Trip counter of hours and starts
- Starting capacitor
- Run capacitor
- Insulation resistance
- Cos φ
- Harmonic distortion.

3. LIMITS

Display and setting of warning and trip limits.

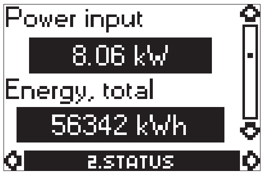
- Tempcon sensor
- Pt sensor
- Tripping current
- Current warning
- Nominal voltage
- Voltage limits
- Current unbalance
- Starting capacitor
- Run capacitor
- Insulation resistance
- Cos φ trip
- Cos φ warning.

4. INSTALLATION

Setting and display of

- Supply mains
- Trip class (described in the following)
- Trip delay
- External current transformers
- Power-on delay
- Restarting (described in the following)
- Automatic restarting (described in the following)
- Tempcon sensor
- Pt sensor
- Insulation resistance measurement
- PTC/thermal switch
- Resetting of trip counters
- Service interval
- Number of automatic restarts
- Units/display
- MP 204 display
- GENIbus ID number
- Learning function.

Power input and energy consumption



Power input

8.06 kW

Energy, total

56342 kWh

Actual input power and motor energy consumption.

The energy consumption is an accumulated value which cannot be reset.

The power is calculated like this:

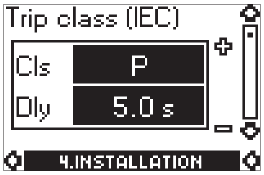
$$U_{average} = \frac{U_{L1-L2} + U_{L2-L3} + U_{L3-L1}}{3} [V]$$

$$I_{average} = \frac{I_{L1} + I_{L2} + I_{L3}}{3} [A]$$

$$\cos\varphi_{average} = \frac{\cos\varphi_{L1} + \cos\varphi_{L2} + \cos\varphi_{L3}}{3} [-]$$

$$P = (U_{average} \times I_{average} \times \sqrt{3} \times \cos\varphi_{average}) [W]$$

Trip class



Trip class (IEC)

Cls P

Dly 5.0 s

Line 1: Select IEC trip class (1 to 45).

If manual indication of trip delay in the case of overload is required, select trip class "P".

Factory setting:

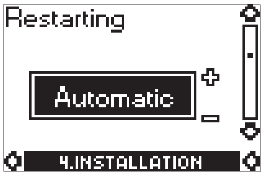
- Cls (trip class): P.

Line 2: Select trip delay.

Factory setting:

- Dly (trip delay): 10 s.

Restarting



Restarting

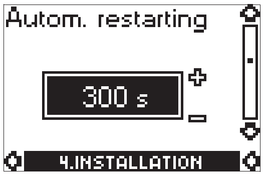
Automatic

Set whether restarting after tripping is to be

- *Automatic* (factory setting)
- *Manual*.

Setting of time, see section "Automatic restarting".

Automatic restarting



Autom. restarting

300 s

Set the time after which the MP 204 is to attempt automatic restarting of motor after cut-out.

The time runs from the moment when the value which triggered the fault has returned to normal.

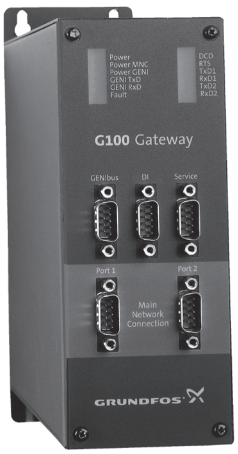
Factory setting:

- 300 s.

G100 gateway for communication with Grundfos products

The G100 offers a wide selection of options for integration of Grundfos products provided with GENIbus interface into main control and monitoring systems.

The G100 enables a pump installation to meet future demands for optimum pump operation in terms of reliability, operating costs, centralization and automation.



GR5940

Fig. 23 G100

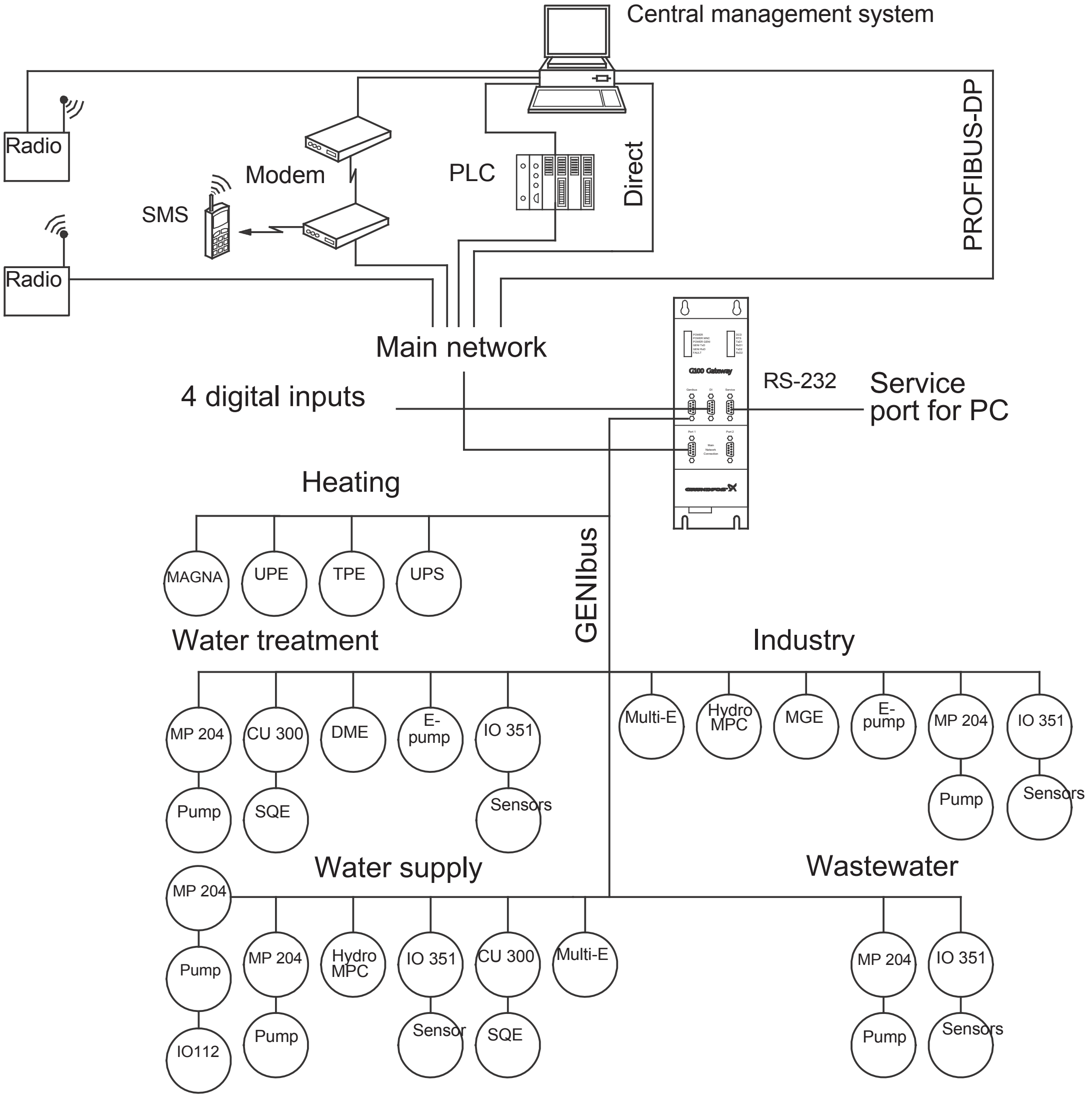


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Fig. 24 Examples of G100 applications

Product description

The G100 Gateway enables communication of operating data, such as measured values and setpoints, between Grundfos products with GENIbus interface and a main network for control and monitoring.

As indicated in the illustration on page 92, the G100 is suitable for use in applications such as water supply, water treatment, wastewater, building automation and industry.

Common to above applications is that downtime is usually costly, and extra investments are therefore often made to achieve maximum reliability by monitoring selected operating variables.

The day-to-day operation, such as starting and stopping of pumps and changing of setpoints, can also be effected from the main system by communication with the G100. In addition, the G100 can be set up to send event-controlled status indications such as alarms via the SMS to mobile phones, and to make automatic alarm call-backs to a central management system.

Data logging

Besides the possibility of data communication, the G100 offers logging of up to 350,000 time-stamped data. The logged data can be transmitted to the main system or a PC for further analysis in a spreadsheet or similar program.

For the data logging, the "PC Tool G100 Data Log" software tool is used. The tool is part of the PC Tool G100 package, which is supplied with the G100.

Other features

- Four digital inputs.
- Stop of all pumps in case of failing communication with the management system (optional).
- Access code for modem communication (optional).
- Alarm log.

Installation

Installation of the G100 is effected by the system integrator. The G100 is connected to the GENIbus as well as to the main network. All units on the GENIbus can thus be controlled from a central management system on the main network.

The "G100 Support Files" CD-ROM supplied with the G100 contains examples of programs to be used when the G100 is connected to the various main network systems. Included is also a description of the data points available in Grundfos products with GENIbus interface.

The "PC Tool G100" software tool included can be used for the installation and use of G100.

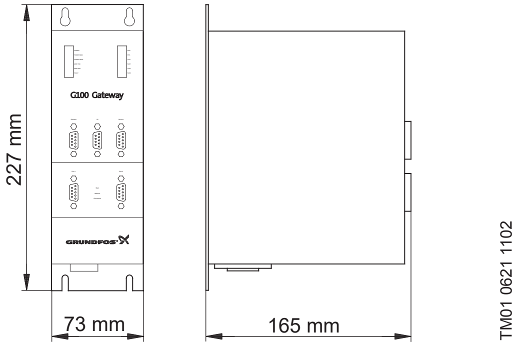

Fig. 25 Dimensional sketch

Technical data

Overview of protocols

Main system	Software protocol
PROFIBUS-DP	DP
Radio	Satt Control COMLI/Modbus
Modem	Satt Control COMLI/Modbus
PLC	Satt Control COMLI/Modbus
GSM mobile phone	SMS, UCP

Other possible connections

GENIbus RS-485:	Connection of up to 32 units.
Service port RS-232:	For direct connection to a PC or via radio modem.
Digital inputs:	4.
Voltage supply:	1 x 110-240 V, 50/60 Hz.
Ambient temperature:	In operation: –4 °F to +140 °F (–20 °C to +60 °C).
Enclosure class:	IP 20.
Weight:	1.8 kg.

Accessories

- PC Tool G100 package (supplied with the product)
- G100 Support Files CD-ROM (supplied with product)

Product numbers

Product	Product number
G100 with Profibus-DP expansion board*	96411135
G100 with Radio/Modem/PLC expansion board*	96411136
G100 Basic Version*	96411137
PC Tool G100 package	96415783

* CD-ROM with G100 Support Files included.

Connecting pieces

The tables below show the range of connecting pieces for connection of thread-to-flange and thread-to-thread.

Thread-to- thread

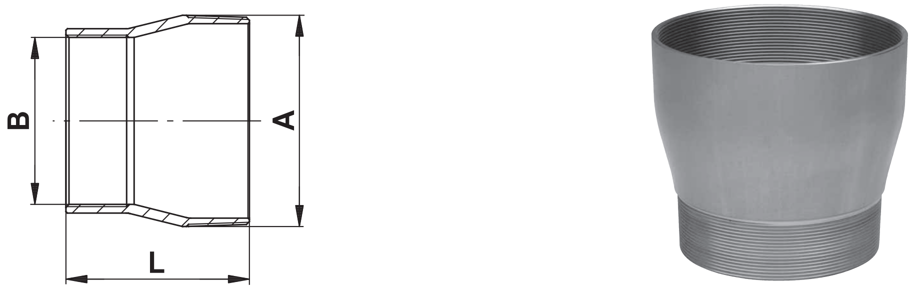

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Fig. 26 Dimensional sketch and photo of connecting piece thread-to-thread

Type	Connecting piece	Dimensions			Product number	
		Thread-to-thread		L [in (mm)]		
		A	B		304 stainless steel	316 stainless steel
385S 475S	NPT 5→ NPT 4	NPT 5	NPT 4	4.76 (121)	190064	190586
	NPT 5→ NPT 6	NPT 5	NPT 6	5.91 (150)	190070	190592
625S 800S 1100S	NPT 6→ NPT 5	NPT 6	NPT 5	5.91 (150)	200135	200645

Zinc anodes

Application

Cathodic protection by means of zinc can be used for corrosion protection of SP pumps in chloride-containing liquids such as brackish water and seawater.

Sacrificial anodes are placed on the outside of the pump and motor as protection against corrosion.

The number of anodes required depends on the pump and motor in question.

Please contact Grundfos for further details.

Liquid temperatures

- Seawater:
  Up to 95 °F (35 °C).
- Brackish water (min. 1500 ppm (g/m^3) chloride):
  Up to 95 °F (35 °C).

Anode life

The zinc anodes have a life of one to four years, depending on operating conditions (temperature, flow and chloride content).

Product numbers of zinc anodes

Zinc anodes for pumps										
Product number	Used for pump type									
	SP 5S to 75S	85S	150S	230S	300S	385S	475S	625S	800S	1100S
96421444	●	-	-	-	-	-	-	-	-	-
96421445	-	●	●	●	●	-	-	-	-	-
96421447	-	-	-	-	-	●	●	-	-	-
96421448	-	-	-	-	-	-	●	-	-	-
96421449	-	-	-	-	-	-	-	●	-	-
96421450	-	-	-	-	-	-	-	●	●	●

Zinc anodes for motors			
4" motors	6" motors	8" motors	10" motors
96421444	96421446	96421450	96564808

SA-SPM 5 control boxes

Application

SA-SPM 5 control boxes are used as starting units for single-phase, 3-wire motors, types MS 402B with power input lower than or equal to 1.5 hp (1.1 kW).

SA-SPM 5 is available in two versions, standard and DeLuxe. The standard version incorporates a motor -protective circuit breaker and thus protects the motor against overload. The DeLuxe version is identical to the standard version with the following addition a motor contactor is included for connection and disconnection of the power supply.

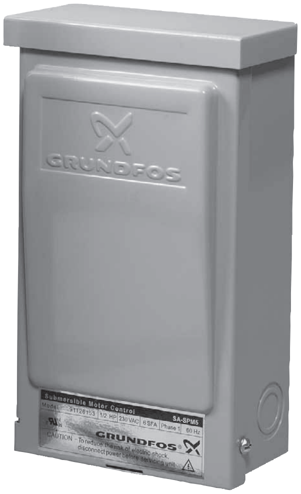


Fig. 27 SA-SPM 5 control box

Technical data

Enclosure class:	IP 42.
Ambient temperature:	–4 °F to +140 °F (–20 °C to +60 °C).
Relative humidity:	Maximum 95 %, normal non-aggressive atmosphere.

Product numbers

Product	Description					Product number
	1 x 220-230 V	1.5 hp	2.0 hp	3.0 hp	5.0 hp	
SA-SPM 5 (Standard version)	●	●	-	-	-	91126212
SA-SPM 5 (DeLuxe version)	●	●	-	-	-	91126213
SA-SPM 5 (Standard version)	●	-	●	-	-	91126214
SA-SPM 5 (DeLuxe version)	●	-	●	-	-	91126215
SA-SPM 5 (Standard version)	●	-	-	●	-	91126216
SA-SPM 5 (DeLuxe version)	●	-	-	●	-	91126217
SA-SPM 5 (Standard version)	●	-	-	-	●	91126218
SA-SPM 5 (DeLuxe version)	●	-	-	-	●	91126219

Pt100

The Pt100 sensor offers these features:

- Continuous monitoring of the motor temperature
- Protection against too high motor temperature.

Protecting the motor against too high motor temperature is the simplest and cheapest way of avoiding that motor lifetime is reduced. Pt100 ensures that operating conditions are not exceeded and indicates when it is time for service of the motor.

Monitoring and protection by means of Pt100 require the following parts:

- Pt100 sensor
- Relay, type PR 5714
- Cable.

The PR 5714 relay is fitted with a Pt100 module. For both relays the following temperature limits are preset on delivery:

- +60 °C (+140 °F) warning limit
- +75 °C (+167 °F) stop limit.

Technical data

	Relay type
	PR 5714
Enclosure class	IP 65 (mounted in a control panel)
Ambient temperature	–4 °F to +140 °F (–20 °C to +60 °C)
Relative humidity	95 % (condensating)
Voltage variation	• 1 x 24-230 VAC ±10 %, 50 - 60 Hz. • 24-250 VDC ±20 %.
Approvals	UL, DNV
Mark	CE

Pt100 sensor with/without PR 5714 relay and cable	**Cable length [ft (m)]**	**PR 5714**	**Product number**		
			MS6	**MMS 6000, MMS 8000**	**MMS 10000, MMS 12000**
	65.6 (20)	Yes	96408953	96494596	96437287
	131.2 (40)	Yes	96408681	96494597	96437288
	196.9 (60)	Yes	96408954	96494598	96437289
	262.5 (80)	Yes	96408955	96494599	96437290
	328.1 (100)	Yes	96408956	96494610	96437291
	65.6 (20)	No	96658626	96658629	96658633
	131.2 (40)	No	96658627	96658630	96658634
	196.9 (60)	No	96658628	96658631	96658635
	262.5 (80)	No	96658637	96658632	96658636
	328.1 (100)	No	96658638	96658639	96658640

PR 5714 relay	**Voltage**	**Product number**
	24-230 VAC, 50/60 Hz / 24-250 VDC	96621274

Pt100 sensor including cable	**Cable length [ft (m)]**	**Product number**	
		MS6, MMS 6000, MMS 8000	**MMS 10000 MMS 12000**
	65.6 (20)	96408957	96437784
	131.2 (40)	96408684	96437785
	196.9 (60)	96408958	96437786
	262.5 (80)	96408959	96437787
	328.1 (100)	96408960	96437788

Staybolts for Pt100	**Description**	**Product number**
	Bolt KIT for Pt100 (for MS6)	96611899

8. Energy consumption

Energy consumption of submersible pumps

The percentage distribution of service life costs of a submersible pump for water supply is:

5 % initial costs (pump)
85 % operating costs / energy consumption
10 % maintenance costs.

It is obvious that the highest savings can be achieved within energy consumption!

The annual energy consumption, E, of a submersible pump can be calculated as follows:

E = c x h x P_1 (USD)

c = specific energy price (USD/kWh)

h = operating hours/year (hours)

P_1 = power input of the submersible pump (hp).

Example: Calculation of the annual energy consumption of the submersible pump, type 625S-3.

625S-3 with MS 8000, 60 hp, 3 x 460 V, 60 Hz.

Duty point:

Flow rate: Q = 528 GPM

Total head: H = 335 ft

Specific energy price: c = USD 0.15/kWh (consisting of day and night rate)

Operating hours/year: h = 3200.

$$P_1 = \frac{Q \times H \times \rho}{367 \times \eta_{pump} \times \eta_{motor}} \text{ in kW}$$

Q = GPM

H = ft

Density ρ = lb/ft^3 (assumed 1)

367 = conversion factor

η_{motor} = (example 84.5 %, in equation 0.845)

η_{pump} = (not to be confused with the stage efficiency curve).

By showing the P_2/Q curve we make it easier for you to calculate the energy consumption.

$$P_1 = \frac{P_2}{\eta_{motor}}$$

P_2 = 35 hp (power requirement of 625S-3 pump at 88 GPM, from curve P_2 / Q.

Calculation of motor efficiency at duty point

As standard the SP 625S-3 is equipped with a 60 hp (45 kW for P1) MS6 motor.

At duty point (Q = 528 GPM) the pump requires 59 hp (44 kW for P1), thus:

a motor load of 87 % (44 kw / 45 kw) and a power reserve of 2 %.

From the table on page 72 the motor efficiency can be read as:

84.6 % at a load of 75 %. ($\eta_{75\%}$)
85.6 % at a load of 100 %. ($\eta_{100\%}$)
The interpolated value in this example is
η_{motor} = 85.1 %, η_{motor} = 0.851.

$$P_1 = \frac{44}{0.851} = 51.7 \text{ kW}$$

E = 0.15 USD/kWh x 3200 h x 51.7 kW.

The annual energy costs amount to USD 24816.

The pay-off time, A, (months) is calculated as follows:

$$A = \frac{\text{Purchase price of energy} - \text{efficiency pump}}{\text{Energy savings/year}} \times 12$$

Cable sizing

In order to obtain an economical duty of the pump the voltage drop should be low.

Today large water works already size cables for a maximum voltage drop of 1 %).

The hydraulic resistance in the discharge pipe should be as low as possible.

9. Cables

Grundfos offers submersible drop cables for all applications: 3-core cable, 4-core cable, single leads.

Cables for Grundfos 4" submersible motors are available with or without plugs. The submersible drop cable is chosen according to application and type of installation.

Standard version: Max. liquid temperature
+140 °F +60 °C).

Hot water version: Max. liquid temperature
+158 °F (+70 °C), for short periods
up to 194 °F (+90 °C)
(for MS only).

Tables indicating cable dimension in borehole

The tables indicate the maximum length of drop cables in meters from motor starter to pump at direct-on-line starting at different cable dimensions.

If star/delta starting is used the current will be reduced by $\sqrt{3}$ (I x 0.58), meaning that the cable length may be $\sqrt{3}$ longer (L x 1.73) than indicated in the tables.

If for example the operating current is 10 % lower than the full-load current, the cable may be 10 % longer than indicated in the tables.

The calculation of the cable length is based on a maximum voltage drop of 1 % to 3 % of the rated voltage and a water temperature of maximum +86 °F (30 °C).

In order to minimize operating losses the cable cross section may be increased compared to what is indicated in the tables. This is economical only if the borehole provides the necessary space, and if the operational time of the pump is long, especially if the operating voltage is below the rated voltage.

The table values are calculated on the basis of the formula:

Max. cable length of a single-phase submersible pump:

$$L = \frac{U \times \Delta U}{I \times 2 \times 100 \times \left(\cos\varphi \times \frac{\rho}{q} + \sin\varphi \times X_L\right)}[\mathrm{ft}]$$

Max. cable length of a three-phase submersible pump:

$$L = \frac{U \times \Delta U}{I \times 1.73 \times 100 \times \left(\cos\varphi \times \frac{\rho}{q} + \sin\varphi \times X_L\right)}[\mathrm{ft}]$$

where

U = Rated voltage [V]

ΔU = Voltage drop [%]

I = Rated current of the motor [A]

q = Cross-section of submersible drop cable [in^2]

X_L = Inductive resistance: 0.024×10^{-3} [Ω/ft]

$\cos\varphi$= Power factor

$\sin\varphi = \sqrt{1 - \cos^2\varphi}$

ρ = Specific resistance: 9.5×10^{-6} [$\Omega\ \mathrm{in}^2$/ft]

Example

Motor size: 40 hp, MMS 8000

Rated current: 64.0 A

Rated voltage: 3 x 460 V, 60 Hz

Starting method: Direct-on-line

Power factor: $\cos\varphi = 0.85$

Voltage drop: 3 %

Cross-section: 0.025 in^2

$\sin\varphi$: 0.53

$$= \frac{460 \times 3}{64.0 \times 1.73 \times 100 \times \left(0.85 \times \frac{0.0000095}{0.025} + 0.53 \times 0.024 \times 10^{-3}\right)}$$

L = 370 ft

Cable dimensions at 1 x 220 V, 60 Hz

Motor	hp	I_n [A]	0.002 in^2	0.004 in^2	0.006 in^2	0.009 in^2	0.016 in^2
4"	0.33	3.3	315	522	833	1243	2047
	0.50	4.4	239	397	630	938	1548
	0.75	6.6	157	262	417	620	1020
	1.00	7.7	121	203	321	482	797
	1.50	9.0	98	164	259	387	643

Maximum cable length in feet from motor starter to pump.

Cable sizing chart

1 phase, 60 Hz														
Motor rating		Copper wire size												
Volts	Hp	14	12	10	8	6	4	2	0	00	000	0000	250	300
		Maximum motor cable length (motor service to entrance) [ft/m]												
115	0.33	130 (40)	210 (64)	340 (104)	540 (165)	840 (256)	1300 (396)	1960 (597)	2910 (887)					
	0.5	100 (30)	160 (49)	250 (76)	390 (119)	620 (189)	960 (293)	1460 (445)	2160 (658)					
	0.33	550 (168)	880 (268)	1390 (424)	2190 (668)	3400 (1036)	5250 (1600)	7960 (2426)						
	0.5	400 (122)	650 (198)	1020 (311)	1610 (491)	2510 (765)	3880 (1183)	5880 (1792)						
	0.75	300 (91)	480 (146)	760 (232)	1200 (366)	1870 (570)	2890 (881)	4370 (1332)	6470 (1972)					
	1	250 (76)	400 (122)	630 (192)	990 (302)	1540 (469)	2380 (725)	3610 (1100)	5360 (1634)	6520 (1987)				
	1.5	190 (58)	310 (94)	480 (146)	770 (235)	1200 (366)	1870 (570)	2850 (869)	4280 (1305)	5240 (1597)				
	2	150 (46)	250 (76)	390 (119)	620 (189)	970 (296)	1530 (466)	2360 (719)	3620 (1103)	4480 (1366)				
	3	120 (37)	190 (58)	300 (91)	470 (143)	750 (229)	1190 (363)	1850 (564)	2890 (881)	3610 (1100)				
	5			180 (55)	280 (85)	450 (137)	710 (216)	1110 (338)	1740 (530)	2170 (661)				
	7.5				200 (61)	310 (94)	490 (149)	750 (229)	1140 (347)	1410 (430)				
	10					250 (76)	390 (119)	600 (183)	930 (283)	1160 (354)				

3 phase, 60 Hz														
Motor rating		Copper wire size												
Volts	Hp	14	12	10	8	6	4	2	0	00	000	0000	250	300
		Maximum motor cable length (motor service to entrance) [ft/m]												
208	1.5	310 (94)	500 (152)	790 (241)	1260 (384)									
	2	240 (73)	390 (119)	610 (186)	970 (296)	1520 (463)								
	3	180 (55)	290 (88)	470 (143)	740 (226)	1160 (354)	1810 (552)							
	5		170 (52)	280 (85)	440 (134)	690 (210)	1080 (329)	1660 (506)						
	7.5			200 (61)	310 (94)	490 (149)	770 (235)	1180 (360)	1770 (539)					
	10				230 (70)	370 (113)	570 (174)	880 (268)	1330 (405)	1640 (500)				
	15					250 (76)	390 (119)	600 (183)	910 (277)	1110 (338)	1340 (408)			
	20						300 (91)	460 (140)	700 (213)	860 (262)	1050 (320)	1270 (387)		
	25							370 (113)	570 (174)	700 (213)	840 (256)	1030 (314)	1170 (357)	
	30							310 (94)	470 (143)	580 (177)	700 (213)	850 (259)	970 (296)	1110 (338)
230	1.5	360 (110)	580 (177)	920 (280)	1450 (442)									
	2	280 (85)	450 (137)	700 (213)	1110 (338)	1740 (530)								
	3	210 (64)	340 (104)	540 (165)	860 (262)	1340 (408)	2080 (634)							
	5		200 (61)	320 (98)	510 (155)	800 (244)	1240 (378)	1900 (579)						
	7.5			230 (70)	360 (110)	570 (174)	890 (271)	1350 (411)	2030 (619)					
	10				270 (82)	420 (128)	660 (201)	1010 (308)	1520 (463)	1870 (570)				
	15					290 (88)	450 (137)	690 (210)	1040 (317)	1280 (390)	1540 (469)			
	20						350 (107)	530 (162)	810 (247)	990 (302)	1200 (366)	1450 (442)		
	25						280 (85)	430 (131)	650 (198)	800 (244)	970 (296)	1170 (357)	1340 (408)	
	30							350 (107)	540 (165)	660 (201)	800 (244)	970 (296)	1110 (338)	1270 (387)
460	1.5	1700 (518)												
	2	1300 (396)	2070 (631)											
	3	1000 (305)	1600 (488)	2520 (768)										
	5	590 (180)	950 (290)	1500 (457)	2360 (719)									
	7.5	420 (128)	680 (207)	1070 (326)	1690 (515)	2640 (805)								
	10	310 (94)	500 (152)	790 (241)	1250 (381)	1960 (597)	3050 (930)							
	15			540 (165)	850 (259)	1340 (408)	2090 (637)	3200 (975)						
	20			410 (125)	650 (198)	1030 (314)	1610 (491)	2470 (753)	3730 (1137)					
	25				530 (162)	830 (253)	1300 (396)	1990 (607)	3010 (917)	3700 (1128)				
	30				430 (131)	680 (207)	1070 (326)	1640 (500)	2490 (759)	3060 (933)	3700 (1128)			
	40						790 (241)	1210 (369)	1830 (558)	2250 (686)	2710 (826)	3290 (1003)		
	50						640 (195)	980 (299)	1480 (451)	1810 (552)	2190 (668)	2650 (808)	3010 (917)	
	60							830 (253)	1250 (381)	1540 (469)	1850 (564)	2240 (683)	2540 (774)	2890 (881)
	75								1030 (314)	1260 (384)	1520 (463)	1850 (564)	2100 (640)	2400 (732)
	100									940 (287)	1130 (344)	1380 (421)	1560 (475)	1790 (546)
	125											1080 (329)	1220 (372)	1390 (424)
	150												1050 (320)	1190 (363)
	200												1080 (329)	1300 (396)
	250													1080 (329)

3 phase, 60 Hz														
Motor rating		Copper wire size												
Volts	Hp	14	12	10	8	6	4	2	0	00	000	0000	250	300
		Maximum motor cable length (motor service to entrance) [ft/m]												
575	1.5	2620 (799)												
	2	2030 (619)												
	3	1580 (482)	2530 (771)											
	5	920 (280)	1480 (451)	2330 (710)										
	7.5	660 (201)	1060 (323)	1680 (512)	2650 (808)									
	10	490 (149)	780 (238)	1240 (378)	1950 (594)									
	15		530 (162)	850 (259)	1340 (408)	2090 (637)								
	20			650 (198)	1030 (314)	1610 (491)	2520 (768)							
	25			520 (158)	830 (253)	1300 (396)	2030 (619)	3110 (948)						
	30				680 (207)	1070 (326)	1670 (509)	2560 (780)	3880 (1183)					
	40					790 (241)	1240 (378)	1900 (579)	2860 (872)	3510 (1070)				
	50						1000 (305)	1540 (469)	2310 (704)	2840 (866)	3420 (1042)			
	60						850 (259)	1300 (396)	1960 (597)	2400 (732)	2890 (881)	3500 (1067)		
	75							1060 (323)	1600 (488)	1970 (600)	2380 (725)	2890 (881)	3290 (1003)	

CAUTION: Use of wire size smaller than listed will void warranty.

Notes:

1. If aluminum conductor is used, multiply lengths by 0.5 Maximum allowable length of aluminum is considerably shorter than copper wire of same size.
2. The portion of the total cable which is between the service entrance and a 3ø motor starter should not exceed 25% of the total maximum length to assure reliable starter operation. Single-phase control boxes may be connected at any point of the total cable length.
3. Cables #14 to #0000 are AWG sizes, and 250 to 300 are MCM sizes.

10. Friction loss tables

Friction loss table - SCH 40 steel pipe

U.S. gpm	U.S. gph	.5"	.75"	1"	1.25"	1.5"	2"	2.5"	3"	4"
		ID 0.622"	ID 0.824"	ID 1.049"	ID 1.380"	ID 1.610"	ID 2.067"	ID 2.469"	ID 3.068"	ID 4.026"
		Friction loss in feet of head per 100 feet of pipe								
2	120	4.8								
3	180	10.0	2.5							
4	240	17.1	4.2							
5	300	25.8	6.3	1.9						
6	360	36.5	8.9	2.7						
7	420	48.7	11.8	3.6						
8	480	62.7	15.0	4.5						
9	540	78.3	18.8	5.7						
10	600	95.9	23.0	6.9						
12	720		32.6	9.6	2.5	1.2				
14	840		43.5	12.8	3.3	1.5				
16	960		56.3	16.5	4.2	2.0				
20	1,200		86.1	25.1	6.3	2.9				
25	1,500			38.7	9.6	4.5	1.3			
30	1,800			54.6	13.6	6.3	1.8			
35	2,100			73.3	18.2	8.4	2.4			
40	2,400			95.0	23.5	10.8	3.1	1.3		
45	2,700				29.4	13.5	3.9	1.6		
50	3,000				36.0	16.4	4.7	1.9		
60	3,600				51.0	23.2	6.6	2.7		
70	4,200				68.8	31.3	8.9	3.6	1.2	
80	4,800				89.2	40.5	11.4	4.6	1.6	
90	5,400					51.0	14.2	5.8	2.0	
100	6,000					62.2	17.4	7.1	2.4	
120	7,200						24.7	10.1	3.4	
140	8,400						33.2	13.5	4.5	1.2
160	9,600						43.0	17.5	5.8	1.5
200	12,000						66.3	27.0	8.9	2.3
260	15,600							45.0	14.8	3.7
300	18,000							59.6	19.5	4.9

Friction loss table - SCH 40 PVC pipe

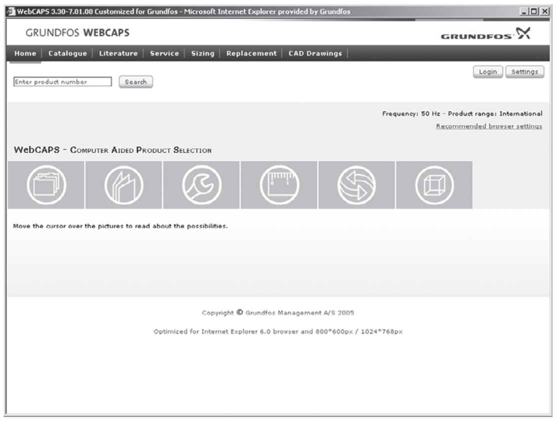
U.S. gpm	U.S. gph	.5"	.75"	1"	1.25"	1.5"	2"	2.5"	3"	4"
		ID 0.622"	ID 0.824"	ID 1.049"	ID 1.380"	ID 1.610"	ID 2.067"	ID 2.469"	ID 3.068"	ID 4.026"
		Friction loss in feet of head per 100 feet of pipe								
2	120	4.1								
3	180	8.7	2.2							
4	240	14.8	3.7							
5	300	22.2	5.7	1.8						
6	360	31.2	8.0	2.5						
7	420	41.5	10.6	3.3						
8	480	53.0	13.5	4.2						
9	540	66.0	16.8	5.2						
10	600	80.5	20.4	6.3	1.7					
12	720		28.6	8.9	2.3	1.1				
14	840		38.0	11.8	3.1	1.4				
16	960		48.6	15.1	4.0	1.9				
20	1,200		60.5	22.8	6.0	2.8				
25	1,500			38.7	9.1	4.3	1.3			
30	1,800				12.7	6.0	1.8			
35	2,100				16.9	8.0	2.4			
40	2,400				21.6	10.2	3.0	1.1		
45	2,700				28.0	12.5	3.8	1.4		
50	3,000					15.4	4.6	1.7		
60	3,600					21.6	6.4	2.3		
70	4,200					28.7	8.5	3.0	1.2	
80	4,800					36.8	10.9	3.8	1.4	
90	5,400					45.7	13.6	4.8	1.8	
100	6,000					56.6	16.5	5.7	2.2	
120	7,200						23.1	8.0	3.0	
140	8,400						30.6	10.5	4.0	1.1
160	9,600						39.3	13.4	5.0	1.4
200	12,000						66.3	20.1	7.6	2.1
260	15,600							32.4	12.2	3.4
300	18,000							42.1	15.8	4.4

Type of fitting and application	Pipe and fitting	Nominal size of fitting and pipe						
		1/2"	3/4"	1"	1.25"	1.5"	2"	2.5"
		Friction loss in equivalent length of straight pipe in feet						
Insert coupling	Plastic	3	3	3	3	3	3	3
Threaded adapter (plastic to thread)	Plastic	3	3	3	3	3	3	3
90° standard elbow	Steel	2	2	3	4	4	5	6
	Plastic	2	2	3	4	4	5	6
Standard tee (flow through run)	Steel	1	2	2	3	3	4	4
	Plastic	1	2	2	3	3	4	4
Standard tee (flow through side)	Steel	4	5	6	7	8	11	13
	Plastic	4	5	6	7	8	11	13
Gate valve[1]	Steel	1	1	1	1	2	2	2
Swing check valve[1]	Steel	5	7	9	12	13	17	21

Notes:
Based on Schedule 40 steel and plastic fittings
[1] Friction loss figures are for screwed valves and are based on equivalent lengths of steel pipe.

11. Further product documentation

WebCAPS


WebCAPS 3.30-7.81.08 Customized for Grundfos - Microsoft Internet Explorer provided by Grundfos
GRUNDFOS WEBCAPS
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Sizing
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Frequency: 50 Hz - Product range: International

WebCAPS - Computer Aided Product Selection

Move the cursor over the pictures to read about the possibilities.

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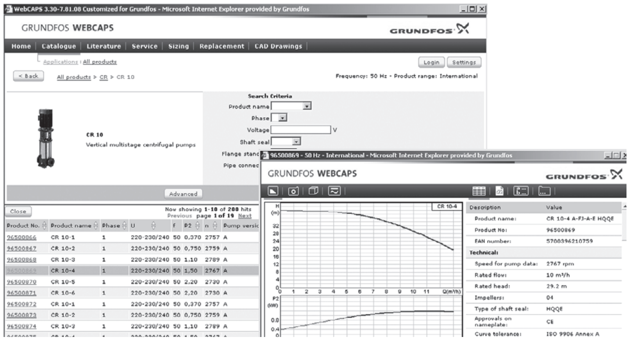
WebCAPS contains detailed information on more than 185,000 Grundfos products in more than 20 languages.

In WebCAPS, all information is divided into 6 sections:

- Catalog
- Literature
- Service
- Sizing
- Replacement
- CAD drawings.



Frequency: 50 Hz - Product range: International

CR 10
Vertical multistage centrifugal pumps

Now showing 1-10 of 200 hits
Previous page 1 of 19 Next

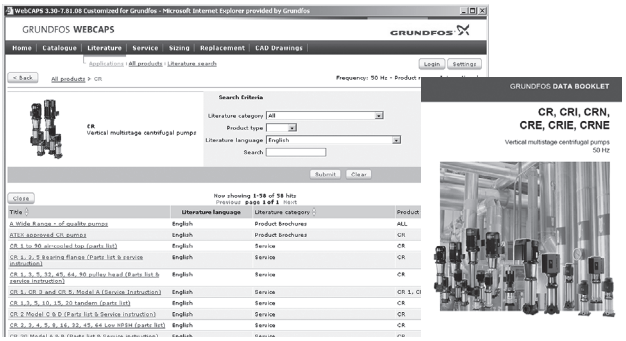
Product No.	Product name	Phase	U	f	P2	n	Pump versic
96500866	CR 10-1	1	220-230/240	50	0,370	2757	A
96500867	CR 10-2	1	220-230/240	50	0,750	2759	A
96500868	CR 10-3	1	220-230/240	50	1,10	2789	A
96500869	CR 10-4	1	220-230/240	50	1,50	2767	A
96500870	CR 10-5	1	220-230/240	50	2,20	2730	A
96500871	CR 10-6	1	220-230/240	50	2,20	2730	A
96500872	CR 10-1	1	220-230/240	50	0,370	2757	A
96500873	CR 10-2	1	220-230/240	50	0,750	2759	A
96500874	CR 10-3	1	220-230/240	50	1,10	2789	A

Description	Value
Product name:	CR 10-4 A-FJ-A-E HQQE
Product No:	96500869
EAN number:	5700396210759
Technical:	
Speed for pump data:	2767 rpm
Rated flow:	10 m³/h
Rated head:	29.2 m
Impellers:	04
Type of shaft seal:	HQQE
Approvals on nameplate:	CE
Curve tolerance:	ISO 9906 Annex A

Catalog

This section is based on fields of application and pump types, and contains

- technical data
- curves (QH, Eta, P1, P2, etc) which can be adapted to the density and viscosity of the pumped liquid and show the number of pumps in operation
- product photos
- dimensional drawings
- wiring diagrams
- quotation texts, etc.



Frequency: 50 Hz - Product r

CR
Vertical multistage centrifugal pumps

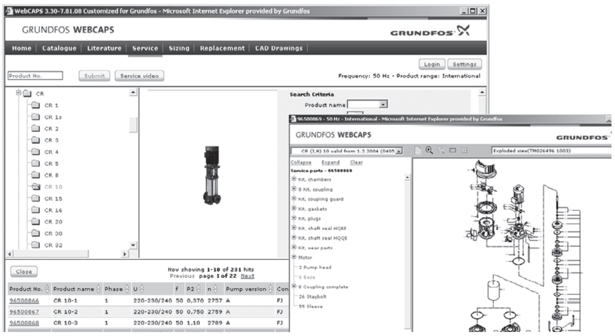
Now showing 1-58 of 58 hits
Previous page 1 of 1 Next

Title	Literature language	Literature category	Product
A Wide Range - of quality pumps	English	Product Brochures	ALL
ATEX approved CR pumps	English	Product Brochures	CR
CR 1 to 90 air-cooled top (parts list)	English	Service	CR
CR 1, 3, 5 Bearing flange (Parts list & service instruction)	English	Service	CR
CR 1, 3, 5, 32, 45, 64, 90 pulley head (Parts list & service instruction)	English	Service	CR
CR 1, CR 3 and CR 5, Model A (Service Instruction)	English	Service	CR 1, CI
CR 1,3, 5, 10, 15, 20 tandem (parts list)	English	Service	CR
CR 2 Model C & D (Parts list & Service instruction)	English	Service	CR
CR 2, 3, 4, 5, 8, 16, 32, 45, 64 Low NPSH (parts list)	English	Service	CR

Literature

In this section you can access all the latest documents of a given pump, such as

- product guides
- installation and operating instructions
- service documentation, such as Service kit catalog and Service kit instructions
- quick guides
- product brochures, etc.



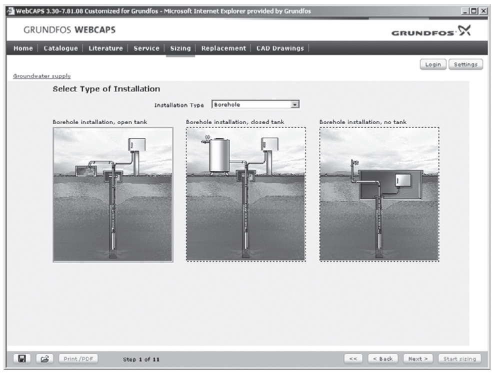
Frequency: 50 Hz - Product range: International

Now showing 1-10 of 231 hits
Previous page 1 of 22 Next

Product No.	Product name	Phase	U	f	P2	n	Pump version	Con
96500866	CR 10-1	1	220-230/240	50	0,370	2757	A	FJ
96500867	CR 10-2	1	220-230/240	50	0,750	2759	A	FJ
96500868	CR 10-3	1	220-230/240	50	1,10	2789	A	FJ

Service

This section contains an easy-to-use interactive service catalog. Here you can find and identify service parts of both existing and discontinued Grundfos pumps.
Furthermore, this section contains service videos showing you how to replace service parts.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Settings
Groundwater supply
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Next >
Start sizing

Select Type of Installation

Installation Type: Borehole

Borehole installation, open tank

Borehole installation, closed tank

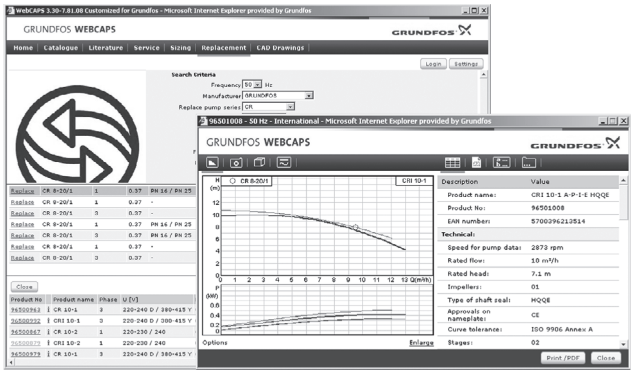
Borehole installation, no tank

Step 1 of 11

Sizing

This section is based on different fields of application and installation examples, and gives easy step-by-step instructions in how to

- select the most suitable and efficient pump for your installation
- carry out advanced calculations based on energy consumption, payback periods, load profiles, life cycle costs, etc.
- analyse your selected pump via the built-in life cycle cost tool
- determine the flow velocity in wastewater applications, etc.


WebCAPS 3.30-7.81.08 Customized for Grundfos - Microsoft Internet Explorer provided by Grundfos
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Close
96501008 - 50 Hz - International - Microsoft Internet Explorer provided by Grundfos
GRUNDFOS WEBCAPS
GRUNDFOS
H (m)
CR 8-20/1
CRI 10-1
12
10
8
6
4
2
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 Q(m³/h)
P (kW)
0.6
0.4
0.2
0
Options
Enlarge
Print /PDF
Close

Search Criteria

Frequency: 50 Hz

Manufacturer: GRUNDFOS

Replace pump series: CR

Replace	CR 8-20/1	1	0.37	PN 16 / PN 25
Replace	CR 8-20/1	1	0.37	-
Replace	CR 8-20/1	3	0.37	-
Replace	CR 8-20/1	1	0.37	PN 16 / PN 25
Replace	CR 8-20/1	3	0.37	PN 16 / PN 25
Replace	CR 8-20/1	1	0.37	-
Replace	CR 8-20/1	3	0.37	-

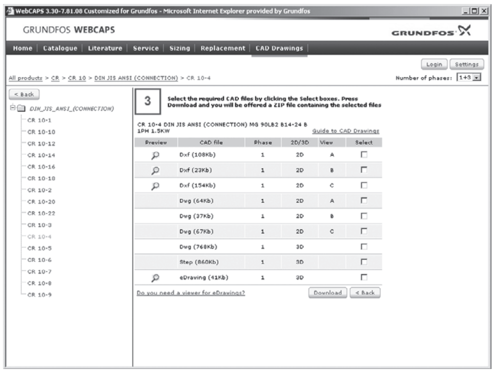
Product No	Product name	Phase	U [V]
96500963	CR 10-1	3	220-240 D / 380-415 Y
96500992	CRI 10-1	3	220-240 D / 380-415 Y
96500867	CR 10-2	1	220-230 / 240
96500879	CRI 10-2	1	220-230 / 240
96500979	CR 10-1	3	220-240 D / 380-415 Y

Description	Value
Product name:	CRI 10-1 A-P-I-E HQQE
Product No:	96501008
EAN number:	5700396213514
Technical:	
Speed for pump data:	2873 rpm
Rated flow:	10 m³/h
Rated head:	7.1 m
Impellers:	01
Type of shaft seal:	HQQE
Approvals on nameplate:	CE
Curve tolerance:	ISO 9906 Annex A
Stages:	02

Replacement

In this section you find a guide to selecting and comparing replacement data of an installed pump in order to replace the pump with a more efficient Grundfos pump.
The section contains replacement data of a wide range of pumps produced by other manufacturers than Grundfos.

Based on an easy step-by-step guide, you can compare Grundfos pumps with the one you have installed on your site. When you have specified the installed pump, the guide will suggest a number of Grundfos pumps which can improve both comfort and efficiency.


WebCAPS 3.30-7.81.08 Customized for Grundfos - Microsoft Internet Explorer provided by Grundfos
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DIN_JIS_ANSI_(CONNECTION)
CR 10-1
CR 10-10
CR 10-12
CR 10-14
CR 10-16
CR 10-18
CR 10-2
CR 10-20
CR 10-22
CR 10-3
CR 10-4
CR 10-5
CR 10-6
CR 10-7
CR 10-8
CR 10-9
Download
< Back

All products > CR > CR 10 > DIN JIS ANSI (CONNECTION) > CR 10-4

Number of phases: 1+3

3 Select the required CAD files by clicking the Select boxes. Press Download and you will be offered a ZIP file containing the selected files

CR 10-4 DIN JIS ANSI (CONNECTION) MG 90LB2 B14-24 B 1PH 1.5KW

Guide to CAD Drawings

Preview	CAD file	Phase	2D/3D	View	Select
🔍	Dxf (108Kb)	1	2D	A	☐
🔍	Dxf (23Kb)	1	2D	B	☐
🔍	Dxf (154Kb)	1	2D	C	☐
	Dwg (64Kb)	1	2D	A	☐
	Dwg (37Kb)	1	2D	B	☐
	Dwg (67Kb)	1	2D	C	☐
	Dwg (768Kb)	1	3D		☐
	Step (860Kb)	1	3D		☐
🔍	eDrawing (41Kb)	1	3D		☐

Do you need a viewer for eDrawings?

CAD drawings

In this section it is possible to download 2-dimensional (2D) and 3-dimensional (3D) CAD drawings of most Grundfos pumps.

These formats are available in WebCAPS:

2-dimensional drawings:
- .dxf, wireframe drawings
- .dwg, wireframe drawings.

3-dimensional drawings:
- .dwg, wireframe drawings (without surfaces)
- .stp, solid drawings (with surfaces)
- .eprt, E-drawings.

WinCAPS

Fig. 28 WinCAPS CD-ROM

WinCAPS is a **Win**dows-based **C**omputer **A**ided **P**roduct **S**election program containing detailed information on more than 185,000 Grundfos products in more than 20 languages.

The program contains the same features and functions as WebCAPS, but is an ideal solution if no Internet connection is available.

WinCAPS is available on CD-ROM and updated once a year.

BE > THINK > INNOVATE >

Being responsible is our foundation
Thinking ahead makes it possible
Innovation is the essence

L-SP-PG-001 0612 US

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GRUNDFOS Canada Inc.
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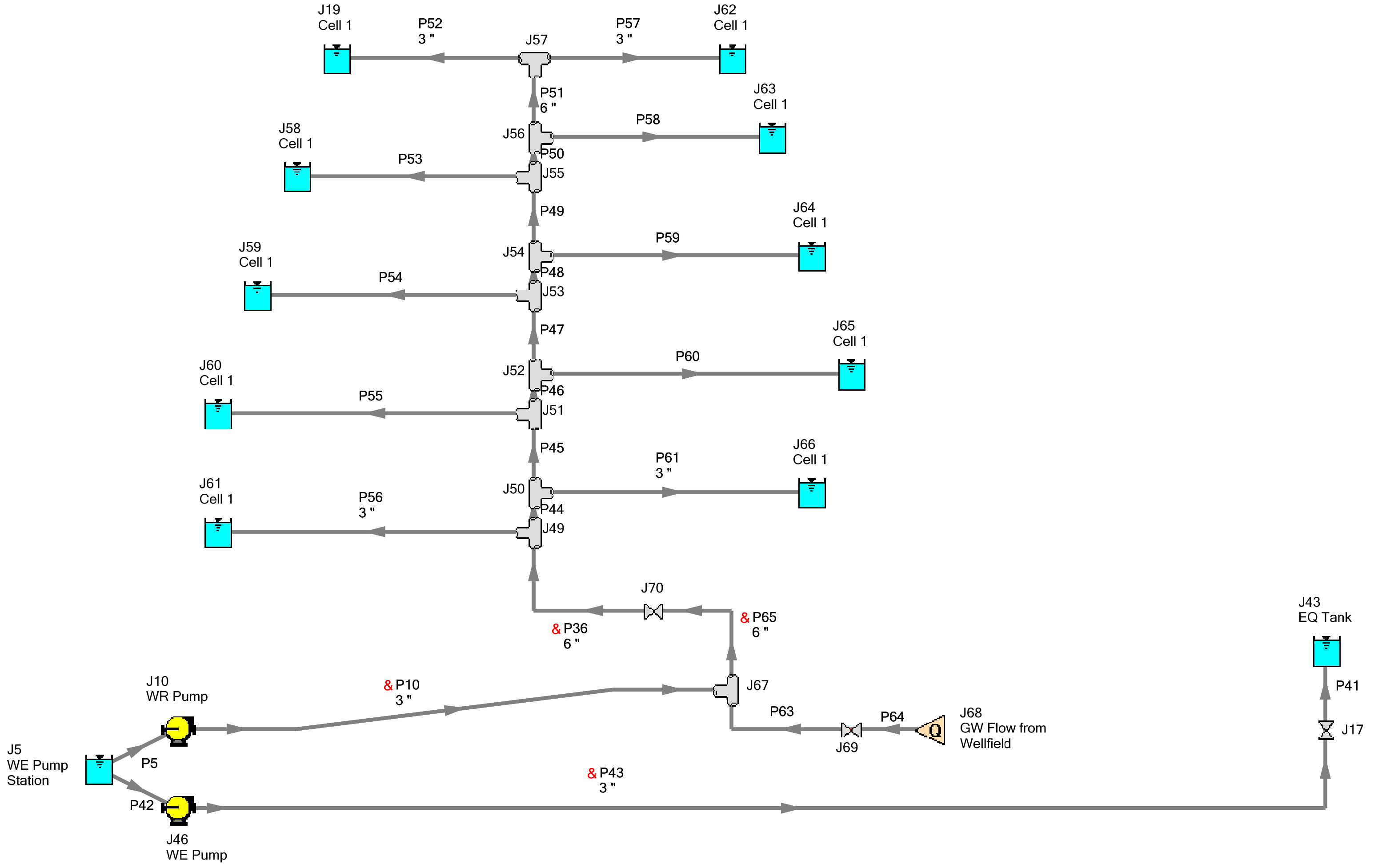
Telefax: +1-905 829 9512

Bombas GRUNDFOS de Mexico S.A. de C.V.
Boulevard TLC No. 15
Parque Industrial Stiva Aeropuerto
Apodaca, N.L. Mexico 66600
Phone: +52-81-8144 4000
Telefax: +52-81-8144 4010

Wetlands Effluent Pump Station including Pipe Sizing



AFT Fathom 10 (Workspace) 3/23/2020 Page 1 of 1	AFT Fathom Model Kaiser Mead GWTS Wetland Effluent Sump Pumps	

Model Reference Information

General

Title: AFT Fathom Model
Analysis run on: 3/23/2020 3:03:33 PM
Application version: AFT Fathom Version 10 (2019.03.28)
Input File: C:\Kaiser Mead GWTS\Mechanical\Fathom\Wetland Sump Pumps Model\Wetland Sump Pumps_v6.fth
Scenario: Base Scenario - HDPE Piping/Two Pumps - 50 gpm
Output File: C:\Kaiser Mead GWTS\Mechanical\Fathom\Wetland Sump Pumps Model\Wetland Sump Pumps_v6_F2.out

Execution Time= 0.13 seconds
Total Number Of Head/Pressure Iterations= 67
Total Number Of Flow Iterations= 11
Total Number Of Temperature Iterations= 0
Number Of Pipes= 27
Number Of Junctions= 28
Matrix Method= Gaussian Elimination

Pressure/Head Tolerance= 0.0001 relative change
Flow Rate Tolerance= 0.0001 relative change
Temperature Tolerance= 0.0001 relative change
Flow Relaxation= (Automatic)
Pressure Relaxation= (Automatic)

Constant Fluid Property Model
Fluid Database: AFT Standard
Fluid: Water at 1 atm
Max Fluid Temperature Data= 212 deg. F
Min Fluid Temperature Data= 32 deg. F
Temperature= 60 deg. F
Density= 62.37215 lbm/ft3
Viscosity= 2.72848 lbm/hr-ft
Vapor Pressure= 0.25024 psia
Viscosity Model= Newtonian
Apply laminar and non-Newtonian correction to: Pipe Fittings & Losses, Junction K factors, Junction Special Losses, Junction Polynomials
Corrections applied to the following junctions: Branch, Reservoir, Assigned Flow, Assigned Pressure, Area Change, Bend, Tee or Wye, Spray Discharge, Relief Valve

Ambient Pressure (constant)= 1 atm
Gravitational Acceleration= 1 g
Turbulent Flow Above Reynolds Number= 4000
Laminar Flow Below Reynolds Number= 2300
Total Inflow= 150.0 gal/min
Total Outflow= 150.0 gal/min
Maximum Static Pressure is 23.30 psia at Pipe 43 Inlet
Minimum Static Pressure is 14.80 psia at Pipe 57 Outlet

Warnings

No Warnings

Pump Summary

Jct	Results Diagram	Name	Vol. Flow (gal/min)	dH (feet)	Speed (Percent)	Ideal Power (hp)	Pump Efficiency (Percent)	Shaft Power (hp)	Motor Efficiency (Percent)	Motor Input Power (hp)	NPSHA (feet)
10	Show	WR Pump	50.00	10.62	65.25	0.1341	52.15	0.2572	80.00	0.3215	38.35
46	Show	WE Pump	50.00	14.95	74.49	0.1888	50.58	0.3733	80.00	0.4667	38.35

Jct	NPSHR (feet)
10	N/A
46	N/A

Valve Summary

Jct	Name	Valve Type	Vol. Flow (gal/min)	Mass Flow (lbm/sec)	dP Stag. (psid)	dH (feet)	P Static In (psia)	Cv	K	Valve State
17	Valve	REGULAR	50.00	6.948	0.0102928	0.023763	18.84	492.8	0.3229	Open
69	Valve	REGULAR	50.00	6.948	0.0102304	0.023619	16.75	494.3	0.3228	Open
70	Valve	REGULAR	100.00	13.897	0.0009805	0.002264	14.83	3,193.5	0.1197	Open

Reservoir Summary

Jct	Name	Type	Liq. Height (feet)	Liq. Elevation (feet)	Surface Pressure (psia)	Liquid Volume (feet3)	Liquid Mass (lbm)	Net Vol. Flow (gal/min)	Net Mass Flow (lbm/sec)
5	WE Pump Station	Infinite	N/A	1,936	14.70	N/A	N/A	-100.000	-13.8966
19	Cell 1	Infinite	N/A	1,944	14.70	N/A	N/A	13.190	1.8329
43	EQ Tank	Infinite	N/A	1,950	14.70	N/A	N/A	50.000	6.9483
58	Cell 1	Infinite	N/A	1,944	14.70	N/A	N/A	8.831	1.2272
59	Cell 1	Infinite	N/A	1,944	14.70	N/A	N/A	7.294	1.0137
60	Cell 1	Infinite	N/A	1,944	14.70	N/A	N/A	6.804	0.9455
61	Cell 1	Infinite	N/A	1,944	14.70	N/A	N/A	7.611	1.0577
62	Cell 1	Infinite	N/A	1,944	14.70	N/A	N/A	15.929	2.2136
63	Cell 1	Infinite	N/A	1,944	14.70	N/A	N/A	11.296	1.5697
64	Cell 1	Infinite	N/A	1,944	14.70	N/A	N/A	9.881	1.3731
65	Cell 1	Infinite	N/A	1,944	14.70	N/A	N/A	8.862	1.2315
66	Cell 1	Infinite	N/A	1,944	14.70	N/A	N/A	10.301	1.4315

Pipe Output Table

Pipe	Name	Vol. Flow Rate (gal/min)	Pipe Nominal Size	Velocity (feet/sec)	P Static Max (psia)	P Static Min (psia)	Elevation Inlet (feet)	Elevation Outlet (feet)	dP Stag. Total (psid)	dP Static Total (psid)
5	Pipe	50.000	12 inch	0.1433	16.86	16.86	1,931	1,931	0.000002168	0.000002168
10	Pipe	50.000	3 inch	2.1763	21.43	14.85	1,931	1,944	6.575308889	6.575308889

Pipe	dP Gravity (psid)	dH (feet)	P Static In (psia)	P Static Out (psia)	P Stag. In (psia)	P Stag. Out (psia)
5	0.000	0.000005006	16.86	16.86	16.86	16.86
10	5.523	2.430565406	21.43	14.85	21.46	14.89

Pipe	Name	Vol. Flow Rate (gal/min)	Pipe Nominal Size	Velocity (feet/sec)	P Static Max (psia)	P Static Min (psia)	Elevation Inlet (feet)	Elevation Outlet (feet)	dP Stag. Total (psid)	dP Static Total (psid)
36	Pipe	100.000	6 inch	1.1033	14.83	14.82	1,944	1,944	0.015501299	0.015501299
41	Pipe	50.000	3 inch	2.1699	18.83	18.81	1,940	1,940	0.015918499	0.015918499
42	Pipe	50.000	12 inch	0.1433	16.86	16.86	1,931	1,931	0.000002168	0.000002168
43	Pipe	50.000	3 inch	2.1763	23.30	18.84	1,931	1,940	4.467759967	4.467759967
44	Pipe	92.391	6 inch	1.0194	14.82	14.82	1,944	1,944	0.000149734	0.000149734
45	Pipe	82.087	6 inch	0.9057	14.82	14.81	1,944	1,944	0.004856489	0.004856489
46	Pipe	75.284	6 inch	0.8306	14.82	14.82	1,944	1,944	0.000104170	0.000104170
47	Pipe	66.421	6 inch	0.7328	14.82	14.81	1,944	1,944	0.003339110	0.003339110
48	Pipe	59.127	6 inch	0.6524	14.81	14.81	1,944	1,944	0.000067984	0.000067984
49	Pipe	49.246	6 inch	0.5433	14.81	14.81	1,944	1,944	0.001970631	0.001970631
50	Pipe	40.414	6 inch	0.4459	14.81	14.81	1,944	1,944	0.000034819	0.000034819
51	Pipe	29.119	6 inch	0.3213	14.81	14.81	1,944	1,944	0.000785073	0.000785073
52	Pipe	13.190	3 inch	0.5741	14.81	14.80	1,944	1,944	0.008958963	0.008958963
53	Pipe	8.831	3 inch	0.3844	14.81	14.80	1,944	1,944	0.007655961	0.007655961
54	Pipe	7.294	3 inch	0.3175	14.81	14.80	1,944	1,944	0.008256774	0.008256774
55	Pipe	6.804	3 inch	0.2961	14.81	14.80	1,944	1,944	0.009765550	0.009765550
56	Pipe	7.611	3 inch	0.3313	14.82	14.80	1,944	1,944	0.011843837	0.011843837
57	Pipe	15.929	3 inch	0.6933	14.81	14.80	1,944	1,944	0.008893607	0.008893607
58	Pipe	11.296	3 inch	0.4917	14.81	14.80	1,944	1,944	0.007819287	0.007819287
59	Pipe	9.881	3 inch	0.4301	14.81	14.80	1,944	1,944	0.008524268	0.008524268
60	Pipe	8.862	3 inch	0.3857	14.81	14.80	1,944	1,944	0.010269552	0.010269552
61	Pipe	10.301	3 inch	0.4484	14.82	14.80	1,944	1,944	0.012494212	0.012494212
63	Pipe	50.000	3 inch	2.1699	16.74	14.85	1,940	1,944	1.889579415	1.889579415
64	Pipe	50.000	3 inch	2.1699	17.02	16.75	1,940	1,940	0.265304714	0.265304714
65	Pipe	100.000	6 inch	1.1033	14.85	14.83	1,944	1,944	0.018947665	0.018947665

Pipe	dP Gravity (psid)	dH (feet)	P Static In (psia)	P Static Out (psia)	P Stag. In (psia)	P Stag. Out (psia)
36	0.000	0.035788202	14.83	14.82	14.84	14.83
41	0.000	0.036751401	18.83	18.81	18.86	18.84
42	0.000	0.000005006	16.86	16.86	16.86	16.86
43	3.898	1.314819203	23.30	18.84	23.34	18.87
44	0.000	0.000345694	14.82	14.82	14.83	14.83
45	0.000	0.011212286	14.82	14.81	14.83	14.82
46	0.000	0.000240499	14.82	14.82	14.82	14.82
47	0.000	0.007709079	14.82	14.81	14.82	14.82
48	0.000	0.000156957	14.81	14.81	14.82	14.82
49	0.000	0.004549640	14.81	14.81	14.82	14.81
50	0.000	0.000080388	14.81	14.81	14.81	14.81
51	0.000	0.001812516	14.81	14.81	14.81	14.81
52	0.000	0.020683761	14.81	14.80	14.81	14.80
53	0.000	0.017675493	14.81	14.80	14.81	14.80
54	0.000	0.019062603	14.81	14.80	14.81	14.80
55	0.000	0.022545949	14.81	14.80	14.81	14.80
56	0.000	0.027344136	14.82	14.80	14.82	14.80
57	0.000	0.020532873	14.81	14.80	14.81	14.80
58	0.000	0.018052565	14.81	14.80	14.81	14.80
59	0.000	0.019680172	14.81	14.80	14.81	14.80
60	0.000	0.023709550	14.81	14.80	14.81	14.80
61	0.000	0.028845672	14.82	14.80	14.82	14.80
63	1.624	0.612515037	16.74	14.85	16.78	14.89
64	0.000	0.612515037	17.02	16.75	17.05	16.79
65	0.000	0.043744905	14.85	14.83	14.86	14.84

All Junction Table

Jct	Name	P Static In (psia)	P Static Out (psia)	P Stag. In (psia)	P Stag. Out (psia)	Vol. Flow Rate Thru Jct (gal/min)	Mass Flow Rate Thru Jct (lbm/sec)	Loss Factor (K)
5	WE Pump Station	14.70	16.86	14.70	16.86	N/A	N/A	See Mult. Losses
10	WR Pump	16.86	21.43	16.86	21.46	50.000	6.9483	0.0000
17	Valve	18.84	18.83	18.87	18.86	50.000	6.9483	0.3229
19	Cell 1	14.70	14.80	14.70	14.80	13.190	1.8329	0.0000
43	EQ Tank	14.70	18.81	14.70	18.81	50.000	6.9483	1.0000
46	WE Pump	16.86	23.30	16.86	23.34	50.000	6.9483	0.0000
49	Tee or Wye	14.82	14.82	14.83	14.83	N/A	N/A	See Mult. Losses
50	Tee or Wye	14.82	14.82	14.83	14.83	N/A	N/A	See Mult. Losses
51	Tee or Wye	14.82	14.82	14.82	14.82	N/A	N/A	See Mult. Losses
52	Tee or Wye	14.82	14.82	14.82	14.82	N/A	N/A	See Mult. Losses

Jct	Name	P Static In (psia)	P Static Out (psia)	P Stag. In (psia)	P Stag. Out (psia)	Vol. Flow Rate Thru Jct (gal/min)	Mass Flow Rate Thru Jct (lbm/sec)	Loss Factor (K)
53	Tee or Wye	14.81	14.81	14.82	14.82	N/A	N/A	See Mult. Losses
54	Tee or Wye	14.81	14.81	14.82	14.82	N/A	N/A	See Mult. Losses
55	Tee or Wye	14.81	14.81	14.81	14.81	N/A	N/A	See Mult. Losses
56	Tee or Wye	14.81	14.81	14.81	14.81	N/A	N/A	See Mult. Losses
57	Tee or Wye	14.81	14.81	14.81	14.81	N/A	N/A	See Mult. Losses
58	Cell 1	14.70	14.80	14.70	14.80	8.831	1.2272	0.0000
59	Cell 1	14.70	14.80	14.70	14.80	7.294	1.0137	0.0000
60	Cell 1	14.70	14.80	14.70	14.80	6.804	0.9455	0.0000
61	Cell 1	14.70	14.80	14.70	14.80	7.611	1.0577	0.0000
62	Cell 1	14.70	14.80	14.70	14.80	15.929	2.2136	0.0000
63	Cell 1	14.70	14.80	14.70	14.80	11.296	1.5697	0.0000
64	Cell 1	14.70	14.80	14.70	14.80	9.881	1.3731	0.0000
65	Cell 1	14.70	14.80	14.70	14.80	8.862	1.2315	0.0000
66	Cell 1	14.70	14.80	14.70	14.80	10.301	1.4315	0.0000
67	Tee or Wye	14.84	14.84	14.86	14.86	N/A	N/A	See Mult. Losses
68	GW Flow from Wellfield	17.02	17.02	17.05	17.05	50.000	6.9483	0.0000
69	Valve	16.75	16.74	16.79	16.78	50.000	6.9483	0.3228
70	Valve	14.83	14.83	14.84	14.84	100.000	13.8966	0.1197

```
Model Reference Information

General

Title: AFT Fathom Model
Analysis run on: 3/23/2020 2:59:32 PM
Application version: AFT Fathom Version 10 (2019.03.28)
Input File: C:\Kaiser Mead GWTS\Mechanical\Fathom\Wetland Sump Pumps Model\Wetland Sump Pumps_v6.fth
Scenario: Base Scenario - HDPE Piping/Two Pumps - 50 gpm
Output File: C:\Kaiser Mead GWTS\Mechanical\Fathom\Wetland Sump Pumps Model\Wetland Sump Pumps_v6_F2.out

Execution Time= 0.59 seconds
Total Number Of Head/Pressure Iterations= 163
Total Number Of Flow Iterations= 35
Total Number Of Temperature Iterations= 0
Number Of Pipes= 27
Number Of Junctions= 28
Matrix Method= Gaussian Elimination

Pressure/Head Tolerance= 0.0001 relative change
Flow Rate Tolerance= 0.0001 relative change
Temperature Tolerance= 0.0001 relative change
Flow Relaxation=  (Automatic)
Pressure Relaxation=  (Automatic)

Constant Fluid Property Model
Fluid Database: AFT Standard
Fluid: Water at 1 atm
Max Fluid Temperature Data= 212 deg. F
Min Fluid Temperature Data= 32 deg. F
Temperature= 60 deg. F
Density= 62.37215 lbm/ft3
Viscosity= 2.72848 lbm/hr-ft
Vapor Pressure= 0.25024 psia
Viscosity Model= Newtonian
Apply laminar and non-Newtonian correction to: Pipe Fittings & Losses, Junction K factors, Junction Special Losses, Junction
Polynomials
Corrections applied to the following junctions: Branch, Reservoir, Assigned Flow, Assigned Pressure, Area Change, Bend, Tee or
Wye, Spray Discharge, Relief Valve

Ambient Pressure (constant)= 1 atm
Gravitational Acceleration= 1 g
Turbulent Flow Above Reynolds Number= 4000
Laminar Flow Below Reynolds Number= 2300
Total Inflow= 100.0 gal/min
Total Outflow= 100.0 gal/min
Maximum Static Pressure is 23.30 psia at Pipe 43 Inlet
Minimum Static Pressure is 14.80 psia at Pipe 57 Outlet


Warnings

No Warnings


Pump Summary
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Jct	Results Diagram	Name	Vol. Flow (gal/min)	dH (feet)	Speed (Percent)	Ideal Power (hp)	Pump Efficiency (Percent)	Shaft Power (hp)	Motor Efficiency (Percent)	Motor Input Power (hp)	NPSHA (feet)
10	Show	WR Pump	50.00	10.55	65.10	0.1333	52.17	0.2555	80.00	0.3193	38.35
46	Show	WE Pump	50.00	14.95	74.49	0.1888	50.58	0.3733	80.00	0.4667	38.35

Jct	NPSHR (feet)
10	N/A
46	N/A

Valve Summary

Jct	Name	Valve Type	Vol. Flow (gal/min)	Mass Flow (lbm/sec)	dP Stag. (psid)	dH (feet)	P Static In (psia)	Cv	K	Valve State
17	Valve	REGULAR	50.00	6.948	0.0102928	0.0237632	18.84	492.8	0.3229	Open
X69	Valve	REGULAR	0.00	0.000	N/A	N/A	N/A	N/A	N/A	Closed By User
70	Valve	REGULAR	50.00	6.948	0.0002451	0.0005659	14.81	3,193.5	0.1197	Open

Reservoir Summary

Jct	Name	Type	Liq. Height (feet)	Liq. Elevation (feet)	Surface Pressure (psia)	Liquid Volume (feet3)	Liquid Mass (lbm)	Net Vol. Flow (gal/min)	Net Mass Flow (lbm/sec)
5	WE Pump Station	Infinite	N/A	1,936	14.70	N/A	N/A	-100.0000010	-13.8965778
19	Cell 1	Infinite	N/A	1,944	14.70	N/A	N/A	7.8196244	1.0866601
43	EQ Tank	Infinite	N/A	1,950	14.70	N/A	N/A	50.0000005	6.9482889
58	Cell 1	Infinite	N/A	1,944	14.70	N/A	N/A	5.3080660	0.7376395
59	Cell 1	Infinite	N/A	1,944	14.70	N/A	N/A	2.8974053	0.4026402
60	Cell 1	Infinite	N/A	1,944	14.70	N/A	N/A	0.0009158	0.0001273
61	Cell 1	Infinite	N/A	1,944	14.70	N/A	N/A	0.0011539	0.0001603
62	Cell 1	Infinite	N/A	1,944	14.70	N/A	N/A	9.4649772	1.3153079
63	Cell 1	Infinite	N/A	1,944	14.70	N/A	N/A	6.7910798	0.9437277
64	Cell 1	Infinite	N/A	1,944	14.70	N/A	N/A	5.9779765	0.8307341
65	Cell 1	Infinite	N/A	1,944	14.70	N/A	N/A	5.4021968	0.7507204
66	Cell 1	Infinite	N/A	1,944	14.70	N/A	N/A	6.3365328	0.8805612

Pipe Output Table

Pipe	Name	Vol. Flow Rate (gal/min)	Pipe Nominal Size	Velocity (feet/sec)	P Static Max (psia)	P Static Min (psia)	Elevation Inlet (feet)	Elevation Outlet (feet)	dP Stag. Total (psid)
5	Pipe	50.0000018	12 inch	0.14331666	16.86	16.86	1,931	1,931	2.168E-06
10	Pipe	50.0000018	3 inch	2.17628548	21.40	14.82	1,931	1,944	6.575E+00

Pipe	dP Static Total (psid)	dP Gravity (psid)	dH (feet)	P Static In (psia)	P Static Out (psia)	P Stag. In (psia)	P Stag. Out (psia)
5	2.168E-06	0.000	0.0000050062	16.86	16.86	16.86	16.86
10	6.575E+00	5.523	2.4305654062	21.40	14.82	21.43	14.86

Pipe	Name	Vol. Flow Rate (gal/min)	Pipe Nominal Size	Velocity (feet/sec)	P Static Max (psia)	P Static Min (psia)	Elevation Inlet (feet)	Elevation Outlet (feet)	dP Stag. Total (psid)
36	Pipe	50.0000018	6 inch	0.55165316	14.81	14.81	1,944	1,944	4.477E-03
41	Pipe	50.0000018	3 inch	2.16994703	18.83	18.81	1,940	1,940	1.592E-02
42	Pipe	50.0000018	12 inch	0.14331666	16.86	16.86	1,931	1,931	2.168E-06
43	Pipe	50.0000018	3 inch	2.17628548	23.30	18.84	1,931	1,940	4.468E+00
44	Pipe	49.9988488	6 inch	0.55164044	14.81	14.81	1,944	1,944	5.060E-05
45	Pipe	43.6623182	6 inch	0.48172910	14.81	14.81	1,944	1,944	1.595E-03
46	Pipe	43.6614021	6 inch	0.48171899	14.81	14.81	1,944	1,944	3.988E-05
47	Pipe	38.2592084	6 inch	0.42211625	14.81	14.81	1,944	1,944	1.265E-03
48	Pipe	35.3618430	6 inch	0.39014944	14.81	14.81	1,944	1,944	2.756E-05
49	Pipe	29.3837489	6 inch	0.32419275	14.81	14.81	1,944	1,944	7.976E-04
50	Pipe	24.0756800	6 inch	0.26562849	14.81	14.81	1,944	1,944	1.409E-05
51	Pipe	17.2846014	6 inch	0.19070209	14.81	14.81	1,944	1,944	3.174E-04
52	Pipe	7.8196244	3 inch	0.34035469	14.81	14.80	1,944	1,944	3.620E-03
53	Pipe	5.3080659	3 inch	0.23103733	14.81	14.80	1,944	1,944	3.189E-03
54	Pipe	2.8974053	3 inch	0.12611162	14.81	14.80	1,944	1,944	1.144E-03
55	Pipe	0.0009158	3 inch	0.00003986	14.80	14.80	1,944	1,944	3.452E-07
56	Pipe	0.0011539	3 inch	0.00005022	14.80	14.80	1,944	1,944	8.208E-08
57	Pipe	9.4649770	3 inch	0.41196983	14.81	14.80	1,944	1,944	3.596E-03
58	Pipe	6.7910799	3 inch	0.29558656	14.81	14.80	1,944	1,944	3.245E-03
59	Pipe	5.9779765	3 inch	0.26019566	14.81	14.80	1,944	1,944	3.584E-03
60	Pipe	5.4021967	3 inch	0.23513444	14.81	14.80	1,944	1,944	4.382E-03
61	Pipe	6.3365327	3 inch	0.27580207	14.81	14.80	1,944	1,944	5.401E-03
63	Pipe	0.0000000	3 inch	0.00000000	16.45	14.82	1,940	1,944	1.624E+00
64	Pipe	0.0000000	3 inch	0.00000000	No Solution	No Solution	1,940	1,940	0.000E+00
65	Pipe	50.0000018	6 inch	0.55165316	14.82	14.81	1,944	1,944	5.489E-03

Pipe	dP Static Total (psid)	dP Gravity (psid)	dH (feet)	P Static In (psia)	P Static Out (psia)	P Stag. In (psia)	P Stag. Out (psia)
36	4.477E-03	0.000	0.0103362881	14.81	14.81	14.82	14.81
41	1.592E-02	0.000	0.0367514009	18.83	18.81	18.86	18.84
42	2.168E-06	0.000	0.0000050062	16.86	16.86	16.86	16.86
43	4.468E+00	3.898	1.3148192031	23.30	18.84	23.34	18.87
44	5.060E-05	0.000	0.0001168188	14.81	14.81	14.81	14.81
45	1.595E-03	0.000	0.0036825613	14.81	14.81	14.81	14.81
46	3.988E-05	0.000	0.0000920606	14.81	14.81	14.81	14.81
47	1.265E-03	0.000	0.0029210473	14.81	14.81	14.81	14.81
48	2.756E-05	0.000	0.0000636212	14.81	14.81	14.81	14.81
49	7.976E-04	0.000	0.0018413838	14.81	14.81	14.81	14.81
50	1.409E-05	0.000	0.0000325381	14.81	14.81	14.81	14.81
51	3.174E-04	0.000	0.0007327803	14.81	14.81	14.81	14.81
52	3.620E-03	0.000	0.0083571079	14.81	14.80	14.81	14.80
53	3.189E-03	0.000	0.0073622822	14.81	14.80	14.81	14.80
54	1.144E-03	0.000	0.0026413374	14.81	14.80	14.81	14.80
55	3.452E-07	0.000	0.0000007970	14.80	14.80	14.80	14.80
56	8.208E-08	0.000	0.0000001895	14.80	14.80	14.80	14.80
57	3.596E-03	0.000	0.0083033092	14.81	14.80	14.81	14.80
58	3.245E-03	0.000	0.0074909847	14.81	14.80	14.81	14.80
59	3.584E-03	0.000	0.0082734305	14.81	14.80	14.81	14.80
60	4.382E-03	0.000	0.0101162907	14.81	14.80	14.81	14.80
61	5.401E-03	0.000	0.0124685988	14.81	14.80	14.81	14.80
63	1.624E+00	1.624	0.0000000000	16.45	14.82	16.45	14.82
64	0.000E+00	0.000	0.0000000000	No Solution	No Solution	No Solution	No Solution
65	5.489E-03	0.000	0.0126726979	14.82	14.81	14.82	14.82

All Junction Table

Jct	Name	P Static In (psia)	P Static Out (psia)	P Stag. In (psia)	P Stag. Out (psia)	Vol. Flow Rate Thru Jct (gal/min)	Mass Flow Rate Thru Jct (lbm/sec)
5	WE Pump Station	14.70	16.86	14.70	16.86	N/A	N/A
10	WR Pump	16.86	21.40	16.86	21.43	50.0000018	6.9482889
17	Valve	18.84	18.83	18.87	18.86	50.0000018	6.9482889
19	Cell 1	14.70	14.80	14.70	14.80	7.8196244	1.0866601
43	EQ Tank	14.70	18.81	14.70	18.81	50.0000018	6.9482889
46	WE Pump	16.86	23.30	16.86	23.34	50.0000018	6.9482889
49	Tee or Wye	14.81	14.81	14.81	14.81	N/A	N/A
50	Tee or Wye	14.81	14.81	14.81	14.81	N/A	N/A
51	Tee or Wye	14.81	14.81	14.81	14.81	N/A	N/A
52	Tee or Wye	14.81	14.81	14.81	14.81	N/A	N/A

AFT Fathom Model
Kaiser Mead GWTS
Wetland Sump Pumps Model

Jct	Loss Factor (K)
5	See Mult. Losses
10	0.0000
17	0.3229
19	0.0000
43	1.0000
46	0.0000
49	See Mult. Losses
50	See Mult. Losses
51	See Mult. Losses
52	See Mult. Losses

Jct	Name	P Static In (psia)	P Static Out (psia)	P Stag. In (psia)	P Stag. Out (psia)	Vol. Flow Rate Thru Jct (gal/min)	Mass Flow Rate Thru Jct (lbm/sec)
53	Tee or Wye	14.81	14.81	14.81	14.81	N/A	N/A
54	Tee or Wye	14.81	14.81	14.81	14.81	N/A	N/A
55	Tee or Wye	14.81	14.81	14.81	14.81	N/A	N/A
56	Tee or Wye	14.81	14.81	14.81	14.81	N/A	N/A
57	Tee or Wye	14.81	14.81	14.81	14.81	N/A	N/A
58	Cell 1	14.70	14.80	14.70	14.80	5.3080659	0.7376395
59	Cell 1	14.70	14.80	14.70	14.80	2.8974053	0.4026402
60	Cell 1	14.70	14.80	14.70	14.80	0.0009158	0.0001273
61	Cell 1	14.70	14.80	14.70	14.80	0.0011539	0.0001603
62	Cell 1	14.70	14.80	14.70	14.80	9.4649770	1.3153079
63	Cell 1	14.70	14.80	14.70	14.80	6.7910799	0.9437277
64	Cell 1	14.70	14.80	14.70	14.80	5.9779765	0.8307341
65	Cell 1	14.70	14.80	14.70	14.80	5.4021967	0.7507204
66	Cell 1	14.70	14.80	14.70	14.80	6.3365327	0.8805612
67	Tee or Wye	14.82	14.82	14.82	14.82	N/A	N/A
68	GW Flow from Wellfield	No Solution	No Solution	No Solution	No Solution	0.0000000	0.0000000
X69	Valve	No Solution	16.45	No Solution	16.45	0.0000000	0.0000000
70	Valve	14.81	14.81	14.82	14.82	50.0000018	6.9482889

Jct	Loss Factor (K)
53	See Mult. Losses
54	See Mult. Losses
55	See Mult. Losses
56	See Mult. Losses
57	See Mult. Losses
58	0.0000
59	0.0000
60	0.0000
61	0.0000
62	0.0000
63	0.0000
64	0.0000
65	0.0000
66	0.0000
67	See Mult. Losses
68	0.0000
X69	0.0000
70	0.1197

Model Reference Information

General

Title: AFT Fathom Model
Analysis run on: 3/23/2020 2:54:35 PM
Application version: AFT Fathom Version 10 (2019.03.28)
Input File: C:\Kaiser Mead GWTS\Mechanical\Fathom\Wetland Sump Pumps Model\Wetland Sump Pumps_v6.fth
Scenario: Base Scenario - HDPE Piping/Two Pumps - 75 gpm
Output File: C:\Kaiser Mead GWTS\Mechanical\Fathom\Wetland Sump Pumps Model\Wetland Sump Pumps_v6_F1.out

Execution Time= 0.18 seconds
Total Number Of Head/Pressure Iterations= 78
Total Number Of Flow Iterations= 12
Total Number Of Temperature Iterations= 0
Number Of Pipes= 27
Number Of Junctions= 28
Matrix Method= Gaussian Elimination

Pressure/Head Tolerance= 0.0001 relative change
Flow Rate Tolerance= 0.0001 relative change
Temperature Tolerance= 0.0001 relative change
Flow Relaxation= (Automatic)
Pressure Relaxation= (Automatic)

Constant Fluid Property Model
Fluid Database: AFT Standard
Fluid: Water at 1 atm
Max Fluid Temperature Data= 212 deg. F
Min Fluid Temperature Data= 32 deg. F
Temperature= 60 deg. F
Density= 62.37215 lbm/ft3
Viscosity= 2.72848 lbm/hr-ft
Vapor Pressure= 0.25024 psia
Viscosity Model= Newtonian
Apply laminar and non-Newtonian correction to: Pipe Fittings & Losses, Junction K factors, Junction Special Losses, Junction Polynomials
Corrections applied to the following junctions: Branch, Reservoir, Assigned Flow, Assigned Pressure, Area Change, Bend, Tee or Wye, Spray Discharge, Relief Valve

Ambient Pressure (constant)= 1 atm
Gravitational Acceleration= 1 g
Turbulent Flow Above Reynolds Number= 4000
Laminar Flow Below Reynolds Number= 2300
Total Inflow= 225.0 gal/min
Total Outflow= 225.0 gal/min
Maximum Static Pressure is 23.94 psia at Pipe 43 Inlet
Minimum Static Pressure is 14.80 psia at Pipe 57 Outlet

Warnings

No Warnings

Pump Summary

Jct	Results Diagram	Name	Vol. Flow (gal/min)	dH (feet)	Speed (Percent)	Ideal Power (hp)	Pump Efficiency (Percent)	Shaft Power (hp)	Motor Efficiency (Percent)	Motor Input Power (hp)	NPSHA (feet)
10	Show	WR Pump	75.00	13.47	79.92	0.2553	51.55	0.4953	80.00	0.6191	38.35
46	Show	WE Pump	75.00	16.50	85.60	0.3126	52.28	0.5979	80.00	0.7473	38.35

Jct	NPSHR (feet)
10	N/A
46	N/A

Valve Summary

Jct	Name	Valve Type	Vol. Flow (gal/min)	dP Stag. (psid)	dH (feet)	P Static In (psia)	Cv	K	Valve State
17	Valve	REGULAR	75.00	0.003860	0.008911	18.85	1,207.2	0.05381	Open
69	Valve	REGULAR	75.00	0.023018	0.053143	17.10	494.3	0.32278	Open
70	Valve	REGULAR	150.00	0.002206	0.005093	14.86	3,193.5	0.11966	Open

Reservoir Summary

Jct	Name	Type	Liq. Height (feet)	Liq. Elevation (feet)	Surface Pressure (psia)	Liquid Volume (feet3)	Net Vol. Flow (gal/min)
5	WE Pump Station	Infinite	N/A	1,936	14.70	N/A	-150.00
19	Cell 1	Infinite	N/A	1,944	14.70	N/A	20.07
43	EQ Tank	Infinite	N/A	1,950	14.70	N/A	75.00
58	Cell 1	Infinite	N/A	1,944	14.70	N/A	13.28
59	Cell 1	Infinite	N/A	1,944	14.70	N/A	10.90
60	Cell 1	Infinite	N/A	1,944	14.70	N/A	10.11
61	Cell 1	Infinite	N/A	1,944	14.70	N/A	11.23
62	Cell 1	Infinite	N/A	1,944	14.70	N/A	24.20
63	Cell 1	Infinite	N/A	1,944	14.70	N/A	16.99
64	Cell 1	Infinite	N/A	1,944	14.70	N/A	14.78
65	Cell 1	Infinite	N/A	1,944	14.70	N/A	13.20
66	Cell 1	Infinite	N/A	1,944	14.70	N/A	15.24

Pipe Output Table

Pipe	Name	Vol. Flow Rate (gal/min)	Pipe Nominal Size	Velocity (feet/sec)	P Static Max (psia)	P Static Min (psia)	Elevation Inlet (feet)	Elevation Outlet (feet)	dP Stag. Total (psid)	dP Static Total (psid)
5	Pipe	75.00	12 inch	0.2150	16.86	16.86	1,931	1,931	0.000004289	0.000004289
10	Pipe	75.00	3 inch	3.2644	22.63	14.91	1,931	1,944	7.718771547	7.718771547

Pipe	dP Gravity (psid)	dH (feet)	P Static In (psia)	P Static Out (psia)	P Stag. In (psia)	P Stag. Out (psia)
5	0.000	0.000009903	16.86	16.86	16.86	16.86
10	5.523	5.070503691	22.63	14.91	22.70	14.98

Pipe	Name	Vol. Flow Rate (gal/min)	Pipe Nominal Size	Velocity (feet/sec)	P Static Max (psia)	P Static Min (psia)	Elevation Inlet (feet)	Elevation Outlet (feet)	dP Stag. Total (psid)	dP Static Total (psid)
36	Pipe	150.00	6 inch	1.6550	14.86	14.83	1,944	1,944	0.032241736	0.032241736
41	Pipe	75.00	3 inch	3.2549	18.84	18.81	1,940	1,940	0.032788716	0.032788716
42	Pipe	75.00	12 inch	0.2150	16.86	16.86	1,931	1,931	0.000004289	0.000004289
43	Pipe	75.00	3 inch	3.2644	23.94	18.85	1,931	1,940	5.088187099	5.088187099
44	Pipe	138.77	6 inch	1.5311	14.83	14.83	1,944	1,944	0.000308779	0.000308779
45	Pipe	123.53	6 inch	1.3630	14.84	14.83	1,944	1,944	0.010038104	0.010038104
46	Pipe	113.42	6 inch	1.2514	14.83	14.83	1,944	1,944	0.000215569	0.000215569
47	Pipe	100.22	6 inch	1.1058	14.83	14.82	1,944	1,944	0.006920303	0.006920303
48	Pipe	89.32	6 inch	0.9855	14.82	14.82	1,944	1,944	0.000141024	0.000141024
49	Pipe	74.54	6 inch	0.8224	14.83	14.82	1,944	1,944	0.004094475	0.004094475
50	Pipe	61.26	6 inch	0.6759	14.82	14.82	1,944	1,944	0.000072375	0.000072375
51	Pipe	44.27	6 inch	0.4885	14.82	14.82	1,944	1,944	0.001634465	0.001634465
52	Pipe	20.07	3 inch	0.8737	14.82	14.80	1,944	1,944	0.018662866	0.018662866
53	Pipe	13.28	3 inch	0.5780	14.82	14.80	1,944	1,944	0.015542499	0.015542499
54	Pipe	10.90	3 inch	0.4745	14.82	14.80	1,944	1,944	0.016543591	0.016543591
55	Pipe	10.11	3 inch	0.4401	14.82	14.80	1,944	1,944	0.019351661	0.019351661
56	Pipe	11.23	3 inch	0.4887	14.83	14.80	1,944	1,944	0.023215324	0.023215324
57	Pipe	24.20	3 inch	1.0533	14.82	14.80	1,944	1,944	0.018513128	0.018513128
58	Pipe	16.99	3 inch	0.7395	14.82	14.80	1,944	1,944	0.015926303	0.015926303
59	Pipe	14.78	3 inch	0.6433	14.82	14.80	1,944	1,944	0.017167186	0.017167186
60	Pipe	13.20	3 inch	0.5745	14.82	14.80	1,944	1,944	0.020500557	0.020500557
61	Pipe	15.24	3 inch	0.6632	14.83	14.80	1,944	1,944	0.024689401	0.024689401
63	Pipe	75.00	3 inch	3.2549	17.08	14.91	1,940	1,944	2.170749694	2.170749694
64	Pipe	75.00	3 inch	3.2549	17.65	17.10	1,940	1,940	0.546474993	0.546474993
65	Pipe	150.00	6 inch	1.6550	14.90	14.86	1,944	1,944	0.039337013	0.039337013

Pipe	dP Gravity (psid)	dH (feet)	P Static In (psia)	P Static Out (psia)	P Stag. In (psia)	P Stag. Out (psia)
36	0.000	0.074437229	14.86	14.83	14.88	14.85
41	0.000	0.075700056	18.84	18.81	18.91	18.88
42	0.000	0.000009903	16.86	16.86	16.86	16.86
43	3.898	2.747213454	23.94	18.85	24.01	18.92
44	0.000	0.000712885	14.83	14.83	14.85	14.85
45	0.000	0.023175199	14.84	14.83	14.85	14.84
46	0.000	0.000497689	14.83	14.83	14.84	14.84
47	0.000	0.015977061	14.83	14.82	14.84	14.83
48	0.000	0.000325585	14.82	14.82	14.83	14.83
49	0.000	0.009453009	14.83	14.82	14.83	14.83
50	0.000	0.000167093	14.82	14.82	14.83	14.83
51	0.000	0.003773526	14.82	14.82	14.83	14.82
52	0.000	0.043087384	14.82	14.80	14.82	14.80
53	0.000	0.035883321	14.82	14.80	14.82	14.80
54	0.000	0.038194566	14.82	14.80	14.82	14.80
55	0.000	0.044677621	14.82	14.80	14.82	14.80
56	0.000	0.053597747	14.83	14.80	14.83	14.80
57	0.000	0.042741681	14.82	14.80	14.82	14.80
58	0.000	0.036769419	14.82	14.80	14.82	14.80
59	0.000	0.039634274	14.82	14.80	14.82	14.80
60	0.000	0.047330104	14.82	14.80	14.82	14.80
61	0.000	0.057000981	14.83	14.80	14.83	14.80
63	1.624	1.261659265	17.08	14.91	17.15	14.98
64	0.000	1.261659265	17.65	17.10	17.72	17.17
65	0.000	0.090818258	14.90	14.86	14.92	14.88

All Junction Table

Jct	Name	P Static In (psia)	P Static Out (psia)	P Stag. In (psia)	P Stag. Out (psia)	Vol. Flow Rate Thru Jct (gal/min)	Loss Factor (K)
5	WE Pump Station	14.70	16.86	14.70	16.86	N/A	See Mult. Losses
10	WR Pump	16.86	22.63	16.86	22.70	75.00	0.00000
17	Valve	18.85	18.84	18.92	18.91	75.00	0.05381
19	Cell 1	14.70	14.80	14.70	14.80	20.07	0.00000
43	EQ Tank	14.70	18.81	14.70	18.81	75.00	1.00000
46	WE Pump	16.86	23.94	16.86	24.01	75.00	0.00000
49	Tee or Wye	14.84	14.84	14.85	14.85	N/A	See Mult. Losses
50	Tee or Wye	14.84	14.84	14.85	14.85	N/A	See Mult. Losses
51	Tee or Wye	14.83	14.83	14.84	14.84	N/A	See Mult. Losses
52	Tee or Wye	14.83	14.83	14.84	14.84	N/A	See Mult. Losses

AFT Fathom Model
Kaiser Mead GWTS
Wetland Sump Pumps Model

Jct	Name	P Static In (psia)	P Static Out (psia)	P Stag. In (psia)	P Stag. Out (psia)	Vol. Flow Rate Thru Jct (gal/min)	Loss Factor (K)
53	Tee or Wye	14.83	14.83	14.83	14.83	N/A	See Mult. Losses
54	Tee or Wye	14.83	14.83	14.83	14.83	N/A	See Mult. Losses
55	Tee or Wye	14.82	14.82	14.83	14.83	N/A	See Mult. Losses
56	Tee or Wye	14.82	14.82	14.83	14.83	N/A	See Mult. Losses
57	Tee or Wye	14.82	14.82	14.82	14.82	N/A	See Mult. Losses
58	Cell 1	14.70	14.80	14.70	14.80	13.28	0.00000
59	Cell 1	14.70	14.80	14.70	14.80	10.90	0.00000
60	Cell 1	14.70	14.80	14.70	14.80	10.11	0.00000
61	Cell 1	14.70	14.80	14.70	14.80	11.23	0.00000
62	Cell 1	14.70	14.80	14.70	14.80	24.20	0.00000
63	Cell 1	14.70	14.80	14.70	14.80	16.99	0.00000
64	Cell 1	14.70	14.80	14.70	14.80	14.78	0.00000
65	Cell 1	14.70	14.80	14.70	14.80	13.20	0.00000
66	Cell 1	14.70	14.80	14.70	14.80	15.24	0.00000
67	Tee or Wye	14.87	14.87	14.92	14.92	N/A	See Mult. Losses
68	GW Flow from Wellfield	17.65	17.65	17.72	17.72	75.00	0.00000
69	Valve	17.10	17.08	17.17	17.15	75.00	0.32278
70	Valve	14.86	14.86	14.88	14.88	150.00	0.11966

Model Reference Information

General

Title: AFT Fathom Model
Analysis run on: 3/23/2020 2:49:45 PM
Application version: AFT Fathom Version 10 (2019.03.28)
Input File: C:\Kaiser Mead GWTS\Mechanical\Fathom\Wetland Sump Pumps Model\Wetland Sump Pumps_v6.fth
Scenario: Base Scenario - HDPE Piping/Two Pumps - 75 gpm
Output File: C:\Kaiser Mead GWTS\Mechanical\Fathom\Wetland Sump Pumps Model\Wetland Sump Pumps_v6_F1.out

Execution Time= 0.18 seconds
Total Number Of Head/Pressure Iterations= 61
Total Number Of Flow Iterations= 11
Total Number Of Temperature Iterations= 0
Number Of Pipes= 27
Number Of Junctions= 28
Matrix Method= Gaussian Elimination

Pressure/Head Tolerance= 0.0001 relative change
Flow Rate Tolerance= 0.0001 relative change
Temperature Tolerance= 0.0001 relative change
Flow Relaxation= (Automatic)
Pressure Relaxation= (Automatic)

Constant Fluid Property Model
Fluid Database: AFT Standard
Fluid: Water at 1 atm
Max Fluid Temperature Data= 212 deg. F
Min Fluid Temperature Data= 32 deg. F
Temperature= 60 deg. F
Density= 62.37215 lbm/ft3
Viscosity= 2.72848 lbm/hr-ft
Vapor Pressure= 0.25024 psia
Viscosity Model= Newtonian
Apply laminar and non-Newtonian correction to: Pipe Fittings & Losses, Junction K factors, Junction Special Losses, Junction Polynomials
Corrections applied to the following junctions: Branch, Reservoir, Assigned Flow, Assigned Pressure, Area Change, Bend, Tee or Wye, Spray Discharge, Relief Valve

Ambient Pressure (constant)= 1 atm
Gravitational Acceleration= 1 g
Turbulent Flow Above Reynolds Number= 4000
Laminar Flow Below Reynolds Number= 2300
Total Inflow= 150.0 gal/min
Total Outflow= 150.0 gal/min
Maximum Static Pressure is 23.94 psia at Pipe 43 Inlet
Minimum Static Pressure is 14.80 psia at Pipe 57 Outlet

Warnings

No Warnings

Pump Summary

AFT Fathom Model
Kaiser Mead GWTS
Wetland Sump Pumps Model

Jct	Results Diagram	Name	Vol. Flow (gal/min)	dH (feet)	Speed (Percent)	Ideal Power (hp)	Pump Efficiency (Percent)	Shaft Power (hp)	Motor Efficiency (Percent)	Motor Input Power (hp)	NPSHA (feet)
10	Show	WR Pump	75.00	13.33	79.63	0.2525	51.49	0.4904	80.00	0.6130	38.35
46	Show	WE Pump	75.00	16.50	85.60	0.3126	52.28	0.5979	80.00	0.7473	38.35

Jct	NPSHR (feet)
10	N/A
46	N/A

Valve Summary

Jct	Name	Valve Type	Vol. Flow (gal/min)	dP Stag. (psid)	dH (feet)	P Static In (psia)	Cv	K	Valve State
17	Valve	REGULAR	75.00	3.860E-03	8.911E-03	18.85	1,207	0.05381	Open
X69	Valve	REGULAR	0.00	N/A	N/A	N/A	N/A	N/A	Closed By User
70	Valve	REGULAR	75.00	5.515E-04	1.273E-03	14.82	3,194	0.11966	Open

Reservoir Summary

Jct	Name	Type	Liq. Height (feet)	Liq. Elevation (feet)	Surface Pressure (psia)	Liquid Volume (feet3)	Net Vol. Flow (gal/min)
5	WE Pump Station	Infinite	N/A	1,936	14.70	N/A	-150.000
19	Cell 1	Infinite	N/A	1,944	14.70	N/A	9.796
43	EQ Tank	Infinite	N/A	1,950	14.70	N/A	75.000
58	Cell 1	Infinite	N/A	1,944	14.70	N/A	6.611
59	Cell 1	Infinite	N/A	1,944	14.70	N/A	5.483
60	Cell 1	Infinite	N/A	1,944	14.70	N/A	5.134
61	Cell 1	Infinite	N/A	1,944	14.70	N/A	5.770
62	Cell 1	Infinite	N/A	1,944	14.70	N/A	11.846
63	Cell 1	Infinite	N/A	1,944	14.70	N/A	8.457
64	Cell 1	Infinite	N/A	1,944	14.70	N/A	7.425
65	Cell 1	Infinite	N/A	1,944	14.70	N/A	6.678
66	Cell 1	Infinite	N/A	1,944	14.70	N/A	7.798

Pipe Output Table

Pipe	Name	Vol. Flow Rate (gal/min)	Pipe Nominal Size	Velocity (feet/sec)	P Static Max (psia)	P Static Min (psia)	Elevation Inlet (feet)	Elevation Outlet (feet)	dP Stag. Total (psid)
5	Pipe	75.000	12 inch	0.2150	16.86	16.86	1,931	1,931	0.000004289
10	Pipe	75.000	3 inch	3.2644	22.56	14.84	1,931	1,944	7.718771547

Pipe	dP Static Total (psid)	dP Gravity (psid)	dH (feet)	P Static In (psia)	P Static Out (psia)	P Stag. In (psia)	P Stag. Out (psia)
5	0.000004289	0.000	0.000009903	16.86	16.86	16.86	16.86
10	7.718771547	5.523	5.070503691	22.56	14.84	22.63	14.91

Pipe	Name	Vol. Flow Rate (gal/min)	Pipe Nominal Size	Velocity (feet/sec)	P Static Max (psia)	P Static Min (psia)	Elevation Inlet (feet)	Elevation Outlet (feet)	dP Stag. Total (psid)
36	Pipe	75.000	6 inch	0.8275	14.82	14.81	1,944	1,944	0.009243161
41	Pipe	75.000	3 inch	3.2549	18.84	18.81	1,940	1,940	0.032788716
42	Pipe	75.000	12 inch	0.2150	16.86	16.86	1,931	1,931	0.000004289
43	Pipe	75.000	3 inch	3.2644	23.94	18.85	1,931	1,940	5.088187099
44	Pipe	69.232	6 inch	0.7638	14.81	14.81	1,944	1,944	0.000089820
45	Pipe	61.431	6 inch	0.6778	14.81	14.81	1,944	1,944	0.002909022
46	Pipe	56.298	6 inch	0.6211	14.81	14.81	1,944	1,944	0.000062354
47	Pipe	49.619	6 inch	0.5474	14.81	14.81	1,944	1,944	0.001996994
48	Pipe	44.136	6 inch	0.4870	14.81	14.81	1,944	1,944	0.000040640
49	Pipe	36.711	6 inch	0.4050	14.81	14.81	1,944	1,944	0.001176912
50	Pipe	30.099	6 inch	0.3321	14.81	14.81	1,944	1,944	0.000020794
51	Pipe	21.642	6 inch	0.2388	14.81	14.81	1,944	1,944	0.000468478
52	Pipe	9.796	3 inch	0.4264	14.81	14.80	1,944	1,944	0.005344160
53	Pipe	6.611	3 inch	0.2878	14.81	14.80	1,944	1,944	0.004647734
54	Pipe	5.483	3 inch	0.2387	14.81	14.80	1,944	1,944	0.005056470
55	Pipe	5.134	3 inch	0.2235	14.81	14.80	1,944	1,944	0.006023690
56	Pipe	5.770	3 inch	0.2512	14.81	14.80	1,944	1,944	0.007357982
57	Pipe	11.846	3 inch	0.5156	14.81	14.80	1,944	1,944	0.005307817
58	Pipe	8.457	3 inch	0.3681	14.81	14.80	1,944	1,944	0.004736490
59	Pipe	7.425	3 inch	0.3232	14.81	14.80	1,944	1,944	0.005202680
60	Pipe	6.678	3 inch	0.2906	14.81	14.80	1,944	1,944	0.006303891
61	Pipe	7.798	3 inch	0.3394	14.81	14.80	1,944	1,944	0.007720843
63	Pipe	0.000	3 inch	0.0000	16.46	14.84	1,940	1,944	1.624274701
64	Pipe	0.000	3 inch	0.0000	No Solution	No Solution	1,940	1,940	0.000000000
65	Pipe	75.000	6 inch	0.8275	14.83	14.82	1,944	1,944	0.011312632

Pipe	dP Static Total (psid)	dP Gravity (psid)	dH (feet)	P Static In (psia)	P Static Out (psia)	P Stag. In (psia)	P Stag. Out (psia)
36	0.009243161	0.000	0.021339897	14.82	14.81	14.83	14.82
41	0.032788716	0.000	0.075700056	18.84	18.81	18.91	18.88
42	0.000004289	0.000	0.000009903	16.86	16.86	16.86	16.86
43	5.088187099	3.898	2.747213454	23.94	18.85	24.01	18.92
44	0.000089820	0.000	0.000207369	14.81	14.81	14.82	14.82
45	0.002909022	0.000	0.006716126	14.81	14.81	14.82	14.81
46	0.000062354	0.000	0.000143959	14.81	14.81	14.81	14.81
47	0.001996994	0.000	0.004610506	14.81	14.81	14.81	14.81
48	0.000040640	0.000	0.000093826	14.81	14.81	14.81	14.81
49	0.001176912	0.000	0.002717163	14.81	14.81	14.81	14.81
50	0.000020794	0.000	0.000048008	14.81	14.81	14.81	14.81
51	0.000468478	0.000	0.001081586	14.81	14.81	14.81	14.81
52	0.005344160	0.000	0.012338184	14.81	14.80	14.81	14.80
53	0.004647734	0.000	0.010730329	14.81	14.80	14.81	14.80
54	0.005056470	0.000	0.011673987	14.81	14.80	14.81	14.80
55	0.006023690	0.000	0.013907031	14.81	14.80	14.81	14.80
56	0.007357982	0.000	0.016987542	14.81	14.80	14.81	14.80
57	0.005307817	0.000	0.012254278	14.81	14.80	14.81	14.80
58	0.004736490	0.000	0.010935243	14.81	14.80	14.81	14.80
59	0.005202680	0.000	0.012011547	14.81	14.80	14.81	14.80
60	0.006303891	0.000	0.014553937	14.81	14.80	14.81	14.80
61	0.007720843	0.000	0.017825287	14.81	14.80	14.81	14.80
63	1.624274701	1.624	0.000000000	16.46	14.84	16.46	14.84
64	0.000000000	0.000	0.000000000	No Solution	No Solution	No Solution	No Solution
65	0.011312632	0.000	0.026117731	14.83	14.82	14.84	14.83

All Junction Table

Jct	Name	P Static In (psia)	P Static Out (psia)	P Stag. In (psia)	P Stag. Out (psia)	Vol. Flow Rate Thru Jct (gal/min)	Loss Factor (K)
5	WE Pump Station	14.70	16.86	14.70	16.86	N/A	See Mult. Losses
10	WR Pump	16.86	22.56	16.86	22.63	75.000	0.00000
17	Valve	18.85	18.84	18.92	18.91	75.000	0.05381
19	Cell 1	14.70	14.80	14.70	14.80	9.796	0.00000
43	EQ Tank	14.70	18.81	14.70	18.81	75.000	1.00000
46	WE Pump	16.86	23.94	16.86	24.01	75.000	0.00000
49	Tee or Wye	14.81	14.81	14.82	14.82	N/A	See Mult. Losses
50	Tee or Wye	14.81	14.81	14.82	14.82	N/A	See Mult. Losses
51	Tee or Wye	14.81	14.81	14.81	14.81	N/A	See Mult. Losses
52	Tee or Wye	14.81	14.81	14.81	14.81	N/A	See Mult. Losses

Jct	Name	P Static In (psia)	P Static Out (psia)	P Stag. In (psia)	P Stag. Out (psia)	Vol. Flow Rate Thru Jct (gal/min)	Loss Factor (K)
53	Tee or Wye	14.81	14.81	14.81	14.81	N/A	See Mult. Losses
54	Tee or Wye	14.81	14.81	14.81	14.81	N/A	See Mult. Losses
55	Tee or Wye	14.81	14.81	14.81	14.81	N/A	See Mult. Losses
56	Tee or Wye	14.81	14.81	14.81	14.81	N/A	See Mult. Losses
57	Tee or Wye	14.81	14.81	14.81	14.81	N/A	See Mult. Losses
58	Cell 1	14.70	14.80	14.70	14.80	6.611	0.00000
59	Cell 1	14.70	14.80	14.70	14.80	5.483	0.00000
60	Cell 1	14.70	14.80	14.70	14.80	5.134	0.00000
61	Cell 1	14.70	14.80	14.70	14.80	5.770	0.00000
62	Cell 1	14.70	14.80	14.70	14.80	11.846	0.00000
63	Cell 1	14.70	14.80	14.70	14.80	8.457	0.00000
64	Cell 1	14.70	14.80	14.70	14.80	7.425	0.00000
65	Cell 1	14.70	14.80	14.70	14.80	6.678	0.00000
66	Cell 1	14.70	14.80	14.70	14.80	7.798	0.00000
67	Tee or Wye	14.83	14.83	14.84	14.84	N/A	See Mult. Losses
68	GW Flow from Wellfield	No Solution	No Solution	No Solution	No Solution	0.000	0.00000
X69	Valve	No Solution	16.46	No Solution	16.46	0.000	0.00000
70	Valve	14.82	14.82	14.83	14.83	75.000	0.11966

GOULDS
WATER TECHNOLOGY
a xylem brand

Tender Hydraulic

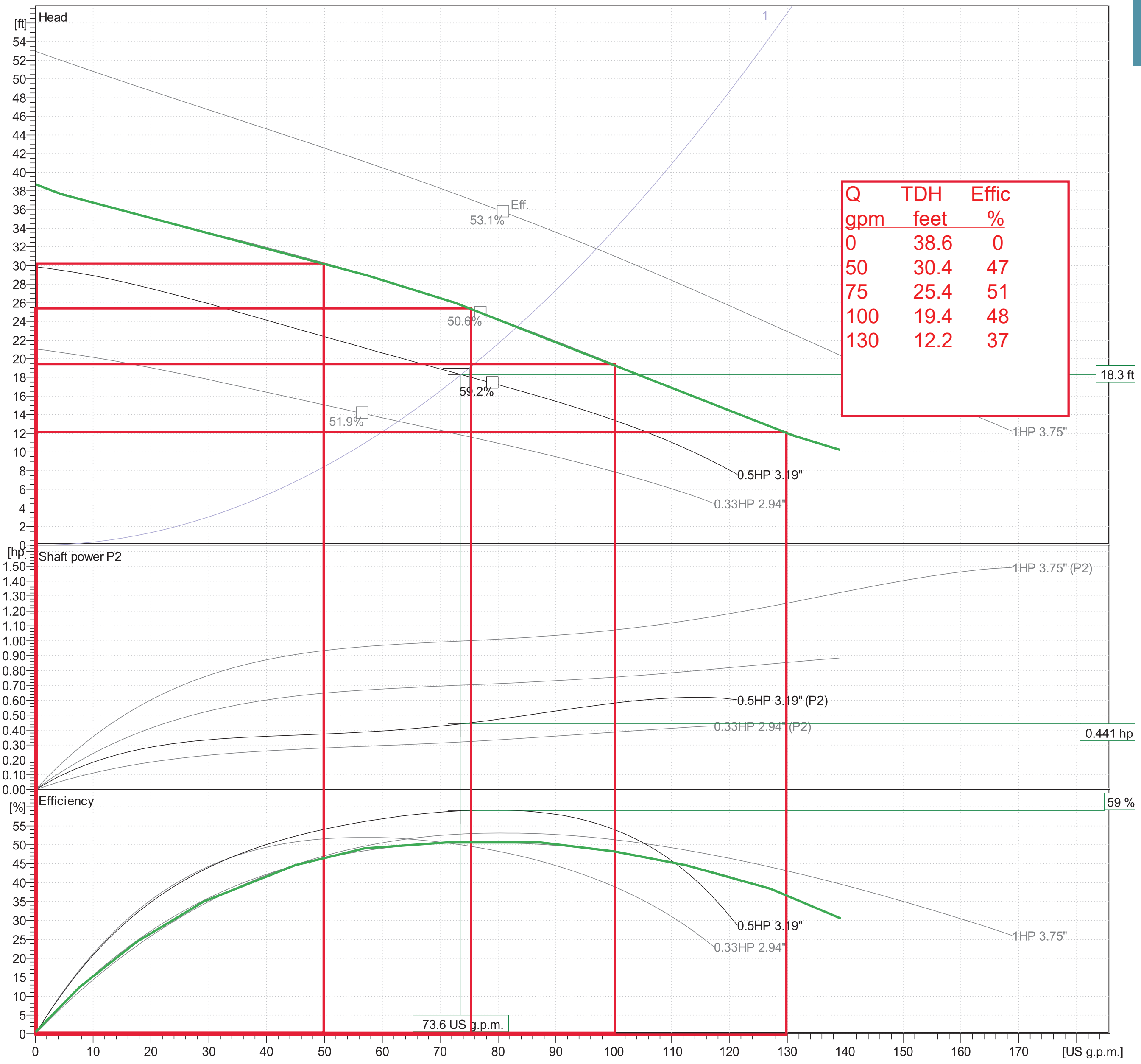
Customer		Date	02.01.2020
Contact		Project	
Phone number		Project no.	
Email			

3WD51C0JA

Hydraulic Data

Operating Data Specification		**Hydraulic data (duty point)**		**Impeller design**	
Flow	75 US g.p.m.			Impeller R	$3^3/_{16}$"
Head	19 ft	Flow	73.6 US g.p.m.	Frequency	60 Hz
Static head	0 ft	Head	18.3 ft	Speed	3500 rpm

Power datas referced to:
Water [100%] ; 39.2°F; 62.4lb/ft³; 1.69E-5ft²/s
Performance according to ISO 9906 - Annex A



Q gpm	TDH feet	Effic %
0	38.6	0
50	30.4	47
75	25.4	51
100	19.4	48
130	12.2	37

ITT

Wastewater

Goulds Pumps

2WD/3WD Submersible 2" Non-Clog Sewage Pump

Dual Seal with Seal Sensor Probe

GOULDS PUMPS

Goulds Pumps is a brand of ITT Corporation.

www.goulds.com

Engineered for life

FEATURES

- **Impeller:** Cast iron, semi-open or enclosed, non-clog, dynamically balanced with pump out vanes for mechanical seal protection. Optional silicon bronze impeller available.
- **Casing:** Cast iron flanged volute type for maximum efficiency. Designed for easy installation on A10-20 guide rail.
- **Dual Mechanical Seals:**
  - Lower Seal: SILICON CARBIDE VS. SILICON CARBIDE sealing faces for superior abrasive resistance, stainless steel metal parts, BUNA-N elastomers.
  - **Upper Seal:** CARBON VS. CERAMIC sealing faces, stainless steel metal parts, BUNA-N elastomers.
- **Seal Sensor Probe:** Located in oil-filled chamber. If pumpage should begin to leak past lower seal it indicates to pump control panel a fault has occurred. **Requires optional Seal Fail Circuit in the control panel.**
- **Shaft:** Corrosion resistant, 400 series stainless steel. Threaded design. Locknut on all models to guard against component damage on accidental reverse rotation.
- **Fasteners:** 300 series stainless steel.
- Capable of running dry without damage to components.
- Designed for continuous operation, when fully submerged.

APPLICATIONS

Specifically designed for the following uses:

- Sewage systems
- Water transfer
- Commercial applications
- Dewatering/Effluent
- Light industrial

Anywhere waste or drainage must be disposed of quickly, quietly and efficiently.

SPECIFICATIONS

Pump

- Solids handling capabilities: 2" maximum.
- Capacities: up to 183 GPM.
- Total heads: up to 52' TDH.
- Discharge size: 2" NPT threaded companion flange on 2WD. 3" NPT threaded companion flange on 3WD.
- Temperature: 104° F (40° C) continuous, 140° F (60° C) intermittent.

MOTORS

- Fully submerged in high grade turbine oil for lubrication and efficient heat transfer. All ratings are within the working limits of the motor.
- **Class F insulation.**

  Single phase (60 Hz):
  - All single phase models feature capacitor start motors for maximum starting torque.
  - Built-in overload with automatic reset.
  - ⅓ and ½ HP – 16/3 SJTOW with 115 V or 230 V three prong plug.
  - ¾ and 1 HP – 14/3 STOW with bare leads.

  Three phase (60 Hz):
  - Overload protection must be provided in starter unit.
  - ½-1 HP – 14/4 STOW with bare leads.
- **Designed for Continuous Operation:** Pump ratings are within the motor manufacturer's recommended working limits, can be operated continuously without damage when fully submerged.
- **Bearings:** Upper and lower heavy duty ball bearing construction.
- **Power and Control Cable:** Severe duty rated, oil and water resistant. Epoxy seal on motor end provides secondary moisture barrier in case of outer jacket damage and to prevent oil wicking. 20 foot standard with optional lengths available.

AGENCY LISTINGS

Tested to UL 778 and CSA 22.2 108 Standards
By Canadian Standards Association
File #LR38549
Goulds Pumps is ISO 9001 Registered.

NOMENCLATURE DESCRIPTION

1st Character – Discharge Size
2 = 2" discharge
3 = 3" discharge

2nd and 3rd Characters – Series/Solids Size
WD = wastewater, 2" solids handling, dual seal with seal fail probe in pump.

4th Character – Mechanical Seals
5 = silicon carbide/silicon carbide/BUNA – lower seal and carbon/ceramic/BUNA – upper seal (standard)
3 = silicon carbide/tungsten carbide/BUNA – lower seal and carbon/ceramic/BUNA – upper seal (optional)

5th Character – Cycle/RPM
1 = 60 Hz/3500 RPM
2 = 60 Hz/1750 RPM
5 = 50 Hz/2900 RPM
6 = 50 Hz/1450 RPM

6th Character – Horsepower
B = ⅓ HP
C = ½ HP
D = ¾ HP
E = 1 HP

7th Character – Phase/Voltage/Enclosure
0 = single phase, 115 V
1 = single phase, 230 V
2 = three phase, 200 V
3 = three phase, 230 V
4 = three phase, 460 V
5 = three phase, 575 V
8 = single phase, 208 V
9 = single phase, 220 V, 50 Hz

8th Character – Impeller Diameter
A = 3.75" 1 HP 3500 RPM
B = 5.75" 1 HP 1750 RPM
C = 5.38" ¾ HP 1750 RPM
D = 5.00" ½ HP 1750 RPM
E = 4.69" ⅓ HP 1750 RPM
H = 3.44" ¾ HP 3500 RPM
J = 3.19" ½ HP 3500 RPM
K = 2.94" ⅓ HP 3500 RPM

9th Character – Cord Length (Power and Sensor)
A = 20' (standard)
D = 30'
F = 50'
J = 100'

10th Character – Options
B = Bronze impeller
E = Epoxy paint
F = Both epoxy paint and bronze impeller

Last Character – Option
H = Pilot duty thermal sensors

MODEL AND MOTOR INFORMATION

Order No.	HP	Phase	Volts	RPM	Impeller		Maximum Amps	L.R. Amps	KVA Code	F.L. Motor Efficiency %	Resistance		Wt. (lbs.)
					Dia. (in.)	Code					Start	Line-Line	
2WD52B0EA	0.33	1	115	1750	4.69	E	10.7	30.0	M	54	11.9	1.7	90
2WD52B8EA			208				6.8	19.5	K	51	9.1	4.2	
2WD52B1EA			230				4.9	14.1	L	53	14.5	8.0	
2WD52C0DA	0.5	1	115	1750	5.00	D	14.5	31.1	J	55	9.3	1.4	94
2WD52C8DA			208				8.0	19.5	K	51	9.1	4.2	
2WD52C1DA			230				7.3	16.5	J	54	11.7	5.6	
2WD52C2DA		3	200				3.8	12.3	K	75	NA	6.7	
2WD52C3DA			230				3.3	9.7	K	75	NA	9.9	
2WD52C4DA			460				1.7	4.9	K	75	NA	39.4	
2WD52C5DA			575				1.4	4.3	K	68	NA	47.8	
2WD52D8CA	0.75	1	208	1750	5.38	C	11.0	39.0	K	65	2.6	1.4	98
2WD52D1CA			230				9.4	24.8	J	57	4.8	2.3	
2WD52D2CA		3	200				4.1	21.2	H	74	NA	4.3	
2WD52D3CA			230				3.6	17.3	J	76	NA	5.6	
2WD52D4CA			460				1.8	8.9	J	76	NA	22.4	
2WD52D5CA			575				1.5	7.3	J	71	NA	29.2	
2WD52E8BA	1	1	208	1750	5.75	B	14.0	39.0	K	65	2.6	1.4	104
2WD52E1BA			230				12.3	30.5	H	60	4.3	1.8	
2WD52E2BA		3	200				6.0	21.2	H	74	NA	4.3	
2WD52E3BA			230				5.8	17.3	J	76	NA	5.6	
2WD52E4BA			460				2.9	8.9	J	76	NA	22.4	
2WD52E5BA			575				2.4	7.3	J	71	NA	29.2	
2WD51B0KA	0.33	1	115	3500	2.94	K	12.4	46.0	M	54	7.5	1.0	90
2WD51B8KA			208				6.8	31.0	K	68	9.7	2.4	
2WD51B1KA			230				6.2	34.5	M	53	9.6	4.0	
2WD51C0JA	0.5	1	115	3500	3.19	J	14.5	46.0	M	54	7.5	1.0	94
2WD51C8JA			208				8.4	31.0	K	68	9.7	2.4	
2WD51C1JA			230				7.6	34.5	M	53	9.6	4.0	
2WD51C2JA		3	200				4.9	22.6	R	68	NA	3.8	
2WD51C3JA			230				3.6	18.8	R	70	NA	5.8	
2WD51C4JA			460				1.8	9.4	R	70	NA	23.2	
2WD51C5JA			575				1.5	7.5	R	62	NA	35.3	
2WD51D8HA	0.75	1	208	3500	3.44	H	11.0	31.0	K	68	9.7	2.4	98
2WD51D1HA			230				10.0	27.5	J	65	12.2	2.7	
2WD51D2HA		3	200				6.2	20.6	L	64	NA	5.7	
2WD51D3HA			230				5.4	15.7	K	68	NA	8.6	
2WD51D4HA			460				2.7	7.9	K	68	NA	34.2	
2WD51D5HA			575				2.2	9.9	L	78	NA	26.5	
2WD51E8AA	1	1	208	3500	3.75	A	14.5	59.0	K	68	9.3	1.1	104
2WD51E1AA			230				13.0	36.2	J	69	10.3	2.1	
2WD51E2AA		3	200				8.6	37.6	M	77	NA	2.7	
2WD51E3AA			230				7.5	24.1	L	79	NA	4.1	
2WD51E4AA			460				3.8	12.1	L	79	NA	16.2	
2WD51E5AA			575				3.1	9.9	L	78	NA	26.5	

To order a pump with a 3" NPT discharge, change the 1st character to a 3, ex. 3WD51E5AA

APPLICATION DATA

Maximum Solid Size	2"	
Minimum Casing Thickness	5/16"	
Casing Corrosion Allowance	1/8"	
Maximum Working Pressure	22 PSI	
Maximum Submergence	50 feet	
Minimum Submergence	Fully submerged for continuous operation	
	6" below top of motor for intermittent operation	
Maximum Environmental Temperature	40ºC (104ºF) continuous operation	
	60ºC (140ºF) intermittent operation	

CONSTRUCTION DETAILS

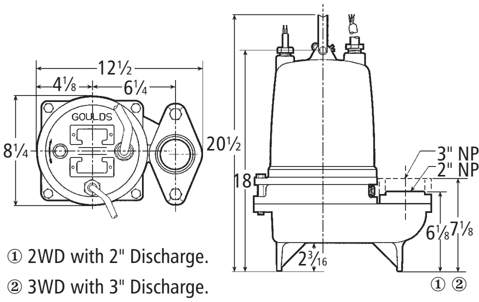
Power Cable – Type	16/3, type SJTOW: single phase, ½ HP
	14/3, type STOW: single phase, ¾ & 1 HP
	14/4, type STOW: all three phase
Sensor Cable – Type	16/2, type SJTOW: seal sensor only
	18/4, type SJTOW: optional seal/heat sensor
Motor Cover	Gray Cast Iron – ASTM A48 Class 30
Bearing Housing	Gray Cast Iron – ASTM A48 Class 30
Seal Housing	Gray Cast Iron – ASTM A48 Class 30
Casing	Gray Cast Iron – ASTM A48 Class 30
Impeller	Gray Cast Iron – ASTM A48 or Cast Bronze – ASTM B584 C87600
Motor Shaft	AISI 300 Series Stainless Steel
Motor Design	NEMA 48 Frame, oil filled with Class F Insulation
Motor Overload Protection	Single Phase: on winding thermal overload protection
	Three Phase: require ambient compensated Class 10, quick trip overloads in the control panel.
Motor Seal Fail (Moisture) Detection	Seal fail sensor in an oil-filled seal chamber. Connect to an optional relay in control panel.
Optional Motor Thermal Protection	Normally closed on-winding thermostats open at 275º F (135 ºC) and close at 112º F (78º C). Require terminal connection in the control panel.
External Hardware	300 Series Stainless Steel
Impeller Type	Semi-opened with pump out vanes on back shroud - 1750 RPM
	Enclosed with pump out vanes on back shroud - 3500 RPM
Oil Capacity – Seal Chamber	10 ounces
Oil Capacity – Motor Chamber	4.0 quarts

STANDARD PARTS

Ball Bearing	Upper	Single row ball – SKF™ 6203-2Z
	Lower	Single row ball – SKF™ 6203-2Z
Mechanical Seals – Standard	Upper	Carbon/Ceramic; John Crane Type 6
	Lower	Silicon Carbon/Silicon Carbon; Type 16
Mechanical Seals – Optional Lower		Silicon Carbide/Tungsten Carbide: Type 16
O-Ring – Stuffing Box		BUNA-N, AS 568A-163
O-Ring – Motor Cover		BUNA-N, AS 568A-166

DIMENSIONS

(All dimensions are in inches. Do not use for construction purposes.)

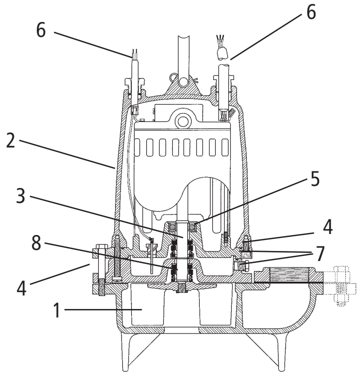


① 2WD with 2" Discharge.
② 3WD with 3" Discharge.

MATERIALS OF CONSTRUCTION

<table>
<tr><th rowspan="2">Item No.</th><th rowspan="2" colspan="3">Part Name</th><th colspan="3">Material</th></tr>
<tr><th colspan="2">Standard</th><th>Optional</th></tr>
<tr><td>1</td><td colspan="3">Impeller</td><td colspan="2">1003</td><td>1179</td></tr>
<tr><td>2</td><td colspan="3">Motor cover</td><td colspan="2">1003</td><td></td></tr>
<tr><td>3</td><td colspan="3">Shaft</td><td colspan="2">300 Series SS</td><td></td></tr>
<tr><td>4</td><td colspan="3">Fasteners</td><td colspan="2">300 Series SS</td><td></td></tr>
<tr><td>5</td><td colspan="3">Ball bearings</td><td colspan="2">Steel</td><td></td></tr>
<tr><td rowspan="2">6</td><td colspan="3">Power cable</td><td colspan="2" rowspan="2">STOW, 20 feet</td><td rowspan="2">Additional lengths</td></tr>
<tr><td colspan="3">Seal sensor cable</td></tr>
<tr><td>7</td><td colspan="3">O-ring</td><td colspan="2">BUNA-N</td><td></td></tr>
<tr><td rowspan="3">8</td><th>Outer Mech. Seal</th><th>Service</th><th>Rotary</th><th>Stationary</th><th>Elasto-mers</th><th>Metal Parts</th></tr>
<tr><td>OPT</td><td>Heavy duty</td><td>Silicon Carbide</td><td>Tungsten Carbide</td><td>BUNA-N</td><td>300 Series SS</td></tr>
<tr><td>STD</td><td>Mild abrasives</td><td colspan="2">Silicon Carbide</td><td>BUNA-N</td><td>300 Series SS</td></tr>
</table>

Material Code	Engineering Standard
1003	Cast iron — ASTM A48 Class 30
1179	Silicon bronze — ASTM C87600



GOULDS PUMPS

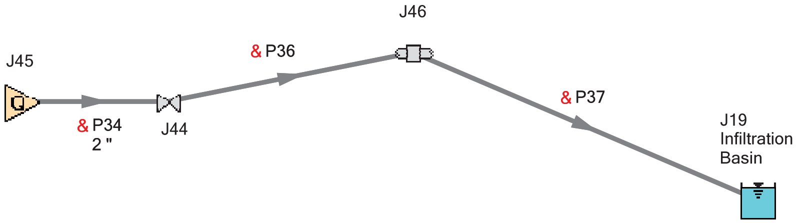
ITT
2881 East Bayard Street, Seneca Falls, NY 13148
Phone: (315) 568-7123 • Fax: (315) 568-7973

www.goulds.com

B2WD-3WD December, 2010 Printed in U.S.A.

Engineered for life

Post-Treatment Pumping and Piping Sizing Hydraulic Check



AFT Fathom 10 (Workspace)
1/12/2020
Page 1 of 1

AFT Fathom Model
GW Extraction System
Post Treatment Pumps Model

Model Reference Information

General

Title: AFT Fathom Model
Analysis run on: 1/12/2020 8:25:08 PM
Application version: AFT Fathom Version 10 (2019.03.28)
Input File: C:\Kaiser Mead GWTS\Mechanical\Fathom\Post Treatment Pumps_v1_added high point.fth
Scenario: Base Scenario/Assigned Flow 75 gpm
Output File: C:\Kaiser Mead GWTS\Mechanical\Fathom\Post Treatment Pumps_v1_added high point_F1.out

Execution Time= 0.09 seconds
Total Number Of Head/Pressure Iterations= 0
Total Number Of Flow Iterations= 2
Total Number Of Temperature Iterations= 0
Number Of Pipes= 3
Number Of Junctions= 4
Matrix Method= Gaussian Elimination

Pressure/Head Tolerance= 0.0001 relative change
Flow Rate Tolerance= 0.0001 relative change
Temperature Tolerance= 0.0001 relative change
Flow Relaxation= (Automatic)
Pressure Relaxation= (Automatic)

Constant Fluid Property Model
Fluid Database: AFT Standard
Fluid: Water at 1 atm
Max Fluid Temperature Data= 212 deg. F
Min Fluid Temperature Data= 32 deg. F
Temperature= 60 deg. F
Density= 62.37215 lbm/ft3
Viscosity= 2.72848 lbm/hr-ft
Vapor Pressure= 0.25024 psia
Viscosity Model= Newtonian
Apply laminar and non-Newtonian correction to: Pipe Fittings & Losses, Junction K factors, Junction Special Losses, Junction Polynomials
Corrections applied to the following junctions: Branch, Reservoir, Assigned Flow, Assigned Pressure, Area Change, Bend, Tee or Wye, Spray Discharge, Relief Valve

Ambient Pressure (constant)= 1 atm
Gravitational Acceleration= 1 g
Turbulent Flow Above Reynolds Number= 4000
Laminar Flow Below Reynolds Number= 2300
Total Inflow= 75.00 gal/min
Total Outflow= 75.00 gal/min
Maximum Static Pressure is 30.12 psia at Pipe 34 Inlet
Minimum Static Pressure is 11.44 psia at Pipe 36 Outlet

Warnings

No Warnings

Valve Summary

Jct	Name	Valve Type	Vol. Flow (gal/min)	Mass Flow (lbm/sec)	dP Stag. (psid)	dH (feet)	P Static In (psia)	Cv	K	Valve State
44	Valve	REGULAR	75.00	10.42	8.940E-03	0.02064	29.28	793.2	0.02000	Open

Reservoir Summary

Jct	Name	Type	Liq. Height (feet)	Liq. Elevation (feet)	Surface Pressure (psia)	Liquid Volume (feet3)	Liquid Mass (lbm)	Net Vol. Flow (gal/min)	Net Mass Flow (lbm/sec)
19	Infiltration Basin	Infinite	N/A	1,921	14.70	N/A	N/A	75.00	10.42

Pipe Output Table

Pipe	Name	Vol. Flow Rate (gal/min)	Pipe Nominal Size	Velocity (feet/sec)	P Static Max (psia)	P Static Min (psia)	Elevation Inlet (feet)	Elevation Outlet (feet)	dP Stag. Total (psid)	dP Static Total (psid)	dP Gravity (psid)
34	Pipe	75.00	2 inch	8.149	30.12	29.28	1,944	1,944	0.8493	0.8493	0.000
36	Pipe	75.00	3 inch	3.264	29.64	11.44	1,944	1,954	18.1972	18.1972	4.331
37	Pipe	75.00	3 inch	3.264	14.62	11.44	1,954	1,921	-3.1797	-3.1797	-14.294

Pipe	dH (feet)	P Static In (psia)	P Static Out (psia)	P Stag. In (psia)	P Stag. Out (psia)
34	1.961	30.12	29.28	30.57	29.72
36	32.012	29.64	11.44	29.71	11.52
37	25.659	11.44	14.62	11.52	14.70

All Junction Table

Jct	Name	P Static In (psia)	P Static Out (psia)	P Stag. In (psia)	P Stag. Out (psia)	Vol. Flow Rate Thru Jct (gal/min)	Mass Flow Rate Thru Jct (lbm/sec)	Loss Factor (K)
19	Infiltration Basin	14.70	14.70	14.70	14.70	75.00	10.42	0.00000
44	Valve	29.28	29.64	29.72	29.71	75.00	10.42	0.02000
45	Assigned Flow	30.12	30.12	30.57	30.57	75.00	10.42	0.00000
46	General Component	11.44	11.44	11.52	11.52	75.00	10.42	0.00000

Heating, Ventilation and Air Conditioning Calculations

Equipment Sizing

KAISER MEAD GROUNDWATER
REMEDIATION INTERIM ACTION

CALCULATIONS

HVAC

CARL JEFFREY SHANK
STATE OF WASHINGTON
49254
REGISTERED PROFESSIONAL ENGINEER

Carl J. Shank

Digitally Signed

on April 3, 2020

Carl Shank

JACOBS

Calculations Cover Sheet

Client	Kaiser Mead Custodial Trust	Project No.	KMCT2019
Project:	Kaiser Mead Groundwater Remediation Interim Action		
Calculation Title:	Equipment Sizing - EC Building and Pump Control House		
Calculation Identifier:			

Rev. No.	Originator Signature/Date		Checker Signature/Date		Seal and Signature (if Req'd)
0	James Cutz	1-Nov-2019			
1	James Cutz	2-Jan-2020			
2	James Cutz	January 7, 2020	Carl Shank	January 20, 2020	
3					
4					
5					
6					

Comments:

1 Nov 2019: Original calculation for sizing equipment in the EC Building only.

2 Jan 2020: Added Pump Control House Sizing, updated HAP for 90% phase

7 Jan 2020: Modified per QC review with Carl Shank (increased EC Bldg supply CFM to accomdate rotary screw compressor).

Information Requiring Confirmation:

Find

Determine ventilation only cooling rate for the EC Building based on Carrier HAP output.

Solution

Space Load	77,356	BTU/hr	HAP
Summer Design Temperature	92.6	degF	ASHRAE
Space Design Temperature	104	degF	United Rentals
Air Coefficient	1.08		Standard Conditions
Cooling Airflow Rate	6282.976	CFM	
Say	6,300	CFM	⬅

Find

Winter Heating Load for the purpose of sizing unit heaters

Solution

Unit heaters will provide heating for the envelope load and make-up air volume

Envelope Load (HAP)	20616	BTU/hr	HAP
Ventilation Load			
Extraction Airflow Rate	200	CFM	Design Extraction Rate
Outdoor Design Temperature	2.5	degF	ASHRAE
Space Design Temperature	40	degF	United Rentals
Air Coefficient	1.08		Standard Conditions
Ventilation Load	8100	BTU/hr	
Total Heating Load	28716	BTU/hr	
Equivalent kW	8.416178	kW	
Say	10	kw	⬅

Find:

Determine the ventilation-only cooling rate required for maintaining space temperatures below 104 degF for the pump control house in peak cooling season.

Solution

Space Load	6,042	BTU/hr	HAP
Summer Design Temperature	92.6	degF	ASHRAE
Space Design Temperature	104	degF	
Air Coefficient	1.08		Standard Conditions
Cooling Airflow Rate	490.7	CFM	
Say	500	CFM	⬅

NOTE: Equipment in the pump control house is protected by either it's own control panel w/heat device or freeze protection not required. No additional heat provided.

Carrier HAP Summary

Calculations Cover Sheet

Client	Kaiser Mead Custodial Trust		Project No.	KMCT2019	
Project:	Kaiser Mead Groundwater Remediation Interim Action				
Calculation Title:	Carrier HAP Summary - EC Building & Pumphouse Shed				
Calculation Identifier:					
Rev. No.	Originator Signature/Date		Checker Signature/Date		Seal and Signature (if Req'd)
0	James Cutz	1-Nov-2019			
1	James Cutz	7-Jan-2020	Carl Shank	20-Jan-2020	
2					
3					
4					

Comments:

1-Nov-2019: Original calculation based on 30% design.

7-Jan-2020: Updated calculation based on 90% design. Refined building construction details and added small factor of safety.

Information Requiring Confirmation:

EC Building

1. General Details:

Floor Area	**3894.0**	ft²
Avg. Ceiling Height	**20.0**	ft
Building Weight	**70.0**	lb/ft²

1.1. OA Ventilation Requirements:

Space Usage	**User-Defined**	
OA Requirement 1	**0.0**	CFM/person
OA Requirement 2	**0.00**	CFM/ft²
Space Usage Defaults	**ASHRAE Std 62.1-2013**	

2. Internals:

2.1. Overhead Lighting:

Fixture Type	**Recessed (Unvented)**	
Wattage	**1.00**	W/ft²
Ballast Multiplier	**1.00**	
Schedule	**Lighting Schedule**	

2.2. Task Lighting:

Wattage	**0.00**	W/ft²
Schedule	**None**	

2.3. Electrical Equipment:

Wattage	**16940.0**	Watts
Schedule	**Lighting Schedule**	

2.4. People:

Occupancy	**0.0**	Person
Activity Level	**Office Work**	
Sensible	**245.0**	BTU/hr/person
Latent	**205.0**	BTU/hr/person
Schedule	**None**	

2.5. Miscellaneous Loads:

Sensible	**0**	BTU/hr
Schedule	**None**	
Latent	**0**	BTU/hr
Schedule	**None**	

3. Walls, Windows, Doors:

Exp.	Wall Gross Area (ft²)	Window 1 Qty.	Window 2 Qty.	Door 1 Qty.
N	1970.0	0	0	2
S	1970.0	0	0	0
W	990.0	0	0	1
E	990.0	0	0	1

3.1. Construction Types for Exposure N

Wall Type	**EC - Insulated Metal Wall 1**
Door Type	**EC - Single Door Hollow Metal**

3.2. Construction Types for Exposure S

Wall Type	**EC - Insulated Metal Wall 1**

3.3. Construction Types for Exposure W

Wall Type	**EC - Insulated Metal Wall 1**
Door Type	**EC - Overhead**

3.4. Construction Types for Exposure E

Wall Type	**EC - Insulated Metal Wall 1**
Door Type	**EC - Overhead**

4. Roofs, Skylights:

Exp.	Roof Gross Area (ft²)	Roof Slope (deg.)	Skylight Qty.
H	3894.0	0	0

4.1. Construction Types for Exposure H

Roof Type	**EC - Insulated Roof 1**

5. Infiltration:

Design Cooling	**0.00**	CFM
Design Heating	**0.00**	CFM
Energy Analysis	**0.00**	CFM

Infiltration occurs only when the fan is off.

6. Floors:

Type	**Slab Floor On Grade**	
Floor Area	**3894.0**	ft²
Total Floor U-Value	**0.100**	BTU/(hr·ft²·°F)
Exposed Perimeter	**268.0**	ft
Edge Insulation R-Value	**0.00**	(hr·ft²·°F)/BTU

7. Partitions:

(No partition data).

Air System Sizing Summary for EC HVAC System

Project Name: Kaiser Mead
Prepared by: CH2M

01/10/2020
09:14AM

Air System Information

Air System Name	**EC HVAC System**		Number of zones	**1**	
Equipment Class	**UNDEF**		Floor Area	**3894.0**	ft²
Air System Type	**SZCAV**		Location	**Spokane, Washington**	

Sizing Calculation Information

Calculation Months	**Jan to Dec**	Zone CFM Sizing	**Sum of space airflow rates**
Sizing Data	**Calculated**	Space CFM Sizing	**Individual peak space loads**

Supply Fan Sizing Data

Actual max CFM	**7123**	CFM	Fan motor BHP	**3.90**	BHP
Standard CFM	**6511**	CFM	Fan motor kW	**3.09**	kW
Actual max CFM/ft²	**1.83**	CFM/ft²	Fan static	**2.00**	in wg

Outdoor Ventilation Air Data

Design airflow CFM	**0**	CFM	CFM/person	**0.00**	CFM/person
CFM/ft²	**0.00**	CFM/ft²			

Zone Sizing Summary for EC HVAC System

Project Name: Kaiser Mead
Prepared by: CH2M

01/10/2020
09:14AM

Air System Information

Air System Name	**EC HVAC System**	Number of zones	**1**
Equipment Class	**UNDEF**	Floor Area	**3894.0** ft²
Air System Type	**SZCAV**	Location	**Spokane, Washington**

Sizing Calculation Information

Calculation Months	**Jan to Dec**	Zone CFM Sizing	**Sum of space airflow rates**
Sizing Data	**Calculated**	Space CFM Sizing	**Individual peak space loads**

Zone Terminal Sizing Data

Zone Name	Design Supply Airflow (CFM)	Minimum Supply Airflow (CFM)	Zone CFM/ft²	Reheat Coil Load (MBH)	Reheat Coil Water gpm @ 20.0 °F	Zone Htg Unit Coil Load (MBH)	Zone Htg Unit Water gpm @ 20.0 °F	Mixing Box Fan Airflow (CFM)
Zone 1	7123	7123	1.83	0.0	0.00	0.0	0.00	0

Zone Peak Sensible Loads

Zone Name	Zone Cooling Sensible (MBH)	Time of Peak Sensible Cooling Load	Zone Heating Load (MBH)	Zone Floor Area (ft²)
Zone 1	77.4	Jul 1400	20.6	3894.0

Space Loads and Airflows

Zone Name / Space Name	Mult.	Cooling Sensible (MBH)	Time of Peak Sensible Load	Air Flow (CFM)	Heating Load (MBH)	Floor Area (ft²)	Space CFM/ft²
Zone 1							
EC Building	1	77.4	Jul 1400	7123	20.6	3894.0	1.83

Air System Design Load Summary for EC HVAC System

Project Name: Kaiser Mead
Prepared by: CH2M

01/10/2020
09:14AM

	DESIGN COOLING			DESIGN HEATING		
	NO COOLING DATA NO COOLING OA DB / WB			HEATING DATA AT DES HTG HEATING OA DB / WB 2.5 °F / -0.7 °F		
ZONE LOADS	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**
Window & Skylight Solar Loads	0 ft²	-	-	0 ft²	-	-
Wall Transmission	5469 ft²	-	-	5469 ft²	8198	-
Roof Transmission	3894 ft²	-	-	3894 ft²	3841	-
Window Transmission	0 ft²	-	-	0 ft²	0	-
Skylight Transmission	0 ft²	-	-	0 ft²	0	-
Door Loads	451 ft²	-	-	451 ft²	2190	-
Floor Transmission	3894 ft²	-	-	3894 ft²	4513	-
Partitions	0 ft²	-	-	0 ft²	0	-
Ceiling	0 ft²	-	-	0 ft²	0	-
Overhead Lighting	-	-	-	0	0	-
Task Lighting	-	-	-	0	0	-
Electric Equipment	-	-	-	0	0	-
People	-	-	-	0	0	0
Infiltration	-	-	-	-	0	0
Miscellaneous	-	-	-	-	0	0
Safety Factor	10% / 10%	-	-	10%	1874	0
>> Total Zone Loads	**-**	**-**	**-**	**-**	**20616**	**0**
Zone Conditioning	-	-	-	-	10560	0
Plenum Wall Load	0%	-	-	0	0	-
Plenum Roof Load	0%	-	-	0	0	-
Plenum Lighting Load	0%	-	-	0	0	-
Return Fan Load	-	-	-	7123 CFM	0	-
Ventilation Load	-	-	-	0 CFM	0	0
Supply Fan Load	-	-	-	7123 CFM	-10560	-
Space Fan Coil Fans	-	-	-	-	0	-
Duct Heat Gain / Loss	0%	-	-	0%	0	-
>> Total System Loads	**-**	**-**	**-**	**-**	**0**	**0**
>> Total Conditioning	**-**	**-**	**-**	**-**	**0**	**0**
Key:	**Positive values are clg loads Negative values are htg loads**			**Positive values are htg loads Negative values are clg loads**		

Zone Design Load Summary for EC HVAC System

Project Name: Kaiser Mead
Prepared by: CH2M

01/10/2020
09:14AM

Zone 1	**DESIGN COOLING**			**DESIGN HEATING**		
	COOLING DATA AT Jul 1400 **COOLING OA DB / WB 91.8 °F / 61.7 °F**			**HEATING DATA AT DES HTG** **HEATING OA DB / WB 2.5 °F / -0.7 °F**		
	OCCUPIED T-STAT 104.0 °F			**OCCUPIED T-STAT 40.0 °F**		
ZONE LOADS	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**
Window & Skylight Solar Loads	0 ft²	0	-	0 ft²	-	-
Wall Transmission	5469 ft²	-821	-	5469 ft²	8198	-
Roof Transmission	3894 ft²	1048	-	3894 ft²	3841	-
Window Transmission	0 ft²	0	-	0 ft²	0	-
Skylight Transmission	0 ft²	0	-	0 ft²	0	-
Door Loads	451 ft²	-988	-	451 ft²	2190	-
Floor Transmission	3894 ft²	0	-	3894 ft²	4513	-
Partitions	0 ft²	0	-	0 ft²	0	-
Ceiling	0 ft²	0	-	0 ft²	0	-
Overhead Lighting	3894 W	13286	-	0	0	-
Task Lighting	0 W	0	-	0	0	-
Electric Equipment	16940 W	57799	-	0	0	-
People	0	0	0	0	0	0
Infiltration	-	0	0	-	0	0
Miscellaneous	-	0	0	-	0	0
Safety Factor	10% / 10%	7032	0	10%	1874	0
>> Total Zone Loads	**-**	**77356**	**0**	**-**	**20616**	**0**

Pump Shed

1. General Details:

Floor Area	**200.0**	ft²
Avg. Ceiling Height	**9.0**	ft
Building Weight	**30.0**	lb/ft²

1.1. OA Ventilation Requirements:

Space Usage	**User-Defined**	
OA Requirement 1	**0.0**	CFM/person
OA Requirement 2	**0.00**	CFM/ft²
Space Usage Defaults	**ASHRAE Std 62.1-2013**	

2. Internals:

2.1. Overhead Lighting:

Fixture Type	**Recessed (Unvented)**	
Wattage	**1.00**	W/ft²
Ballast Multiplier	**1.00**	
Schedule	**Lighting Schedule**	

2.2. Task Lighting:

Wattage	**0.00**	W/ft²
Schedule	**None**	

2.3. Electrical Equipment:

Wattage	**1050.0**	Watts
Schedule	**Lighting Schedule**	

2.4. People:

Occupancy	**0.0**	Person
Activity Level	**Office Work**	
Sensible	**245.0**	BTU/hr/person
Latent	**205.0**	BTU/hr/person
Schedule	**None**	

2.5. Miscellaneous Loads:

Sensible	**0**	BTU/hr
Schedule	**None**	
Latent	**0**	BTU/hr
Schedule	**None**	

3. Walls, Windows, Doors:

Exp.	Wall Gross Area (ft²)	Window 1 Qty.	Window 2 Qty.	Door 1 Qty.
N	180.0	0	0	0
S	180.0	0	0	0
E	90.0	0	0	1
W	90.0	0	0	0

3.1. Construction Types for Exposure N

Wall Type	**Pump Shed Wall**

3.2. Construction Types for Exposure S

Wall Type	**Pump Shed Wall**

3.3. Construction Types for Exposure E

Wall Type	**Pump Shed Wall**
Door Type	**Pump Shed Door (metal)**

3.4. Construction Types for Exposure W

Wall Type	**Pump Shed Wall**

4. Roofs, Skylights:

Exp.	Roof Gross Area (ft²)	Roof Slope (deg.)	Skylight Qty.
H	200.0	0	0

4.1. Construction Types for Exposure H

Roof Type	**Pump Shed Roof**

5. Infiltration:

Design Cooling	**0.00**	CFM
Design Heating	**0.00**	CFM
Energy Analysis	**0.00**	CFM

Infiltration occurs only when the fan is off.

6. Floors:

Type	**Slab Floor On Grade**	
Floor Area	**200.0**	ft²
Total Floor U-Value	**0.100**	BTU/(hr·ft²·°F)
Exposed Perimeter	**60.0**	ft
Edge Insulation R-Value	**0.00**	(hr·ft²·°F)/BTU

7. Partitions:

(No partition data).

Air System Sizing Summary for Pump House Fan

Project Name: Kaiser Mead
Prepared by: CH2M

01/10/2020
09:17AM

Air System Information

Air System Name	**Pump House Fan**		Number of zones	**1**	
Equipment Class	**UNDEF**		Floor Area	**200.0**	ft²
Air System Type	**SZCAV**		Location	**Spokane, Washington**	

Sizing Calculation Information

Calculation Months	**Jan to Dec**	Zone CFM Sizing	**Sum of space airflow rates**
Sizing Data	**Calculated**	Space CFM Sizing	**Individual peak space loads**

Supply Fan Sizing Data

Actual max CFM	**537**	CFM	Fan motor BHP	**0.18**	BHP
Standard CFM	**491**	CFM	Fan motor kW	**0.15**	kW
Actual max CFM/ft²	**2.68**	CFM/ft²	Fan static	**1.25**	in wg

Outdoor Ventilation Air Data

Design airflow CFM	**0**	CFM	CFM/person	**0.00**	CFM/person
CFM/ft²	**0.00**	CFM/ft²			

Zone Sizing Summary for Pump House Fan

Project Name: Kaiser Mead
Prepared by: CH2M

01/10/2020
09:17AM

Air System Information

Air System Name	**Pump House Fan**	Number of zones	**1**
Equipment Class	**UNDEF**	Floor Area	**200.0** ft²
Air System Type	**SZCAV**	Location	**Spokane, Washington**

Sizing Calculation Information

Calculation Months	**Jan to Dec**	Zone CFM Sizing	**Sum of space airflow rates**
Sizing Data	**Calculated**	Space CFM Sizing	**Individual peak space loads**

Zone Terminal Sizing Data

Zone Name	Design Supply Airflow (CFM)	Minimum Supply Airflow (CFM)	Zone CFM/ft²	Reheat Coil Load (MBH)	Reheat Coil Water gpm @ 20.0 °F	Zone Htg Unit Coil Load (MBH)	Zone Htg Unit Water gpm @ 20.0 °F	Mixing Box Fan Airflow (CFM)
Zone 1	537	537	2.68	0.0	0.00	0.0	0.00	0

Zone Peak Sensible Loads

Zone Name	Zone Cooling Sensible (MBH)	Time of Peak Sensible Cooling Load	Zone Heating Load (MBH)	Zone Floor Area (ft²)
Zone 1	6.0	Jul 1400	3.7	200.0

Space Loads and Airflows

Zone Name / Space Name	Mult.	Cooling Sensible (MBH)	Time of Peak Sensible Load	Air Flow (CFM)	Heating Load (MBH)	Floor Area (ft²)	Space CFM/ft²
Zone 1							
Pump Shed	1	6.0	Jul 1400	537	3.7	200.0	2.68

Air System Design Load Summary for Pump House Fan

Project Name: Kaiser Mead
Prepared by: CH2M

01/10/2020
09:17AM

	DESIGN COOLING			**DESIGN HEATING**		
	NO COOLING DATA **NO COOLING OA DB / WB**			**HEATING DATA AT DES HTG** **HEATING OA DB / WB 2.5 °F / -0.7 °F**		
ZONE LOADS	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**
Window & Skylight Solar Loads	0 ft²	-	-	0 ft²	-	-
Wall Transmission	520 ft²	-	-	520 ft²	1870	-
Roof Transmission	200 ft²	-	-	200 ft²	795	-
Window Transmission	0 ft²	-	-	0 ft²	0	-
Skylight Transmission	0 ft²	-	-	0 ft²	0	-
Door Loads	20 ft²	-	-	20 ft²	148	-
Floor Transmission	200 ft²	-	-	200 ft²	541	-
Partitions	0 ft²	-	-	0 ft²	0	-
Ceiling	0 ft²	-	-	0 ft²	0	-
Overhead Lighting	-	-	-	0	0	-
Task Lighting	-	-	-	0	0	-
Electric Equipment	-	-	-	0	0	-
People	-	-	-	0	0	0
Infiltration	-	-	-	-	0	0
Miscellaneous	-	-	-	-	0	0
Safety Factor	10% / 10%	-	-	10%	335	0
>> Total Zone Loads	**-**	**-**	**-**	**-**	**3690**	**0**
Zone Conditioning	-	-	-	-	497	0
Plenum Wall Load	0%	-	-	0	0	-
Plenum Roof Load	0%	-	-	0	0	-
Plenum Lighting Load	0%	-	-	0	0	-
Return Fan Load	-	-	-	537 CFM	0	-
Ventilation Load	-	-	-	0 CFM	0	0
Supply Fan Load	-	-	-	537 CFM	-497	-
Space Fan Coil Fans	-	-	-	-	0	-
Duct Heat Gain / Loss	0%	-	-	0%	0	-
>> Total System Loads	**-**	**-**	**-**	**-**	**0**	**0**
>> Total Conditioning	**-**	**-**	**-**	**-**	**0**	**0**
Key:	**Positive values are clg loads** **Negative values are htg loads**			**Positive values are htg loads** **Negative values are clg loads**		

Zone Design Load Summary for Pump House Fan

Project Name: Kaiser Mead
Prepared by: CH2M

01/10/2020
09:17AM

Zone 1	DESIGN COOLING			DESIGN HEATING		
	COOLING DATA AT Jul 1400 **COOLING OA DB / WB 91.8 °F / 61.7 °F**			**HEATING DATA AT DES HTG** **HEATING OA DB / WB 2.5 °F / -0.7 °F**		
	OCCUPIED T-STAT 104.0 °F			**OCCUPIED T-STAT 50.0 °F**		
ZONE LOADS	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**
Window & Skylight Solar Loads	0 ft²	0	-	0 ft²	-	-
Wall Transmission	520 ft²	460	-	520 ft²	1870	-
Roof Transmission	200 ft²	819	-	200 ft²	795	-
Window Transmission	0 ft²	0	-	0 ft²	0	-
Skylight Transmission	0 ft²	0	-	0 ft²	0	-
Door Loads	20 ft²	-51	-	20 ft²	148	-
Floor Transmission	200 ft²	0	-	200 ft²	541	-
Partitions	0 ft²	0	-	0 ft²	0	-
Ceiling	0 ft²	0	-	0 ft²	0	-
Overhead Lighting	200 W	682	-	0	0	-
Task Lighting	0 W	0	-	0	0	-
Electric Equipment	1050 W	3583	-	0	0	-
People	0	0	0	0	0	0
Infiltration	-	0	0	-	0	0
Miscellaneous	-	0	0	-	0	0
Safety Factor	10% / 10%	549	0	10%	335	0
>> Total Zone Loads	**-**	**6042**	**0**	**-**	**3690**	**0**

Louver Sizing

Calculations Cover Sheet

Client	Kaiser Mead Custodial Trust		Project No.	KMCT2019
Project:	Kaiser Mead Groundwater Remediation Interim Action			
Calculation Title:	Louver Sizing - EC Building & Pump Control House			
Calculation Identifier:				

Rev. No.	Originator Signature/Date		Checker Signature/Date		
0	James Cutz	1-Nov-2019	C. Shank	20-Jan-2020	
1					
2					
3					
4					Seal and Signature (if Req'd)

Comments:

Information Requiring Confirmation:

PROJECT NUMBER:	KMCT2019	**CALCULATED BY:**	James Cutz
PROJECT NAME:	Kaiser Mead Groundwater Remediation Interim Action	**DATE:**	1-Nov-2019
CALCULATION TITLE:	Louver Sizing - EC Building & Pump Control House		

														Square Louver		Round Louver		Rectangular Louver												
Building	**Room Served**	**Primary Airflow, ACFM**	**Louver No.**	**Associated Fan**	**Motorized Damper Tag Number**	**Intake, Open Exhaust, or Ducted Exhaust**	**Calculated Unit Airflow, ACFM**	**Total Air Flow, ACFM**	**Louver Model**	**Free Area Velocity, fpm**	**Max. Allowed Pressure Drop, in. WC**	**Free Area Required, sq. ft.**	**Guess Louver Face Area Required, sq. ft.**	**Minimum Square Dimension Equivalent, ft.**	**Minimum Square Dimension Equivalent, in.**	**Minimum Round Diameter Equivalent, ft.**	**Minimum Round Diameter Equivalent, in**	**Selected Louver Size Height X Width, ft**		**Initial Guess Louver Free Area, %**	**Selected Louver Size Height X Width, in.**		**Selected Louver Actual Free Area, %**	**Selected Louver Face Area, sq. ft.**	**Free Area Check - Selected Free Area greater than Required?**	**Area Difference, sq. ft.**	**Final Selected Louver Velocity, fpm**	**Velocity Difference Check, fpm**	**Final Selected Louver Velocity, mph**	**Combined Design Free Area Check (Selected > Guess)?**
Single systems																														
Intake Louver	EC Building	6,300	1	Supply	03-MD-02 & 03-MD-03	Intake	6,300	6,300	RUSKIN ELF375DX	600	0.05	10.50	21.00	4.58	55.0	5.01	60.1	4 ft, 0 in	5 ft, 4 in	50%	48	64	51%	21.33	Size OK	(-0.333)	579	21	7	OK Free Area
Exhaust Louver	EC Building	6,300	2	Exhaust	03-MD-01	Ducted Exhaust	6,300	6,300	RUSKIN ELF375DX	1,000	0.10	6.30	12.60	3.55	42.6	3.88	46.6	3 ft, 6 in	4 ft, 6 in	50%	42	54	50%	15.75	Size OK	(-3.150)	800	200	9	OK Free Area
Intake Louver	Pump Control House	500	3	Supply	NA	Intake	400	400	RUSKIN ELF375DX	600	0.05	0.67	2.38	1.54	18.5	1.69	20.2	1 ft, 0 in	2 ft, 6 in	28%	12	30	28%	2.50	Size OK	(-0.119)	571	29	6	OK Free Area
Exhaust Louver	Pump Control House	500	4	Exhaust	NA	Open Exhaust	500	500	RUSKIN ELF375DX	600	0.05	0.83	2.78	1.67	20.0	1.82	21.9	1 ft, 6 in	2 ft, 0 in	30%	18	24	34%	3.00	Size OK	(-0.222)	490	110	6	OK Free Area

Input Data Cells		Louver Pressure Drop		
Max. Intake Velocity, fpm	600	Intake louver max. pressure drop, in. w.c.	-	0.05
Max. Open Exhaust Velocity, fpm	600	Open Exhaust louver max. pressure drop, in. \	-	0.05
Max. Ducted Exhaust Velocity, fpm	1,000	Ducted Exhaust louver max. pressure drop, in	-	0.10

		Free Area Percentage Starting Point	0
Free Area, Extra Small Louvers	x < 18"	25%	0%
Free Area, Small Louvers	18" <= x < 24"	30%	0%
Free Area, Medium Louvers	24" <= x < 30"	40%	0%
Free Area, Large Louvers	30" <= x < 36"	42%	0%
Free Area, Extra Large Louvers	36" <= x < 48"	47%	0%
Free Area, Extra, Extra Large Louvers	x >= 48"	50%	0%
Free Area, Acoustical Louvers		30%	0%

Electrical Gear Heat Gain

JACOBS®

Calculation Cover Sheet

Project:	Kaiser Mead Groundwater Remediation Interim Action			
Client:	Kaiser Mead Custodial Trust	Project No.		KMCT2019

Calculation Title:	Electrical Gear Heat Generation
Calculation Identifier:	

	Originator		Checker		
Rev. No.	Signature	Date	Signature	Date	
0	James Cutz	October 2, 2019			
1	James Cutz	January 2, 2020			
2	James Cutz	January 7, 2020	C. Shank	January 20, 2020	
					Seal and Signature (if Req'd)

Comments:

October 2: Original calculation.

January 2: Added Pump Control House, updated EC Building per United Rental's updated scope.

January 7: Refined following brief QC review.

Information Requiring Confirmation:

PROJECT NUMBER: 0
PROJECT NAME: Kaiser Mead Custodial Trust
DESCRIPTION: Electrical Gear Heat Generation
Revision 1 Provided By:
Revision 2 Provided By:
Revision 3 Provided By:
Revision 4 Provided By:
BUILDING: EC Building

CALCULATED BY: James Cutz
ORIGINAL DATE: 2-Jan-2020
Data Provided By: Mariah Alexander/CVO United Rentals
REVISED 1 DATE: 0-Jan-1900
REVISED 2 DATE: 0-Jan-1900
REVISED 3 DATE: 0-Jan-1900
REVISED 4 DATE: 0-Jan-1900
SPACE:

Equipment	Description	Installed Quantity	Peak Operating Quantity	Heat Loss per Unit (Watts)	Total Watts	Total (BTU/hr)	Comments
Electrical Equipment List							
AFDs - See Data Table Tab							HP
	Duplex EC Feed Pumps VFDs	2	1	110	110	376	3
	Post EC Pump VFDs	2	1	110	110	376	3
	Post Treatment Pump VFDs	2	1	225	225	768	5
	Water Reuse Pump VFDs	2	1	110	110	376	2
Assume 95% Efficiency	Rectifiers 48VDC/2000AMP; Input: 460V/3ph/145 amp	2	1	4,400	4,400	15,026	150
				-	-	-	
				-	-	-	
				-	-	-	
				-	-	-	
Power Panel							
Panel Board	225 Amp, 42 Circuit	1	1	300	300	1,025	Main Electrical Panel; 30 amps
Lighting Panel	225 Amp, 42 Circuit			300	-	-	
HVAC Panel	225 Amp, 42 Circuit			300	-	-	
Process Panel	225 Amp, 42 Circuit			300	-	-	
480V Panel	225 Amp, 42 Circuit			300	-	-	
	24V, Battery Charging			300	-	-	
	Medium Voltage 4000 Amp			2,400	-	-	
Lighting (If no HAP calculation)	1 W/SF			-	-	-	Using HAP for Lighting
Miscellaneous Equipment							
Battery Inverter				500	-	-	
Emergency Panel Transfer Switch				200	-	-	
I&C Equipment List							
Centrifuge Panels	Per cabinet (no UPS)			400	-	-	
LCP Panel	Per cabinet (no UPS)			200	-	-	
Network Panel	Per cabinet (no UPS)			200	-	-	
FACP Panel	Per cabinet (no UPS)			200	-	-	
UPS Panel	Per cabinet (no UPS)			200	-	-	
UPS Bypass Panel	Per cabinet (no UPS)			200	-	-	
Lighting Panel	Per cabinet (no UPS)			200	-	-	
HCP Cabinet	Per cabinet (no UPS)			200	-	-	
DDC Cabinet - Process	Per cabinet (no UPS)	1	1	200	200	683	Control Cabinet - 60 amps
UPS (For I&C Equipment)	1.5 KVA			117	-	-	
	5 KVA			305	-	-	
	10 KVA			649	-	-	
	15 KVA			840	-	-	
	20 KVA			886	-	-	
	30 KVA			1,602	-	-	
Computer	Average Value			55	-	-	
	Conservative			65	-	-	
	Highly Conservative			75	-	-	
Printer	Laser			100	-	-	
Monitor	Small (13-15 in.)			55	-	-	
	Medium (16-18 in.)			70	-	-	
	Large (19-20 in.)			80	-	-	
	"Count"	12	7		**Watts**	**BTU/hr**	**Tons**
			Grand Total:		5,455	18,629	1.6

Electrical Equipment Heat Gains
Pump House - Heat Gain

1/10/2020 9:35 AM

PROJECT NUMBER:	0	**CALCULATED BY:**	James Cutz
PROJECT NAME:	Kaiser Mead Custodial Trust	**ORIGINAL DATE:**	2-Jan-2020
DESCRIPTION:	Electrical Gear Heat Generation	**Data Provided By:**	
Revision 1 Provided By:		**REVISED 1 DATE:**	0-Jan-1900
Revision 2 Provided By:		**REVISED 2 DATE:**	0-Jan-1900
Revision 3 Provided By:		**REVISED 3 DATE:**	0-Jan-1900
Revision 4 Provided By:		**REVISED 4 DATE:**	0-Jan-1900
BUILDING:	EC Building	**SPACE:**	

Equipment	Description	Installed Quantity	Peak Operating Quantity	Heat Loss per Unit (Watts)	Total Watts	Total (BTU/hr)	Comments
Electrical Equipment List							
AFDs - See Data Table Tab							HP
	Pump House Pump VFDs	5	5	90	450	1,537	1
					-		
					-		
					-		
					-		
					-		
					-		
Panel Board	225 Amp, 42 Circuit	1	1	300	300	1,025	VFD Control Panel
Lighting Panel	225 Amp, 42 Circuit	1	1	300	300	1,025	Lighting Sub Panel
HVAC Panel	225 Amp, 42 Circuit			300	-	-	
Process Panel	225 Amp, 42 Circuit			300	-	-	
480V Panel	225 Amp, 42 Circuit			300	-	-	
	24V, Battery Charging			300	-	-	
Lighting (If no HAP calculation)	1 W/SF			-	-	-	Using HAP for Lighting
Miscellaneous Equipment							
Battery Inverter				500	-	-	
Emergency Panel Transfer Switch				200	-	-	
	"Count"	7	7		**Watts**	**BTU/hr**	**Tons**
				Grand Total:	1,050	3,586	0.3

Mechanical Equipment Loads

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Calculations Cover Sheet

Client	Kaiser Mead Custodial Trust	Project No.	KMCT2019
Project:	Kaiser Mead Groundwater Remediation Interim Action		
Calculation Title:	Equipment Heat Loads - EC Building and Pump House		
Calculation Identifier:			

Rev. No.	Originator Signature/Date		Checker Signature/Date		Seal and Signature (if Req'd)
0	James Cutz	1-Nov-2019			
1	James Cutz	2-Jan-2020			
2	James Cutz	January 7, 2020	C. Shank	January 20, 2020	
3					
4					
5					
6					

Comments:

1 Nov 2019: Initial calculation with preliminary UR information.

2 Jan 2020: Updating heat load values and equipment counts per UR's revised scope from 12-24-2019.

7 Jan 2020: Updated per QC Review with Carl Shank to include heat gain associated with Rotary Screw Compressor.

Information Requiring Confirmation:

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Equipment Heat Loads - EC Building and Pump House

Calculation Title: Equipment Heat Loads - EC Building and Pump House
Client: Kaiser Mead Custodial Trust
Project Name: Kaiser Mead Groundwater Remediation Interim Action
Project Number:
Date:
Engineer: James Cutz

Count	Facility	Room	Watts	Btu/hr
	EC Building	EC Building	11,485	39,199
	EC Building	EC Building - Carryover from Electrical Heat Gain Calc	5,455	18,629
		Total HAP Input	**16,940**	**57,828**
	Pump House	Pump House (No mechanical equipment)	0	0
	Pump House	Pump House - Carryover from Electrical Heat Gain Calc	1,050	3,581
		Total HAP Input	**1,050**	**3,581**

HVAC COOLING LOADS FROM MECHANICAL EQUIPMENT
EC Building

PROJECT NUMBER:		**CALCULATED BY:**	James Cutz
PROJECT NAME:	Kaiser Mead	**DATE:**	October 9, 2019
FACILITY:	EC Building	**ORIGINAL DATA BY:**	Provided by United Rentals via Jim Stefanoff/SPK
Revision 1 Provided By:	James Cutz	**Revision 1 Date:**	2-Jan-2020
Revision 2 Provided By:		**Revision 2 Date:**	
Revision 3 Provided By:		**Revision 3 Date:**	
Revision 4 Provided By:		**Revision 4 Date:**	
Revision 5 Provided By:		**Revision 5 Date:**	
Revision 6 Provided By:		**Revision 6 Date:**	

Facility and Equipment Name	Installed Quantity	Motor HP	Peak Quantity Operating	Duty Cycle	Efficiency	Heat to Space (Watts)	Heat to Space (BTU/hr)	Comments
EC Building								
Rotary Screw Air Compressor - Kaeser SK-20	1	20	1	0.40	60,000	7,032	24,000	Anticipated use at 40% per United Rentals. Heat rejection is 60,000 BTU/hr per Kaeser Compressor (phone call to district office). Used efficiency column to document the heat rejection for this line item only. Model is 20 HP w/aftercooler and internal fan.
Hoist Trolley (3 ton/7.5 HP)	1	7 1/2	1	0.15	87.5%	120	409	Anticipated use is 2 times/week.
Auger Motor/Bulk Handling System	1	2	1	1.00	84.0%	284	970	
Shaker Motor/Bulk Handling System	1	1	1	1.00	80.0%	186	636	
Winch Motor (Belt Filter Press)	1	3	1	1.00	85.5%	379	1,295	
Water Reuse Pumps (2HP max)	1	2	1	1.00	84.0%	284	970	
Sump Pump - 1 HP Zoeller	1	1	1	1.00	80.0%	186	636	
EQ Tank Mixer	1	1 1/2	1	1.00	82.5%	237	810	
Defoam Tank Agitator	1	1 1/2	1	1.00	82.5%	237	810	
Flocc Tank Agitator	1	1	1	1.00	80.0%	186	636	
CaCl Tank Agitator	1	1/2	1	1.00	68.0%	175	599	
Polymer Tank Agitator	1	1/2	1	1.00	68.0%	175	599	
EC Feed Pumps	2	3	1	1.00	85.5%	379	1,295	
Polymer Tank Pumps	2	1/4	1	1.00	55.0%	153	521	
Post-EC Pumps	2	3	1	1.00	85.5%	379	1,295	
Post-Treatment Pumps	2	5	1	1.00	85.5%	632	2,158	
CaCl Pumps (Chemical Metering)	2	1/4	1	1.00	55.0%	153	521	
Acid Pumps (Chemical Metering)	4	1/4	2	1.00	55.0%	305	1,041	
AODD Pumps - Air Operated	3	0	3	1.00	#N/A	#N/A	#N/A	Air operated pump
ROOM TOTAL						**11,485**	**39,199**	

	Watts	BTU/hr
TOTAL	**11,485**	**39,199**

input cell

Duct Pressure Loss Calculations

Calculations Cover Sheet *

*Light yellow cells are to be edited by the user.

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Client	Kaiser Mead Custodial Trust	Project No.	KMCT2019

Calculation Title:	Duct Pressure Loss Calculations - EC Building and Pump Control House

Calculation Identifier:

Rev. No.	Originator Signature/Date		Checker Signature/Date		
0	James Cutz	2-Jan-20			
1	James Cutz	7-Jan-20	C. Shank	20-Jan-20	
2					
3					
4					
					Seal and Signature (if Req'd)

Comments:

2-Jan-2020: Initial calculation for final equipment selection for 90% design phase.

7-Jan-2020: Revised calculation to reflect increased airflows in EC Building for accomadation of compressor heat load.

Information Requiring Confirmation:

PROJECT NAME:	Kaiser Mead Custodial Trust	**TEMPERATURE:**	70	DEGREES F	**G - GALVANIZED (SPIRAL SEAM) DUCT ABSOLUTE ROUGHNESS FACTOR:**	**0.0003**	ft (Taken From ASHRAE 2009 Fundamentals: Chap. 21, Table 1)
PROJECT NUMBER	KMCT2019	**ELEVATION:**	1900	FT.	**A - ALUMINUM, CARBON STEEL, PVC DUCT ABSOLUTE ROUGHNESS FACTOR:**	**0.0001**	ft (Taken From ASHRAE 2009 Fundamentals: Chap. 21, Table 1)
TAG NUMBER:	03-SF-01	**DUCT PRESSURE DROP CRITERIA:**	0.10	IN. W.C. PER 100 FT.	**C - CONCRETE OR FLEXIBLE DUCT ABSOLUTE ROUGHNESS FACTOR:**	**0.0100**	ft (Taken From ASHRAE 2009 Fundamentals: Chap. 21, Table 1)
CALCULATED BY:	James Cutz	**DUCT VELOCITY CRITERIA:**	2,000	FPM	**F - FRP DUCT OR DUCT LINER ABSOLUTE ROUGHNESS FACTOR:**	**0.0030**	ft (Taken From ASHRAE 2009 Fundamentals: Chap. 21, Table 1)
DATE:	3-Jan-20	**FLEX PRESSURE DROP CRITERIA:**	0.10	IN. W.C. PER 100 FT.	**S - STAINLESS STEEL DUCT ABSOLUTE ROUGHNESS FACTOR:**	**0.0002**	ft (Extrapolated from ASHRAE 2009 Fundamentals: Chap 21, Table 1)
QC REVIEW BY:		**FLEX VELOCITY CRITERIA:**	600	FPM	**X - FLEXIBLE DUCT ABSOLUTE ROUGHNESS FACTOR:**	**0.0030**	ft (Taken From ASHRAE 2013 Fundamentals: Chap. 21, Page 21.6)
DATE:		**SAFETY FACTOR:**	10	PERCENT	**FLEXIBLE DUCT PERCENT COMPRESSION:**	**20.0000**	% (Taken From ASHRAE 2013 Fundamentals: Chap. 21, Figure 8)
COMMENTS:		**ABSOLUTE AIR PRESSURE:**	27.923	13.71465	**O1 - OTHER DUCT ABSOLUTE ROUGHNESS FACTOR:**	**0.0200**	ft (Manual Input Value)
		CORRECTED AIR DENSITY:	0.0697	0.069666	**O2 - OTHER DUCT ABSOLUTE ROUGHNESS FACTOR:**	**0.0300**	ft (Manual Input Value)

Duct Section	Fitting Number	Duct Material	Duct Roughness *E, ft*	Duct Element	Airflow (CFM)	Rectangular Duct Width (in)	Rectangular Duct Height (in)	Flat Oval Duct Major (in)	Flat Oval Duct Minor (in)	Round Diameter (in)	Equivelant Diameter (in)	Hydraulic Diameter (in)	Actual Duct Velocity (FPM)	Velocity Pressure	Calculated Reynold's Number	Friction Factor - f	Duct Length (ft)	Fitting Loss Coefficient	Other Losses (In W.C.)	Duct Pressure Drop (In W.C./ft)	Duct Pressure Drop (In W.C./100 ft)	Section Press. Drop (In W.C.)	Pressure Loss Test	Velocity Test
1		G	**0.0003**	Intake Louver + Screen	6,300	64	48				**60**	**55**	**295**	**0.005**	**128,258**	**0.017**			0.12	**0.0000**	**0.002**	**0.120**		
2	SR4-2	G	**0.0003**	Transition	6,300	64	48				**60**	**55**	**295**	**0.005**	**128,258**	**0.017**		16.31		**0.0000**	**0.002**	**0.082**		
3		G	**0.0003**	Backdraft Damper	6,300	26	26				**28**	**26**	**1,342**	**0.104**	**276,249**	**0.016**			0.05	**0.0008**	**0.077**	**0.050**		
4		G	**0.0003**	Flex Connection	6,300	26	26				**28**	**26**	**1,342**	**0.104**	**276,249**	**0.016**			0.05	**0.0008**	**0.077**	**0.050**		
5		G	**0.0003**	Filter Housing + Filter Allowance	6,300	26	26				**28**	**26**	**1,342**	**0.104**	**276,249**	**0.016**			0.90	**0.0008**	**0.077**	**0.900**		
6		G	**0.0003**	Fan	6,300						**0**	**0**	**0**	**0.000**	**0**	**0.000**			0.00	**0.0000**	**0.000**	**0.000**		
7		G	**0.0003**	Flex Connection	6,300	26	26				**28**	**26**	**1,342**	**0.104**	**276,249**	**0.016**			0.05	**0.0008**	**0.077**	**0.050**		
8	SR5-15	G	**0.0003**	Bullhead Tee	3,150	26	26				**28**	**26**	**671**	**0.026**	**138,124**	**0.018**		3.33		**0.0002**	**0.021**	**0.087**		
9	SR4-2	G	**0.0003**	Transition	3,150	22	22				**24**	**22**	**937**	**0.051**	**163,238**	**0.017**		0.08		**0.0005**	**0.048**	**0.004**		
10		G	**0.0003**	Duct	3,150	22	22				**24**	**22**	**937**	**0.051**	**163,238**	**0.017**	8			**0.0005**	**0.048**	**0.004**		
11	SR5-13	G	**0.0003**	Tee - Supply Grille - Cross Grilles	3,150	22	22				**24**	**22**	**937**	**0.051**	**163,238**	**0.017**		0.99		**0.0005**	**0.048**	**0.050**		
12		G	**0.0003**	Duct	1,050	14	14				**15**	**14**	**771**	**0.034**	**85,506**	**0.020**	8			**0.0006**	**0.058**	**0.005**		
13		G	**0.0003**	Volume Damper	1,050	14	14				**15**	**14**	**771**	**0.034**	**85,506**	**0.020**			0.10	**0.0006**	**0.058**	**0.100**		
14		G	**0.0003**	Supply Grille	1,050	14	14				**15**	**14**	**771**	**0.034**	**85,506**	**0.020**			0.10	**0.0006**	**0.058**	**0.100**		
15		G	**0.0003**	Space Pressurization	1,050						**0**	**0**	**0**	**0.000**	**0**	**0.000**			0.02	**0.0000**	**0.000**	**0.020**		
16	CR6-1	G	**0.0003**	Exaust Screen	6,300					28	**28**	**28**	**1,473**	**0.126**	**326,607**	**0.016**		0.44		**0.0008**	**0.083**	**0.055**		
17		G	**0.0003**	Duct	6,300					28	**28**	**28**	**1,473**	**0.126**	**326,607**	**0.016**	22			**0.0008**	**0.083**	**0.018**		
18		G	**0.0003**	Motorized Damper	6,300					28	**28**	**28**	**1,473**	**0.126**	**326,607**	**0.016**			0.10	**0.0008**	**0.083**	**0.100**		
19	ER2-4	G	**0.0003**	Plenum Entrance	6,300	64	42				**56**	**51**	**338**	**0.007**	**135,518**	**0.017**		0.25		**0.0000**	**0.003**	**0.002**		
20		G	**0.0003**	Exhaust Louver + Screen	6,300	64	42				**56**	**51**	**338**	**0.007**	**135,518**	**0.017**			0.12	**0.0000**	**0.003**	**0.120**		

Note: This table created for the use of calculating static pressure loss in air systems. The worksheet will calculate the columns that are grayed out and protected: Equivalent Round Duct Size, Duct Velocity, Velocity Pressure, Reynolds Number, Duct Friction, Duct Section Pressure Drop, and Total System Pressure drop. Simply add the duct absolute roughness factor from ASHRAE and add any additional losses.

	Total Press. Drop (In W.C.)
	1.92
Safety Factor	**0.19**
Total S.P.:	**2.11**

PROJECT NAME:	Kaiser Mead Custodial Trust	**TEMPERATURE:**	70	DEGREES F	**G - GALVANIZED (SPIRAL SEAM) DUCT ABSOLUTE ROUGHNESS FACTOR:**	**0.0003**	ft (Taken From ASHRAE 2009 Fundamentals: Chap. 21, Table 1)
PROJECT NUMBER	KMCT2019	**ELEVATION:**	1900	FT.	**A - ALUMINUM, CARBON STEEL, PVC DUCT ABSOLUTE ROUGHNESS FACTOR:**	**0.0001**	ft (Taken From ASHRAE 2009 Fundamentals: Chap. 21, Table 1)
TAG NUMBER:	03-EF-01	**DUCT PRESSURE DROP CRITERIA:**	0.10	IN. W.C. PER 100 FT.	**C - CONCRETE OR FLEXIBLE DUCT ABSOLUTE ROUGHNESS FACTOR:**	**0.0100**	ft (Taken From ASHRAE 2009 Fundamentals: Chap. 21, Table 1)
CALCULATED BY:	James Cutz	**DUCT VELOCITY CRITERIA:**	2,000	FPM	**F - FRP DUCT OR DUCT LINER ABSOLUTE ROUGHNESS FACTOR:**	**0.0030**	ft (Taken From ASHRAE 2009 Fundamentals: Chap. 21, Table 1)
DATE:	3-Jan-20	**FLEX PRESSURE DROP CRITERIA:**	0.10	IN. W.C. PER 100 FT.	**S - STAINLESS STEEL DUCT ABSOLUTE ROUGHNESS FACTOR:**	**0.0002**	ft (Extrapolated from ASHRAE 2009 Fundamentals: Chap 21, Table 1)
QC REVIEW BY:		**FLEX VELOCITY CRITERIA:**	600	FPM	**X - FLEXIBLE DUCT ABSOLUTE ROUGHNESS FACTOR:**	**0.0030**	ft (Taken From ASHRAE 2013 Fundamentals: Chap. 21, Page 21.6)
DATE:		**SAFETY FACTOR:**	10	PERCENT	**FLEXIBLE DUCT PERCENT COMPRESSION:**	**20.0000**	% (Taken From ASHRAE 2013 Fundamentals: Chap. 21, Figure 8)
COMMENTS:		**ABSOLUTE AIR PRESSURE:**	27.923	13.71465	**O1 - OTHER DUCT ABSOLUTE ROUGHNESS FACTOR:**	**0.0200**	ft (Manual Input Value)
		CORRECTED AIR DENSITY:	0.0697	0.069666	**O2 - OTHER DUCT ABSOLUTE ROUGHNESS FACTOR:**	**0.0300**	ft (Manual Input Value)

Duct	Fitting	Duct	Duct	Duct	Airflow	Rectangular Duct		Flat Oval Duct		Round	Equivelant	Hydraulic	Actual Duct	Velocity	Calculated	Friction	Duct	Fitting Loss	Other	Duct Pressure	Duct Pressure	Section	Pressure	
Section	Number	Material	Roughness	Element		Width	Height	Major	Minor	Diameter	Diameter	Diameter	Velocity	Pressure	Reynold's	Factor - f	Length	Coefficient	Losses	Drop	Drop	Press. Drop	Loss	Velocity
			E, ft		(CFM)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(FPM)		Number		(ft)		(In W.C.)	(In W.C./ft)	(In W.C./100 ft)	(In W.C.)	Test	Test
1	CR6-1	G	0.0003	Exhaust Screen	200					10	10	10	367	0.008	29,032	0.025		0.44		0.0002	0.023	0.003		
2		G	0.0003	Duct	200					10	10	10	367	0.008	29,032	0.025	11			0.0002	0.023	0.003		
3	CR3-14	G	0.0003	Elbow-90 deg	200					10	10	10	367	0.008	29,032	0.025		0.38		0.0002	0.023	0.003		
4		G	0.0003	Vertical Duct	200					10	10	10	367	0.008	29,032	0.025	5			0.0002	0.023	0.001		
5	CR3-14	G	0.0003	Elbow-90 deg	200					10	10	10	367	0.008	29,032	0.025		0.38		0.0002	0.023	0.003		
6		G	0.0003	Duct	200					10	10	10	367	0.008	29,032	0.025	33			0.0002	0.023	0.008		
7	CR3-14	G	0.0003	Elbow-90 deg	200					10	10	10	367	0.008	29,032	0.025		0.38		0.0002	0.023	0.003		
8		G	0.0003	Vertical Duct	200					10	10	10	367	0.008	29,032	0.025	4			0.0002	0.023	0.001		
9	CR3-14	G	0.0003	Elbow-90 deg	200					10	10	10	367	0.008	29,032	0.025		0.38		0.0002	0.023	0.003		
10		G	0.0003	Duct	200					10	10	10	367	0.008	29,032	0.025	2			0.0002	0.023	0.000		
11	ER4-2	G	0.0003	Transition	200	10	10				11	10	288	0.005	22,801	0.026		0.15		0.0001	0.015	0.001		
12		G	0.0003	Flex Connection	200	10	10				11	10	288	0.005	22,801	0.026			0.05	0.0001	0.015	0.050		
13		G	0.0003	Fan	200						0	0	0	0.000	0	0.000			0.00	0.0000	0.000	0.000		
14		G	0.0003	Flex Connection	200	10	10				11	10	288	0.005	22,801	0.026			0.05	0.0001	0.015	0.050		
15	ER4-2	G	0.0003	Transition	200					10	10	10	367	0.008	29,032	0.025		0.15		0.0002	0.023	0.001		
16		G	0.0003	Motorized Damper	200					10	10	10	367	0.008	29,032	0.025			0.10	0.0002	0.023	0.100		
17		G	0.0003	Duct	200					10	10	10	367	0.008	29,032	0.025	2			0.0002	0.023	0.000		
18	ER2-4	G	0.0003	Plenum Entrance	200					10	10	10	367	0.008	29,032	0.025		0.48		0.0002	0.023	0.004		
19		G	0.0003	Exhaust Louver + Screen	200	48	36				45	41	17	0.000	5,429	0.037			0.12	0.0000	0.000	0.120		

Note: This table created for the use of calculating static pressure loss in air systems. The worksheet will calculate the columns that are grayed out and protected: Equivalent Round Duct Size, Duct Velocity, Velocity Pressure, Reynolds Number, Duct Friction, Duct Section Pressure Drop, and Total System Pressure drop. Simply add the duct absolute roughness factor from ASHRAE and add any additional losses.

	Total Press. Drop (In W.C.)
	0.35
Safety Factor	0.04
Total S.P.:	0.39

PROJECT NAME:	Kaiser Mead Custodial Trust	**TEMPERATURE:**	70	DEGREES F	**G - GALVANIZED (SPIRAL SEAM) DUCT ABSOLUTE ROUGHNESS FACTOR:**	**0.0003**	ft (Taken From ASHRAE 2009 Fundamentals: Chap. 21, Table 1)
PROJECT NUMBER	KMCT2019	**ELEVATION:**	1900	FT.	**A - ALUMINUM, CARBON STEEL, PVC DUCT ABSOLUTE ROUGHNESS FACTOR:**	**0.0001**	ft (Taken From ASHRAE 2009 Fundamentals: Chap. 21, Table 1)
TAG NUMBER:	XX-EF-01	**DUCT PRESSURE DROP CRITERIA:**	0.10	IN. W.C. PER 100 FT.	**C - CONCRETE OR FLEXIBLE DUCT ABSOLUTE ROUGHNESS FACTOR:**	**0.0100**	ft (Taken From ASHRAE 2009 Fundamentals: Chap. 21, Table 1)
CALCULATED BY:	James Cutz	**DUCT VELOCITY CRITERIA:**	2,000	FPM	**F - FRP DUCT OR DUCT LINER ABSOLUTE ROUGHNESS FACTOR:**	**0.0030**	ft (Taken From ASHRAE 2009 Fundamentals: Chap. 21, Table 1)
DATE:	3-Jan-20	**FLEX PRESSURE DROP CRITERIA:**	0.10	IN. W.C. PER 100 FT.	**S - STAINLESS STEEL DUCT ABSOLUTE ROUGHNESS FACTOR:**	**0.0002**	ft (Extrapolated from ASHRAE 2009 Fundamentals: Chap 21, Table 1)
QC REVIEW BY:		**FLEX VELOCITY CRITERIA:**	600	FPM	**X - FLEXIBLE DUCT ABSOLUTE ROUGHNESS FACTOR:**	**0.0030**	ft (Taken From ASHRAE 2013 Fundamentals: Chap. 21, Page 21.6)
DATE:		**SAFETY FACTOR:**	10	PERCENT	**FLEXIBLE DUCT PERCENT COMPRESSION:**	**20.0000**	% (Taken From ASHRAE 2013 Fundamentals: Chap. 21, Figure 8)
COMMENTS:		**ABSOLUTE AIR PRESSURE:**	27.923	13.71465	**O1 - OTHER DUCT ABSOLUTE ROUGHNESS FACTOR:**	**0.0200**	ft (Manual Input Value)
		CORRECTED AIR DENSITY:	0.0697	0.069666	**O2 - OTHER DUCT ABSOLUTE ROUGHNESS FACTOR:**	**0.0300**	ft (Manual Input Value)

Duct Section	Fitting Number	Duct Material	Duct Roughness *E, ft*	Duct Element	Airflow (CFM)	Rectangular Duct		Flat Oval Duct		Round Diameter (in)	Equivelant Diameter (in)	Hydraulic Diameter (in)	Actual Duct Velocity (FPM)	Velocity Pressure	Calculated Reynold's Number	Friction Factor - f	Duct Length (ft)	Fitting Loss Coefficient	Other Losses (In W.C.)	Duct Pressure Drop (In W.C./ft)	Duct Pressure Drop (In W.C./100 ft)	Section Press. Drop (In W.C.)	Pressure Loss Test	Velocity Test
						Width (in)	Height (in)	Major (in)	Minor (in)															
1		G	**0.0003**	Intake Louver + Screen	400	18	18				**20**	**18**	**178**	**0.002**	**25,335**	**0.025**			0.12	**0.0000**	**0.003**	**0.120**		
2	SR4-2	G	**0.0003**	Transition	400	12	12				**13**	**12**	**400**	**0.009**	**38,002**	**0.023**		2.03		**0.0002**	**0.021**	**0.019**		
3		G	**0.0003**	Flex Connection	400	12	12				**13**	**12**	**400**	**0.009**	**38,002**	**0.023**			0.05	**0.0002**	**0.021**	**0.050**		
4		G	**0.0003**	Filter Housing + Loaded Filter Allowance	400	12	12				**13**	**12**	**400**	**0.009**	**38,002**	**0.023**			0.90	**0.0002**	**0.021**	**0.900**		
5		G	**0.0003**	Fan	400						**0**	**0**	**0**	**0.000**	**0**	**0.000**			0.00	**0.0000**	**0.000**	**0.000**		
6		G	**0.0003**	Supply Grille	400	12	12				**13**	**12**	**400**	**0.009**	**38,002**	**0.023**			0.10	**0.0002**	**0.021**	**0.100**		
7		G	**0.0003**	Space Pressurization	400						**0**	**0**	**0**	**0.000**	**0**	**0.000**			0.02	**0.0000**	**0.000**	**0.020**		
8		G	**0.0003**	Exhaust Louver + Screen	400	18	18				**20**	**18**	**178**	**0.002**	**25,335**	**0.025**			0.12	**0.0000**	**0.003**	**0.120**		

Note: This table created for the use of calculating static pressure loss in air systems. The worksheet will calculate the columns that are grayed out and protected: Equivalent Round Duct Size, Duct Velocity, Velocity Pressure, Reynolds Number, Duct Friction, Duct Section Pressure Drop, and Total System Pressure drop. Simply add the duct absolute roughness factor from ASHRAE and add any additional losses.

	Total Press. Drop (In W.C.)
	1.33
Safety Factor	**0.13**
Total S.P.:	**1.46**

Electrical Calculations

KAISER MEAD GROUNDWATER
REMEDIATION INTERIM ACTION

CALCULATIONS

ELECTRICAL

BRIAN MACLEAN PILMER
STATE OF WASHINGTON
20111121
REGISTERED
PROFESSIONAL ENGINEER

Digitally Signed

on April 3, 2020

Brian Pilmer

Load Flow

Project: Kaiser_Power_Draw
Base Project

Load Flow Summary Report

Load Flow Study Settings

Include Source Impedance	Yes	**Bus Voltage Drop %**	5.00
Solution Method	Exact (Iterative)	**Branch Voltage Drop %**	3.00
Load Specification	Demand Load		

Swing Generators

Source	In/Out Service	Vpu	Angle	kW	kvar	VD%	Utility Impedance
AVISTA-UTILITY-240V_1P	In	1.00	0.00	8.9	4.9	0.00	0.00 +*j* 0.00
AVISTA-UTILITY-480V_3P	In	1.00	0.00	402.8	299.5	0.00	0.00 +*j* 0.00

Buses

Bus Name	In/Out Service	Design Volts	LF Volts	Angle Degree	PU Volts	%VD
02-PC-01	In	240	115	-1.25	0.48	52.11
03-LCP-01	In	240	200	-1.05	0.83	16.75
03-PB-01	In	480	470	-0.88	0.98	2.06

Bus Name	In/Out Service	Design Volts	LF Volts	Angle Degree	PU Volts	%VD
03-PB-01-CKT-13,15-MPC	In	480	468	-0.70	0.97	2.58
SUB_PANEL	In	240	239	-0.07	1.00	0.23

Cables

From Bus To Bus	Component Name	In/Out Service	%VD	kW Loss	kvar Loss	kVA Loss	LF Amps Rating %	PF
02-PC-01	PMP-201-CBL	In	0.00	0.0	0.0	0.0	0.0	0.00
BUS-0087				0.0	0.0	0.0	0.0	
02-PC-01	PMP-202-CBL	In	0.00	0.0	0.0	0.0	0.0	0.00
BUS-0088				0.0	0.0	0.0	0.0	
03-LCP-01	003-EH-01-CBL	In	0.17	3.3	2.5	4.1	5.1	0.80
BUS-0060				0.0	0.0	0.0	25.4	
03-LCP-01	003-EH-02-CBL	In	0.17	3.3	2.5	4.1	5.1	0.80
BUS-0061				0.0	0.0	0.0	25.4	
03-LCP-01	003-EH-04-CBL	In	0.00	0.0	0.0	0.0	0.0	0.00
BUS-0063				0.0	0.0	0.0	0.0	

From Bus To Bus	Component Name	In/Out Service	%VD	kW Loss	kvar Loss	kVA Loss	LF Amps Rating %	PF
03-LCP-01	003-EH-03-CBL	In	0.00	0.0	0.0	0.0	0.0	0.00
BUS-0064				0.0	0.0	0.0	0.0	
03-LCP-01	003-EH-05-CBL	In	0.00	0.0	0.0	0.0	0.0	0.00
BUS-0065				0.0	0.0	0.0	0.0	
03-LCP-01	003-EH-06-CBL	In	0.00	0.0	0.0	0.0	0.0	0.00
BUS-0066				0.0	0.0	0.0	0.0	
03-LCP-01	03-EP-01-CBL	In	0.74	10.8	8.0	13.4	38.8	0.80
BUS-0072				0.1	0.0	0.1	193.9	
03-PB-01	02-PC-01-XFMR-CBL-PRI	In	0.52	8.5	6.4	10.6	13.1	0.80
03-PB-01-CKT-13, 15-MPC				0.1	0.0	0.1	17.4	
03-PB-01	03-EF-01-CBL	In	0.03	0.6	0.5	0.8	0.9	0.80
BUS-0059				0.0	0.0	0.0	4.6	
03-PB-01	03-SF-01-CBL	In	0.00	0.0	0.0	0.0	0.0	0.00
BUS-0067				0.0	0.0	0.0	0.0	

From Bus To Bus	Component Name	In/Out Service	%VD	kW Loss	kvar Loss	kVA Loss	LF Amps Rating %	PF
03-PB-01	EC_CONTROLS_CBL	In	0.34	53.5	40.0	66.7	82.0	0.80
BUS-0069				0.2	0.1	0.3	63.0	
03-PB-01	WATER_HTR-CBL	In	10.66	84.9	54.6	101.0	124.0	0.84
BUS-0079				12.9	0.6	13.0	55.1	
03-PB-01	01XFMR0002-CBL-PRI	In	0.37	21.1	15.8	26.4	32.4	0.80
EC-PRI-BUS				0.1	0.0	0.1	19.1	
03-PB-01	EC-RECTIFIER-1_CBL	In	0.86	97.5	72.8	121.6	149.4	0.80
EC-RECTIFIER-1-DSW				1.0	0.4	1.1	76.6	
03-PB-01	EC-RECTIFIER-2_CBL	In	1.03	97.7	72.8	121.8	149.6	0.80
EC-RECTIFIER-1-DSW0				1.3	0.4	1.4	88.0	
03-PB-01	EC-AIR_COMPRESS_CBL	In	1.51	18.4	13.5	22.8	28.0	0.81
EC-RECTIFIER-1-DSW1				0.4	0.0	0.4	93.3	
03-PB-01	EC-HOIST_CBL	In	0.43	3.3	2.5	4.2	5.1	0.80
EC-RECTIFIER-1-DSW2				0.0	0.0	0.0	25.6	

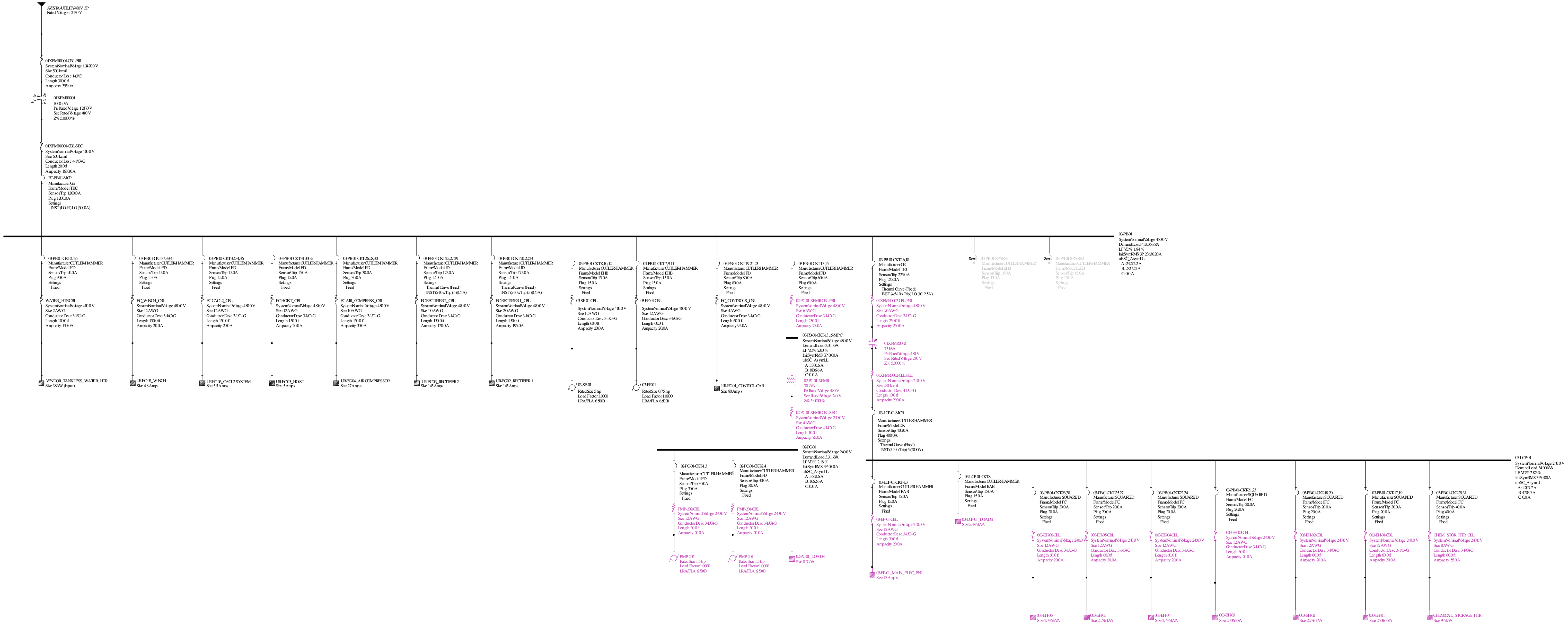
From Bus To Bus	Component Name	In/Out Service	%VD	kW Loss	kvar Loss	kVA Loss	LF Amps Rating %	PF
03-PB-01	EC-CACL2_CBL	In	0.47	3.7	2.7	4.6	5.6	0.80
EC-RECTIFIER-1-DSW3				0.0	0.0	0.0	28.2	
03-PB-01	EC_WINCH_CBL	In	0.41	3.2	2.4	4.0	4.9	0.80
EC-RECTIFIER-1-DSW4				0.0	0.0	0.0	24.6	
BUS-0015	01XFMR0002-CBL-SEC	In	0.81	20.9	15.6	26.1	74.8	0.80
03-LCP-01				0.2	0.2	0.3	28.8	
BUS-0017	02-PC-01-XFMR-CBL-SEC	In	0.12	8.3	6.2	10.4	52.2	0.80
02-PC-01				0.0	0.0	0.0	36.0	
BUS-0037	WF-CBL-01	In	0.01	0.4	0.3	0.5	1.2	0.80
BUS-0021				0.0	0.0	0.0	6.0	
BUS-0038	WF-CBL-02	In	0.01	0.4	0.3	0.5	1.2	0.80
BUS-0022				0.0	0.0	0.0	6.0	
BUS-0039	WF-CBL-03	In	0.01	0.4	0.3	0.5	1.2	0.80
BUS-0023				0.0	0.0	0.0	6.0	

From Bus To Bus	Component Name	In/Out Service	%VD	kW Loss	kvar Loss	kVA Loss	LF Amps Rating %	PF
BUS-0040	WF-CBL-04	In	0.01	0.4	0.3	0.5	1.2	0.80
BUS-0024				0.0	0.0	0.0	6.0	
BUS-0041	WF-CBL-05	In	0.01	0.4	0.3	0.5	1.2	0.80
BUS-0025				0.0	0.0	0.0	6.0	
BUS-0043	02XFMR0001-CBL-SEC	In	0.03	8.9	6.7	11.1	26.8	0.80
SUB_PANEL				0.0	0.0	0.0	2.1	
BUS-0076	01XFMR0001-CBL-SEC	In	0.04	399.1	289.1	492.8	605.0	0.81
03-PB-01				0.1	0.2	0.2	36.0	
BUS-0077	02XFMR0001-CBL-PRI	In	0.00	8.9	4.9	10.2	0.8	0.88
BUS-0062				0.0	-1.8	1.8	0.1	
BUS-0078	01XFMR0001-CBL-PRI	In	0.00	402.8	299.5	501.9	23.2	0.80
BUS-0075				0.0	-1.8	1.8	5.9	
SUB_PANEL	WF-HEATER-CBL	In	0.00	0.0	0.0	0.0	0.0	0.00
BUS-0081				0.0	0.0	0.0	0.0	

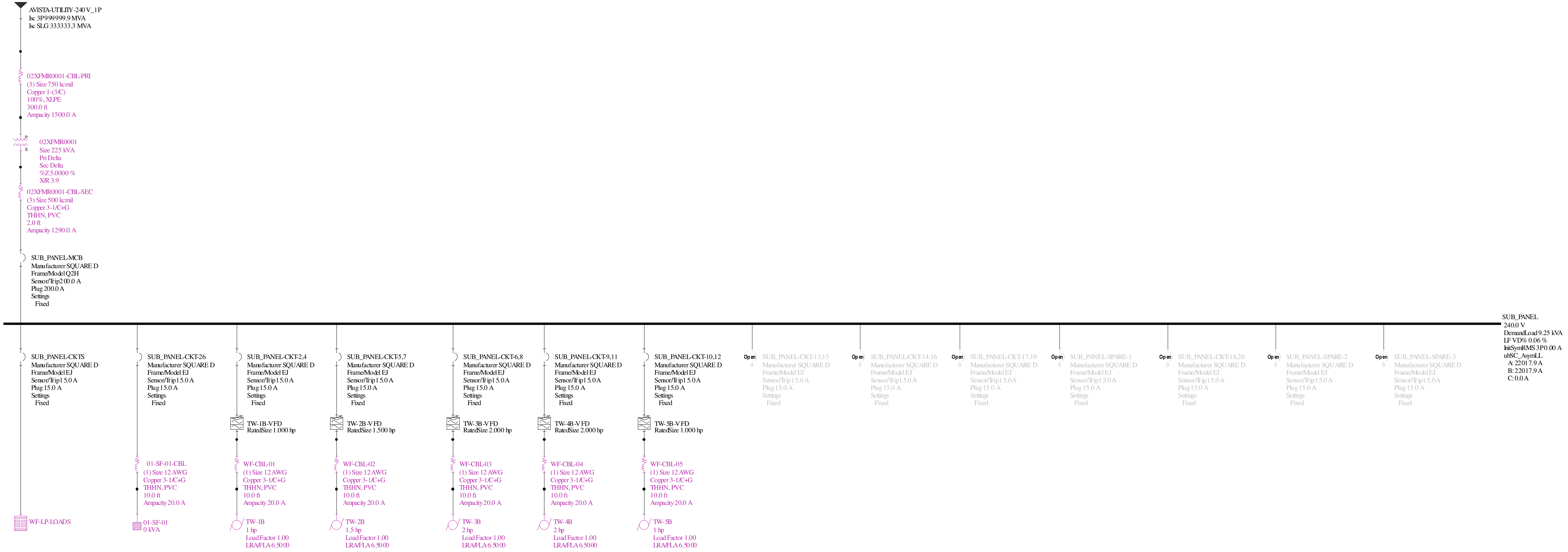
2-Winding Transformers

From Bus To Bus	Component Name	In/Out Service	%VD	kW Loss	kvar Loss	kVA Loss	LF Amps Rating %	PF
03-PB-01-CKT-13,15-MPC	02-PC-01-XFMR	In	1.52	8.4	6.4	10.6	13.0	0.79
BUS-0017				0.1	0.2	0.2	20.9	
BUS-0062	02XFMR0001	In	0.21	8.9	6.7	11.1	1.0	0.80
BUS-0043				0.0	0.0	0.0	2.1	
BUS-0075	01XFMR0001	In	2.01	402.7	301.2	502.9	23.0	0.80
BUS-0076				3.6	12.1	12.6	50.3	
EC-PRI-BUS	01XFMR0002	In	13.51	21.0	15.8	26.3	32.0	0.80
BUS-0015				0.1	0.2	0.2	20.7	

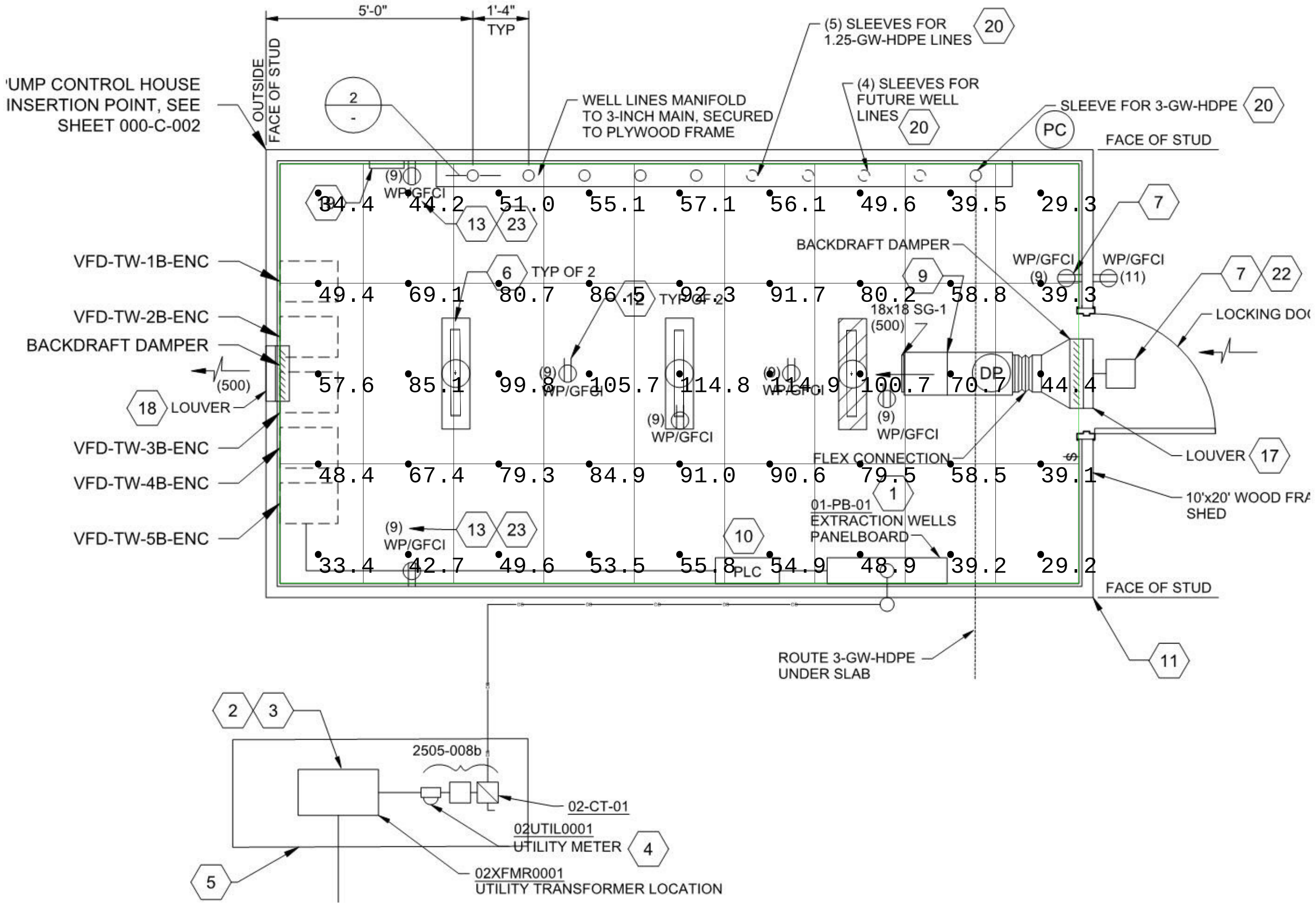
Electro-coagulation Building Oneline


AVISTA-UTILITY-480V_3P
Rated Voltage 12470 V
01XFMR0001-CBL-PRI
SystemNominalVoltage 12470.0 V
Size 500 kcmil
Conductor Desc 1-(3/C)
Length 300.0 ft
Ampacity 395.0A
01XFMR0001
1000 kVA
Pri Rated Voltage 12470 V
Sec Rated Voltage 480 V
Z% 5.0000 %
P
S
01XFMR0001-CBL-SEC
SystemNominalVoltage 480.0 V
Size 600 kcmil
Conductor Desc 4-1/C+G
Length 20.0 ft
Ampacity 1680.0A
EC-PB-01-MCP
Manufacturer GE
Frame/Model TKC
Sensor/Trip 1200.0A
Plug 1200.0A
Settings
INST (LO-HI) LO (3000A)
03-PB01
SystemNominalVoltage 480.0 V
DemandLoad 433.35 kVA
LF VD% 1.84 %
InitSymRMS 3P 23630.20A
ubSC_AsymLL
A : 23272.2 A
B: 23272.2 A
C: 0.0 A
03-PB-01-CKT-2,4,6
Manufacturer CUTLER-HAMMER
Frame/Model FD
Sensor/Trip 90.0A
Plug 90.0A
Settings
Fixed
WATER_HTRCBL
SystemNominalVoltage 480.0 V
Size 2 AWG
Conductor Desc 3-1/C+G
Length 100.0 ft
Ampacity 130.0A
VENDOR_TANKLESS_WATER_HTR
Size 38 kW (Input)
03-PB-01-CKT-37,39,41
Manufacturer CUTLER-HAMMER
Frame/Model FD
Sensor/Trip 15.0A
Plug 15.0A
Settings
Fixed
EC_WINCH_CBL
SystemNominalVoltage 480.0 V
Size 12 AWG
Conductor Desc 3-1/C+G
Length 150.0 ft
Ampacity 20.0A
UR-EC-07_WINCH
Size 4.8 Amps
03-PB-01-CKT-32,34,36
Manufacturer CUTLER-HAMMER
Frame/Model FD
Sensor/Trip 15.0A
Plug 15.0A
Settings
Fixed
EC-CACL2_CBL
SystemNominalVoltage 480.0 V
Size 12 AWG
Conductor Desc 3-1/C+G
Length 150.0 ft
Ampacity 20.0A
UR-EC-06_CACL2 SYSTEM
Size 5.5 Amps
03-PB-01-CKT-31,33,35
Manufacturer CUTLER-HAMMER
Frame/Model FD
Sensor/Trip 15.0A
Plug 15.0A
Settings
Fixed
EC-HOIST_CBL
SystemNominalVoltage 480.0 V
Size 12 AWG
Conductor Desc 3-1/C+G
Length 150.0 ft
Ampacity 20.0A
UR-EC-05_HOIST
Size 5 Amps
03-PB-01-CKT-26,28,30
Manufacturer CUTLER-HAMMER
Frame/Model FD
Sensor/Trip 30.0A
Plug 30.0A
Settings
Fixed
EC-AIR_COMPRESS_CBL
SystemNominalVoltage 480.0 V
Size 10 AWG
Conductor Desc 3-1/C+G
Length 150.0 ft
Ampacity 30.0A
UR-EC-04_AIR COMPRESSOR
Size 27 Amps
03-PB-01-CKT-25,27,29
Manufacturer CUTLER-HAMMER
Frame/Model JD
Sensor/Trip 175.0A
Plug 175.0A
Settings
Thermal Curve (Fixed)
INST (5-10 x Trip) 5 (875A)
EC-RECTIFIER-2_CBL
SystemNominalVoltage 480.0 V
Size 1/0 AWG
Conductor Desc 3-1/C+G
Length 150.0 ft
Ampacity 170.0A
UR-EC03_RECTIFIER 2
Size 145 Amps
03-PB-01-CKT-20,22,24
Manufacturer CUTLER-HAMMER
Frame/Model JD
Sensor/Trip 175.0A
Plug 175.0A
Settings
Thermal Curve (Fixed)
INST (5-10 x Trip) 5 (875A)
EC-RECTIFIER-1_CBL
SystemNominalVoltage 480.0 V
Size 2/0 AWG
Conductor Desc 3-1/C+G
Length 150.0 ft
Ampacity 195.0A
UR-EC02_RECTIFIER 1
Size 145 Amps
03-PB-01-CKT-8,10,12
Manufacturer CUTLER-HAMMER
Frame/Model EHB
Sensor/Trip 15.0A
Plug 15.0A
Settings
Fixed
03-SF-01-CBL
SystemNominalVoltage 480.0 V
Size 12 AWG
Conductor Desc 3-1/C+G
Length 60.0 ft
Ampacity 20.0A
03-SF-01
RatedSize 5 hp
Load Factor 1.0000
LRA/FLA 6.5000
03-PB-01-CKT-7,9,11
Manufacturer CUTLER-HAMMER
Frame/Model EHB
Sensor/Trip 15.0A
Plug 15.0A
Settings
Fixed
03-EF-01-CBL
SystemNominalVoltage 480.0 V
Size 12 AWG
Conductor Desc 3-1/C+G
Length 60.0 ft
Ampacity 20.0A
03-EF-01
RatedSize 0.75 hp
Load Factor 1.0000
LRA/FLA 6.5000
03-PB-01-CKT-19,21,23
Manufacturer CUTLER-HAMMER
Frame/Model FD
Sensor/Trip 80.0A
Plug 80.0A
Settings
Fixed
EC_CONTROLS_CBL
SystemNominalVoltage 480.0 V
Size 4 AWG
Conductor Desc 3-1/C+G
Length 60.0 ft
Ampacity 95.0A
UR-EC01_CONTROL CAB
Size 80 Amps
03-PB-01-CKT-13,15
Manufacturer CUTLER-HAMMER
Frame/Model FD
Sensor/Trip 60.0A
Plug 60.0A
Settings
Fixed
02-PC-01-XFMR-CBL-PRI
SystemNominalVoltage 480.0 V
Size 6 AWG
Conductor Desc 3-1/C+G
Length 250.0 ft
Ampacity 75.0A
03-PB-01-CKT-13,15-MPC
SystemNominalVoltage 480.0 V
DemandLoad 3.31 kVA
LF VD% 2.00 %
InitSymRMS 3P 0.00A
ubSC_AsymLL
A : 1806.6 A
B: 1806.6 A
C: 0.0 A
02-PC-01-XFMR
30 kVA
Pri Rated Voltage 480 V
Sec Rated Voltage 240 V
Z% 5.0000 %
02-PC-01-XFMR-CBL-SEC
SystemNominalVoltage 240.0 V
Size 4 AWG
Conductor Desc 4-1/C+G
Length 10.0 ft
Ampacity 95.0A
02-PC-01
SystemNominalVoltage 240.0 V
DemandLoad 3.31 kVA
LF VD% 2.18 %
InitSymRMS 3P 0.00A
ubSC_AsymLL
A : 1662.6 A
B: 1662.6 A
C: 0.0 A
02-PC-01-CKT-1,3
Manufacturer CUTLER-HAMMER
Frame/Model FD
Sensor/Trip 30.0A
Plug 30.0A
Settings
Fixed
PMP-202-CBL
SystemNominalVoltage 240.0 V
Size 12 AWG
Conductor Desc 3-1/C+G
Length 30.0 ft
Ampacity 20.0A
PMP-202
RatedSize 1.5 hp
Load Factor 1.0000
LRA/FLA 6.5000
02-PC-01-CKT-2,4
Manufacturer CUTLER-HAMMER
Frame/Model FD
Sensor/Trip 30.0A
Plug 30.0A
Settings
Fixed
PMP-201-CBL
SystemNominalVoltage 240.0 V
Size 12 AWG
Conductor Desc 3-1/C+G
Length 30.0 ft
Ampacity 20.0A
PMP-201
RatedSize 1.5 hp
Load Factor 1.0000
LRA/FLA 6.5000
02-PC-01_LOADS
Size 0.3 kVA
03-PB-01-CKT-16,18
Manufacturer GE
Frame/Model TFJ
Sensor/Trip 225.0A
Plug 225.0A
Settings
Thermal Curve (Fixed)
INST (4.5-10 x Trip) LO (1012.5A)
01XFMR0002-CBL-PRI
SystemNominalVoltage 480.0 V
Size 4/0 AWG
Conductor Desc 3-1/C+G
Length 250.0 ft
Ampacity 260.0A
01XFMR0002
75 kVA
Pri Rated Voltage 480 V
Sec Rated Voltage 240 V
Z% 5.0000 %
01XFMR0002-CBL-SEC
SystemNominalVoltage 240.0 V
Size 250 kcmil
Conductor Desc 4-1/C+G
Length 10.0 ft
Ampacity 290.0A
03-LCP-01-MCB
Manufacturer CUTLER-HAMMER
Frame/Model DK
Sensor/Trip 400.0A
Plug 400.0A
Settings
Thermal Curve (Fixed)
INST (5-10 x Trip) 5 (2000A)
Open
03-PB01-SPARE1
Manufacturer CUTLER-HAMMER
Frame/Model EHB
Sensor/Trip 15.0A
Plug 15.0A
Settings
Fixed
Open
03-PB01-SPARE2
Manufacturer CUTLER-HAMMER
Frame/Model EHB
Sensor/Trip 15.0A
Plug 15.0A
Settings
Fixed
03-LCP-01
SystemNominalVoltage 240.0 V
DemandLoad 34.00 kVA
LF VD% 2.82 %
InitSymRMS 3P 0.00A
ubSC_AsymLL
A : 4703.7 A
B: 4703.7 A
C: 0.0 A
03-LCP-01-CKT-1,3
Manufacturer CUTLER-HAMMER
Frame/Model BAB
Sensor/Trip 15.0A
Plug 15.0A
Settings
Fixed
03-EP-01-CBL
SystemNominalVoltage 240.0 V
Size 12 AWG
Conductor Desc 3-1/C+G
Length 30.0 ft
Ampacity 20.0A
03-EP-01_MAIN_ELEC_PNL
Size 13 Amps
03-LCP-01-CKTS
Manufacturer CUTLER-HAMMER
Frame/Model BAB
Sensor/Trip 15.0A
Plug 15.0A
Settings
Fixed
03-LCP-01_LOADS
Size 5.486 kVA
03-PB01-CKT-26,28
Manufacturer SQUARE D
Frame/Model FC
Sensor/Trip 20.0A
Plug 20.0A
Settings
Fixed
003-EH-06-CBL
SystemNominalVoltage 240.0 V
Size 12 AWG
Conductor Desc 3-1/C+G
Length 60.0 ft
Ampacity 20.0A
003-EH-06
Size 2.736 kVA
03-PB01-CKT-25,27
Manufacturer SQUARE D
Frame/Model FC
Sensor/Trip 20.0A
Plug 20.0A
Settings
Fixed
003-EH-05-CBL
SystemNominalVoltage 240.0 V
Size 12 AWG
Conductor Desc 3-1/C+G
Length 60.0 ft
Ampacity 20.0A
003-EH-05
Size 2.736 kVA
03-PB01-CKT-22,24
Manufacturer SQUARE D
Frame/Model FC
Sensor/Trip 20.0A
Plug 20.0A
Settings
Fixed
003-EH-04-CBL
SystemNominalVoltage 240.0 V
Size 12 AWG
Conductor Desc 3-1/C+G
Length 60.0 ft
Ampacity 20.0A
003-EH-04
Size 2.736 kVA
03-PB-01-CKT-21,23
Manufacturer SQUARE D
Frame/Model FC
Sensor/Trip 20.0A
Plug 20.0A
Settings
Fixed
003-EH-03-CBL
SystemNominalVoltage 240.0 V
Size 12 AWG
Conductor Desc 3-1/C+G
Length 60.0 ft
Ampacity 20.0A
003-EH-03
Size 2.736 kVA
03-PB-01-CKT-18,20
Manufacturer SQUARE D
Frame/Model FC
Sensor/Trip 20.0A
Plug 20.0A
Settings
Fixed
003-EH-02-CBL
SystemNominalVoltage 240.0 V
Size 12 AWG
Conductor Desc 3-1/C+G
Length 60.0 ft
Ampacity 20.0A
003-EH-02
Size 2.736 kVA
03-PB-01-CKT-17,19
Manufacturer SQUARE D
Frame/Model FC
Sensor/Trip 20.0A
Plug 20.0A
Settings
Fixed
003-EH-01-CBL
SystemNominalVoltage 240.0 V
Size 12 AWG
Conductor Desc 3-1/C+G
Length 60.0 ft
Ampacity 20.0A
003-EH-01
Size 2.736 kVA
03-PB-01-CKT-29,31
Manufacturer SQUARE D
Frame/Model FC
Sensor/Trip 40.0A
Plug 40.0A
Settings
Fixed
CHEM_STOR_HTR_CBL
SystemNominalVoltage 240.0 V
Size 8 AWG
Conductor Desc 3-1/C+G
Length 60.0 ft
Ampacity 55.0A
CHEMICAL_STORAGE_HTR
Size 9.6 kVA

Extration Wells Pump House Oneline


AVISTA-UTILITY-240 V_1P
Isc 3P 999999.9 MVA
Isc SLG 333333.3 MVA
02XFMR0001-CBL-PRI
(3) Size 750 kcmil
Copper 1-(3/C)
100%, XLPE
300.0 ft
Ampacity 1500.0 A
P
S
02XFMR0001
Size 225 kVA
Pri Delta
Sec Delta
%Z 5.0000 %
X/R 3.9
02XFMR0001-CBL-SEC
(3) Size 500 kcmil
Copper 3-1/C+G
THHN, PVC
2.0 ft
Ampacity 1290.0 A
SUB_PANEL-MCB
Manufacturer SQUARE D
Frame/Model Q2H
Sensor/Trip 200.0 A
Plug 200.0 A
Settings
Fixed
SUB_PANEL
240.0 V
DemandLoad 9.25 kVA
LF VD% 0.06 %
InitSymRMS 3P 0.00 A
ubSC_AsymLL
A: 22017.9 A
B: 22017.9 A
C: 0.0 A
SUB_PANEL-CKTS
Manufacturer SQUARE D
Frame/Model EJ
Sensor/Trip 15.0 A
Plug 15.0 A
Settings
Fixed
WF-LP-LOADS
SUB_PANEL-CKT-26
Manufacturer SQUARE D
Frame/Model EJ
Sensor/Trip 15.0 A
Plug 15.0 A
Settings
Fixed
01-SF-01-CBL
(1) Size 12 AWG
Copper 3-1/C+G
THHN, PVC
10.0 ft
Ampacity 20.0 A
01-SF-01
0 kVA
SUB_PANEL-CKT-2,4
Manufacturer SQUARE D
Frame/Model EJ
Sensor/Trip 15.0 A
Plug 15.0 A
Settings
Fixed
TW-1B-VFD
RatedSize 1.000 hp
WF-CBL-01
(1) Size 12 AWG
Copper 3-1/C+G
THHN, PVC
10.0 ft
Ampacity 20.0 A
TW-1B
1 hp
Load Factor 1.00
LRA/FLA 6.5000
SUB_PANEL-CKT-5,7
Manufacturer SQUARE D
Frame/Model EJ
Sensor/Trip 15.0 A
Plug 15.0 A
Settings
Fixed
TW-2B-VFD
RatedSize 1.500 hp
WF-CBL-02
(1) Size 12 AWG
Copper 3-1/C+G
THHN, PVC
10.0 ft
Ampacity 20.0 A
TW-2B
1.5 hp
Load Factor 1.00
LRA/FLA 6.5000
SUB_PANEL-CKT-6,8
Manufacturer SQUARE D
Frame/Model EJ
Sensor/Trip 15.0 A
Plug 15.0 A
Settings
Fixed
TW-3B-VFD
RatedSize 2.000 hp
WF-CBL-03
(1) Size 12 AWG
Copper 3-1/C+G
THHN, PVC
10.0 ft
Ampacity 20.0 A
TW-3B
2 hp
Load Factor 1.00
LRA/FLA 6.5000
SUB_PANEL-CKT-9,11
Manufacturer SQUARE D
Frame/Model EJ
Sensor/Trip 15.0 A
Plug 15.0 A
Settings
Fixed
TW-4B-VFD
RatedSize 2.000 hp
WF-CBL-04
(1) Size 12 AWG
Copper 3-1/C+G
THHN, PVC
10.0 ft
Ampacity 20.0 A
TW-4B
2 hp
Load Factor 1.00
LRA/FLA 6.5000
SUB_PANEL-CKT-10,12
Manufacturer SQUARE D
Frame/Model EJ
Sensor/Trip 15.0 A
Plug 15.0 A
Settings
Fixed
TW-5B-VFD
RatedSize 1.000 hp
WF-CBL-05
(1) Size 12 AWG
Copper 3-1/C+G
THHN, PVC
10.0 ft
Ampacity 20.0 A
TW-5B
1 hp
Load Factor 1.00
LRA/FLA 6.5000
Open
SUB_PANEL-CKT-13,15
Manufacturer SQUARE D
Frame/Model EJ
Sensor/Trip 15.0 A
Plug 15.0 A
Settings
Fixed
Open
SUB_PANEL-CKT-14,16
Manufacturer SQUARE D
Frame/Model EJ
Sensor/Trip 15.0 A
Plug 15.0 A
Settings
Fixed
Open
SUB_PANEL-CKT-17,19
Manufacturer SQUARE D
Frame/Model EJ
Sensor/Trip 15.0 A
Plug 15.0 A
Settings
Fixed
Open
SUB_PANEL-SPARE-1
Manufacturer SQUARE D
Frame/Model EJ
Sensor/Trip 15.0 A
Plug 15.0 A
Settings
Fixed
Open
SUB_PANEL-CKT-18,20
Manufacturer SQUARE D
Frame/Model EJ
Sensor/Trip 15.0 A
Plug 15.0 A
Settings
Fixed
Open
SUB_PANEL-SPARE-2
Manufacturer SQUARE D
Frame/Model EJ
Sensor/Trip 15.0 A
Plug 15.0 A
Settings
Fixed
Open
SUB_PANEL-SPARE-3
Manufacturer SQUARE D
Frame/Model EJ
Sensor/Trip 15.0 A
Plug 15.0 A
Settings
Fixed

Extraction Wells Building Lighting



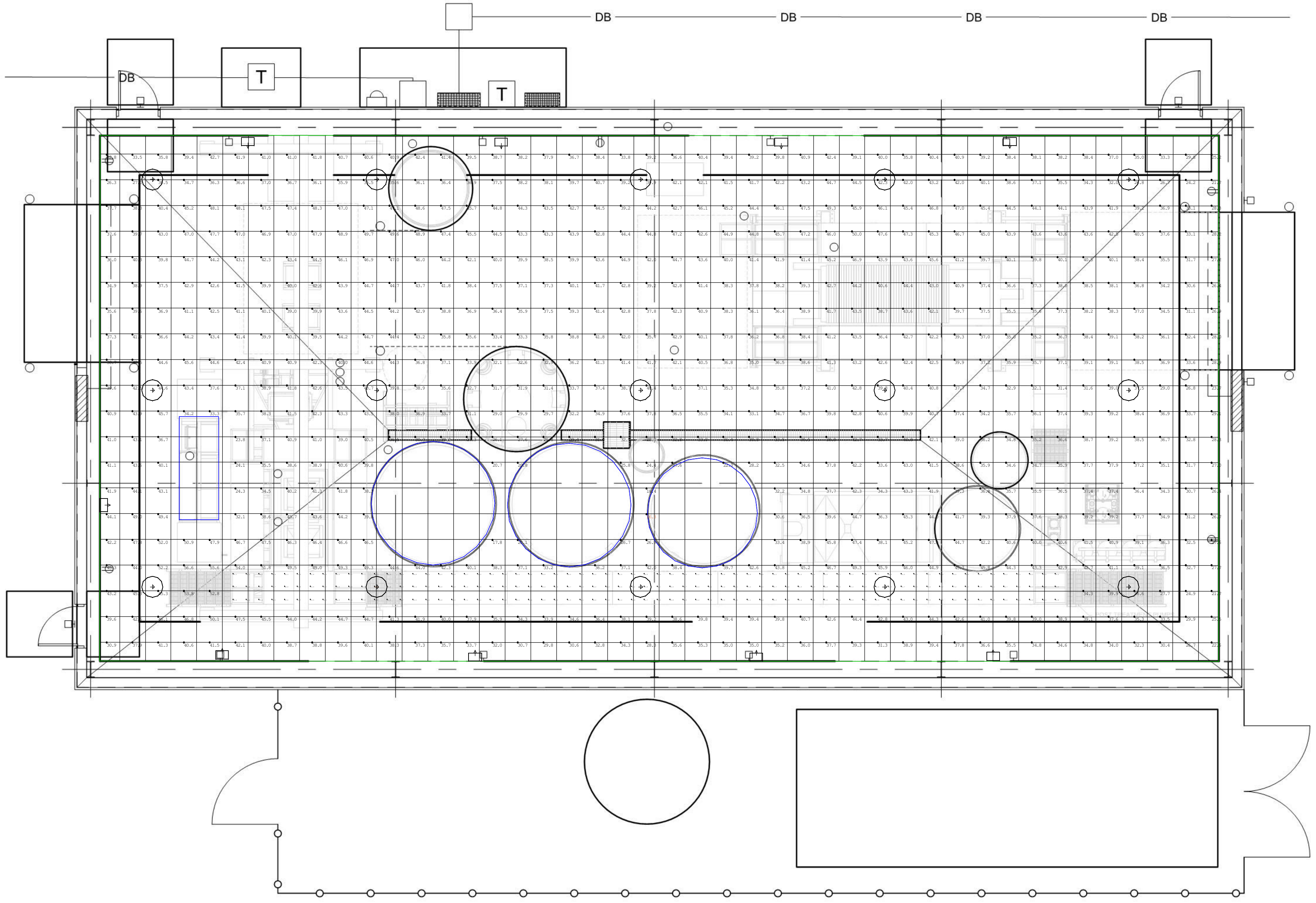
Luminaire Schedule

Symbol	Qty	Label	Arrangement	Total Lamp Lumens	LLF	Description
▭	3	ZL1D_L48_5000LM_FST_MVOLT_40K	SINGLE	N.A.	1.000	ZL1D L48 5000LM FST MVOLT 40K 80 CRI

Calculation Summary

Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
PumpHouse_Workplane	Illuminance	Fc	64.53	114.9	29.2	2.21	3.93

EC Building Lighting



EC BUILDING ELECTRICAL FLOOR PLAN

3/16" = 1'-0"

Luminaire Schedule						
Symbol	Qty	Label	Arrangement	Total Lamp Lumens	LLF	Description
⊡	9	WST_LED_P2_40K_VW_MVOLT	SINGLE	N.A.	1.000	WST LED P2 40K VW MVOLT
⊙	15	JHBL_12000LM_GL_ND_40K_80CRI_	SINGLE	N.A.	1.000	JHBL 12000LM GL ND 40K 80CRI XX

Calculation Summary							
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
Catwalk_Surface	Illuminance	Fc	52.61	69.4	35.4	1.49	1.96
Room_1_Workplane	Illuminance	Fc	39.01	56.6	16.3	2.39	3.47

GENERAL NOTES

1.

SHEET KEYNOTES

1.

NO.	DATE	REVISION	BY	APVD
DSGN	DR	CHK	APVD	
DESIGNER	DRAWN-BY	CHECKED-BY	SEALNAME	

Project Description
Project Location
Client Name
Client Location

JACOBS

KAISER MEAD CUSTODIAL TRUST

EC UNIT:
ELECTRICAL PLANS

1" = X'

VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	9999/09/09
PROJ	PROJECT NO
DWG	DRAWING-NO
SHEET	ShtNum of ShtTot

Appendix E
SEPA Environmental Checklist

SEPA **ENVIRONMENTAL CHECKLIST**

Purpose of checklist:

Governmental agencies use this checklist to help determine whether the environmental impacts of your proposal are significant. This information is also helpful to determine if available avoidance, minimization or compensatory mitigation measures will address the probable significant impacts or if an environmental impact statement will be prepared to further analyze the proposal.

This Checklist was prepared by the Mead Custodial Trust (MCT) at the request of Washington Department of Ecology (Ecology) Industrial Section. This Checklist follows the SEPA Environmental Checklist template obtained from the Ecology website (https://ecology.wa.gov/Regulations-Permits/SEPA/Environmental-review/SEPA-document-templates) on November 15, 2018. The Checklist is identical to the template with the following exceptions:

- *All text added to the template by MCT is shown in italicized fonts.*
- *The original template contains hotlinks that link to instruction on how to complete the template. These hotlinks have been removed for clarity.*

A. Background

1. Name of proposed project, if applicable: *Kaiser Mead NPL Site Groundwater Interim Action*

2. Name of applicant: *Mead Custodial Trust*

3. Address and phone number of applicant and contact person:

Dan Silver
Mead Custodial Trust
606 Columbia St. NW, Ste. 212
Olympia, WA 98501
(360) 754-9343

4. Date checklist prepared: January 30, 2019

5. Agency requesting checklist: *Washington Department of Ecology, Industrial Section*

6. Proposed timing or schedule (including phasing, if applicable):

Engineering design is anticipated to begin in 2019. Construction would begin after Ecology approvals, expected to occur in 2019.

7. Do you have any plans for future additions, expansion, or further activity related to or connected with this proposal? If yes, explain.

No changes are anticipated.

8. List any environmental information you know about that has been prepared, or will be prepared, directly related to this proposal.

The project is described in the February 2019 "Kaiser Mead Interim Action Workplan" prepared by Hydrometrics for the Mead Custodial Trust. Additional information is available in the October 2018 " Supplemental Feasibility Study for Kaiser Mead NPL Site" prepared by Hydrometrics for the Mead Custodial Trust.

9. Do you know whether applications are pending for governmental approvals of other proposals directly affecting the property covered by your proposal? If yes, explain.

There are no pending applications.

10. List any government approvals or permits that will be needed for your proposal, if known.

- *Notice of Intent for construction of dewatering/resource protection wells.*
- *Compliance with substantive requirements of State Waste Discharge Permit for discharge treated water to groundwater as described in Appendix A of the Interim Action Workplan.*
- *Electric permit from WA Labor and Industries*
- *Local (Spokane County) permits or approvals are anticipated and may include:*
    - *Building Permit*
    - *Erosion and Control Plan approval*
    - *Critical and Hazardous Materials List/Hazardous Material Management Plan approval*
    - *Septic system permit.*

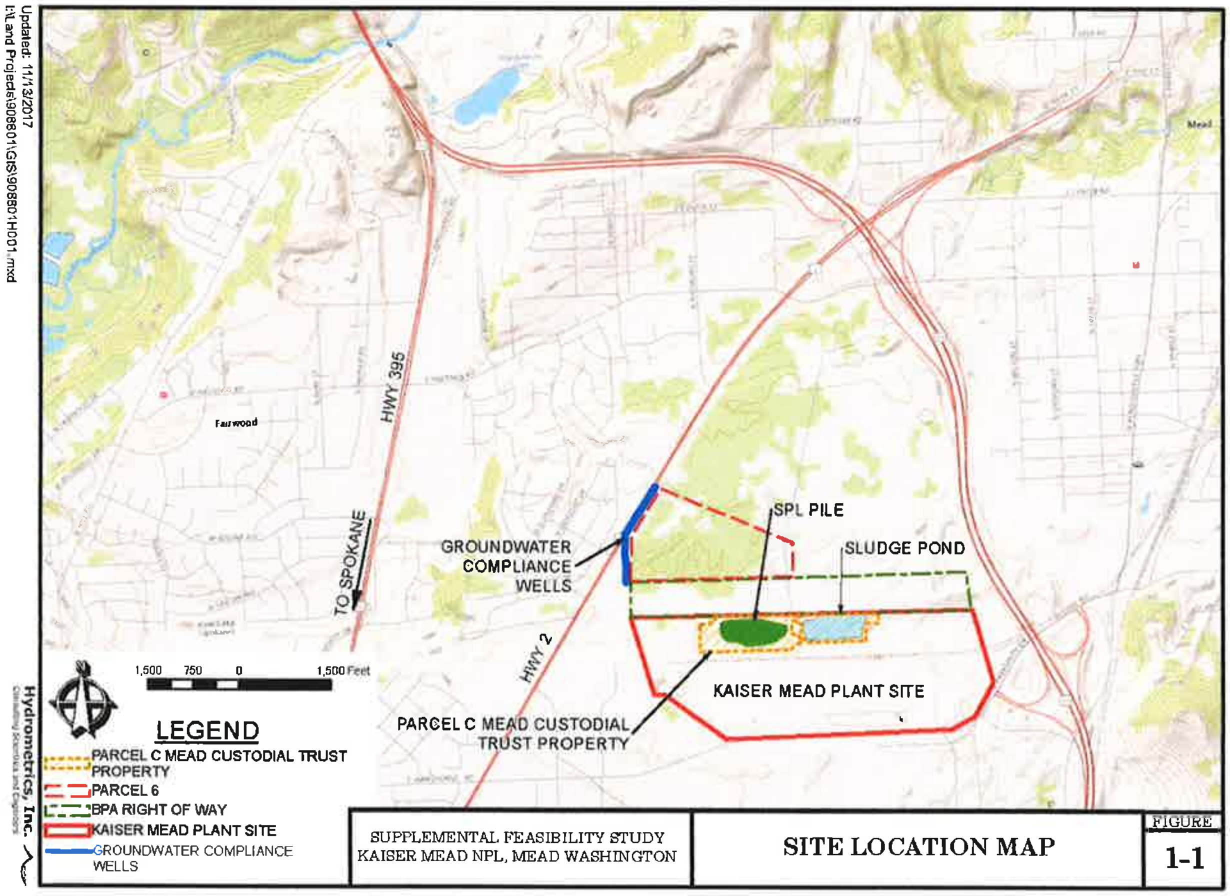
11. Give brief, complete description of your proposal, including the proposed uses and the size of the project and site. There are several questions later in this checklist that ask you to describe certain aspects of your proposal. You do not need to repeat those answers on this page. (Lead agencies may modify this form to include additional specific information on project description.)

The proposal is to construct a "pump and treat" system for remediation of groundwater at the Kaiser Mead NPL Site. This will include the following elements:

- *Installation and operation of approximately 4 to 8 groundwater extraction wells to extract approximately 50 gpm of contaminated groundwater.*
- *Construction of pipelines to convey the pumped groundwater to a water treatment system.*
- *Construction and operation of an approximately 3 acre constructed wetland water treatment system.*
- *Construction and operation of an electrocoagulation water treatment system housed in an approximately 10,000 ft^{2}building.*
- *Construction and operation of an approximately 0.25 acre infiltration pond and associated piping for discharge of treated groundwater to the underlying groundwater system.*

12. Location of the proposal. Give sufficient information for a person to understand the precise location of your proposed project, including a street address, if any, and section, township, and range, if known. If a proposal would occur over a range of area, provide the range or boundaries of the site(s). Provide a legal description, site plan, vicinity map, and topographic map, if reasonably available. While you should submit any plans required by the agency, you are not required to duplicate maps or detailed plans submitted with any permit applications related to this checklist.

The project location is the Kaiser Mead NPL Site located at 2111 E Hawthorne Rd, Mead, WA 99021 within Section 16, Township 26 North, Range 43 East, approximately 7 miles north of Spokane, Washington and 1 mile southwest of Mead, Washington (Figure 1-1).


Updated: 11/13/2017
I:\Land Projects\908801\GIS\908801H001.mxd
Mead
Fairwood
HWY 395
TO SPOKANE
HWY 2
GROUNDWATER COMPLIANCE WELLS
SPL PILE
SLUDGE POND
KAISER MEAD PLANT SITE
PARCEL C MEAD CUSTODIAL TRUST PROPERTY
1,500 750 0 1,500 Feet
LEGEND
PARCEL C MEAD CUSTODIAL TRUST PROPERTY
PARCEL 6
BPA RIGHT OF WAY
KAISER MEAD PLANT SITE
GROUNDWATER COMPLIANCE WELLS
Hydrometrics, Inc.
Consulting Scientists and Engineers
SUPPLEMENTAL FEASIBILITY STUDY
KAISER MEAD NPL, MEAD WASHINGTON
SITE LOCATION MAP
FIGURE
1-1

B. Environmental Elements

1. Earth

a. General description of the site:

(circle one): Flat, rolling, hilly, steep slopes, mountainous, other ____________

The site is flat.

b. What is the steepest slope on the site (approximate percent slope)?

Approximately 2 to 4 percent

c. What general types of soils are found on the site (for example, clay, sand, gravel, peat, muck)? If you know the classification of agricultural soils, specify them and note any agricultural land of long-term commercial significance and whether the proposal results in removing any of these soils.

Natural soils are fine to medium sand.

d. Are there surface indications or history of unstable soils in the immediate vicinity? If so, describe.

No unstable soils are present.

e. Describe the purpose, type, total area, and approximate quantities and total affected area of any filling, excavation, and grading proposed. Indicate source of fill.

Approximately 3 acres will be graded to construct the wetland treatment system and approximately 0.25 acres for the infiltration pond. The conceptual design is to balance cut and fill to achieve a neutral material balance so that no import or export of fill is required.

f. Could erosion occur as a result of clearing, construction, or use? If so, generally describe.

Erosion is unlikely and best management practices (BMPs) will be implemented consistent with the State Department of Ecology Stormwater Management Manual for Eastern Washington (Ecology, 2004).

g. About what percent of the site will be covered with impervious surfaces after project construction (for example, asphalt or buildings)?

The area where the constructed wetland and electrocoagulation water treatment systems will be built are currently covered with impervious surfaces (asphalt). Thus, no increase in impervious surfaces is expected.

h. Proposed measures to reduce or control erosion, or other impacts to the earth, if any:

As part of engineering design for the project, a SWPP will be developed and BMPs will be implemented consistent with the State Department of Ecology Stormwater Management Manual for Eastern Washington (Ecology, 2004).

2. Air

a. What types of emissions to the air would result from the proposal during construction, operation, and maintenance when the project is completed? If any, generally describe and give approximate quantities if known.

Insignificant amounts of fugitive dust may be generated during excavation and construction. No air emissions would occur during operation and maintenance.

b. Are there any off-site sources of emissions or odor that may affect your proposal? If so, generally describe.

No off-site emissions or odors are expected.

c. Proposed measures to reduce or control emissions or other impacts to air, if any:

Not applicable.

3. Water

a. Surface Water:

1) Is there any surface water body on or in the immediate vicinity of the site (including year-round and seasonal streams, saltwater, lakes, ponds, wetlands)? If yes, describe type and provide names. If appropriate, state what stream or river it flows into.

The closest surface water to the Project is the Little Spokane River, located approximately two miles northwest of the Site.

2) Will the project require any work over, in, or adjacent to (within 200 feet) the described waters? If yes, please describe and attach available plans.

No.

3) Estimate the amount of fill and dredge material that would be placed in or removed from surface water or wetlands and indicate the area of the site that would be affected. Indicate the source of fill material.

Not applicable.

4) Will the proposal require surface water withdrawals or diversions? Give general description, purpose, and approximate quantities if known.

No.

5) Does the proposal lie within a 100-year floodplain? If so, note location on the site plan.

No.

6) Does the proposal involve any discharges of waste materials to surface waters? If so, describe the type of waste and anticipated volume of discharge.

No.

b. Ground Water:

1) Will groundwater be withdrawn from a well for drinking water or other purposes? If so, give a general description of the well, proposed uses and approximate quantities withdrawn from the well. Will water be discharged to groundwater? Give general description, purpose, and approximate quantities if known.

Groundwater withdrawn will be treated but will not be used for drinking water or any other beneficial purposes.

Treated groundwater that meets discharge requirements described in Appendix A of the Interim Action Plan will be discharged to groundwater at the approximate rate of 50 gallons per minute. Expected quality of treated water is further described in Table 6-1 of the Interim Action Workplan.

2) Describe waste material that will be discharged into the ground from septic tanks or other sources, if any (for example: Domestic sewage; industrial, containing the following chemicals. . . ; agricultural; etc.). Describe the general size of the system, the number of such systems, the number of houses to be served (if applicable), or the number of animals or humans the system(s) are expected to serve.

The project will require very limited staffing (1 or less full time employees) for operation of the treatment plant and thus domestic sewage generation will be limited. Handling of domestic sewage will be determined during engineering design and may include a small on-site septic system or the use of temporary holding facilities (e.g., Porta potties).

Treated groundwater that meets discharge requirements described in Appendix A of the Interim Action Plan will be discharged to groundwater at the approximate rate of 50 gallons per minute. Expected quality of treated water is further described in Table 6-1 of the Interim Action Workplan.

c. Water runoff (including stormwater):

1) Describe the source of runoff (including storm water) and method of collection and disposal, if any (include quantities, if known). Where will this water flow? Will this water flow into other waters? If so, describe.

Rain falling on the wetland treatment cell will be captured and will not runoff. Pipeline disturbances will be reclaimed with soil and revegetated after construction and will not generate runoff. Roof runoff from the electrocoagulation building will disperse and flow to surrounding areas.

2) Could waste materials enter ground or surface waters? If so, generally describe.

No. Waste materials (sludge) from the water treatment system will be contained, temporarily stored in a roofed and secure area, and shipped off-site to a landfill for disposal.

3) Does the proposal alter or otherwise affect drainage patterns in the vicinity of the site? If so, describe.

No.

d. Proposed measures to reduce or control surface, ground, and runoff water, and drainage pattern impacts, if any:

As part of engineering design for the project, a SWPP will be developed and BMPs will be implemented consistent with the State Department of Ecology Stormwater Management Manual for Eastern Washington (Ecology, 2004).

4. **Plants**

a. Check the types of vegetation found on the site:

____deciduous tree: alder, maple, aspen, other
_X__evergreen tree: fir, cedar, pine, other
__X__shrubs
__X__grass
____pasture
____crop or grain
____ Orchards, vineyards or other permanent crops.
____ wet soil plants: cattail, buttercup, bullrush, skunk cabbage, other
____water plants: water lily, eelgrass, milfoil, other
____other types of vegetation

b. What kind and amount of vegetation will be removed or altered?

Vegetation (primarily grass and possibly trees) may be temporarily removed during well installation, pipeline construction and infiltration pond construction.

c. List threatened and endangered species known to be on or near the site.

The site where the water treatment system will be constructed is a former industrial facility covered with asphalt and no significant vegetation is present. The area where the pipelines and wells will be constructed is a grassy sparse evergreen forest. WA Natural Heritage Program responded to an information request on December 4, 2018 and indicated the following:

> *"We've searched the Natural Heritage Information System for information on significant natural features in your project area. Currently, we have no records for rare plants or rare/high quality ecological communities in the vicinity of your project.*

The information provided by the Washington Natural Heritage Program is based solely on existing information in the database. In the absence of field inventories, we cannot state whether or not a given site contains high quality ecosystems or rare plant species; there may be significant natural features in your study area of which we are not aware." (email from Jasa Holt, WA NHP to Scott Mason, Hydrometrics)

d. Proposed landscaping, use of native plants, or other measures to preserve or enhance vegetation on the site, if any:

Not applicable. Primary area of disturbance is currently asphalt within an industrial setting.

e. List all noxious weeds and invasive species known to be on or near the site.

Not applicable. Primary area of disturbance is currently asphalt within an industrial setting.

5. Animals

a. List any birds and other animals which have been observed on or near the site or are known to be on or near the site.

Examples include:

birds: hawk, heron, eagle, songbirds, other:
mammals: deer, bear, elk, beaver, other:
fish: bass, salmon, trout, herring, shellfish, other ________

The site where the water treatment system will be constructed is a former industrial facility covered with asphalt and no significant wildlife is present or to be expected. The area where the pipelines and wells will be constructed is a grassy sparse evergreen forest where deer and other upland mamals may be present. A search of the US Fish and Wildlife Service "Information for Planning and Consultation" search engine on November 28, 2018 identified the following migratory species that may be present on or near the site: Bald eagle, Cassin's finch, Golden eagle, Lesser yellowlegs, Olive-sided flycatcher, Rufous hummingbird.

b. List any threatened and endangered species known to be on or near the site.

The site where the water treatment system will be constructed is a former industrial facility covered with asphalt and no significant wildlife is present or to be expected. The area where the pipelines and wells will be constructed is a grassy sparse evergreen forest. A search of the US Fish and Wildlife Service "Information for Planning and Consultation" search engine on November 28, 2018 identified the following species that may be present on or near the site:

- *Endangered Species: None.*

- *Threatened species: Yellow-billed Cuckoo (Coccyzus americanus). The project site is outside the critical habitat for this species.*

c. Is the site part of a migration route? If so, explain.

Unknown, but not believed to be.

d. Proposed measures to preserve or enhance wildlife, if any:

None proposed. The site where the water treatment system will be constructed is a former industrial facility covered with asphalt and no significant wildlife is present or to be expected.

e. List any invasive animal species known to be on or near the site.

None known.

6. Energy and Natural Resources

a. What kinds of energy (electric, natural gas, oil, wood stove, solar) will be used to meet the completed project's energy needs? Describe whether it will be used for heating, manufacturing, etc.

Energy will be used in the water treatment system, in heating/cooling the water treatment building, and pumping groundwater. Electricity will be used for pumping and treating water. Gas or electric will be used for heating and cooling the building.

b. Would your project affect the potential use of solar energy by adjacent properties? If so, generally describe.

No.

c. What kinds of energy conservation features are included in the plans of this proposal? List other proposed measures to reduce or control energy impacts, if any:

None are proposed at this time but will be evaluated during engineering design as an important cost factor.

7. Environmental Health

a. Are there any environmental health hazards, including exposure to toxic chemicals, risk of fire and explosion, spill, or hazardous waste, that could occur as a result of this proposal? If so, describe.

1) Describe any known or possible contamination at the site from present or past uses.

The Site is a state and federal superfund site undergoing cleanup under WA Model Toxics Control Act. Contamination includes cyanide and fluoride contamination of soil and groundwater associated with the former aluminum plant that occupied the site previously.

2) Describe existing hazardous chemicals/conditions that might affect project development and design. This includes underground hazardous liquid and gas transmission pipelines located within the project area and in the vicinity.

The Site is a state and federal superfund site undergoing cleanup under WA Model Toxics Control Act. Contamination includes cyanide and fluoride contamination of soil and groundwater associated with the former aluminum plant that occupied the site previously. Waste contained in the existing engineered on-site containment facility known as the Spent Potliner Pile contains material that may be listed or characterized as dangerous or hazardous waste.

3) Describe any toxic or hazardous chemicals that might be stored, used, or produced during the project's development or construction, or at any time during the operating life of the project.

Certain reagents (e.g., sodium hydroxide, calcium chloride, sulfuric acid, anionic or cationic polymers) that might be employed during water treatment may be harmful if mishandled or spilled. Proper engineering controls, PPE and standard operating procedures will be developed for storage, handling and use of potentially harmful chemicals. No existing hazardous chemicals or conditions are known.

The water treatment process will generate approximately 1,000 tons/year of sludge that will contain fluoride and cyanide. The sludge is not expected to have hazardous characteristics but is a listed hazardous waste (K088) as it is derived from spent potliner with is a listed hazardous material.

4) Describe special emergency services that might be required.

None known.

5) Proposed measures to reduce or control environmental health hazards, if any:

The contractor that is hired by MCT will be responsible for preparing a Project and Work Site-specific Health and Safety Plan (HASP) for the interim action. The Contractor will submit the plan to Ecology a minimum of two weeks prior to commencing excavation work at the Site.

b. Noise

1) What types of noise exist in the area which may affect your project (for example: traffic, equipment, operation, other)?

None.

2) What types and levels of noise would be created by or associated with the project on a short-term or a long-term basis (for example: traffic, construction, operation, other)? Indicate what hours noise would come from the site.

Construction noise will be generated by a variety of construction equipment such as truck engines, generators and other small engines, and earthmoving equipment. Construction noise will be limited to daytime hours and is not expected to create adverse impacts.

3) Proposed measures to reduce or control noise impacts, if any:

Construction activities will be carried out in a manner consistent with Spokane County municipal code and State environmental noise standards.

8. Land and Shoreline Use

a. What is the current use of the site and adjacent properties? Will the proposal affect current land uses on nearby or adjacent properties? If so, describe.

The Kaiser Mead NPL Site is located on the former Kaiser Aluminum Chemical Corporation smelter complex. The facility was a prebake aluminum smelter that was constructed by the US government during WWII in 1942. The smelter complex covers approximately 240 acres and the area immediately adjacent to the smelter is zoned for heavy industrial use. The nearest residential properties are located approximately 1,500 feet to the northwest of the smelter.

b. Has the project site been used as working farmlands or working forest lands? If so, describe. How much agricultural or forest land of long-term commercial significance will be converted to other uses as a result of the proposal, if any? If resource lands have not been designated, how many acres in farmland or forest land tax status will be converted to nonfarm or nonforest use?

Not applicable.

1) Will the proposal affect or be affected by surrounding working farm or forest land normal business operations, such as oversize equipment access, the application of pesticides, tilling, and harvesting? If so, how:

No.

c. Describe any structures on the site.

Current structures on the site consists of a capped waste pile, fencing, and a metal-sided building with a footprint of approximately 20' by 40'.

d. Will any structures be demolished? If so, what?

No.

e. What is the current zoning classification of the site?

HI, heavy industrial under the Spokane County Zoning Code.

f. What is the current comprehensive plan designation of the site?

HI, heavy industrial under the Spokane County Zoning Code.

g. If applicable, what is the current shoreline master program designation of the site?

Not applicable.

h. Has any part of the site been classified as a critical area by the city or county? If so, specify.

No.

i. Approximately how many people would reside or work in the completed project?

It is anticipated that 1 to 2 people (0.5 to 1 full time equivalent) will work at the water treatment plant.

j. Approximately how many people would the completed project displace?

None.

k. Proposed measures to avoid or reduce displacement impacts, if any:

None.

L. Proposed measures to ensure the proposal is compatible with existing and projected land uses and plans, if any:

None.

m. Proposed measures to reduce or control impacts to agricultural and forest lands of long-term commercial significance, if any:

None.

9. Housing

a. Approximately how many units would be provided, if any? Indicate whether high, middle, or low-income housing.

None.

b. Approximately how many units, if any, would be eliminated? Indicate whether high, middle, or low-income housing.

None.

c. Proposed measures to reduce or control housing impacts, if any:

None.

10. Aesthetics

a. What is the tallest height of any proposed structure(s), not including antennas; what is the principal exterior building material(s) proposed?

To be determined during engineering design, preliminary estimate of water treatment building is less than 30 feet; exterior to be determined, possibly metal siding.

b. What views in the immediate vicinity would be altered or obstructed?

None.

b. Proposed measures to reduce or control aesthetic impacts, if any:

None.

11. Light and Glare

a. What type of light or glare will the proposal produce? What time of day would it mainly occur?

Minimal, lighting will only be required for security.

b. Could light or glare from the finished project be a safety hazard or interfere with views?

Not believed to be likely.

c. What existing off-site sources of light or glare may affect your proposal?

None known.

d. Proposed measures to reduce or control light and glare impacts, if any:

None.

12. Recreation

a. What designated and informal recreational opportunities are in the immediate vicinity?

None. Site is heavy industrial.

b. Would the proposed project displace any existing recreational uses? If so, describe.

No.

c. Proposed measures to reduce or control impacts on recreation, including recreation

None.

13. Historic and cultural preservation

a. Are there any buildings, structures, or sites, located on or near the site that are over 45 years old listed in or eligible for listing in national, state, or local preservation registers ? If so, specifically describe.

A search of the Spokane City/County Historic Preservation Office online records (http://properties.historicspokane.org) on December 7, 2018 revealed no identified historic properties associated with the Site. The smelter complex itself is over 45 years old. The sole structure on the Trust portion of the complex is an approximately 50' by 120' storage shed of unknown age.

b. Are there any landmarks, features, or other evidence of Indian or historic use or occupation? This may include human burials or old cemeteries. Are there any material evidence, artifacts, or areas of cultural importance on or near the site? Please list any professional studies conducted at the site to identify such resources.

None known.

c. Describe the methods used to assess the potential impacts to cultural and historic resources on or near the project site. Examples include consultation with tribes and the department of archeology and historic preservation, archaeological surveys, historic maps, GIS data, etc.

No formal assessment performed. The project site is the Kaiser Mead NPL Site located on the former Kaiser Aluminum Chemical Corporation smelter complex. The area is primarily asphalt covered. The Spokane Tribe will be consulted prior to construction to determine the likelihood of potential cultural resources in the project area. An "Inadvertent Discovery Plan" will be prepared for the project that will describe the appropriate measures that will be taken during construction to ensure cultural resources are identified and protected and that appropriate notifications are made.

d. Proposed measures to avoid, minimize, or compensate for loss, changes to, and disturbance to resources. Please include plans for the above and any permits that may be required.

None.

14. Transportation

a. Identify public streets and highways serving the site or affected geographic area and describe proposed access to the existing street system. Show on site plans, if any.

See Figure 1-1 above. The Site is bounded by Hawthorne Drive to the South and Highway 2 to the north. Access to the site is from Hawthrone Drive through the Kaiser Mead Plant Site, owned by Spokane Recycling Company.

b. Is the site or affected geographic area currently served by public transit? If so, generally describe. If not, what is the approximate distance to the nearest transit stop?

Yes, nearest Spokane Transit Authority bus stop is approximately 0.5 miles west of site at corner of Hawthorne Road and Nevada Street.

c. How many additional parking spaces would the completed project or non-project proposal have? How many would the project or proposal eliminate?

None.

d. Will the proposal require any new or improvements to existing roads, streets, pedestrian, bicycle or state transportation facilities, not including driveways? If so, generally describe (indicate whether public or private).

No.

e. Will the project or proposal use (or occur in the immediate vicinity of) water, rail, or air transportation? If so, generally describe.

No.

f. How many vehicular trips per day would be generated by the completed project or proposal? If known, indicate when peak volumes would occur and what percentage of the volume would be trucks (such as commercial and nonpassenger vehicles). What data or transportation models were used to make these estimates?

To be determined during final engineering design. Based on professional judgement, approximately 2 to 4 trips per day are estimated for water treatment plant staff plus additional occasional trips (1 to 2 times/week) for supplies and deliveries.

g. Will the proposal interfere with, affect or be affected by the movement of agricultural and forest products on roads or streets in the area? If so, generally describe.

No.

h. Proposed measures to reduce or control transportation impacts, if any:

None.

15. Public Services

a. Would the project result in an increased need for public services (for example: fire protection, police protection, public transit, health care, schools, other)? If so, generally describe.

None anticipated.

b. Proposed measures to reduce or control direct impacts on public services, if any.

None.

16. Utilities

a. Circle utilities currently available at the site:
electricity, natural gas, water, refuse service, telephone, sanitary sewer, septic system, other ___________

All services except septic are currently available on or near the project site.

c. Describe the utilities that are proposed for the project, the utility providing the service, and the general construction activities on the site or in the immediate vicinity which might be needed.

- *Electric and natural gas are available at Hawthorne Road and on the adjacent property and would be provided by Avista. Some extension of services may be required.*
- *Water needs will be determined during engineering design and are expected to be minimal for the 0.5 to 1 full time staff. Water supply may include connection to Spokane municipal system (Whitworth Water District) or the use of bottled water.*
- *No refuse collection is anticipated (staff will transport to landfill as needed).*
- *Telephone service is expected to be provided by wireless service provider.*
- *Sanitary sewer needs will be determined during engineering design and are expected to be minimal for the 0.5 to 1 full time staff. Sewer service may include connection to the Spokane municipal system (available at northwest corner of Site), a small on-site septic system, or the use of a private collection service (e.g., Porta Pottie).*

C. Signature

The above answers are true and complete to the best of my knowledge. I understand that the lead agency is relying on them to make its decision.

Signature: ______________________

Name of signee DANIEL J SILVER

Position and Agency/Organization Trustee, Kaiser Mead Custodial Trust

Date Submitted: 2-07-19