Silver Bullet™
WATER TREATMENT

TREATING WATER. BETTER.™

Recirculating Filtration & Ozone System Operating Manual

REVISION 1 – JANUARY 2023

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Recirculating Filtration & Ozone System

Congratulations on the purchase of your Silver Bullet Water Treatment (SBWT) system. This is a state-of-the-art solution designed to be an integral component of your overall water management program.

- It is important that personnel who will be operating the Recirculating Filtration & Ozone System read this manual and understand the purpose and operations of each component.

- This document aims to provide detailed technical information to the end user. It is the responsibility of each facility to generate internal Standard Operating Procedures (SOP's) which correspond to their equipment and layout.

Failure to adhere to the terms and conditions outlined in the SBWT agreement and to adhere to operational guidance in this document can result in suboptimal performance of SBWT equipment and/or void of manufacturer's warranty.

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Introduction

Silver Bullet Water Treatment (SBWT) embraces the challenge of being a leading water management company, developing and introducing innovative, progressive solutions to help solve our customers' water problems. We strive to be a go-to knowledge resource for the industries we serve. Through the lifetime of the relationship with each of our customers, we are the water quality consultants, engineers, technical service advisors, laboratories, educators, and business partners to depend on.

What is a Recirculating Filtration & Ozone System?

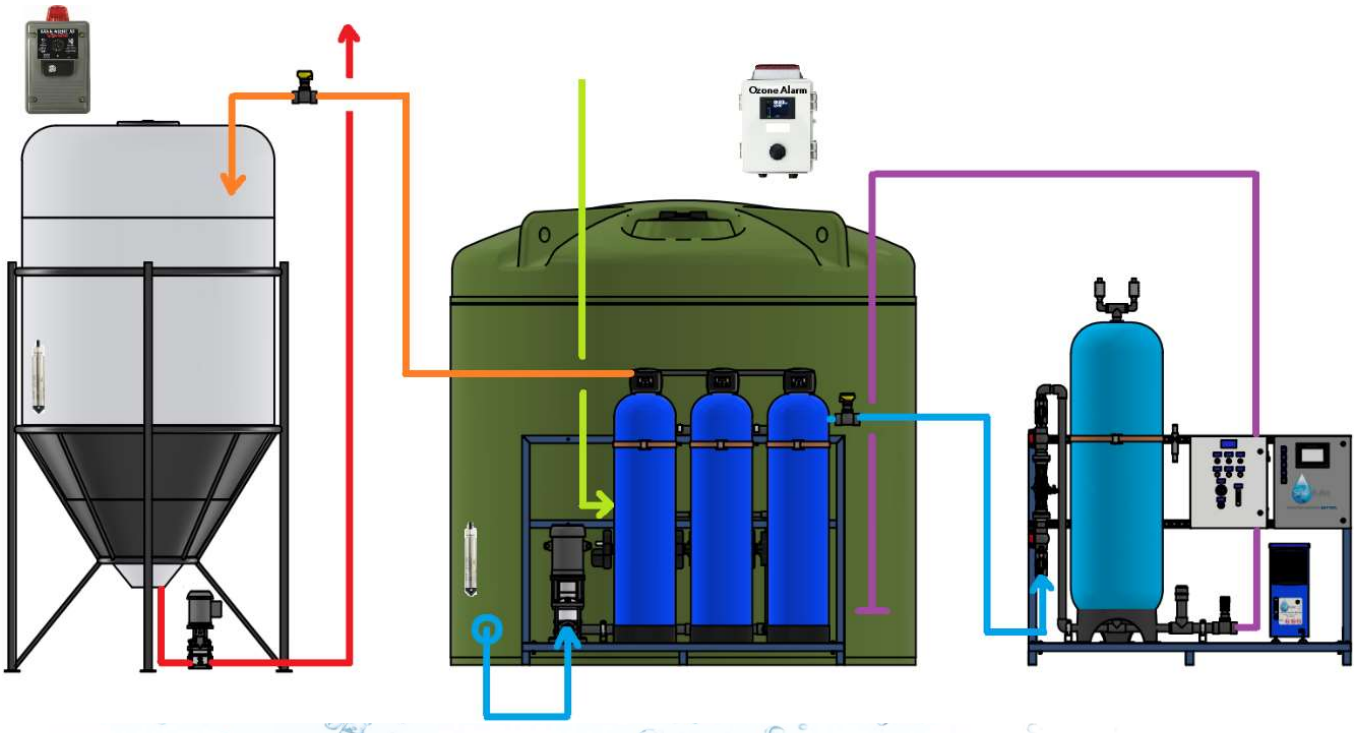
The SBWT Recirculating Filtration & Ozone System is an all-in-one system which provides continuous recirculation of the freshwater storage tank, filtration of unwanted solids (greater than 5 micron), dissolved oxygen enhancement, ozone disinfection (up to 60g/hr), and a fully automatic controls system.

When operated in ORP mode, this system maintains a desired ORP value with integrated safety features to mitigate overshoots or lagging. When operated in DO mode, this system can maintain high levels of dissolved oxygen inside the Freshwater Tank without ozone disinfection.

A multitude of safety features are included to mitigate risk including independent ambient ozone detector with audio and visual alarm, ozone generator cabinet leak detector, tank low-level safety shutoffs, ozone destruct system for undissolved gas, and other low-level and high-level safety shutoffs including pressure and flow. Refer to the project's Piping & Instrumentation Diagram (P&ID) for additional details on equipment and controls.

Advantages of Ozone

- ✓ Ozone is one of the most powerful oxidizers commercially available
- ✓ Ozone can be generated onsite without the use of harmful chemicals
- ✓ Ozone is extremely effective at disinfecting bacteria and viruses
- ✓ Ozone oxidizes both organic and inorganic material



Theory of Operation

When sufficient water level is in the Freshwater Storage Tank, the recirculating system's initial conditions are met. The recirculating pump on the Filter Skid will turn on automatically when the tank's Level Transmitter is above a pre-programmed setpoint, usually 20% of tank height. The Shutdown Feature can be enabled or disabled to provide Low-Level Safety Shutoff controls. A time delay minimizes VFD/Pump cycling when the tank is being filled and drained simultaneously and at approximately the same rates. The Recirculating Pump's VFD speed is regulated by a flow transmitter (filtered water outlet) and maintains 50 GPM.

The (3) filter vessels have their own, independent 3-way valves for separate source backwashing (AG Water). The 3-way separate source valves are normally aligned such that Port A is a filtered water supply to be used for backwashing media, Port B is unfiltered / untreated water coming from the discharge of the skid's pump, and Port C supplies the inlet to the associated filter head control valve. Each filter vessel is pre-programmed to backwash at a specific time during the day and/or week. In addition to a timer function, each filter vessel will backwash when it senses a high differential pressure (usually 5-10 psi) across the vessel's inlet and outlet piping. When a backwash cycle is enabled, the 3-way valve redirects and allows AG Water to backwash the filter media. Simultaneously, the filter head control valve repositions and directs backwashed water to the Waste Tank via its drain port. The (3) filter vessels communicate such that only (1) vessel will backwash at a time. Each filter vessel sends a status command to the Control System so that the user can see which vessel is backwashing directly from the HMI located on the Ozone Skid. Filter inlet pressure and filter outlet pressures can be monitored on the HMI. Pump discharge pressure is also indicated by filter inlet pressure.

Backwash water from the Filter Skid is directed to the Waste Tank. When the tank level reaches a pre-programmed setpoint, usually 80%, the Waste Pump will turn on by way of motor starter. The Waste Pump will then direct the contents of the tank to drain. To prevent the pump running dry, the Waste Pump automatically shuts off at a pre-programmed setpoint, usually 20%. The Waste Tank includes an independent High-Level Alarm and float to provide redundancy with the primary Control System.

Filtered water from the Filter Skid is directed to the Ozone Skid. To create the ozone gas, the oxygen concentrator first removes nitrogen from the ambient air. This high purity oxygen feedstock is then fed into the corona discharge unit (ozone generator). The corona discharge unit requires 5 to 10 psi supply pressure to function properly. The supply pressure can be monitored with the pressure gauge located between the oxygen concentrator and ozone generator and adjusted with the ozone generator outlet valve. Oxygen is passed over a high electric field to strip apart the oxygen molecules so that ozone can form. If an ozone leak is detected within the ozone generator cabinet, an alarm will sound.

The ozone gas passes through a motorized ball valve and check valve to enter the recirculation piping via the Venturi injector. The Venturi injector's inlet and outlet pressures can be monitored on the Control System HMI. The ozone gas reacts with the water primarily in the ozone contact tank. Undissolved gas is vented through the air/water separators at the top of the contact tank and passed through an ozone destruct unit, though some residual ozone is expected to enter the Freshwater Tank for additional disinfection. The ozone destruct unit uses an inline heater and water trap to remove unwanted moisture and passes the ozone gas through a catalytic media to break ozone back down into oxygen and heat. An ambient ozone detector located near the ozone destruct unit (or tank head space) provides an audible and visual alarm if ozone reaches a manually programmable setpoint, usually below OSHA's 8-hour permissible level.

After leaving the Ozone Skid, the treated water enters the Freshwater Storage Tank through an internal standpipe, discharging at ~20% tank height. The standpipe provides an added safety margin so that any undissolved ozone gas does not immediately accumulate in the tank's headspace. The standpipe also provides churning action inside the tank which improves recirculation properties.

The system is intended to be run using ORP Mode. In this setting, the system injects ozone when a minimum ORP setpoint is reached. As ozone enters the system, the ORP value will begin increasing. Once a maximum ORP setpoint is reached, the system stops injecting ozone, but maintains injection of oxygen. To minimize the risk of lagging and/or overshooting, the system has (2) ORP probes. The first is located on the Filter Skid and is most representative of the water quality in the Freshwater Tank. The second is located on the Ozone Skid, just downstream of the contact tank, and is most representative of the water quality inside the recirculation piping. Together, these (2) ORP probes provide feedback to the Control System to automatically adjust the grams per hour of ozone output to maintain desired ORP levels within the Freshwater Tank.

The system can also be run using DO Mode. In this setting, the system operates to maintain a desired Dissolved Oxygen setpoint. Because there is minimal risk to overdosing dissolved oxygen, the oxygen concentrator will normally operate continuously while in this setting. When using DO Mode, the Dissolved Oxygen probe provides feedback to the Control System to maintain desired DO levels in the Freshwater Tank. The oxygen concentrator usually operates when DO levels are below 40 mg/L. To minimize the risk of crop damage, the DO Mode setting will reduce the ozone output to negligible grams per hour if a maximum ORP value is reached.

When the system is run using Manual Mode, each component of the Recirculating Filtration & Ozone System can be independently operated. This method of control bypasses all safety features and should only be used when at the direction of a Silver Bullet representative or if the user is knowledgeable and proficient with the system. The system should normally never be left unattended for prolonged durations in Manual Mode, including Local Start/Stop functions.

Safety Instructions

The following outlines general safety considerations when installing, operating, or conducting maintenance on Silver Bullet equipment. This includes additional requirements on grounding, electrical, concentrated oxygen, ozone, chemical, biosecurity, and other general safety precautions. In addition to these precautions, there are many training courses available online including OSHA, ozone, and chemical safety which are highly recommended.

1. Read and follow all instructions prior to installing, operating, or servicing any Silver Bullet treatment equipment including any associated ancillary equipment.
2. Silver Bullet oxygen concentrators are commonly powered through the associated SBWT Control Panel.
    a. If power cabling is damaged, ensure the equipment is deenergized and replace immediately.
    b. Power cabling should not be buried.
    c. Follow local electrical codes and SBWT site specific installation instructions when installing the equipment.

    WARNING – Risk of Electric Shock. Electrical connections and/or receptacles are to be isolated from potential water exposure from spills or splashes.

3. In certain applications, if the ozone system sits idle during low/no water flow, oxidant gas may accumulate, and heat may build within the unit. Pressure switches, flow switches and other safety equipment are included to mitigate risk.

4. During installation and maintenance, follow instructions carefully. Also, ensure relevant building codes, state and local laws and regulations, and requirements of the Authority Having Jurisdiction are all met.
5. Basic safety precautions should be followed when installing, operating, and/or servicing Silver Bullet equipment.
    a. Do not sit or stand on equipment.
    b. Do not store other items on Silver Bullet equipment.
    c. Do not allow children to operate equipment.
    d. To prevent trip or fire hazards, maintain water treatment area free of clutter and debris. This will also allow for easier service access during routine maintenance.
6. SAVE THESE INSTRUCTIONS

Grounding Instructions

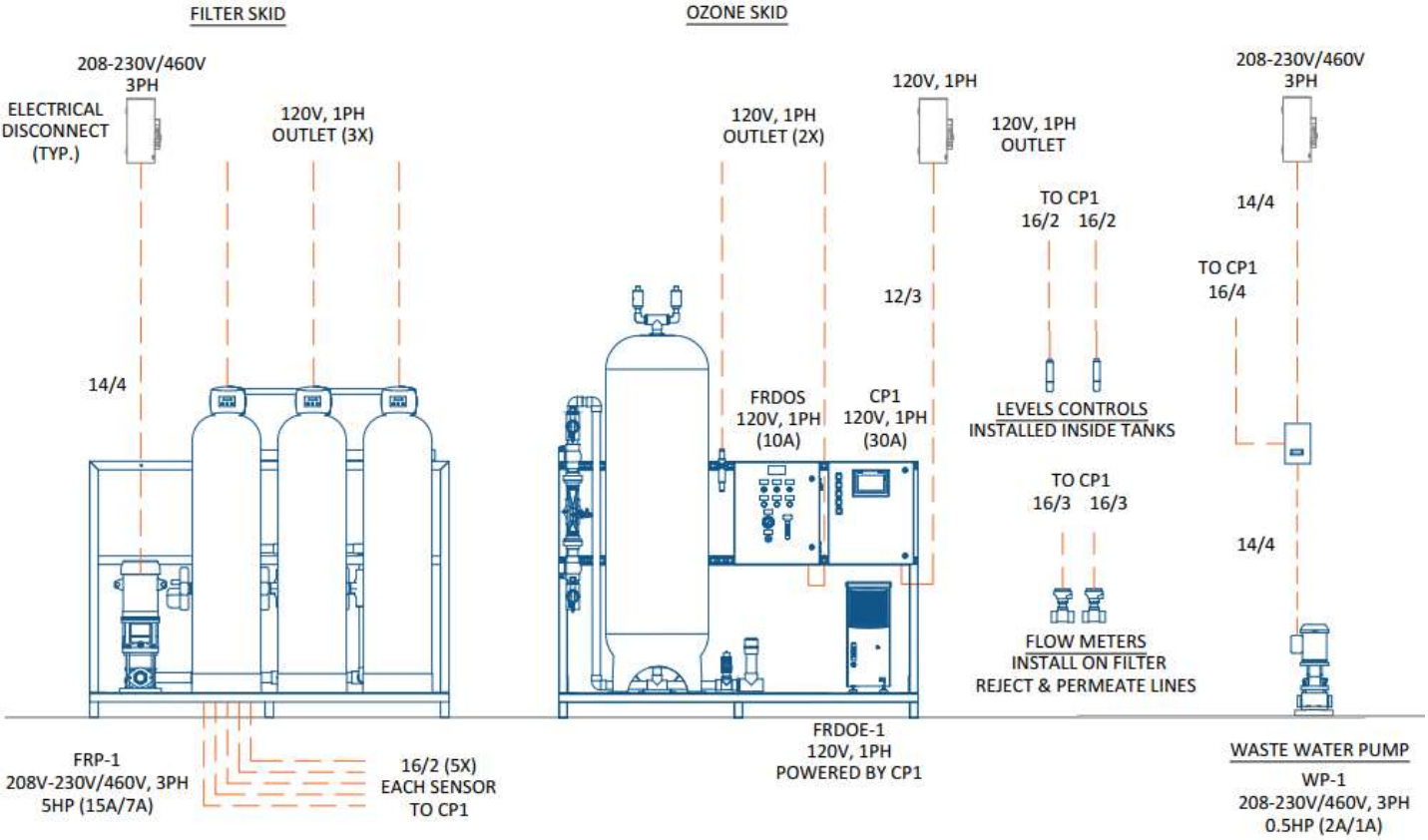
The Silver Bullet Processor must be grounded. In the event of a malfunction or breakdown, grounding will reduce the risk of electric shock by providing a path of least resistance for electric current. The Silver Bullet equipment is recommended to be hard-wired to an electrical disconnect. Ensure the system is installed and grounded in accordance with all local codes and ordinances.

WARNING – Improper grounding of Silver Bullet equipment can result in a risk of electric shock. Check with a qualified electrician or service representative if you are in doubt whether the equipment is properly grounded. Do not attempt to modify the plug.

Electrical Safety

1. Only trained technicians should conduct electrical maintenance.
2. Do not service the Silver Bullet equipment when the power is turned ON.
3. The power supply wire gauge and insulation must meet the temperature and power requirements.
4. To avoid personal injury, never touch exposed electrical connections or components while power is ON.
5. Do not install/service Silver Bullet equipment if you or the electrical equipment is standing in water while the power is ON.
6. Protect the power cord from being walked upon or pinched, particularly at plugs, convenience receptacles and the point where they exit from the equipment.
7. Do not use extension cords or other retrofitted power devices.

Refer to the associated Electrical Diagram for wiring details. The Recirculating Filtration & Ozone System requires routing electrical wires and conduit between components. Several components require independent electrical disconnects and outlets. It is recommended that the power supply be hardwired through conduit to the associated 1-phase or 3-phase disconnect, depending on application and facility preferences (these details must be determined ahead of installation as part of the site preparation stage). It is recommended that only trained professionals are used for wiring or conducting other electrical-related tasks. Refer to and abide by local electrical codes when installing the equipment.



Concentrated Oxygen Safety

Safe operation of the oxygen concentrator is vital to reduce enriched oxygen hazards. SBWT has worked to reduce the hazards associated with concentrated oxygen in our Recirculating Filtration & Ozone System by ensuring material compatibility, safe operating conditions, and conducting an external Oxygen Hazard Analysis. To assure the highest standards of safety, SBWT requires that customers follow these guidelines when using our Recirculating Filtration & Ozone System:

- Do not smoke or allow open flames within the same room as this equipment.
- DO NOT USE OIL, GREASE, OR PETROLEUM BASED PRODUCTS WITH OUR EQUIPMENT.
- Only allow personnel who are properly trained and informed of oxygen risks to service the oxygen concentrator..
- Never use unauthorized materials and equipment when servicing oxygen equipment.
- Place the oxygen concentrator in a well-ventilated area, free from smoke and atmospheric pollution.
- DO NOT ATTEMPT TO WORK INSIDE OF WATER STORAGE TANKS UNTIL TREATMENT EQUIPMENT IS SHUT OFF AND THE TANK HEAD SPACE HAS BEEN VENTED TO ATMOSPHERE FOR 1+ HOUR.
- Ensure all nearby electrical connections are secure to prevent unwanted sparks or arcs
- Do not change or add fittings/fixtures to system as enriched oxygen can lead to combustion if not compatible.

	This device supplies highly concentrated oxygen enriched product gas that promotes rapid burning. **DO NOT** allow smoking or open flames within the same room of this device. Failure to observe this warning can result in severe fire, property damage, and / or cause physical injury or death.
	Oxygen accelerates the combustion of flammable substances. **DO NOT** use oil, grease, petroleum based or other flammable products on the device.
	This device is intended for industrial use. It should be placed in a well-ventilated area, free from smoke and atmospheric pollution, where the intake filter ventilation is not obstructed or blocked.
	**DO NOT** use in an explosive environment. **DO NOT** use in a magnetic environment.

	**DO NOT** open the device while in operation. Failure to observe this warning can result in electrical shock. **DO NOT** remove the cabinets unless you are a qualified service technician.
	**DO NOT** use extension cords or adapters. Use the power cord provided. Check that the electrical characteristics of the power outlet used match those indicated on the manufacturer's plate on the rear panel of the device.
	This unit may be equipped with a polarized plug. That is one blade wider than the other. If it does not fit into the outlet, reverse the plug. If it still does not fit, contact a qualified electrician. Do not defeat this safety feature.
	Only persons who have read and understood this entire manual should be allowed to operate the *device*.

Ozone Safety

Ozone (O_3) is a colorless to blue gas with a pungent odor that when exposure occurs, may cause headaches, coughing, dry throat, shortness of breath, a heavy feeling in the chest, and fluid in the lungs. The current OSHA standard for ozone is 0.10 part of ozone per million parts of air (ppm) averaged over an eight-hour work shift. This may also be expressed as 0.2 milligrams of ozone per cubic meter of air (mg/m^3). Along with the 0.10 ppm eight-hour limit, OSHA has also established a 15-minute limit for levels of 0.3 ppm and above. At above 0.3 ppm, there is a risk of damage to respiratory tissue.

O_3 is extremely irrigating to the respiratory tract and produces local irritation of the eyes and mucous membranes. When a person is exposed to very low concentrations of O_3 for even a brief period, the person may notice a sharp, irritating odor. As the concentration of O_3 increases, the ability to smell it may decrease. Irritation of the eyes, dryness of the nose and throat, and cough may be experienced. If the O_3 concentration continues to rise, more severe symptoms can develop. These may include headache, upset stomach or vomiting, pain or tightness in the chest, shortness of breath or tiredness, which may last for several days to weeks. Finally, with higher levels of exposure, the lungs may be damaged, and death may occur. OSHA guidelines for monitoring and exposure control should be always followed.

Chemical Safety

Chemicals are an important aspect to most systems. Whether used for sanitation, various inhibitions, nutrient delivery, water conditioning, medication delivery or other process, chemicals will be encountered. From a technical perspective, all substances can be considered chemicals including oxygen, O_3, ozone destruct catalyst, and even water itself. The following presents general guidelines for chemical safety when working around water treatment systems.

- Treat all chemicals as if they are hazardous.
- Utilize appropriate Personal Protective Equipment (PPE) when handling chemicals.

- Intentionally minimize your exposure to any chemical.
- Avoid repeated exposures to any chemical.
- When mixing two or more chemicals, assume the reaction product will be more hazardous than any one component.
- Carefully review the associated Material Safety Data Sheet (MSDS).
- Only remove/use the amount of chemical required for a given task. Avoid storing excess amounts of chemical.
- Properly seal, label, and store chemicals based on information gathered from the MSDS.
- Clean up chemical spills immediately – refer to MSDS.
- Have a plan in place in case of emergency (spill, exposure, reaction, etc.).
- Dispose of waste chemicals properly and in accordance with local and federal regulations.
- Do not eat, smoke, or drink near chemicals.
- Do not wear contact lenses near chemicals, particularly corrosive and/or volatile solvents.
- Do not store food or drinks around chemical storage.
- Do not taste or sniff chemicals.
- Wash hand frequently when handling chemicals.

Biosecurity Safety

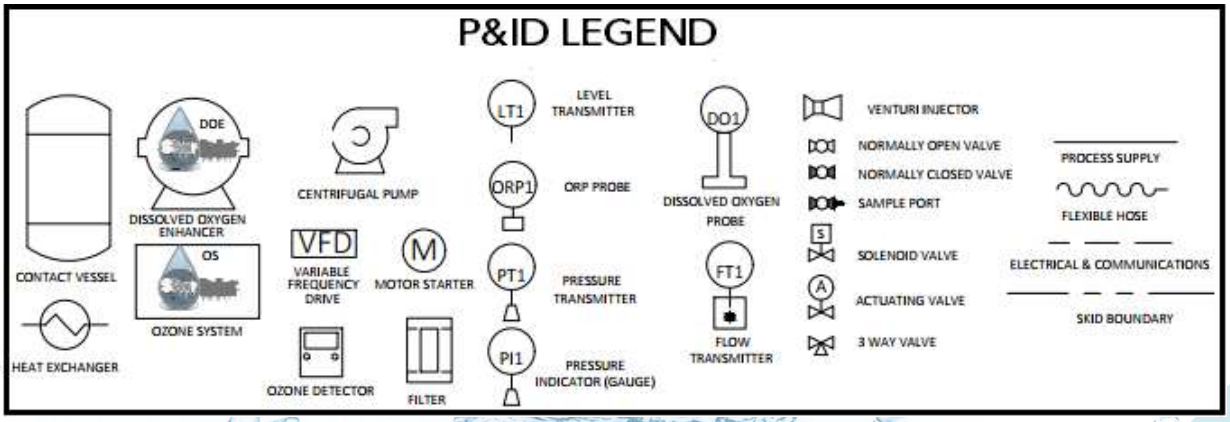
Each of the industries SBWT operates within have unique biosecurity aspects and considerations. Good biosecurity practices not only protect the facility and products from contamination, but also the personnel from infectious disease. Each industry/facility will have specific best practices for their respective biosecurity plan and these plans should be consulted prior to entering a facility.

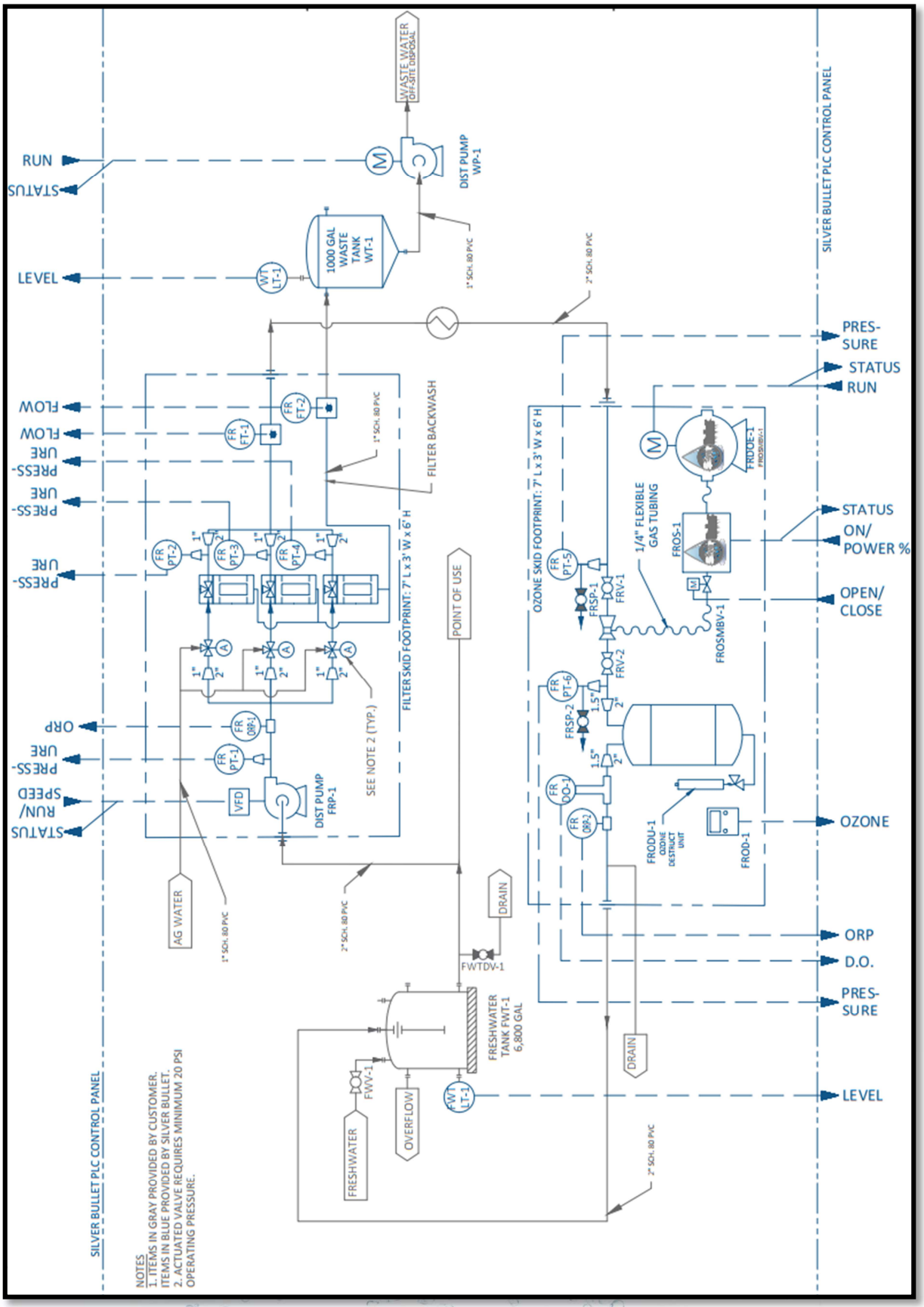
General Safety

Use PPE (hard hat, steel toed shoes, hearing protection, eye protection, gloves, etc.) when installing Silver Bullet equipment. Follow Ladder Safety requirements. In certain applications and industries, additional biosecurity measures must also be taken into consideration. Consult local authorities to ensure adequate environmental and personal safety are met.

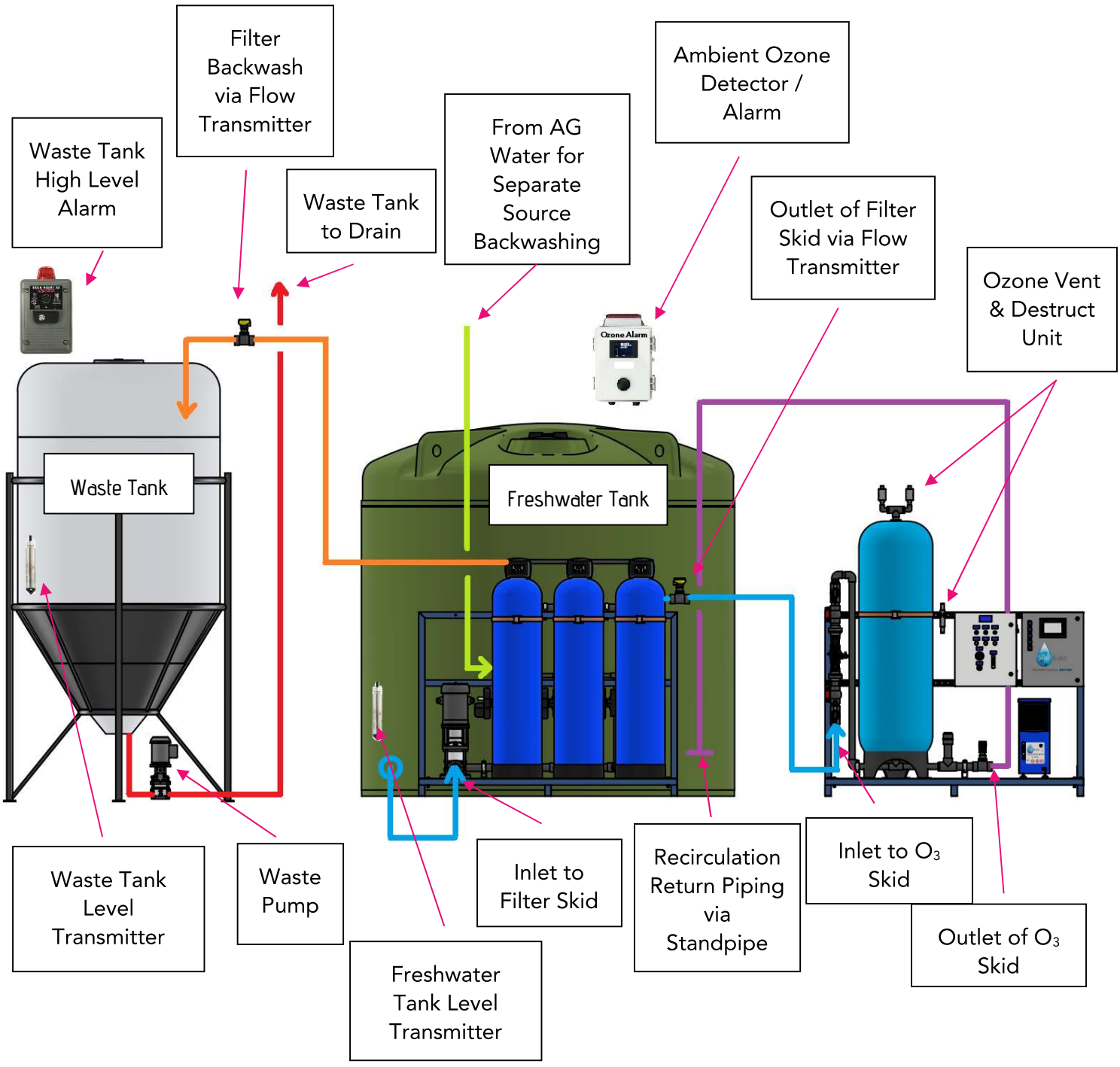
Generic Recirculating Filtration & Ozone System Piping & Instrumentation Diagram (P&ID)

A piping and instrumentation diagram (P&ID) displays a system's piping, valves, equipment, instrumentation, and controls. A P&ID demonstrates the physical sequence of equipment and systems, including how these systems connect. Below is Recirculating Filtration & Ozone P&ID example. Refer to your project's documentation for complete details.



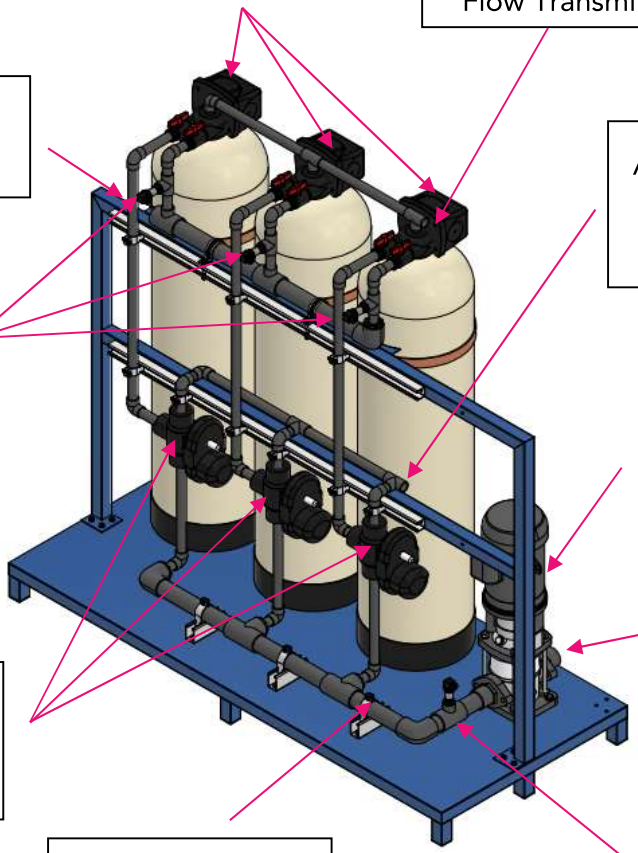

WASTE WATER OFF-SITE DISPOSAL
DIST PUMP WP-1
1000 GAL WASTE TANK WT-1
WT LT-1
RUN
STATUS
LEVEL
1" SCH. 80 PVC
2" SCH. 80 PVC
SILVER BULLET PLC CONTROL PANEL
PRES-SURE
STATUS
RUN
FILTER BACKWASH
FLOW
FLOW
PRESS-URE
PRESS-URE
PRESS-URE
FR FT-1
FR FT-2
FR PT-2
FR PT-3
FR PT-4
FILTER SKID FOOTPRINT: 7' L x 3' W x 6' H
POINT OF USE
OZONE SKID FOOTPRINT: 7' L x 3' W x 6' H
FR PT-5
FRV-1
FRSP-1
1/4" FLEXIBLE GAS TUBING
FRODE-1
FROS-1
FROSMBV-1
STATUS
ON/ POWER %
OPEN/ CLOSE
FR PT-6
FRV-2
FRSP-2
FR OO-1
FR OR-1
FR PT-1
ORP
PRESS-URE
RUN/ SPEED
STATUS
VFD
DIST PUMP FRP-1
SEE NOTE 2 (TYP.)
FRODU-1 OZONE DESTRUCT UNIT
FROD-1
OZONE
AG WATER
DRAIN
FWTDV-1
ORP
D.O.
PRES-SURE
FRESHWATER TANK FWT-1 6,800 GAL
FWV-1
FWT LT-1
OVERFLOW
FRESHWATER
DRAIN
LEVEL
NOTES
1. ITEMS IN GRAY PROVIDED BY CUSTOMER. ITEMS IN BLUE PROVIDED BY SILVER BULLET.
2. ACTUATED VALVE REQUIRES MINIMUM 20 PSI OPERATING PRESSURE.

Section 1 – System Flow Path & Installation Orientation



Section 2 – Component Identification

Figure 1: Filter Skid System



Off-Skid Components

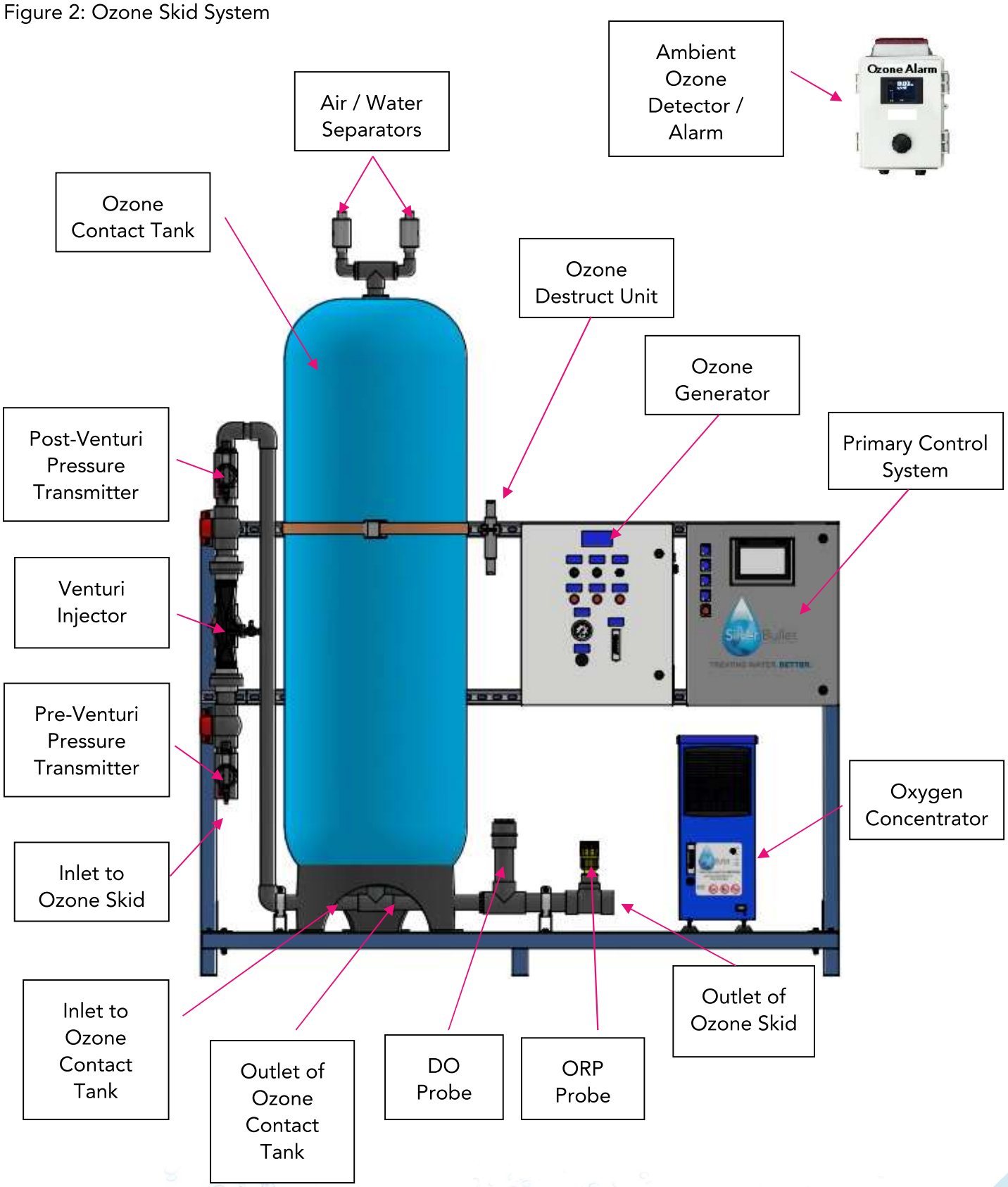
Freshwater Tank Level Transmitter

Filtered Water (2") & Backwash Water (1") Flow Transmitters

Recirculating Pump Variable Frequency Drive (VFD)

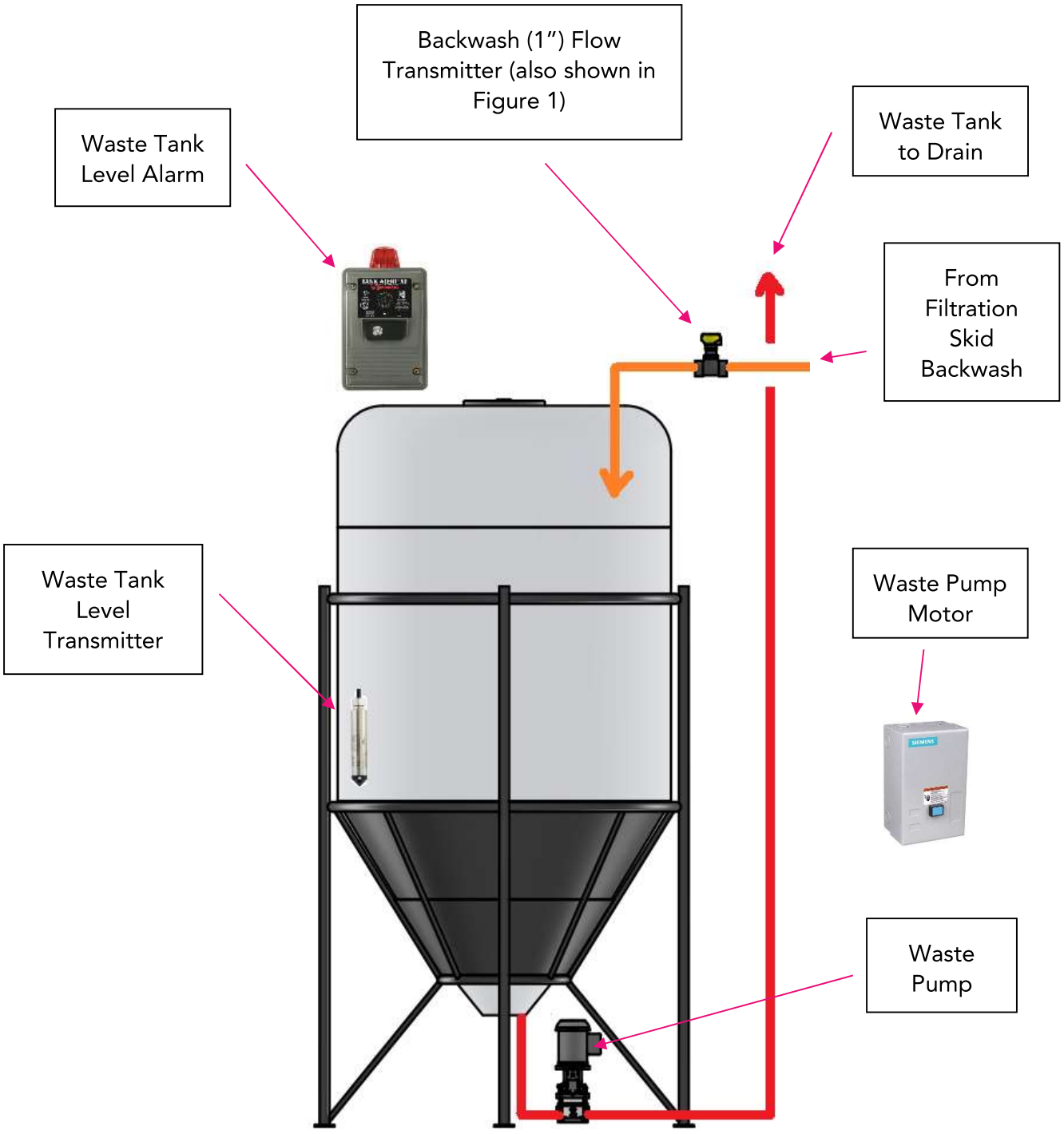
Section 2 – Component Identification (cont.)

Figure 2: Ozone Skid System



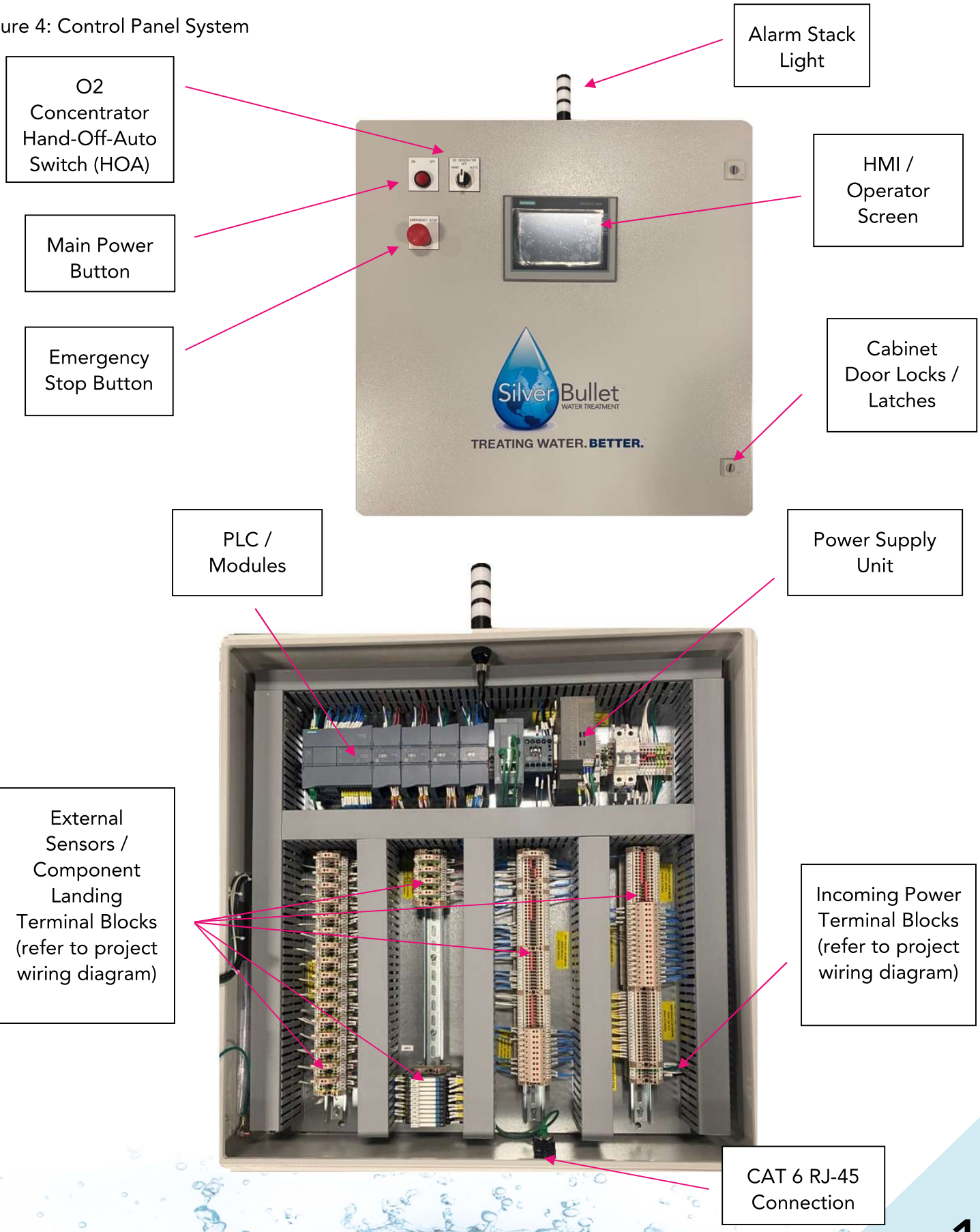
Section 2 – Component Identification (cont.)

Figure 3: Waste Tank System



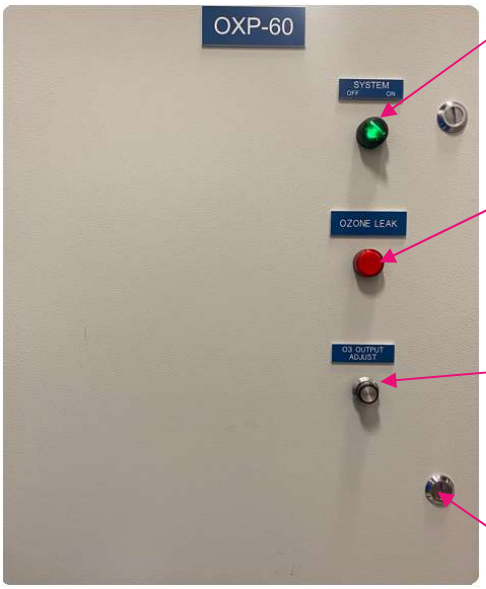
Section 2 – Component Identification (cont.)

Figure 4: Control Panel System



Section 2 – Component Identification (cont.)

Figure 5: Ozone Generator System



On/Off Switch

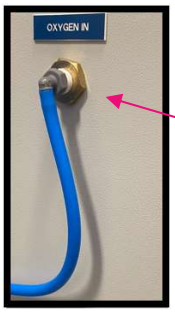
Ozone Leak Detected Light

Manual Ozone Output Adjustment

Cabinet Door Locks / Latches

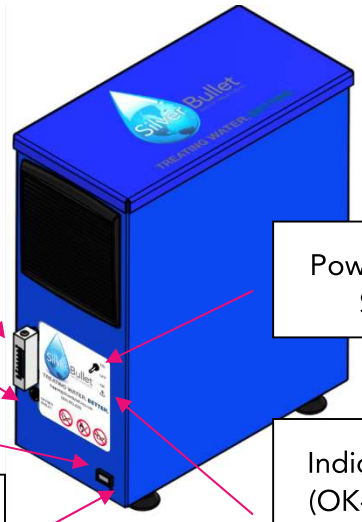
Manual Ozone Flow Control

Ozone Outlet Motorized Ball Valve



Oxygen Inlet (from Oxygen Concentrator)

Figure 6: Oxygen Concentrator Components



Flow Meter / Adjustment

Oxygen Outlet

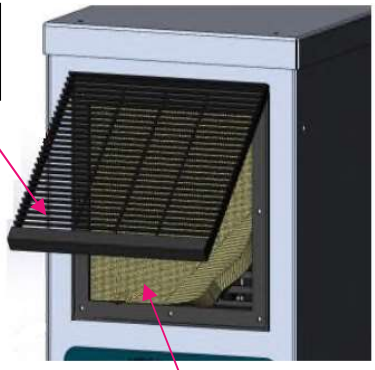
Hour Meter

Circuit Breaker

Power Toggle Switch

Indicator Lights (OK-Green and Caution-Yellow)

Air Filter Grille



Cabinet Air Filter

Section 3 – Initial Conditions & Precautions

1. Walk the flow path and perform a thorough inspection of the system prior to startup. Ensure all plumbing and electrical connections have been properly made according to project documentation.
2. Ensure the Ozone Generator, Oxygen Concentrator, Recirculating Pump, and Waste Pump are OFF. Ensure the Oxygen Concentrator Hand-Off-Auto (HOA) switch is selected to OFF.
3. Ensure recirculating system is filled, and water level is sufficient for recirculating pump operations (usually >20% tank height).
4. Ensure the recirculation loop and treatment system are free from obstructions and aligned to receive flow (i.e., valves in line with the treatment system are opened).
5. Ensure O_3 gas and oxygen feedstock connections are tight and free from pinches, kinks, or leaks.
6. Ensure ozone generator motorized ball valve and check valve are free of leaks to prevent backflow.
7. Ensure all system Backwash Times, Alarm Features, Shutdown Features, Instrument Setups, and associated Setpoints have been pre-programmed and established/enabled.
8. Ensure recirculating pump VFD has been pre-programmed.
9. Ensure Manual Oxygen Flow Adjustment, Manual O_3 Flow Control, and Manual O_3 Output Adjustment settings have been pre-established.
10. Ensure there are no visible leaks, damage, obstructions, or irregularities. Investigate anything that appears abnormal.
11. Prime the recirculating pump and waste pump when they are OFF by performing the following:
    a. Loosen the priming plug on the recirculating pump.
    b. When a solid stream of water discharges from the weep hole, tighten the priming plug.
12. Ensure power is supplied to each component by shutting the associated disconnect or plugging the power cable into an outlet.
13. Ensure ORP probes have been calibrated with unexpired calibration solution.
14. Ensure filtration media has been flushed if performing first startup after media replacement.

WARNING: NEVER OPERATE OZONE GENERATOR WITH OXYGEN CONCENTRATOR POWERED OFF.
WARNING: ENSURE AMBIENT OZONE DETECTOR/ALARM IS ON AND OZONE DESTRUCT UNIT IS POWERED ON.
WARNING: NEVER RUN THE RECIRCULATING PUMP DRY OR ALLOW DEBRIS TO ENTER THE IMPELLER HOUSING.

Section 4 – System Startup

1. Verify initial conditions are met and precautions understood (see Section 3).
2. If not already performed, prime the recirculating pump and waste pump by performing the following:
    a. Loosen the priming plug on the pump.
    b. When a solid stream of water discharges from the weep hole, tighten the priming plug.
3. Turn the system ON as follows:
    a. Press the Main Power On/Off button on the Control Panel. The HMI screen will load, and the ozone generator's motorized outlet valve will open.
    b. If not already performed, calibrate the ORP probes using unexpired calibration solution.
    c. Turn on the Oxygen Concentrator by toggling the On/Off switch to On.
    d. Place the Oxygen Concentrator HOA switch to AUTO.
    e. Turn the Ozone Generator On/Off switch to On.

f. When the Main Screen of the system appears on the Control System's HMI, press START. The recirculating pump should start. If the pump does not start, troubleshoot in accordance with Section 10.5.1 or the Troubleshooting Tree (Section 16).

4. With the recirculating pump running, repeat Step 2 above to ensure pump is fully primed. Once the waste pump is operating, also repeat Step 2 above to ensure pump is fully primed.

WARNING: AVOID REMOVING THE PRIMING PLUG FULLY WHILE THE PUMP IS OPERATING. IMMEDIATELY SECURE POWER TO THE RECIRCULATING PUMP IF THIS OCCURS AND RESTART THE STARTUP PROCEDURE.

5. Ensure the oxygen concentrator's flow adjustment knob is set to the maximum flowrate and is supplying 5 to 10 psi to the ozone generator as indicated on the skid's pressure gauge.
    a. Record the following indications in the Logbook found in Appendix A:
        i. Ozone generator inlet pressure / oxygen concentrator outlet pressure.
        ii. Recirculating pump discharge pressure / filter vessel inlet pressure (PT-1).
        iii. Filter vessel outlet pressures (PT-2, PT-3, & PT-4).
        iv. Venturi inlet and outlet pressures (PT-5 & PT-6).
    b. Compare pressures with baseline recordings to trend performance over time. If the readings are significantly different from initial recordings, investigate the cause.
6. Place system in desired operating mode (ORP, DO, or Manual). The system will now operate continuously until the STOP button is selected. If the system temporarily loses power (usually for less than 8 hours), it will automatically restart under the previously selected settings.

Section 5 – Filter Head Control Valve Operations

1. Manual Regeneration
    a. For Immediate Backwash – Press and Hold UP and DOWN button simultaneously until valve motor starts (typically 3 seconds).
    b. For Backwash Tonight (at pre-programmed time) – Press and Release UP and DOWN button simultaneously. If done correctly, the screen will have an arrow with alert signs indicating a backwash is expected tonight.
2. Setting Time of Day
    a. Press and Hold SET until the hour setting is selected (typically 3 seconds).
    b. Adjust hour with UP or DOWN button. Press SET to go to the next step.

   c. Adjust minutes with UP or DOWN button. Press SET to complete and return to normal operations.
3. Setting Backwash Time and/or Day
   a. Press and Hold SET and the UP button simultaneously until the backwash hour setting is selected (typically 3 seconds).
   b. Adjust backwash start hour with UP or DOWN button. Press SET to go to the next step.
   c. Adjust backwash start minutes with UP or DOWN button. Press SET to go to the next step.
   d. Adjust number of days between backwash cycles with UP or DOWN button. Press SET to complete and return to normal operations.
   e. Ensure backwash time (from start to finish) does not overlap with another filter vessel on the same system.
4. General Operation
   a. When the system is operating, the user can toggle between two displays using the UP or DOWN button. One display shows the time of day and the other shows days until next backwash cycle. An arrow will indicate if a backwash cycle is scheduled for tonight.
   b. If the filter vessel is currently backwashing, the system will display the backwash step and time remaining (i.e., C249).
   c. If the filter vessel differential pressure setpoint is reached and maintained for at least 2 minutes, the filter vessel will enter a backwash cycle at the next scheduled time and "dP" will be displayed.
5. Error Messages – If an error message is displayed, follow the maintenance & troubleshooting guidance in Section 10.5.2, or the Troubleshooting Tree in Section 16.

Section 6 – ORP Mode

1. Operate the system in ORP Mode as follows:
   a. From the Main Screen on HMI, press on the "Ozone Skid".
   b. Within the Ozone Skid screen, select the "ozone generator".
   c. Set the PID control to "ON" and the sensor selection to "ORP".
   d. Adjust the ORP set point value to the targeted maintenance value (in units of mV).
   e. Exit the ozone generator screen and press "Local Start" to start the ORP mode controls for the Ozone Skid.
   f. To make adjustments to the ORP setpoint, return to the ozone generator screen.
   g. To switch between ORP and DO modes, press the "Local Stop" button to post-purge for 30 seconds, then follow the directions in Section 7.

   NOTE: for ORP mode, both the oxygen concentrator and ozone generator must be pre-set to "ON" using their manual switches.

   ORP mode will integrate PID controls to tune the O_3 output to maintain an ORP setpoint. On initial start-up, there will likely be some overshooting of the ORP value during initial program tuning. Please validate O_3 controls are maintaining the expected ORP setpoint before irrigating crops.

   ORP is correlated to O_3 output, but other factors such as water quality and tank exchange rate will impact the ORP value of Freshwater tanks. Consider this if/when making adjustments to your operations.

2. To stop the system, you can:

a. Select "Local Stop" within the Ozone Skid screen to stop ONLY the oxygen concentrator and ozone generator.
b. Navigate to the main screen and press "STOP" to halt all SBWT recirculation operations.
c. Switch the control panel to "OFF" via the LED-backed button and manually switch off the ozone generator and oxygen concentrator to halt ALL SBWT equipment operations. This is only recommended during system maintenance or emergent safety concerns.

Section 7 – DO Mode

1. Operate the system in DO Mode as follows:
    a. From the Main Screen on HMI, press on the "Ozone Skid".
    b. Within the Ozone Skid screen, select the "ozone generator".
    c. Set the PID control to "ON" and the sensor selection to "DO".
    d. Adjust the DO set point value to the targeted maintenance value (in units of ppm oxygen).
    e. Exit the ozone generator screen and press "Local Start" to start the DO mode controls for the Ozone Skid.
    f. To make adjustments to the DO setpoint, return to the ozone generator screen.
    g. To switch between ORP and DO modes, press the "Local Stop" button to post-purge for 30 seconds, then follow the directions in Section 6.

    NOTE: DO mode will only operate the oxygen concentrator and does not allow for control based on the system ORP. To provide disinfection within the recirculation system, SBWT recommends utilizing the ORP mode.

    The DO reading in this system is based on the post-injection DO probe. The actual residual DO content in the FW tank, and within downstream irrigation systems, is not measured directly in this equipment and may vary from the DO sensor reading.

2. To stop the system, you can:
    a. Select "Local Stop" within the Ozone Skid screen to stop ONLY the oxygen concentrator and ozone generator.
    b. Navigate to the main screen and press "STOP" to halt all SBWT recirculation operations.
    c. Switch the control panel to "OFF" via the LED-backed button and manually switch off the ozone generator and oxygen concentrator to halt ALL SBWT equipment operations. This is only recommended during system maintenance or emergent safety concerns.

Section 8 – Manual Mode

The Filter Skid can be operated independent of the Ozone Skid using the Local Start function on the Filter Skid screen. The Local Start function should only be used when directed by a Silver Bullet representative or when the user is knowledgeable and proficient with the system's advanced operations.

If the Filter Skid is ON with the Ozone Skid OFF, the following steps should be taken:

1. Disconnect tubing from the Venturi injector.
2. Ensure the oxygen concentrator toggle switch is in the OFF position.
3. Ensure the ozone generator power switch is in the OFF position.

The Ozone Skid can be operated independent of the Filter Skid using the Local Start function on the Ozone Skid screen. Injecting oxygen and/or O_3 into the system without flow could cause damage to the system. Do not operate the oxygen concentrator or ozone generator without water flow. Do not operate the ozone generator without the oxygen concentrator and with sufficient supply pressure. Do not operate ozone generator without the ozone destruct unit or additional O_3 safety precautions. It is recommended that the user do not operate under Local Start unless at the specific direction of a Silver Bullet representative.

The Waste Pump can be operated independent of the Filter Skid or Ozone Skid using the Local Start function on the Waste screen.

If using the Waste Pump under its Local Start function, monitor the Waste Tank during pumping operations. Do not let water level drop below 10% of tank volume to ensure Waste Pump maintains primed with sufficient NPSH. Press the Local Stop button to stop pumping operations prior to reaching 10% of tank volume.

The entire system can be operated independent of the primary Control System. The system should not be operated in this condition unless at the specific direction of a Silver Bullet representative. To perform this, the VFD-controlled recirculating pump must be re-programmed to run continuously at a predefined speed. The filter vessels can operate on a timer-based function independent of the Control System. The oxygen concentrator must be powered on using an alternate method by disconnecting from the primary Control System and installing a 3-prong cable. When an alternate power source is provided, the unit can be turned on using its ON toggle switch. The ozone generator can be operated independently by removing the motorized ball valve and using its ON switch. The system can be setup to run with a continuous O_3 output. The Waste Pump can be operated independent of the primary Control System only if the motor starter is jumpered. In this condition where the entire system is being controlled independently, all safety features are disabled and personnel injury and/or equipment damage can quickly occur.

To exit Manual Mode and enter ORP or DO Mode, first select Local Stop on all systems that were operated Locally. Then, ensure the system's initial conditions and precautions are met using Section 3 before starting the system using Section 4.

Section 9 – Communications with Facility BMS

The Recirculating Filtration & Ozone System can communicate with a Facility BMS system through Modbus/TCP protocols using the CAT 6 RJ-45 terminal located on the bottom of the Control System.

Section 10 – Calibration, Monitoring, & Maintenance

SECTION 10.1 – ORP PROBE CALIBRATION

1. ORP probes should be calibrated monthly at a minimum. Ensure the system is OFF using the STOP button on the main screen.
2. Isolate the ORP probe to be calibrated by shutting the nearest valves upstream and downstream of their location. If a sample valve is located between the isolation valves, drain water from the system to minimize leakage at probe location during calibration.
3. Pour ORP calibration solution into a small container that will be sufficient to submerse the ORP electrode. The recommended calibration solution is Zobell's which must be kept refrigerated and warmed to room temperature during use. Calibration solution made of quinhydrone is very unstable and should be discarded after being exposed to air for a few hours.

	Zobell's Sol'n	Light's Sol'n	4 pH buffer w/ quinhydrone*	7 pH buffer w/ quinhydrone*
ORP @ 20C			268 mV	92 mV
ORP @ 25C	228 mV	469 mV	263 mV	86 mV
ORP @ 30C			258 mV	79 mV

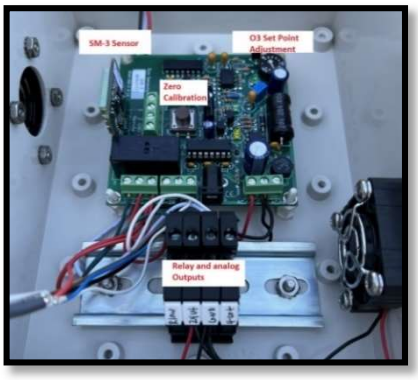
*Saturate 50mL of pH 4 or pH 7 with 1/8 g quinhydrone

4. Navigate to the Instrument Menu and adjust the offset such that the Scaled Value is within 50 mV of the calibration solution's mV value in the table above.
5. Dispose of calibration solution in accordance with local, state, and federal guidelines.

SECTION 10.2 – DO PROBE CALIBRATION

Calibration is not normally required for the Dissolved Oxygen probe. The unit, as shipped from the factory, will measure within 2% of reading for the life of the sensor cap. Periodically replace the sensor cap to ensure reading is within 2% accuracy.

SECTION 10.3 – AMBIENT OZONE DETECTOR CALIBRATION



1. Perform a system calibration monthly. When initially powered on, the alarm will engage until the sensor is fully warmed up (30 min – 12 hours)
    a. After 30 minutes of warmup, press the BROWN button on the circuit board inside to perform a zero calibration. Make sure this is done in an ozone free environment.
    b. After 12 hours of warmup, reperform the zero calibration above.

    Note: The ambient ozone detector setpoint can be manually set by operators if needed. The maximum value (100%) is 1 ppm.

SECTION 10.4 – SYSTEM MONITORING

1. Recirculating & Waste Pump:
    a. Monitor recirculating pump suction pressure daily at the vacuum/pressure gauge (if installed).
    b. Monitor recirculating pump discharge pressure daily.
    c. Monitor recirculating pump motor temperatures weekly using an on-contact temperature probe. A significant temperature increase from initial recordings should be investigated.
2. Filtration System:
    a. Monitor filtration system inlet pressure (PT-1) and outlet pressures (PT-2, PT-3, & PT-4) daily. Ensure the system is backwashing at expected frequency and when differential pressures reach their setpoint.
    b. During normal operation, the display of each filter head control valve will either show the current time of day and if a backwash event is scheduled for that evening, or the number of days before the next backwash event is planned.
3. Oxygen Concentrator:
    a. The Green indicator light illuminates to provide the primary indication that the oxygen concentrator is operating.
    b. The Yellow indicator light illuminates to indicate that a system fault has occurred.
    c. The Process Failure audible alarm and Yellow indicator light activates when a process failure occurs.
    d. In the event of a surge or drop in power supply, the circuit breaker will trip. To restart the device, depress the Circuit Breaker button.
    e. Monitor the oxygen concentrator system flowrate and outlet pressure daily.
4. Ozone Generator:
    a. The Green indicator light illuminates to provide the primary indication that the ozone generator is operating.
    b. The motorized ball valve can be heard operating when the system begins communicating with the Control System.
5. Venturi Injector:
    a. Monitor Venturi inlet pressure daily.
    b. Monitor Venturi outlet pressure daily.
    c. Monitor Venturi differential pressure daily to ensure proper operation.
6. Air/Water Separators:
    a. Monitor air/water separators on top of the ozone contact tank for bubbling. Take note of the rate at which the vent fluctuates to aid in comparison between initial and subsequent recordings.

SECTION 10.5 – SYSTEM MAINTENANCE & TROUBLESHOOTING

NOTE: REFER TO SECTION 16 FOR A DETAILED TROUBLESHOOTING TREE.

Section 10.5.1 – Recirculating & Waste Pump

1. If pump discharge pressure is low or the pump will not start, investigate the following:
    a. Verify flow path is unobstructed and all valves in line with the treatment equipment are in their normally open positions.
    b. Verify source tank water level is above the level of the pump suction piping.
    c. Verify the pump is primed.
    d. Verify the pump disconnect switch is shut.
    e. Verify the dedicated electrical breaker has not tripped.

f. Verify the pump's disconnect fuses have not blown (if installed).
g. Verify a system safety feature has not been enabled.
h. Verify source tank is full and the pump has not run dry.
i. Verify pump motor is spinning in the correct direction.
j. Verify pump on-contact temperature readings and compare to initial recordings.
k. Verify incoming and outgoing voltages.
l. If all troubleshooting efforts have failed, contact a Silver Bullet representative for further guidance.

Section 10.5.2 – Filtration System

1. If the inlet pressure or flowrate is too low due to low supply pressure coming from recirculating pump, troubleshoot recirculating pump.
2. If the outlet flowrate is too low due to media being fouled:
    a. Backwash the associated filter vessel.
    b. Replace filtration media.
3. If the effluent (filtered) water quality is poor:
    a. Confirm influent (inlet) water quality has not changed.
    b. Investigate filter head control valve settings.
    c. Investigate filter head control valve for damage.
    d. Replace filtration media.
4. If display or PC board fails:
    a. Ensure required power is being supplied to filter head control valve.
    b. Inspect for tripped breakers or GFI outlets.
    c. Inspect all connections between filter head control valve, 3-way valve, and Control System.
5. If filter vessels are backwashing at the wrong time of day:
    a. Confirm current time is set correctly.
    b. Confirm backwash time (for each vessel) is set correctly.
6. If the filter head control valve does not backwash when the UP and DOWN buttons are pressed simultaneously for >5 seconds:
    a. Inspect the drive gear, drive cap, piston rod, and/or PC board for damage.
7. If water is continuously running out the drain port and into the Waste Tank:
    a. Investigate if a power outage occurred during a backwash event.
    b. Inspect drive cap, piston assembly, and/or stack assembly for damage.
8. If an E1 (or 1001) error message occurs, the control valve was unable to sense motor movement:
    a. Confirm motor is fully inserted to engage pinion.
    b. Confirm motor wires are not disconnected or damaged.
    c. Confirm PC board is properly snapped into drive bracket.
    d. Confirm reduction gears are not missing.
9. If an E2 (or 1002) error message occurs, the control valve motor has run too short and was unable to find the next cycle position and stalled:
    a. Confirm foreign material is not lodged in the control valve.
    b. Confirm the control valve is not being mechanically bound during operation.
    c. Confirm drive gear is not too tight.
    d. Confirm proper voltage being supplied to PC board.
10. If an E3 (or 1003) error message occurs, the control valve motor ran too long and was unable to find the next cycle position:
    a. Confirm motor did not fail during backwash event.

   b. Confirm foreign matter has not built up on piston and stack assemblies which would create enough friction and drag to time out the motor.
   c. Confirm drive bracket has not sapped out of position such that the reduction gears and drive gear do not interface properly.
11. If an E4 (or 1004) error message occurs, the control valve motor ran too long and timed out trying to reach home position:
   a. Confirm drive bracket has not snapped out of position such that the reduction gears and drive gear do not interface properly.

Section 10.5.3 – Oxygen Concentrator

1. Only the outside of the device is to be cleaned. After making sure the On/Off toggle switch is in the Off position, use a soft, dry cloth or, if necessary, a damp sponge with mild soap. Do not use acetone, solvents, abrasive powders or any inflammable products to clean the cabinet.
2. The removable Cabinet Air Filter must be cleaned at least monthly.
   a. Use warm water and household detergent to rinse the cabinet air filter thoroughly. Ensure the filter is dried before reinstalling.
   b. The Inlet Filter/ Element should be inspected monthly and replaced if required. The Inlet Filter / Element should be replaced annually at minimum.
3. If the Yellow indicator light remains illuminated, product pressure or concentration may not be at an acceptable level.
4. If the oxygen concentrator suddenly stops and then starts again in a few moments, the filters may be dirty or the compressor thermal shut-off may have activated.

Section 10.5.4 – Ozone Generator

The ozone generator is intended to run maintenance free. If the corona discharge cell remains clear of water and VOCs, and is operated at the correct internal pressures, the cell could last for 10+ years. To maximize life expectancy, DO NOT allow water to backflow into ozone generator. If the cell does require replacement, contact a Silver Bullet representative.

Section 10.5.5 – Venturi Injector

1. If Venturi differential pressure is outside of the normal operating range or if the readings have changed significantly from initial recordings:
   a. Verify Venturi outlet flow path is unobstructed.
   b. Verify Venturi inlet valve is open.
   c. Verify pump discharge pressure has not dropped significantly by comparing with baseline numbers recorded on Logbook (Appendix A).
   d. Disconnect the gas tubing from the Venturi injector and ensure it is drawing a suction. Do not allow O_3 to discharge in a worker's breathing area during this step.
   e. Verify Venturi injector internals have not failed.
2. If excessive noise is coming from the Venturi injector with the oxygen concentrator and ozone generator operating:
   a. Verify motorized ball valve on outlet of ozone generator has not shut. The valve will shut when the oxygen concentrator is off.
   b. Verify no pinches or kinks in the O_3 gas line.
   c. Verify oxygen supply pressure is adequate.
   d. Verify no obstructions or interference in recirculation flow path.
   e. Verify check valve has not malfunctioned and is installed in the correct direction.
   f. Verify Venturi injector is installed in the proper direction relative to water flow.

Section 10.5.6 – Air/Water Separator

1. If the air/water separator is leaking, investigate the source:
    a. If the leak is occurring at the vent plug, tighten the plug while taking care not to overtighten or crack the PVC fitting. If necessary, remove and reapply Teflon tape and thread sealant.
    b. If the leak is occurring at the threaded connections between vent and ozone contact tank, tighten the threaded fittings taking care not to overtighten or crack the PVC fitting.
    c. If the leak is occurring due to a crack in the PVC, or if the leak cannot be fixed by tightening, replace the component:
        i. Remove and reapply Teflon tape and thread sealant by isolating the air/water separator and unthreading from the ozone contact tank. Do not isolate both air/water separators simultaneously while the system is in operation. Do not allow the system to operate for a prolonged time with one air/water separator.
        Note: Two air/water separators per ozone contact tank allows redundancy for maintenance while the Ozone Skid is still operational.
2. If the air/water separator is not bubbling / fluctuating as expected, investigate the cause:
    a. Ensure isolation valve is open.
    b. Ensure recirculating system is operating.
    c. Ensure Venturi is operating by inspecting its inlet and outlet pressures.
    d. Verify no kinks or pinches in the gas line.
    e. Ensure vent path is not obstructed.
    f. Ensure vent float is not jammed in place.
    g. Remove the malfunctioning component by isolating the air/water separator and unthreading from the ozone contact tank. Do not isolate both air/water separators simultaneously while the system is in operation. Do not allow the system to operate for a prolonged time with one air/water separator. Inspect small internal vent hold inside air/water separator housing to ensure there are no obstructions. Clear as needed.
    Note: Two air/water separators per ozone contact tank allows redundancy for maintenance while the Ozone Skid is still operational.

Section 10.5.7 – Ozone Destruct Unit

1. If the destruct media becomes fouled or contaminated over time, replace as follows:
    a. With the Ozone Skid off and no flow through the ozone contact tank, shut the air/water separator isolation valves.
    b. Disconnect gas tubing and unplug ozone destruct unit.
    c. When the unit is cool to the touch, unmount from the Ozone Skid.
    d. Remove dust cover from top of unit.
    e. Completely empty unit by sucking the catalyst media out with vacuum or by tipping the unit upside down.
    f. Clean the inside if necessary. Remove any buildup due to moisture if it has occurred. If detergents or solvents are used, rinse the unit thoroughly with water and dry before refilling.
    g. Dump new media into unit.
    h. With wood mallet or similar object, tap the side of the unit while filling so that the media settles from the bottom.
    i. Inspect condition of top cover gasket and reinstall into clean mating surface if reusable. Do not use sealants and replace gasket if damage is visible.
    j. Reinstall the cover and remount the unit onto the Ozone Skid.
    k. Reinstall the gas tubing and plug the unit into an outlet.

l. Open the air/water separator isolation valves before operating the Ozone Skid or allowing flow through the ozone contact tank.

Section 10.5.8 – Flow Transmitter

1. If the output value is erratic and unstable:
    a. Verify no upstream obstructions.
    b. Verify flow meter is installed in the correct direction.
    c. Verify flow meter is not being exposed to excessive amounts of air bubbles/pockets.
    d. Verify electrical noise is not interfering with measurement by inspecting grounding.
    e. Verify electrodes are not coated with solids.
    f. Verify new sensor has been properly conditioned.
2. If the output value is not 0 when flow is stopped:
    a. Verify new sensor has been properly conditioned.
    b. Verify vibrations at piping are not interfering with measurement. If so, increase the low flow cutoff setpoint.
    c. Verify electrical noise is not interfering with measurement by inspecting grounding.
    d. Verify meter is not defective.
3. If the 4-20mA current output is incorrect:
    a. Verify span setting in the Control System.
    b. Verify range jumper placed correctly.
4. If the frequency output is inoperative, if the digital output (S^3L) is inoperative, or if the loop output is inoperative:
    a. Verify blue jumper is in the correct position.
    b. Inspect the wiring and all connections.
    c. Confirm if pull-up resistors are required.
5. If the output is 22.1 mA:
    a. Conductivity is too low for accurate measurement (<20µS/cm).
    b. The component has failed.

Section 10.5.9 – Pressure Transmitter

1. After final installation of the pressure transmitter, no routine maintenance is required. A periodic check of system calibration is suggested through a nationally recognized calibration facility.
2. If the pressure reading is erratic or unstable, inspect the wiring and all connections.
3. If the output value is incorrect, verify span setting in the Control System.

Section 10.5.10 – Level Transmitter

1. If the level reading is erratic or unstable, inspect the wiring and all connections.
2. If the output value is incorrect:
    a. Verify span setting in the Control System.
    b. Verify level transmitter is sitting ~6” from the bottom of the tank.
    c. Verify level transmitter is not in the middle of churning water.

Section 10.5.11 – ORP Probe

1. ORP electrodes are like batteries, they age with time and should be replaced periodically. A spare ORP electrode should always be available to ensure uninterrupted operations.
2. If the output value is incorrect:
    a. Recalibrate the probe with unexpired calibration solution.

   b. Verify span setting in the Control System.
3. If the offset measures greater than 50 mV, the sensor should be cleaned or replaced.
4. Cleaning procedure:
   a. For Hard Coatings – Use dilute acid solution (HCl of 5% or less) if the electrode has been used in applications with a pH value higher than 7 and soak the electrode for 2-5 minutes. Use dilute alkaline solution (NaOH of 5% or less) if the electrode has been used in applications with a pH value less than 7 and soak the electrode for 2-5 minutes. Alternating immersion in acidic and alkaline solutions may be necessary for thorough cleaning.
   b. For Soft Coatings – Spray or vigorously stir the electrode with a mild detergent, such as dishwashing liquid. Chlorine bleach can also be used.
   c. For Oily or Organic Coatings – Spray or vigorously stir the electrode with a mild detergent or an appropriate solvent that will not attack the materials of construction (isopropyl alcohol or similar).
   d. After Cleaning – Always rinse the electrode with water after cleaning. Soak the electrode in pH 4 buffer (with KCl if available) for at least 10 minutes after cleaning.

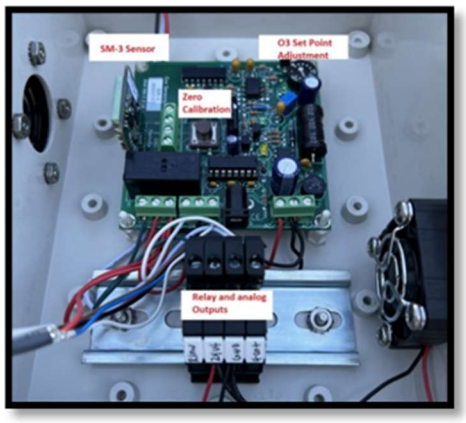
Section 10.5.12 – DO Probe

1. If the output value is incorrect:
   a. Verify span setting in the Control System.
2. Cleaning procedure:
   a. Cleaning the Sensor Cap:
      i. Leave the cap and nose cone on the sensor.
      ii. Rinse the sensor with clean water from a squirt bottle or spray bottle.
      iii. Gently wipe with a soft-bristled brush or soft cloth if biofouling is present. Use Alconox® to remove grease.
      iv. If extensive fouling or mineral buildup is present, soak the cap end in vinegar for 15 minutes, then soak in deionized water for 15 minutes.
   b. Cleaning the Optical Window:
      i. Perform only when changing the cap under the sensor replacement procedure.
   c. Cleaning the Sensor Body:
      i. Install the sensor cap, and gently scrub sensor body with a soft-bristled brush or nylon dish scrubber.
      ii. Soak in vinegar and deionized water to remove mineral deposits.
      iii. If extensive fouling or mineral buildup is present, soak the cap end in vinegar for 15 minutes, then soak in deionized water for 15 minutes.
3. Sensor cap replacement procedure:
   a. Ensure the Ozone Skid is OFF and not recirculating through the ozone contact tank. Isolate the DO probe by shutting the nearest valves upstream and downstream of its location. If a sample valve is located between the isolation valves, drain water from the system to minimize leakage at probe location during calibration.
   b. Pull the sensor cap off the sensor. DO NOT TWIST.
   c. Remove the existing O-ring from the sensor.
   d. Using a lint-free cloth, remove any moisture from the sensor body. Make sure the O-ring grooves are dry and avoid touching or cleaning the lens with anything other than the factory provided lens wipes.
   e. Use your finger to apply a thin layer of lubricant around the O-ring grooves. Place the O-rings on the sensor. Do not transfer lubricant to the lens or sensor pins.

f. Clean the lens on the sensor using the factory provided lens wipes and allow to dry thoroughly. Inspect for scratches or dirt.
g. Remove the new cap from its sealed package.
h. Aling the arrow on the cap with the index mark on the sensor and press it firmly until it seals over the probe body. DO NOT TWIST. Make sure the O-rings are not pinched or rolled between the cap and sensor.
i. Replace the nose cone on the sensor.
j. Reinstall the sensor and return the system to normal operation.

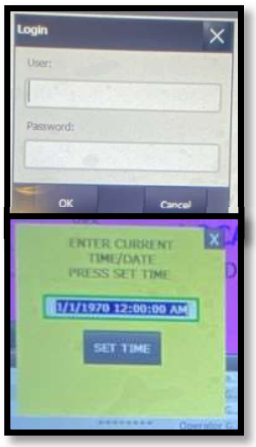
Section 10.5.13 – Ambient Ozone Detector/Alarm

1. Perform a zero calibration monthly.
2. Clean the alarm monthly.
3. Bump test the alarm with O_3 monthly.
4. Replace ozone leak sensor annually.



Section 11 – Alarms, Shutdowns, Setpoints, Trending, & Administrative Operations

1. Adjusting ozone alarm on independent Ozone Detector/Alarm:
    a. Adjust the O_3 Set Point dial on the inside of the ozone detector. The maximum value (100%) correlates to 1 ppm. If the user wants to establish 0.10 ppm, the dial should be set to 1%.
2. Accessing ADMIN features:
    a. Some features including alarms, setpoints, instrument menus, and other advanced features require the user to login to the ADMIN screen. Administrative logins are normally only required once after the system has been powered on. The default login from the factory is as follows:
        i. User: e
        ii. Password: 1111
    b. Once the ADMIN menu is accessed, the user can perform the following:
        i. Review PLC Diagnostics for advanced troubleshooting.
        ii. Adjust Alarms, Setpoints, and Shutdown Features.
        iii. Set current time.
        iv. Access memory devices such as SD cards.
        v. Update instrument spans, offsets, and other advanced features.



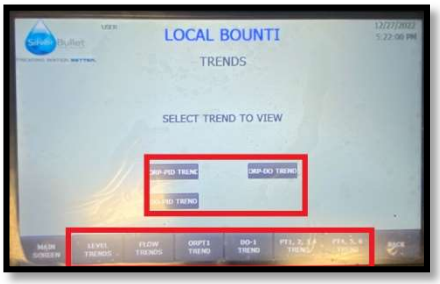
3. Adjusting Alarm Feature:
    a. Navigate to the Alarm Setup menu and select the instrument or sensor to be adjusted.
    b. Enter the alarming value for the Low Alarm and High Alarm.
    c. Enter a time delay (if applicable).
    d. ENABLE or DISABLE the following features by sliding the button on the screen:
        i. Low Alarm
        ii. High Alarm
        iii. Sensor Fail Alarm

4. Adjusting Shutdown Safety Feature:
    a. Navigate to the Alarm Setup menu and select the instrument or sensor to be adjusted.
    b. Enter the alarming value for the Low Alarm and High Alarm.
    c. Enter a time delay (if applicable).
    d. ENABLE or DISABLE the following features by pressing the button below SHUTDOWN
        i. Low Shutdown
        ii. High Shutdown
        iii. Sensor Fail Shutdown

5. Establishing Tank Height:
    a. Navigate to the treatment system screen and press on the Tank or Level Transmitter reading icon.
    b. Input the tank height in feet and confirm the Alarm Low and Alarm High values have carried over from the Alarm Setup menu.
        i. ALARM LOW is normally set at 20% tank volume.
        ii. ALARM HIGH is normally set below the tank overflow piping.

6. Adjusting instrument spans, offsets, or other advanced settings:
    a. Navigate to Instrument Menu or Instrument Menu 1 depending on the instrument or sensor.
    b. Input the MIN SPAN and MAX SPAN for the instrument and confirm the SCALED VALUE. Confirm the instrument is operating correctly.
    c. Input the MIN IL, OFFSET, and ORP MAX O_3 I/L if applicable and confirm the instrument is operated correctly.

7. Trending data using Control System:
    a. Navigate to the Trends screen and select the trend you wish to see.
    b. Zoom in and out and use the left and right arrow buttons to see the desired trend.



Section 12 – System Cleaning & Sanitization

Keeping grow areas clean helps ensure a thriving crop by removing bacteria, algae, and pathogens. Areas should be kept clean through a program of regularly scheduled sanitization and intermittent sterilization. Sanitization requires a consistent effort of cleaning spilled water, removing dead plant matter, and changing air intake filters to inhibit microbial growth and limit the incidence of pests and pathogens. Occasional sterilization of the system requires an in-depth cleaning of the system to rid the grow area of viruses, bacteria, fungi, and fixed-growth microorganisms (e.g., biofilms). Sanitization should be maintained daily while sterilization typically is performed following a harvest.

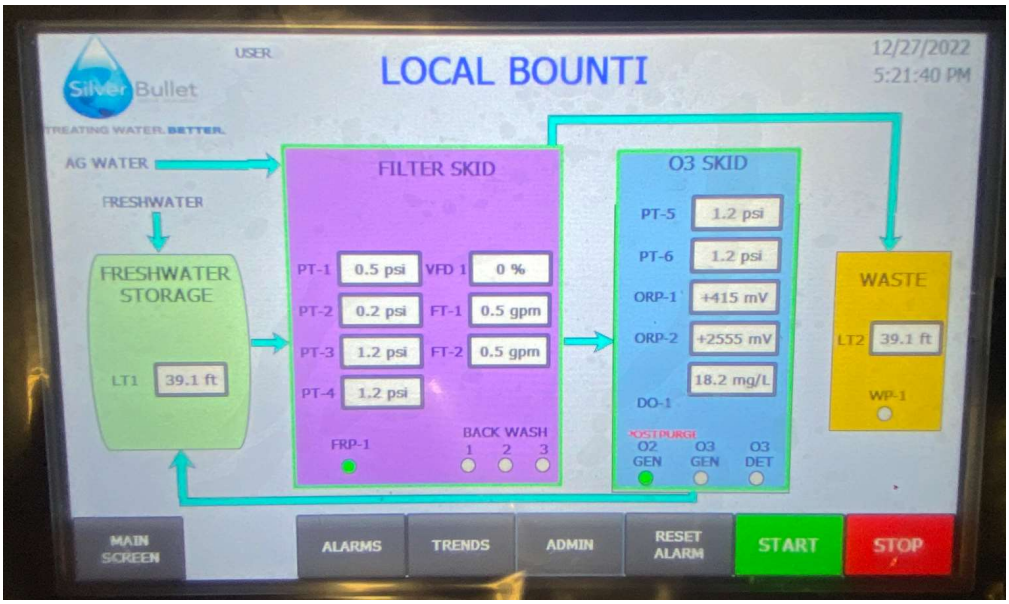
Section 13 – Control System Navigation & Features

The following sections provide an outline for quickly navigating through the HMI screens associated with the Recirculating Filtration & Ozone Control System, followed by more detailed sections on each individual screens.

- 1.0 Main Screen
  - 1.1 Freshwater Storage
    - 1.1.1 LT-1
  - 1.2 Filter Skid
    - 1.2.1 PT-1
    - 1.2.2 FT-1
  - 1.3 Ozone Skid
    - 1.3.1 DOT-1
    - 1.3.2 ORPT-1
    - 1.3.3 Ozone Generator
    - 1.3.4 Oxygen Concentrator
  - 1.4 Waste
    - 1.4.1 LT-1
- 2.0 Alarms
  - 2.1 Alarm Setup
    - 2.1.1 Pressure Alarms PT-1, PT-2
    - 2.1.2 Pressure Alarms PT-3, PT-4
    - 2.1.3 Pressure Alarms PT-5, PT-6
    - 2.1.4 Flow Tx Alarms FT-1, FT-2
    - 2.1.5 O2 Sensor Alarms DOT-1
    - 2.1.6 Level Alarms LT-1, LT-2
    - 2.1.7 ORP Sensor Alarms ORPT-1, ORPT-2
- 3.0 Trends
  - 3.1 Level Trends
  - 3.2 Flow Trends
  - 3.3 ORPT1 Trend
  - 3.4 DO-1 Trend
  - 3.5 PT-1, 2, 3, 4 Trend
  - 3.6 PT 5, 6 Trend
  - 3.7 ORP-PID Trend
  - 3.8 ORP-DO Trend
  - 3.9 DO-PID Trend
- 4.0 ADMIN
- 4.0.1 ADMIN Login
  - 4.1 PLC Diagnostics
    - 4.1.1 Digital Inputs
    - 4.1.2 Digital Outputs
    - 4.1.3 Analog IO
  - 4.2 Instrument Menu
    - 4.2.1 Instrument Menu 1
  - 4.3 Set Time

1.0 MAIN SCREEN

The main screen provides a quick overview of all (4) systems that make up the Recirculating Filtration & Ozone System: Freshwater Storage, Filter Skid, Ozone Skid, and Waste System. The main screen is also where the complete system is started and stopped. Included on the main screen are Freshwater Storage level indication, Filter Skid pressure indications (x4), VFD Speed %, Filtered Water Flowrate, Backwash Water Flowrate, Recirculating Pump Status, Backwash Status (x3), Ozone Skid pressure indications (x2), ORP Readout (x2), DO Readout, Oxygen Concentrator Status, Ozone Generator Status, Ozone Detector Status, Waste Tank level indication, and Waste Pump Status.



1.1 FRESHWATER STORAGE

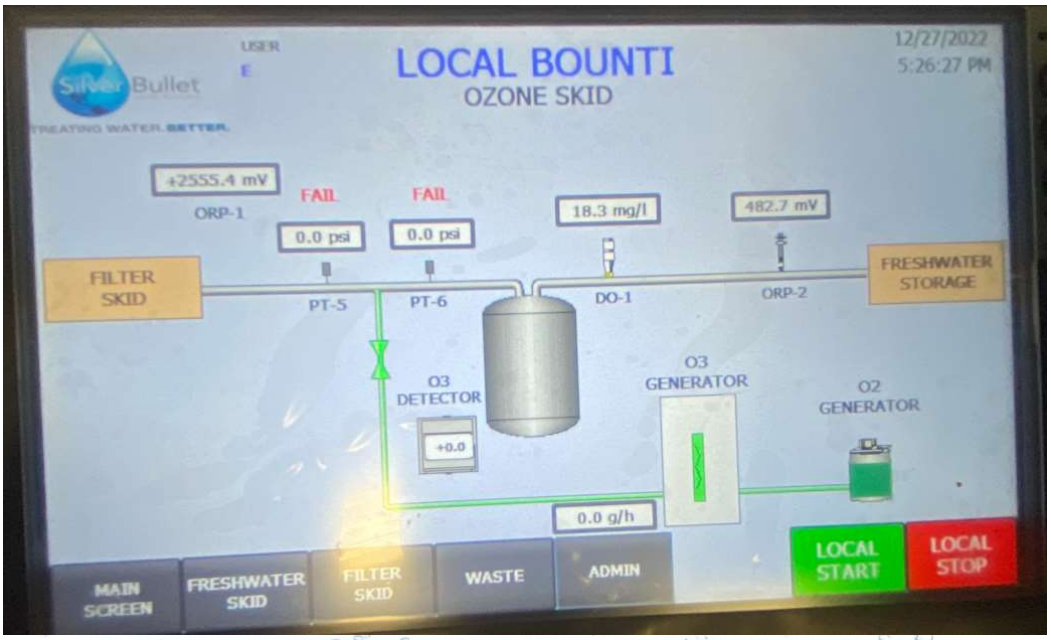
The freshwater storage screen provides a more detailed view of the Freshwater Storage Tank and allows for quick view of system setpoints by clicking on the associated sensor or component.

1.2 FILTER SKID

The filter skid screen provides a more detailed view of the Filter Skid System and allows for quick view of system setpoints by clicking on the associated sensor or component. The Filter Skid System can be started and stopped locally (independent of Ozone Skid Waste Tank systems) using the Local Start and Local Stop features.

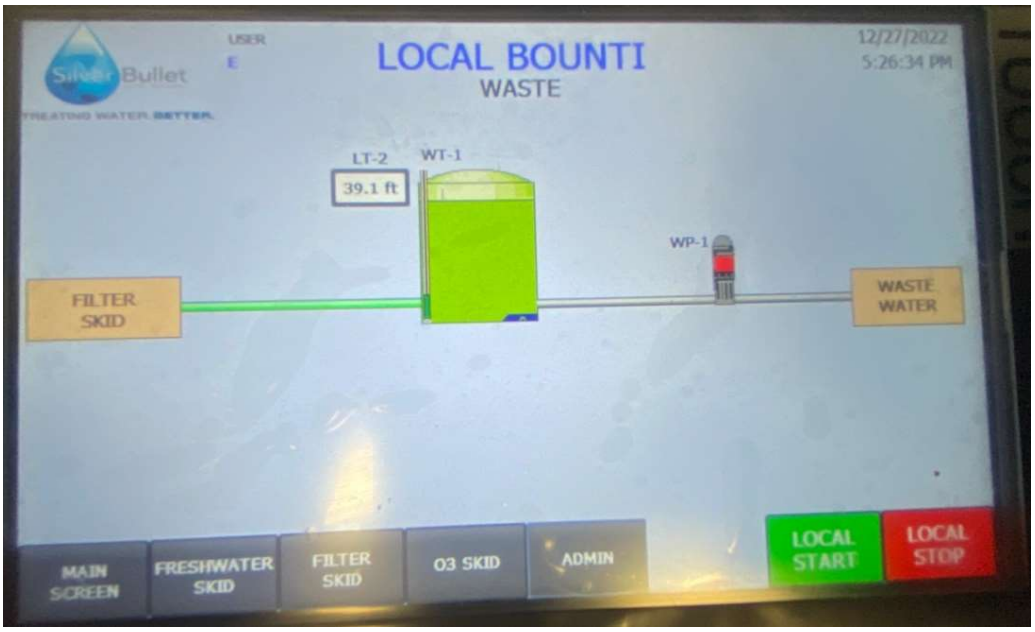
1.3 OZONE SKID

The ozone skid screen provides a more detailed view of the Ozone Skid System and allows for quick view of system setpoints by clicking on the associated sensor or component. The Ozone Skid System can be started and stopped locally (independent of Filter Skid and Waste Tank systems) using the Local Start and Local Stop features.



1.4 WASTE

The waste screen provides a more detailed view of the Waste Tank and allows for quick view of system setpoints by clicking on the associated sensor or component. The Waste System can be started and stopped locally (independent of Filter Skid or Ozone Skid systems) using the Local Start and Local Stop features.

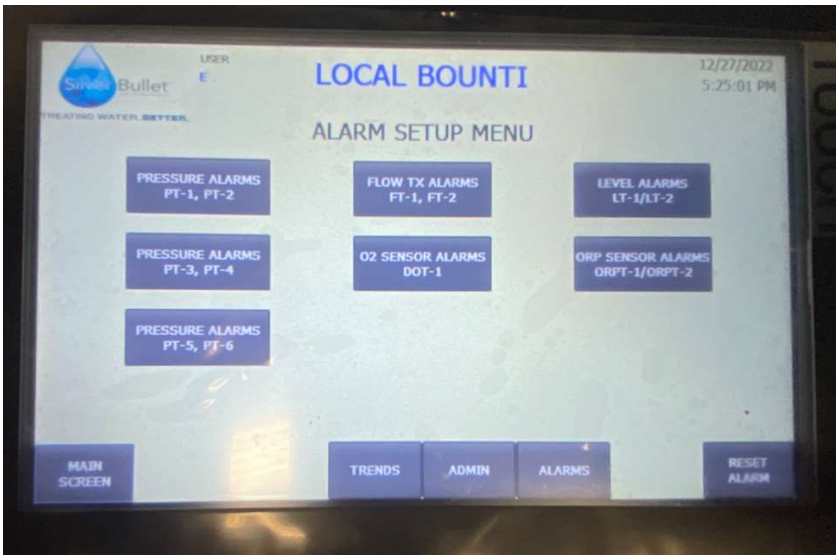


2.0 ALARMS

The alarms screen shows alarm history and active alarms. Alarm setpoints can be adjusted and alarms can be cleared using this screen.

2.1 ALARM SETUP

The alarms setup screen allows for adjusting setpoints for all alarms associated with the Recirculating Filtration & Ozone System.



2.1.1 ALARM SETUP EXAMPLES

The individual alarms setup screens allow the user to adjust the alarm setpoint (including time delays) for each sensor or component where applicable.

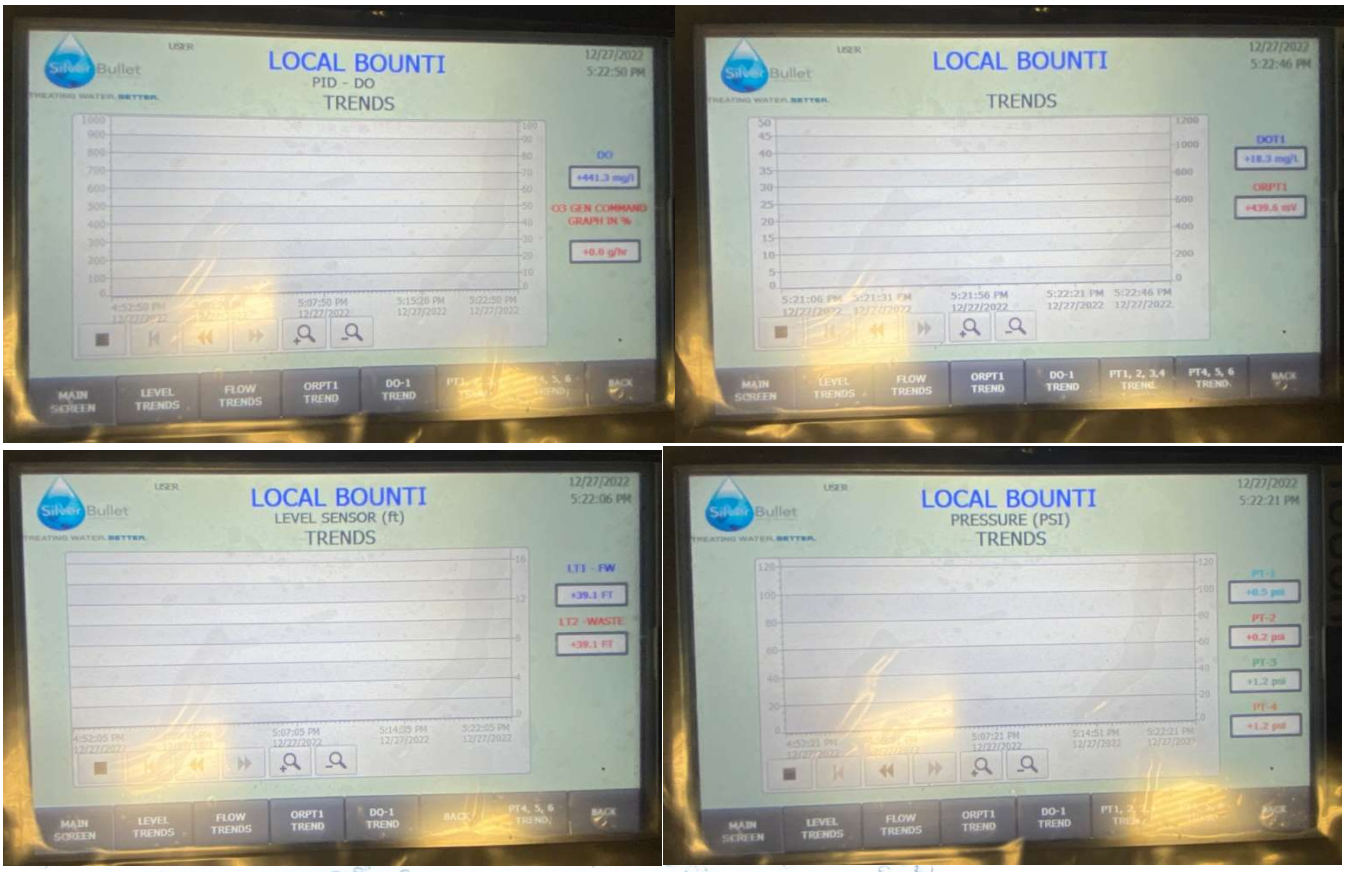
In addition to setpoint adjustments, the user can manually ENABLE or DISABLE the Low-Level Alarm, the High-Level Alarm, and the Sensor Failure Alarm. The individual alarms setup screen also allows the user to ENABLE or DISABLE the SHUTDOWN safety feature associated with each sensor or component alarm.

3.0 TRENDS

The trends screen allows for viewing trends for multiple sensors associated with the Recirculating Filtration & Ozone System.

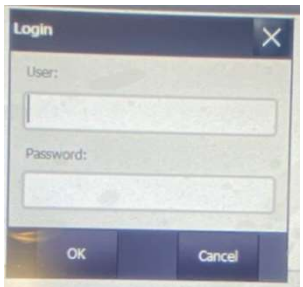
3.1 TRENDING EXAMPLES

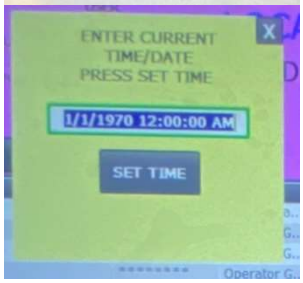
The individual trending screens allow the user to view the associated sensor(s) readouts over time. The user can zoom in or out of the trending menu to adjust the datapoints.



4.0 ADMIN

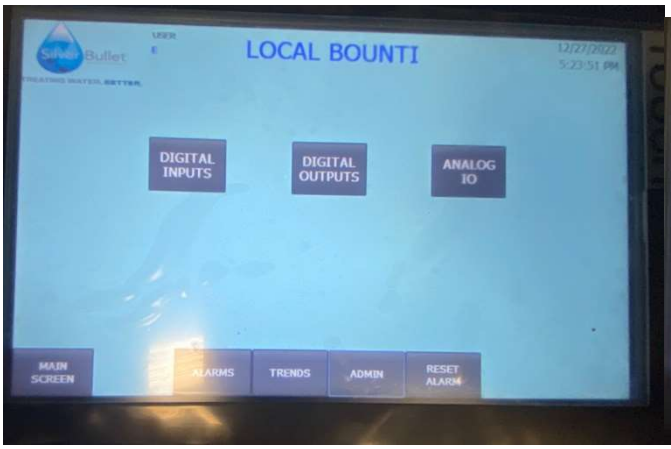
The ADMIN screen requires a login for the first time after system startup. This is also where the system time can be adjusted. The admin screen should be used for system diagnostics, alarm setpoint adjustments, and instrumentation setup.

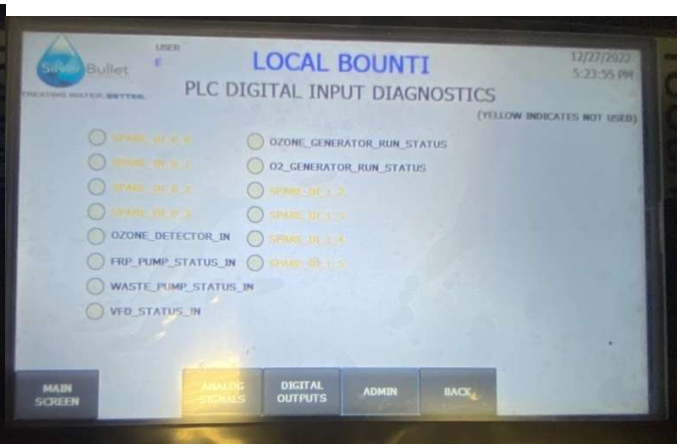


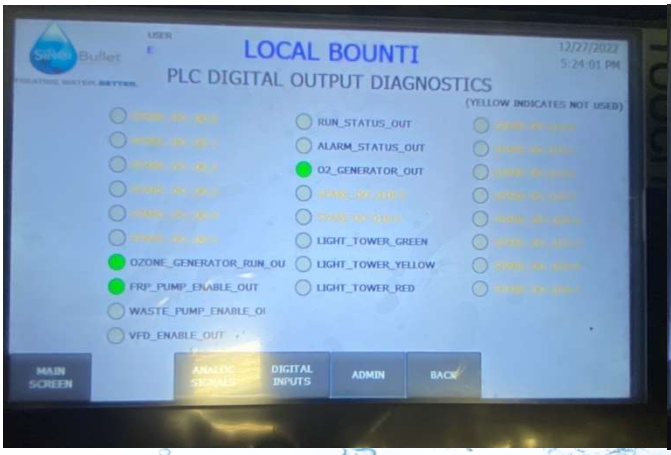


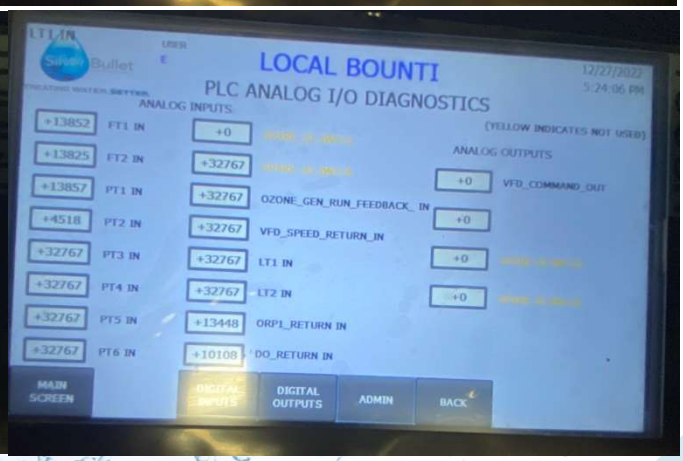
4.1 PLC DIAGNOSTICS

The PLC diagnostics screens allow the user to view more detailed information around the associated sensor or components communications with the PLC.



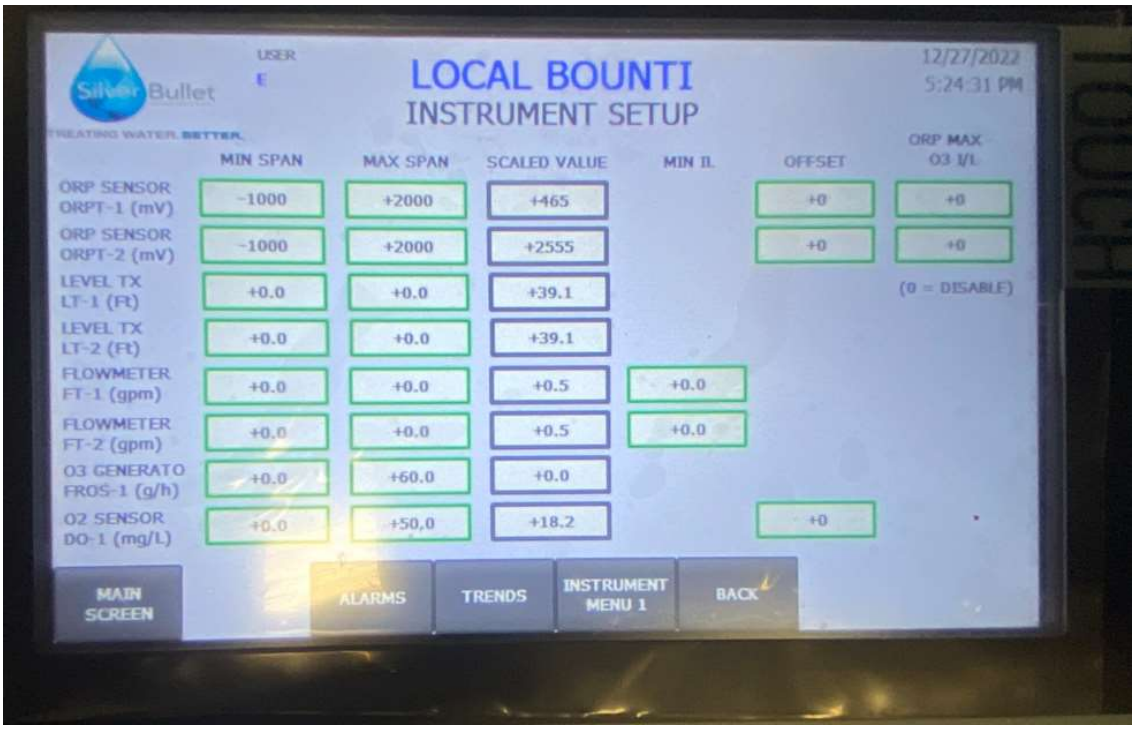






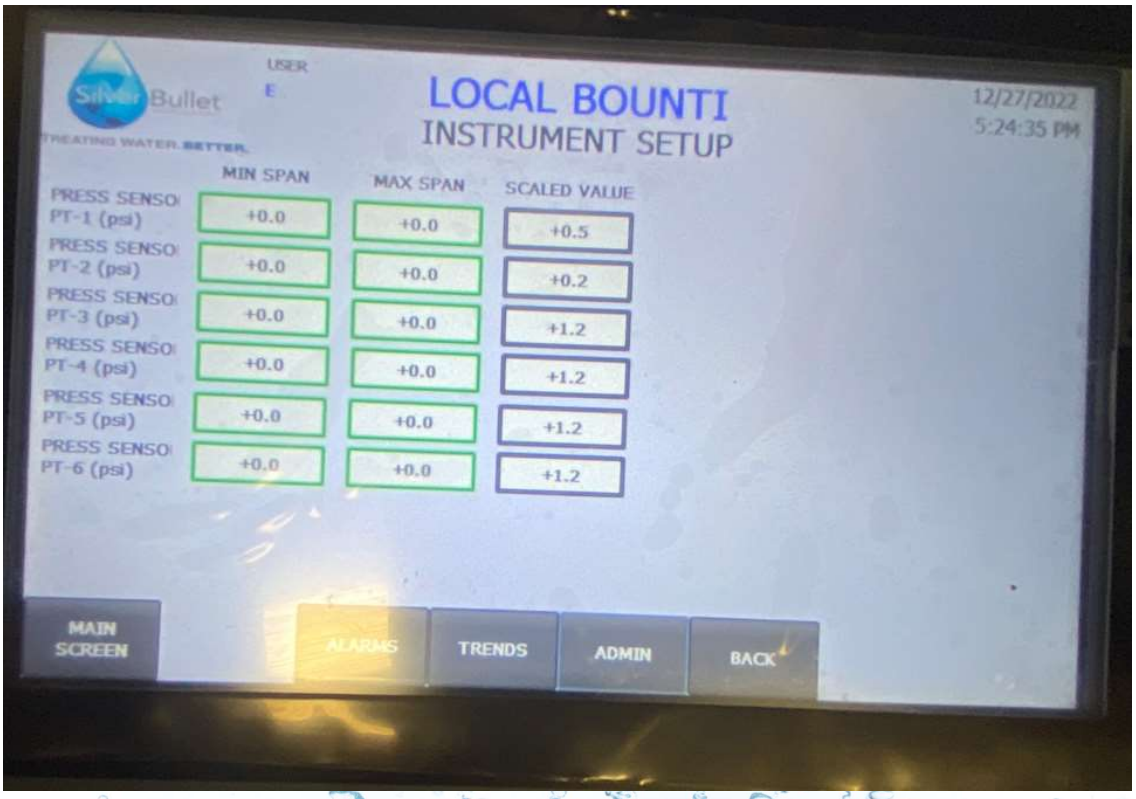
4.2 INSTRUMENT MENU

The instrument menu screen provides additional sensor and component information including minimum and maximum span setpoints, scaled values, and offsets.



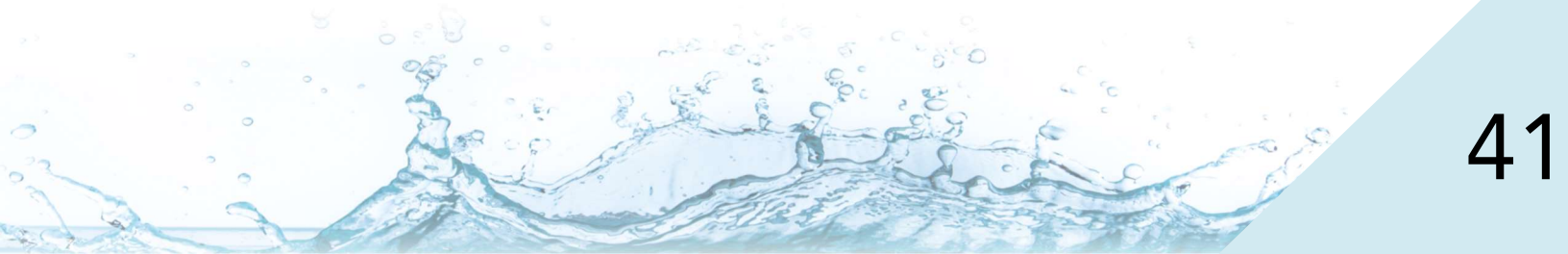
4.2.1 INSTRUMENT MENU 1

The instrument menu 1 screen is a continuation of the instrument menu screen in 4.2 above.

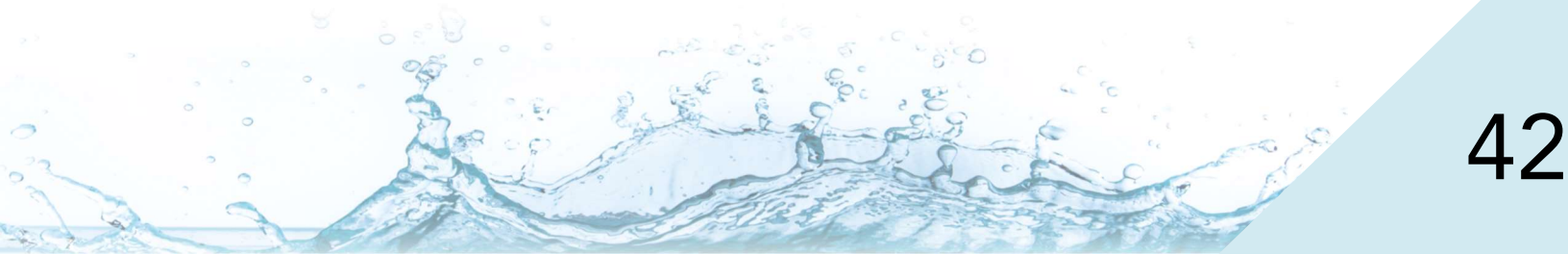


Section 14 – FAQs

1. **Should disinfection methods change throughout the plant grow cycle?**
    a. Disinfection should be an on-going part of your system maintenance. Whether hand applying a disinfectant or using a sophisticated automated dosing system, your dose needs will vary based on water (nutrient) chemistry, type of irrigation system, environmental conditions, type and the type and age of plants. Generally, a lower dose of disinfection chemistry, ozone or otherwise, is used while plants are young and more susceptible to stress, and the oxidant demand is low due to things like shedding root cells and fibers. As the plants mature, the treatment dose will proportionally increase to match the increase in oxidant demand and tolerance of the maturing plants.
2. **How often should we be sanitizing our system(s)?**
    a. Sanitization should be an ongoing daily process and considered an essential part of daily duties and housekeeping. Failure to maintain consistent sanitization can lead to plant stress, microbial build-up, disease and even system failure due to biofilm plugging.
3. **How do we get into "hard to reach" sections of our system(s) when sterilizing?**
    a. Manual cleaning of visible debris and biofilm is desirable. However, in the case where piping infrastructure or equipment layout prohibits manual cleaning, a high strength shock dose of suitable chemical for an extended contact time (typically 8-24 hours) followed by thorough flushing with clean water is usually sufficient to clean hard to reach areas. The type of shock chemistry used is specific to a system's conditions and goals.
4. **Are solids bad to have in my hydroponic system?**
    a. Solids are a normal part of hydroponic farming as root cells and fibers are shed, growth substrates beak down, and other biological inputs mature. However, solids can plug filters, form deposits, promote unwanted microbial growth and reduce DO levels. Organic solids also increase the relative oxidant demand in a water system, limiting the effective availability of disinfecting agents. Removing solids via filtration provides cleaner, easier to treat water for plant irrigation.
5. **Why is low dissolved oxygen (DO) bad?**
    a. Studies have shown that anoxic (low oxygen) environments are detrimental to plant growth and root development. Additionally, low DO levels can promote the growth of anaerobic microbes, several of which have pathogenic or corrosive properties that should be avoided.
6. **How can I monitor my sanitization/sterilization process for effectiveness?**
    a. Routine monitoring of water chemistry and microbial levels (heterotrophic plate count, total coliforms, and/or yeast and mold plate count, for example) is recommended to track the performance and efficacy of a sanitization and sterilization process. The resulting data can be trended to show consistency in the process as well as highlight areas of potential improvement.
7. **How does water quality (pH, temperature, organic load, etc.) effect disinfection/sanitization?**
    a. Sanitization chemicals (e.g., hydrogen peroxide) vary in efficacy based on several variables such as pH, temperature, and oxidant demand. For example, oxidizers like ozone, hydrogen peroxide, and chlorine typically work faster in low pH and warm temperatures. Likewise, the relative amount of oxidant demand impacts the appropriate dose needed to adequately clean a system. High oxidant demand (from dissolved organics, microbes, solids, etc.) means more chemical is required to achieve a desired level of oxidizing (i.e., disinfecting) capacity.



8. **Are there alternatives to chlorine for disinfection?**
    a. There are many chemicals available for water disinfection. Many are strong oxidants, including ozone, hydrogen peroxide, peracetic acid, and chlorine (often as sodium hypochlorite). Other chemistries include organic (carbon-containing) biocides, enzymes, and surfactants. Ozone has advantages of being one of the most powerful oxidants that can be generated on-site while avoiding the environmental concerns like chlorine. Ultimately, the chosen chemistry will depend on specific requirements of a grow facility.
9. **Where can I go to get more information?**
    a. Visit https://silverbulletcorp.com/resources/ to access online technical resources or contact us directly to speak with an SBWT technical specialist(s) for more information about your grow.
10. **My roots are turning brown, what does this mean?**
    a. Root coloration can be indicative of many things from simple staining from nutrient formulas to serious disease from pathogens. If the roots appear well-separated with clearly visible lateral root fibers, it is likely the coloration may be a simple staining. If the roots appear slimy, are clumped together with minimal lateral root fibers, and/or have a foul odor, the coloration may be due to a disease. Confirmation testing is recommended to diagnose and identify the underlying issue.
11. **I want to set up routine monitoring of my water quality and plant health. How can I do this?**
    a. Silver Bullet offers a range of consultative water quality and genomic testing that compliment your water treatment program. Contact Silver Bullet for more details.
12. **How often should I be changing my irrigation water?**
    a. Water changes outs are an important consideration in a facility's water management program. Factors including economics, plant performance, sustainability and waste management all play a part. Ultimately, the rate at which irrigation water should be changed depends on its quality as it changes over time. Monitoring the water quality for both mineral and biological constituents will indicate if it is still suitable for use or if it should be changed.
13. **How does ORP impact my plant production?**
    a. ORP (oxidation-reduction potential) is an umbrella metric that describes the oxidizing capacity of a water system. High ORP values indicate environments with an affinity to strip electrons from (i.e., oxidize) contaminants, thus providing the capacity to disinfect pathogens. Though correlated to oxidant dosing, many factors impact an ORP value, and it is recommended that ORP be considered alongside other water quality factors when considering plant irrigation. Typical ORP values for plant production range from 300 mV to 600 mV, though the optimal level for your system should be experimentally determined if possible. Wide fluctuations in ORP values over time may indicate issues with the water system and/or operational processes.



Section 15 – Technical Service & Support

INITIATING A SERVICE TICKET

When a service ticket with Silver Bullet Technical Support is initiated, all pertinent information should be in hand to expedite case resolution. The technical support checklist below may be referred to by the customer:

- Product number and serial number to quickly recognize your product.
- Alarms or messages displayed around the time the issue occurred.
- Has this happened before? Can it be re-created?
- How long has this been going on?
- When did this happen?
- Were there any possible changes before or around the time this occurred?

Once the customer's service ticket has been logged, it will be assigned a service ticket number and an appropriate technical support engineer.

RESOLVING A SERVICE TICKET

When reaching out to Silver Bullet Water Treatment Support, a Silver Bullet technical support member will verify the customer support contract coverage, case details, and priority. Resolving a service ticket during the initial call/email may not be always possible. Additional information and tests may be required to better handle and address the issue. A technical support engineer may require additional expertise to resolve the customer's case and may transfer the case to an engineer that specializes in the specific product.

CLOSING A SERVICE TICKET

A service ticket is closed when at least one of the following conditions is met:

- The resolution provided by Silver Bullet has resolved the issue
- The customer informs Silver Bullet Water Treatment that the issue is no longer relevant
- The customer and Silver Bullet Technical Support agree that the issue cannot be resolved for reasons outside of Silver Bullet's control
- Repeated unanswered attempts for status query by Silver Bullet Technical Support

CONTACTING TECHNICAL SUPPORT

You may contact Silver Bullet Water Treatment's support in the following ways:

- **Email:** support@silverbulletcorp.com
- **Phone: Silver Bullet Toll Free Technical Support: 1-855-250-4228**

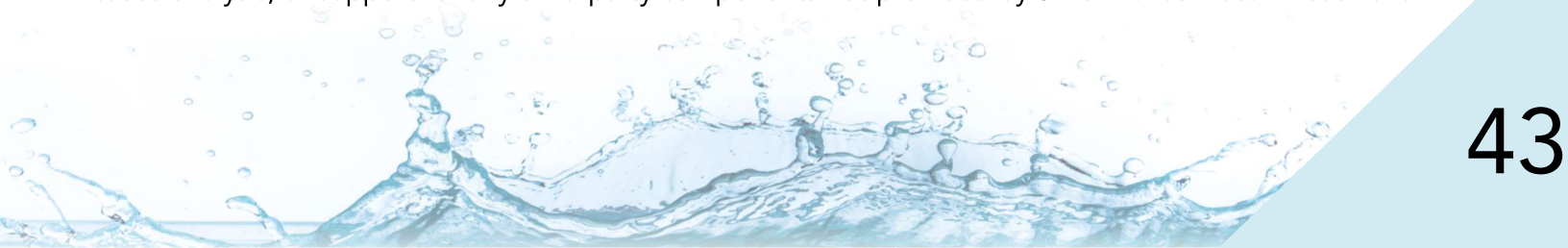
Silver Bullet Technical Support Hours of Operation: 9:00 am to 5:00 pm Mountain Time, Monday-Friday

If you have non-technical questions, please use the following contact points:

- Accounting Department: accounting@silverbulletcorp.com
- All other Silver Bullet questions: info@silverbulletcorp.com

SERVICE EXCLUSIONS

Any technical support not expressly included in your Service Agreement is deemed excluded. Unless otherwise agreed in writing by the parties, your Service Agreement is your Support Certificate, including any documents that it specifically incorporates by reference. Without limiting the foregoing, the following services are specifically excluded from technical support but may be available for purchase under a separate order for additional services: Software installation, upgrade services, training, configuration, and implementation, troubleshooting of environmental issues, creation of custom scripts, queries, or reports, root cause analysis, or support for any third-party components not provided by Silver Bullet Water Treatment.



Section 16 – Troubleshooting Tree

Problem	Possible Cause(s)	Possible Solution(s)
Control panel red light is off / unit is not powering on	-Unit is powered off -Loose or disconnected wire(s) -No power to unit -Faulty On/Off button -Emergency Stop depressed	-Toggle On/Off button -Check wires to make sure none are loose (ensure the unit is electrically isolated before trying to remove wires) -Ensure breaker has not tripped / fuses have not blown -Replace On/Off button -Ensure Emergency Stop button is not depressed
Low setting alarm	-Alarm set too high -Sudden change in water quality/level/type -Introduction of new chemical (e.g., reducing agent) -Insufficient oxidizer -Component setpoint failure	-Adjust "Low Alarm" setting to a lower value -When possible, ensure water quality is unchanged; adjust setpoints and alarms if needed -Repair/replace component OR adjust setpoint, where applicable
High setting alarm	-Alarm set too low -Sudden change in water quality/level/type -Introduction of new chemical -Component setpoint failure	-Adjust "High Alarm" setting to a higher value -When possible, ensure water quality is unchanged; adjust setpoints and alarms if needed -Repair/replace component OR adjust setpoint, where applicable
Instrument failure alarm	-Component fouled -Variable water quality -Target values out of achievable range -Instrument not connected or wired properly	-Clean and calibrate probe; replace if needed -Allow more time for readings; adjust HMI setpoints as needed -Adjust target to a range within the capabilities of the system
Incorrect instrument reading	-Probe not calibrated -Incorrect wiring -Fouled electrode / component -Incorrect HMI settings (e.g., span) -Instrument failure	-Calibrate instrument (if applicable) -Review vendor-supplied operators manual for correct wiring -Isolate instrument and remove to inspect and clean -Review HMI settings -Replace defective instrument when applicable
Reduced / decreasing gas flow	-Obstruction in gas tubing -Venturi fouled -Plugged oxygen concentrator intake filter -Ozone output motorized ball valve shut -Ozone outlet valve closed	-Check to make sure there are no kinks, holes, or shar bends in gas tubing -Disconnect tubing at various locations to locate the source of obstruction -Disconnect tubing from Venturi to ensure it is drawing a vacuum

		-Inspect oxygen concentrator cabin and compressor air filters; replace if necessary -Ensure ozone generator motorized ball valve opens during started; replace if failure occurs -Ensure ozone valve is open enough to allow gas flow while maintaining 5-10 psi internal pressure in ozone generator
Excessive temperature of ozone generator	-Vent fan failure or obstructed -Increased backpressure / reduced flow -Environmental temperatures high	-Clean fan intake screen clear obstructions, or replace fan if not flowing air -Troubleshoot gas pressure or flow -Move equipment to less harsh environment when applicable
Excessive noise or vibration	-Loose/defective panel door locks -Loose hardware inside equipment	-Inspect door latches, tighten as needed -Inspect rubber door seals; replace as needed -Inspect mounting hardware, tighten as needed
Not producing ozone gas	-Gas tubing leak -Gas tubing obstruction -Manual adjustment valve shut -Manual ozone output adjustment dialed down -Oxygen flow disrupted -Control panel not sending signal to ozone generator	-Inspect for gas leaks -Inspect gas tubing for obstructions (including any upstream valves shut) -Ensure manual ozone flow control valve has not shut -Ensure manual ozone output adjustment knob has not dialed down
Less than 20 psi drop across the Venturi	-Excessive backpressure post-Venturi -Debris clogging pump or piping	-Ensure valves downstream of the Venturi are fully open -Check that there are no obstructions in the pump or lines leading to the pump
No water going through skid pump	-Valve closed (inlet or outlet) -Venturi clogged with debris -Pump air locked -Power supply issue	-Ensure skid inlet and outlet valves are open -Ensure recirculating pump is primed -Ensure recirculating pump is rotating when energized
Low water pressure through skid	-Pump motor spinning backwards -Venturi clogged with debris	-Check motor rotation with arrows; if backward, confirm motor wiring
Leaks from skid plumbing	-Union or true union ball valve not tightened -Union or true union ball valve missing O-ring -Cracked fitting	-Check unions for O-rings and tighten as needed -Inspect fittings for cracks or defects; replace as needed
Slow ORP readings	-ORP electrode fouled -Variable water quality	-Clean and calibrate electrode; replace as needed

	-Target ORP values out of achievable range -Low or no water flow	-Allow more time for ORP readings and adjust HMI setpoints as needed -Adjust ORP target to a range within capabilities of the system -Ensure water conductivity is >100 µS/cm
Excessive solids passing through filters	-Improper initial flushing of media fines -Inadequate media bed depth -Improper media selection -Solids too fine and/or are dissolved	-Ensure fines are backflushed during startup -Ensure proper media bed depth is used -Reference media type to desired solids removal type
Filter head does not display time of day	-Power adapter unplugged -No electric power at outlet -Defective power adapter -Defective PC board	-Connect power -Repair outlet or use working outlet -Replace power adapter -Replace PC board
Filter head timer does not display correct time of day	-Power outage -Defective PC board	-Reset time of day (if battery is present the battery may be depleted) -Replace PC board
Filter head display does not indicate water is flowing	-Meter connection disconnected -Restricted/stalled meter turbine -Defective meter -Defective PC board -Meter not installed -PC board incorrectly programmed	-Connect meter to PC board -Remove meter and check for rotation or foreign material -Replace meter -Replace PC board -Install meter -Refer to programming instructions
Filter head control valve backwashes at the wrong time of day	-Power outages -Time of day not set correctly -Time of backwash incorrect -Control valve set at “on 0” (immediate backwash) -Control valve set at NORMAL + on 0 (delay + immediate backwash)	-Reset time of day (if battery is present the battery may be depleted) -Reset to correct time of day -Reset backwash time -Check control valve set-up procedure backwash time option
Filter head control valve stalls during backwash	-Motor not operating -No electric power at outlet -Defective power adapter -Defective PC board -Broken drive gear or drive cap assembly -Broken piston retainer -Broken main or regenerate piston	-Replace motor -Repair outlet or use working outlet -Replace power adapter -Replace PC board -Replace drive gear or cap assembly -Replace drive cap assembly -Replace main or regenerate piston
Filter head control valve does not backwash automatically when the correct button(s) is depressed and held	-Power adapter unplugged -No electric power at outlet -Broken drive gear or drive cap assembly -Defective PC board	-Connect power adapter -Repair outlet or use working outlet -Replace drive gear or drive cap assembly

		-Relace PC board
Filter head control valve does not backwash automatically, but does when the correct button(s) is depressed and held	-Meter connection disconnected -Restricted/stalled meter turbine -Defective meter --Defective PC board -Set-up error	-Connect meter to PC board -Remove meter and check for rotation or foreign matter -Replace meter -Replace PC board -Check control valve set-up procedure
Filter head display time of day flashes on and off	-Power outage	-Reset time of day (if battery is present the battery may be depleted)
Filter Head Error Codes • 101, 1001, or E1 – Unable to recognize start of backwash • 102, 1002, or E2 – Unexpected stall • 103, 1003, or E3 – Motor ran too long, timed out trying to reach next cycle position • 104, 1004, or E4 – Motor ran too long, timed out trying to reach home position • If other error code display, contact Silver Bullet	-Control valve has just been serviced -Foreign matter is lodged in control valve -High drive forces on piston -Control valve piston not in home position -Motor not inserted fully to engage pinion, motor wires broken or disconnected, motor failure -Drive gear label dirty or damaged, missing or broken gear -Drive bracket incorrectly aligned to back plate -PC board is damaged or defective -PC board incorrectly aligned to drive bracket	-Unplug power source jack from printed circuit board (black wire) and plug back in or press button sequence to reset valve -Check piston and spacer stack assembly for foreign matter -Replace piston(s) and spacer stack assembly -Check motor and wiring; replace motor if necessary -Replace or clean drive gear -Reseat drive bracket properly -Replace PC board -Ensure PC board is correctly snapped on to the drive bracket
Filter Vessel Separate Source Backwash Valve Error Codes • General error code • 106 or 1006 – Separate Source Backwash Valve unable to find proper park position, motor ran too long • 107 or 1007 – Separate Source Backwash Valve motor ran too short (stalled) while looking for proper park position • If other error code display, contact Silver Bullet	-Foreign matter is lodged in the valve -High drive forces on the valve -Valve motor not inserted fully to engage pinion, motor wires broken or disconnected, motor failure -Valve drive gear damaged, missing or broken gear -Valve main gear cover assembly incorrectly aligned to drive assembly -PC board is damaged or defective	-Check valve piston and spacer stack assembly for foreign matter -Replace valve piston and spacer stack assembly -Check valve motor and wiring; check interconnect wiring to both PC boards; replace motor or wiring if necessary -Replace valve drive cap -Reseat valve main gear cover assembly properly -Replace PC board

Section 17 – Water Sampling and Testing

Materials Required:

1. Sterile, 120mL bottle with sodium thiosulfate preservative used for bacteria analysis (e.g. *E. Coli*, Total Coliforms, Total Aerobic Bacteria, Yeast and Mold, etc.)
2. 500 mL non-sterile battle used for Mineral Analysis
3. Sterile Gloves
4. Isopropyl Alcohol or Bleach

Sampling Procedure:

1. Review Appendix B for an in-depth synopsis of Aseptic Sampling Techniques, Best Practices.
2. Collect water samples from the Venturi bypass assembly sample valve. The sample valve/port should be disinfected with Isopropyl Alcohol or Bleach prior to sampling.
3. Fully open sample valve and purge approximately 1 liter into a collection vessel. Discard purge volume.
    a. For systems without a sample valve, follow the guidance in Appendix B Step 9 to collect samples directly from the system's storage tank.
4. Fill the sample bottle(s) fully to limit head space. Ensure the cap is tightly secured.
5. Label the sample bottle with the exact sample location (i.e., Freshwater Tank Post Venturi, Post Carbon Tank), sample date, sample time, and Facility Name.
6. Ship water samples overnight on the same day of sampling to the following address:

    Silver Bullet Water Treatment Laboratory
    9500 W. 49th Ave. #A-100
    Wheat Ridge, CO 80033

Appendix A: System Logbook (Page 1 of 2)

Filtration + O_3 Logbook

Source Tank:

Date of Last Calibration:

ORP-1:_____ ORP-2:_____ O3 Det:_____#1:_____#2:_____#3:_____

Filter Vessel Backwash Times:

Date	O2 Gas Flow (LPM)	O2 Supply Pressure (psi)	O2 Hour Meter (hrs)	O2 Yellow Light	Alarm Stack Light	Ozone Destruct Unit	Ozone Leak Detect Light	Ambient Ozone Detector (ppm)	Air/Water Separators	Recrc. Pump Disch. Pressure PT-1 (psi)	Venturi Inlet Pressure PT-5 (psi)	Venturi Outlet Pressure PT-6 (psi)	Filtered Water Flowrate FT-1 (gpm)	DO-1 (mg/L)	ORP-1 (mV)	ORP-2 (mV)	Name
NORM	10	>10	N/A	Off	OFF	ON	Off	<0.10	Bubbling				50				N/A
BASELINE																	N/A
1																	
2																	
3																	
4																	
5																	
6																	
7																	
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31																	

Month:_____

Date of Last DO Sensor Replacement:_____

Appendix A: System Logbook (Page 2 of 2)

Filtration + O_3 Logbook

Source Tank:

Date of Last Calibration:

ORP-1:_____ ORP-2:_____ O3 Det:_____

Filter Vessel Backwash Times:

#1:_____ #2:_____ #3:_____

NOTES:

Date of Last DO Sensor Replacement:_____

Month:_____

Appendix B: A Synopsis of Aseptic Sampling Technique – Best Practices

A Synopsis of Aseptic Sampling Technique – Best Practices

The following includes a brief summary of aseptic water sampling techniques in relation to the Horticulture industry as prescribed by a number of governmental and regulatory bodies for primary use in municipal human drinking water systems which is considered to be a gold standard. These guidelines are viewed as best practices in conducting water sampling for use in microbial analysis and evaluation. It should be noted that deviation from these best practices comes with the risk of sample contamination and in turn, potentially misleading results.

The horticulture industry is varied in possible water systems and treatment applications. As a result, there are a variety of potential sample sources that may be used for a given application. Possible sample sources include drip emitters, nutrient reservoirs, in-line sample taps/valves, under current recirculation loops/modules, etc. The following methods outline sample collection techniques from sample taps or bulk water bodies such as open tanks or reservoirs. NOTE: aseptic sampling technique is focused on microbial sampling and evaluation but can be adapted for use in mineral sample collection as well.

1. Sample location(s) should remain constant for long term evaluations of treatment efficiency of a given facility. In choosing a sample location, consider the following if a sample tap/faucet is present:
    a. Faucets directly connected to cisterns, hot water heaters, or softeners should be avoided.
    b. Leaky faucets should be avoided.
    c. Any attachments on the sampling tap should be removed prior to sampling (i.e., hoses).
    d. Sample taps located close to the ground or other surface should be avoided to prevent back splashing.
    e. Threaded or swing taps should be avoided as solids and contaminates can be harbored in those surfaces.
    f. The sample tap must be able to flush for upwards of 5 to 6 minutes to clear out any static water in the distribution line. Often a change from warm to cool water is associated with an adequate flush.
    g. If tap cleanliness is questionable due to environmental conditions, it should be avoided.
    h. Avoid areas that are regularly dusty or have a high level of airborne particulates.
    i. In bulk water bodies/tanks, avoid areas of obvious contamination such as floating algae mats or clusters of organic mass (unless the contamination is systemic in the body of water and therefore is representative of the bulk water quality).
    j. When possible, a sample tap should be added to tanks/reservoirs (bulkhead) for consistent sampling. Taps placed near the mid to bottom 1/3 of the tank height are typically advisable.
2. Prior to sampling, proper PPE (Personal Protective Equipment) should be used including safety glasses and sterile gloves.
    a. Take care to not contaminate gloves with solids or particulates. It may be necessary to change gloves after opening a sample tap prior to sampling.
3. Fully open the sample tap and allow to run for 5 to 6 minutes to flush the distribution line.
4. The sample tap should be disinfected using either a torch and/or 70% alcohol followed by flame (if tap is metal) or a solution of sodium hypochlorite (bleach, 5-8%) covering both the inside and outside of the sample tap and soaking for 2 to 3 minutes. (When sampling from a bulk water body or if sampling for non-microbial analysis, mineral or otherwise, skip this sterilization step).
    a. *Use caution with an open flame for risk of burns and fire danger. In certain environments where fire danger is high, bleach disinfection is preferred.

Appendix B: A Synopsis of Aseptic Sampling Technique – Best Practices (cont.)

5. Following disinfection, the sample tap should be flushed for an additional 2 to 3 minutes to remove any potential disinfection residual. Reduce the water flow for sampling to avoid splashing.
6. Ensure sterile gloves are clean. This may require using new gloves or washing gloved hands with a bleach solution.
7. Using a sealed, sterile container, fill the container with water. Ensure the following conditions are met:
    a. The sample bottle should remain sealed until used.
    b. Avoid touching the inside of the container or lid. Handle the container/lid on the sides only.
    c. If the sample container was opened or otherwise compromised in any way, discard it and use a new container.
    d. Do not set the lid or the open container down once opened and do not allow them to contact any other surfaces. The sample bottle should only be open for the few seconds it takes to fill the container.
    e. Hold the lid facing downwards to avoid airborne particulates from settling into it from above.
    f. Fill the sample container near the top to limit headspace but avoid overflowing or allowing splash-back in sample container.
8. Seal the sample bottle before closing the sample tap.
9. When sampling from a bulk water body, submerge the sample container keeping the sealed lid on. Open the lid underwater to pull water in from roughly 6-8" below the surface. Reseal the lid under water to avoid potential contamination from the air or surface of the water.
10. Ensure relevant identifying labels are filled out for sample tracking. The collected sample then should be immediately returned to a Silver Bullet representative where specific chain of custody, sample storage and hold time procedures are followed.

References

AAFCO. (2016). *Inspection and Aseptic Sampling .*

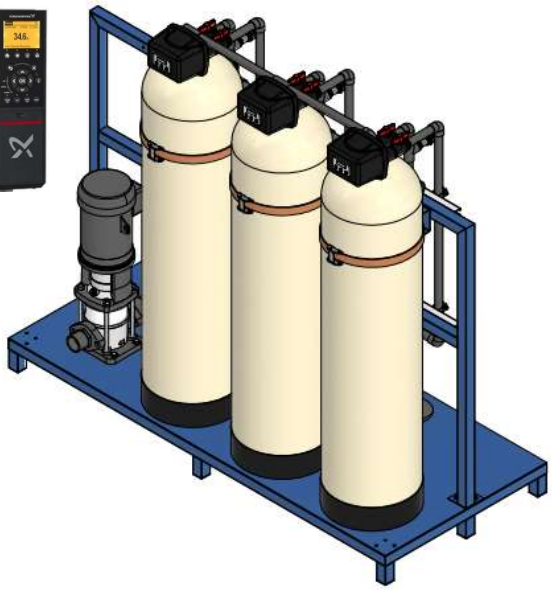
Aseptic Technique Procedure of Water Sample Collection. (2015). Retrieved from gensanwater.gov

GWA Department of Public Health. (2010). *Standard Microbiological Water Sampleing Technique.* Environmental Health Directorate.

World Health Organization (n.d.). *Water Sampling and Analysis.* Retrieved from WHO international: www.who.int/water_sanitation_health/dwq/2edvol3d.pdf

United States EPA. (2016). Sampling for Biological Contaminates. In E. R. Laboratory, *Quick Guide to Drinking Water Sample Collection* (pp. 6-8). Golden: US EPA.

Appendix C: Equipment Specifications



FILTER SKID

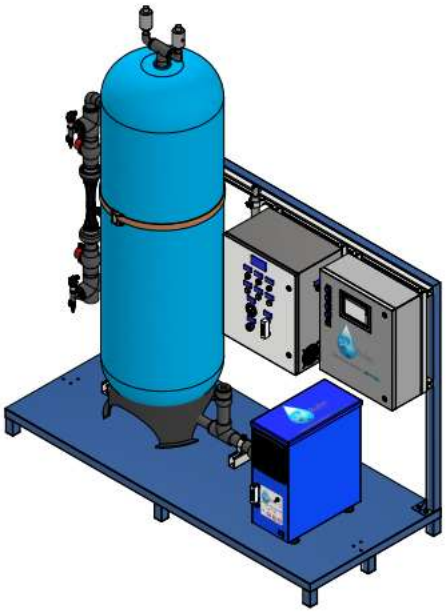
Power Specifications:

- Pump & VFD: 3-Phase, 200-240V, 60Hz, 5HP
- Filter Head Control Valve (x3): 1-Phase, 120V

Weight: 1650 lbs. empty & ~2800 lbs full
Dimensions: 84” x 36” x 80”

Off Skid Components:

- Recirculating Pump VFD
- Filtered Water Flow Transmitter (FT-1)
- Backwash Waster Flow Transmitter (FT-2)
- Freshwater Tank Level Transmitter (LT-1)



OZONE SKID

Power Specifications:

- Control System: 1-Phase, 120V, 30A
- Ozone Generator: 1-Phase, 120V, 10A
- Ozone Destruct: 1-Phase, 120V
- Ambient Ozone Detector: 1-Phase, 120V

Weight: 650 lbs. empty & ~1400 lbs. full
Dimensions: 84” x 36” x 100”

Off Skid Components:

- Ambient Ozone Detector (OD-1)

WASTE TANK

Waste Tank Pump and Motor Starter (WP-1)

Power Specifications:

- Pump & Motor Starter: 3-Phase, 208-230V, 0.5 HP
- Waste Tank Independent High-Level Alarm: 1-Phase, 120V

Weight: 50 lbs.
Dimensions: 11” x 7” x 5” (Motor Starter) / 18” x 12” (Pump)

Misc. Components:

- Waste Tank Level Transmitter (LT-2)
- Waste Tank Independent High-Level Alarm

Appendix D: Spare Parts List & OEM References

SPARE PARTS LIST

- Recirculating Pump – Grundfos CRI 15-2
  - PU-WP-4498
- Recirculating Pump VFD – Grundfos CUE
  - PU-FD-04842
- Waste Pump – Grundfos CRI 3-3
  - PU-WP-04184
- Waste Pump Motor Starter
  - EC-SW-03616
- Level Transmitters – Keller Econolevel
  - IN-TH-02531
- Flow Transmitters – GF Signet Magmeter
  - IN-FM-1675
- Pressure Transmitters – Dwyer
  - IN-PG-03187
- ORP Electrode – GF Signet
  - IN-WQ-1186
- ORP Calibration Solution – Zobells
  - AB-RG-01121
- DO Probe – In-Situ 0-50ppm
  - IN-WQ-04688
- Air/Water Separator – Armstrong
  - PB-VA-1687
- Oxygen Concentrator Sieve Bed Module
  - MH-TH-04721
- Oxygen Concentrator Cabinet Filter Element
  - MH-TH-04392
- Oxygen Concentrator Compressor Filter Element
  - MH-TH-04723

OEM MANUAL REFERENCES

- Clack WS1EE Control Valve Service & Operating Manual
- Clack Motorized Actuating Valve (M.A.V.) Installation Guide
- Oxygen Concentrator. 10 LPM
- Ozone Generator, 60 g/hr
- Ozone Destruct Unit
- Grundfos CRI 15-2 Installation & Operating Manual
- Grundfos CUE VFD Installation & Operating Manual
- Grundfos CRI 3-3 Installation & Operating Manual
- GF Signet 2551 Operating Manual
- GF Signet 2725 / 2751 Operating Manual
- In-Situ Pro RDO Dissolved Oxygen Operating Manual

Silver Bullet™
WATER TREATMENT

TREATING WATER. BETTER.™

Recirculating Filtration & Ozone System Operating Manual

REVISION 1 – JANUARY 2023

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