DOC# - 906206

Solar pHAT Box Installation, Operation, and Maintenance Manual

INITIAL APPROVAL		
Function/Title	**Signature**	**Date**

REVISION HISTORY			
Rev	**Description**	**Date**	**Change Originator**
A	Draft	1/12/2019	W Waldroup
B	Clean, format, add warning section, etc. Fixed fig 12 to show probe below discharge valve	1/15/2019	WLDM

TABLE OF CONTENTS

1. Safety Information

1.1 Safety Information

Read this entire manual before operating this equipment. Pay attention to all warning, danger, and caution statements. Failure to do so could result in serious injury to the operator or damage to the equipment.

1.2 Operational Safeguards

The following safety directives must be observed and followed at all times:

- Wear proper personal protection (PPE) gear at all times when servicing the pHAT Box.
- Exercise caution at all times while working inside the system.
- The pHAT Box contains flooded cell batteries. Battery acid is extremely corrosive and can cause serious burns when not handled properly. Exposure to sulfuric acid can cause severe eye and respiratory tract irritation and tissue damage.
- Flammable gas may be vented from the batteries during and shortly after charging. Sunlight shining on the solar panel or plugging in the auxiliary battery charger constitutes charging.
- CO_2 released in the basin by the normal operation of the pHAT Box will displace oxygen. Because CO_2 is heavier than air it will remain trapped in the basin. Anyone entering the basin without proper breathing apparatus is at risk of death from suffocation.
- Sparks may result from connecting or disconnecting solar panel leads, battery leads, or valve wiring. If sparks contact flammable gas, a fire or explosion may occur.

1.3 Safety Notations and Symbols

The following notations emphasize important safety information in this manual:

- **DANGER:** Indicates a potentially or imminently hazardous situation which, if not avoided, could result in death or serious injury.
- **WARNING:** Indicates a potentially hazardous situation that may result in minor or moderate injury.
- **Note:** Information that requires special emphasis or attention.

2. Terminology

Term	Definition
AAC	Amperage alternating current (AC)
ADC	Amperage direct current (DC)
CO_2	Carbon dioxide, a weak acid used for pH adjustment.
Dewar	A double-walled flask used to hold liquids at well below ambient temperature.
GAC	Granular activated carbon – commonly used to adsorb natural organic compounds, taste and odor compounds, and synthetic organic chemicals.
gpm	Gallons per minute – a measure of flow rate
HMI	Human machine interface, the system touch screen.
hp	Horsepower, a measurement of power.
µS	microsiemens, a measure of conductivity.
MF	Media filter – a type of filter that uses sand, crushed glass, anthracite, or other material to filter water.
pH	A scale of acidity from 0 to 14. It describes how acidic or alkaline a substance is. More acidic solutions have lower pH. More alkaline solutions have higher pH.
PLC	Programmable logic controller – a single-purpose computer.
psi	Pounds per square inch
PSV	Pressure sustaining valve – a valve that maintains a minimum set pressure upstream of the valve, adjusting for fluctuations in pressure.
NTU	Nephelometric turbidity units, a measure of water clarity.
VAC	Volts alternating current (AC)
VDC	Volts direct current (DC)
Volts	Used in context, usually means VDC.

3. Introduction

This manual contains instructions for the installation, operation, and maintenance of the Solar pHAT Box system. The intended audience of this document is the pHAT Box operator and trained technicians.

3.1. Purpose of the pHAT Box System

The **pHA**utomated **T**reatment (pHAT Box) system is a fully-contained pH adjustment system. The incoming storm water is treated with carbon dioxide (CO_2). The CO_2 dosage (pounds per hour) is based on the influent storm water pH, total alkalinity, and fixed hydraulic flow rate.

3.2. Theory of Operation

The pHAT Box system is based on the principle that introducing CO_2, a weak acid in a gaseous state, to water can adjust the pH from a *basic* state to a *neutral* one. Acid in a gaseous state is also less hazardous to handle and transport than liquid hydrochloric acid (HCl) solutions.

The pHAT Box system contains a Hach sc200 universal controller and two pH monitoring probes. The controller and pH probe monitor water quality, control the CO_2 injection, and also control a valve that allows treated water to be discharged. A pH probe measures the water in the basin. This system provides monitoring and control for two basins.

The sc200 monitors use the pH probes to measure the pH level of the water in the basin. If the pH level is 8.2 or greater the sc200 calls for CO_2 injection. CO_2 is supplied by a CO_2 dewar or CO_2 cylinder. The CO_2 pressure is lowered by a regulator connected to the dewar or tank. The flow of gas is controlled by the sc200 sending a signal to a solenoid valve. When the solenoid valve is open the CO_2 flows to a bubbler tube at the bottom of the basin. The CO_2 dissolves into the water and lowers the pH of the water.

When the pH of the water is between 6.0 and 8.9 the water may be discharged from the basin. The sc200 monitors the pH and when in range, the sc200 sends a signal to open the valve located near the bottom of the basin. This allows the water to gravity drain out of the basin.

The sc200 uses relays to control the CO_2 solenoid and the valves. The relays are controlled based on alarm settings in the sc200. The following chart identifies the rules and setpoints.

SC200 Relay logic			Func Type	High Alm	Low Alm	High DB	Low DB	Delays	Fail Sf
Relay A	Tank 1 Dose	On when pH >8.2	Alarm	8.2	0	0	0	0	No
Relay B	Tank 2 Dose	On when pH >8.2	Alarm	8.2	0	0	0	0	No
Relay C	T1 Compliant	On if 6 < pH < 8.9	Alarm	8.9	6.0	0.4	0.4	0	Yes
Relay D	T2 Compliant	On if 6 < pH < 8.9	Alarm	8.9	6.0	0.4	0.4	0	Yes

The quantity of CO_2 injected is a function of differential pressure. The regulated CO_2 pressure must be a minimum of 6 psi greater than the water pressure in the tank or the CO_2 will not inject.

The dosage of CO_2 required depends on the influent pH, total alkalinity, and the fixed hydraulic flow rate of 950 gpm. This process is described in Section 7.11 CO2 Regulator Pressure. The CO_2 dosage can be manually adjusted by turning the adjustment knob on the pressure regulator. The correct setting provides a constant flow of CO_2 while the system is processing water. Setting the CO_2 injection rate too high may result in undesirable pH spikes that cause the solenoid valve to cycle rapidly.

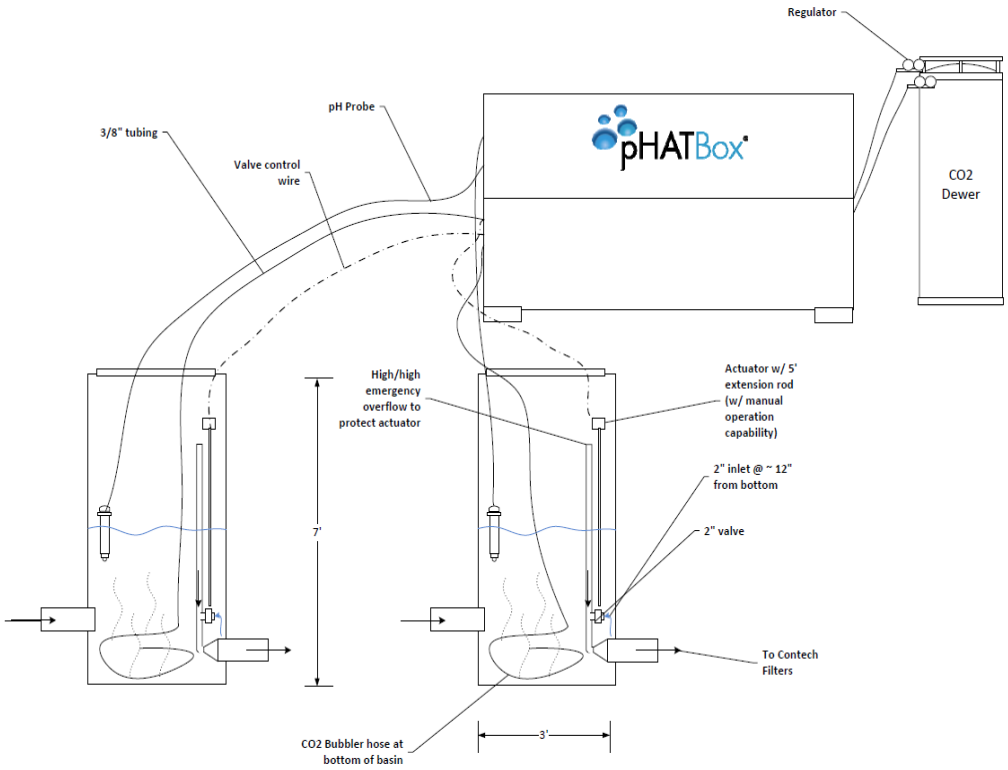

Figure 2: Conceptual pHAT Box Flow Diagram

4. Internal Components of the pHAT Box System

This section lists and explains the parts inside the pHAT Box system provided by Water Tectonics.

4.1. Hach sc200

The Hach sc200 controller is located inside the pHAT Box. The sc200 controller contains a display module and supports up to two digital sensors. It monitors the pH level in real time and manages the activation/deactivation of CO_2 into the process and controls the discharge valves. The controller also has data logging capabilities. The sc200 is equipped with four form-C relays, two 4-20 mA outputs, and two digital probe inputs. The sc200 is also capable of accepting a variety of additional I/O modules, communications modules, and sensor modules.

Figure 3: Hach sc2000 Controller

4.2. Status LED Indicators

There are three status indicators and a display push button located on the outside of the pHAT Box on the left side (see Figure 4). Note that in order to conserve power the indicators are not illuminated unless the **DISPLAY** button is pressed.

- The **POWER** indicator will light if the batteries are charged above 23.5 volts.
- The **T1 NC** indicator will light if the water being measured by pH probe 1 is not compliant (a state where the water doesn't meet the discharge requirements).
- The **T2 NC** indicator provides the same information for pH probe 2. Normally, pH probe 1 must be installed in basin 1.

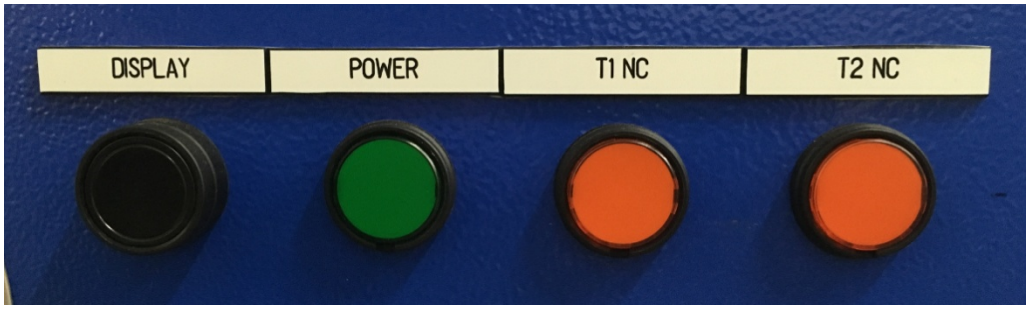

Figure 4: Status LED panel

4.3. Junction Box

A junction box is located on the inside of the pHAT Box on the left wall (see Figure 5). It contains the circuit breakers for the solar panels (CB-PV-GFP), solar charger input (CB-PV), and solar charger load (CB-LOAD). The junction box also contains the terminal blocks for landing the discharge valve's control cables.

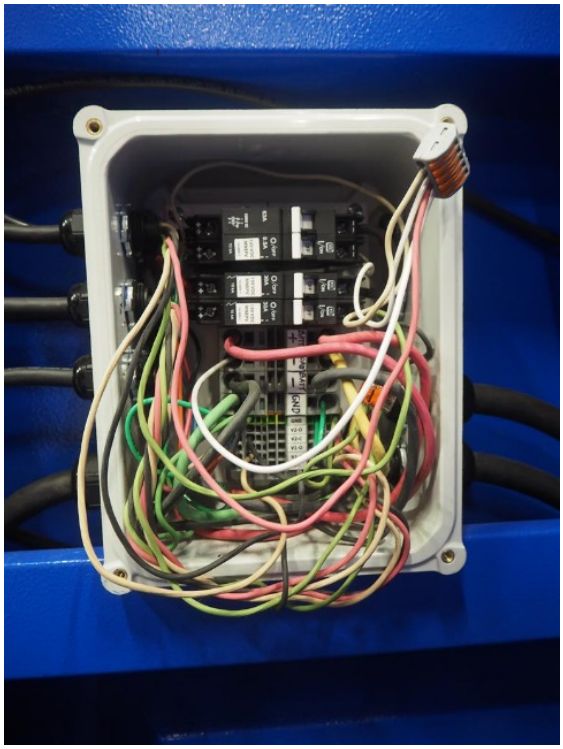

Figure 5: Junction Box

4.4. CO_2 Solenoids

Located on the inside of the pHAT Box on the right wall are the CO_2 solenoids. When energized by the sc200 the solenoids open and allow the CO_2 to flow to the bubbler hose in the basin.

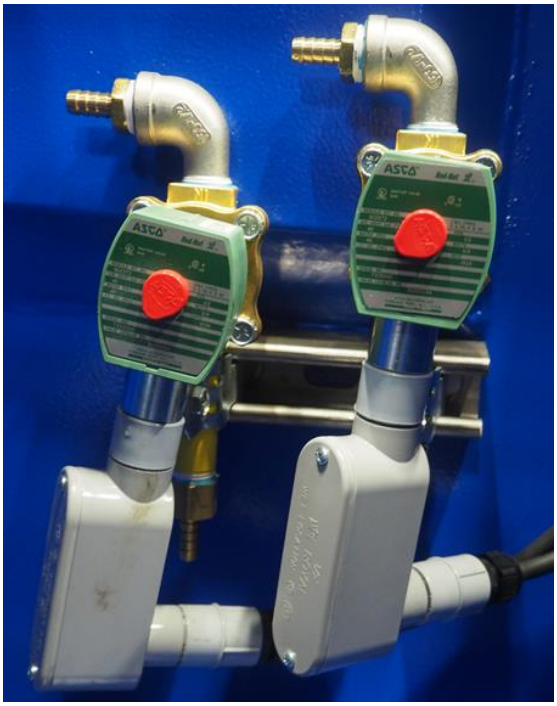

Figure 6: CO_2 solenoids

4.5. Solar Charger Module

Inside the pHAT Box on the back wall is the solar charger module (see Figure 7). This is a programmable controller that regulates the power from the solar panels and uses that voltage to charge the pHAT Box batteries. It also provides a low-voltage cutout function to disconnect the batteries from the load when the batteries are very low on charge. This function will protect the batteries from being damaged by preventing deep discharge. The low-voltage cutout will activate when the battery voltage drops below 23.0 VDC. It will reconnect the load when the battery voltage rises above 23.5 VDC.

Figure 7: Solar charger module

4.6. Auxiliary Charger

Located inside the pHAT Box on the back wall is the auxiliary charger (see Figure 8). This is used to provide a way to charge the batteries when no solar panel is connected, or if sunlight has not been available for a long period of time. It also provides a way to keep the batteries charged while the pHAT Box isn't being used or is in storage for more than two months.

In order to use the charger, plug the power cord into a 120 VAC, 60 Hz receptacle that can supply a minimum of 4 amps.

Figure 8: Auxiliary charger module

4.7. Batteries

There are two battery boxes located on the floor of pHAT Box. Each box contains two 6 volt, 110 ampere hour, flooded cell lead acid batteries. The batteries are connected in series to provide 24 VDC to operate the pHAT Box.

The batteries require maintenance and must be properly maintained to realize the longest possible operating life. The number one killer of lead acid batteries is deep-discharge. Discharging the battery below its minimum voltage will result in permanent, irreversible damage. This damage will result in lower capacity, meaning the battery will not be able to hold as many ampere hours of charge.

The more discharged the battery becomes, the more capacity is lost. If the battery is totally depleted or left in a discharged state for a long period of time, the battery will sulfate and will no longer function. If the solar panel is shaded, not connected, or there is a lack of sunlight for more than 3 days, the batteries must be charged using the auxiliary charger in order to prevent battery damage.

WARNING: If the pHAT Box is in storage with the load disconnected the batteries will still discharge. They must be charged every two months at a minimum.

The number two killer of the batteries is allowing the electrolyte level to drop below the fill ring in the battery cells. Check the electrolyte level in the batteries at a minimum every three months and every time before charging them with the auxiliary charger. Add

distilled water to bring the electrolyte level back up to the fill ring. **Do not use tap or bottled water.** Minerals and chorine in the water will damage the battery.

WARNING: Batteries will outgas when charging. The discharged gas is flammable. Keep ignition sources away from the pHAT Box.

5. External Components of the pHAT Box System

This section lists and explains the parts outside the pHAT Box system provided by other vendors.

5.1. Solar Panels

Two 300 watt solar panels provide the power to run the pHAT Box and to charge the batteries inside the pHAT Box (see Figure 9). The pHAT Box runs directly from the batteries. This allows the pHAT Box to operate during hours of darkness. Solar panels require direct sunlight and need to be aimed at the sun to provide maximum output power.

Anything that blocks sunlight to any portion of the panels will reduce the output to near zero. Dust and dirt buildup on the surface of the solar panels will also significantly reduce power output. Without full solar output the batteries will eventually be depleted (and possibly damaged) and the pHAT Box will no longer operate.

Figure 9: Solar panel array

5.2. pH Probes

One Hach DPD1P1 pH probe is located inside each basin (see Figure 10). Each pH probe measures the pH of the water and is monitored by the sc200 over a proprietary digital bus.

There is a salt bridge located in the sensing end of the pH probe. **The salt bridge must be kept wet at all times.** It the bridge dries out it will be damaged. The probes are shipped with protective caps. The protective cap contains a sponge that must be kept wet. The cap must be removed before the probe is installed in the basin. If the probe is removed or the basin drains so that the salt bridge becomes exposed to the air, the protective cap must be wetted and placed over the end of the probe.

The probe must be kept above freezing. If the probe freezes the salt bridge will be destroyed.

Figure 10: pH probe

5.3. CO_2 Storage Tank and Regulator

The carbon dioxide storage tank must be provided by a local gas supplier (see Figure 11). Dewar or cylinder tanks can be used, but a regulator must be used to lower the CO_2 gas pressure below 50 psi. Excessive pressure can damage the solenoid.

Small CO_2 cylinders can be placed inside the pHAT Box as long as they are secured to prevent falling over. Obey all local safety codes when using pressurized gas cylinders.

Figure 11 CO_2 Regulator

5.4. Basin Configuration

The pHAT Box will be used with two basins (see Figure 12). The water to be treated will flow into the basin. CO_2 will be added as required to raise the pH to a safe, dischargeable level. A discharge valve is used to prevent or allow the water to gravity flow out of the basin.

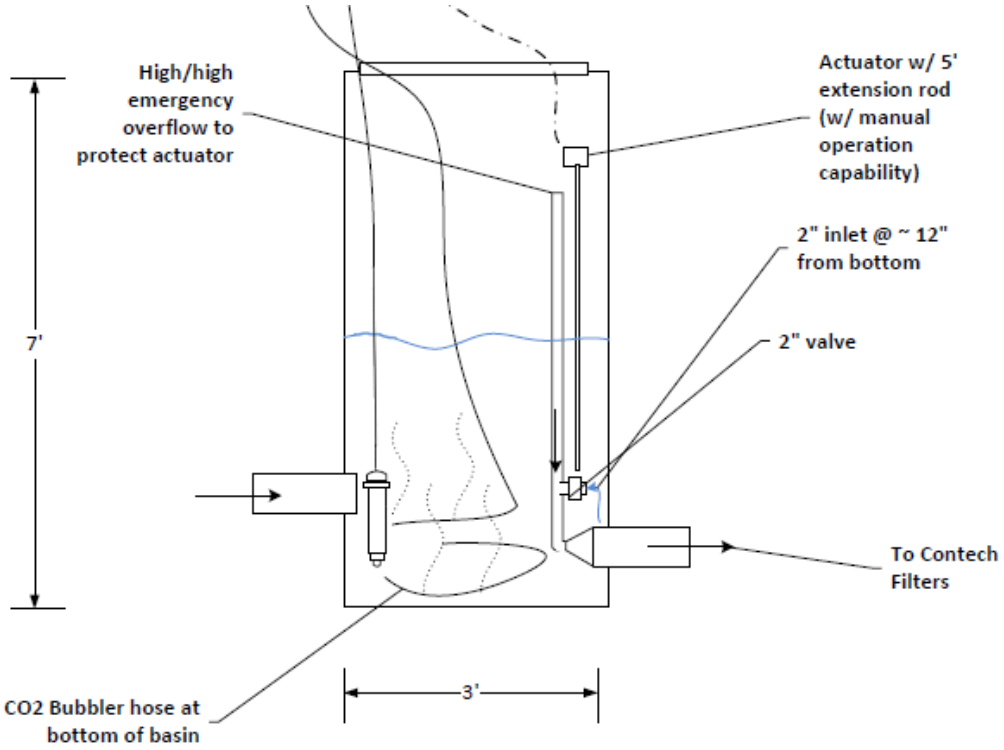

Figure 12: Basin showing pH probe, bubbler tube and discharge valve

5.5. Discharge Valve

An electrically operated discharge valve is installed in the basin to control the flow of water out of the basin. The valve position is controlled by the sc200 based on the pH reading of the water. The valve opens when the pH value is in the dischargeable range based on the sc200 rules. See Figure 12 for more detail. The valve actuator must not be

submerged. Therefore, an overflow pipe must be provided and it must be positioned at a level lower than the valve actuator. See Figure 12 for more detail.

5.6. Power Requirements

Since the pHAT Box is solar powered, no external power connection other than the solar panels are required for normal operation. However, an auxiliary battery charger has been provided. The auxiliary battery charger requires a 120 VAC, 15 amp circuit.

6. Installation and Setup

6.1. Disable Power

The pHAT Box is shipped from the factory with the circuit breakers turned off (see Figure 13). Remove the cover from the junction box (see Figure 5) and confirm that the three circuit breakers are in the **OFF** position before connecting the solar panels or wiring the discharge valves.

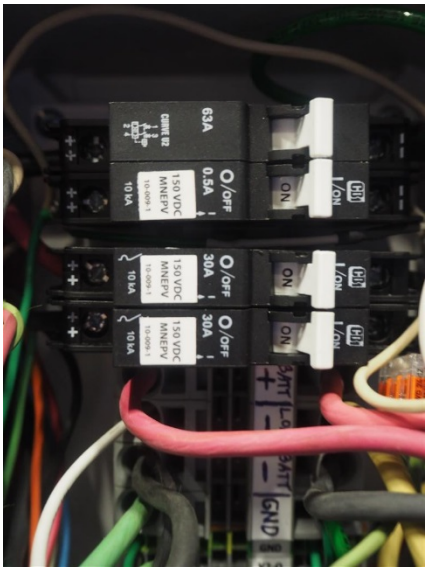

Figure 13: Circuit Breakers (shown in ON position)

6.2. Locating the System

The entire system occupies a footprint of roughly 18 feet by 6 feet, depending on availability of full sunlight at the location. Place the pHAT Box on flat level ground. Anchor the pHAT Box securely in accordance with local building codes.

Chose a location for the pHAT Box that is secure from public access. The pHAT Box uses a CO_2 dewar tank or cylinders that could pose a danger to someone tampering with them. When heated the tanks may vent very cold gas that could cause frost bite. Disconnecting fittings under pressure could result in impact injury or death. CO2 is heavier than air and displaces oxygen. Venting CO2 in confined areas such as a building or low lying depressions can cause suffocation.

.

6.3. Solar Panel Placement

Placing the solar panels so they have maximum exposure to the Sun is critical. Without full solar output the batteries' charge will eventually be depleted and the pHAT Box will no longer operate.

Solar panels require direct sunlight and must be aimed at the sun to provide maximum output power. The solar panels must be aimed due South and oriented to face the sun at its high point (the period of maximum illumination) during the day.

Ensure overhead branches, power lines, etc. don't cast a shadow on the panels. Clean the panels periodically to prevent dust and dirt buildup on the surface of the solar panels, which will significantly reduce power output.

The solar panels present a large surface area and can easily be blown over by the wind. Assemble the solar panels on the provided rack and anchor them securely in accordance with local building codes.

6.4. pHAT Box Placement

Place the pHAT Box in proximity of the solar panels and the water basins. The pHAT Box has four feet with anchoring holes to facilitate securing the box to the mounting surface. Anchor the pHAT Box as required by local building codes.

6.5. CO_2 Supply

External CO_2 tanks are required to adjust the pH of the water in the basins. Install the tanks on a flat level surface and secure them so they cannot be tipped over.

Locate the CO_2 regulators included with the pHAT Box (see Figure 11). Before connecting to the CO_2 tanks, close the discharge valve by rotating fully clockwise. Back the pressure regulation knob off by turning it counter-clockwise until the tension is released. Ensure the valve on the CO_2 tank is closed, then connect the regulators to the tanks.

Connect one end of the supplied hose to the regulator and connect the other end to the top of the solenoid. Do not shorten the hose as the length of the hose will give the CO_2 a chance to warm up before passing through the solenoid. Connect the second hose to the second regulator.

Open the valve on the CO_2 tank and slowly rotate the pressure adjustment knob clockwise until the gauge reads 5~10 psi. Then close the valve on the tank until the rest of the pHAT Box installation has been completed.

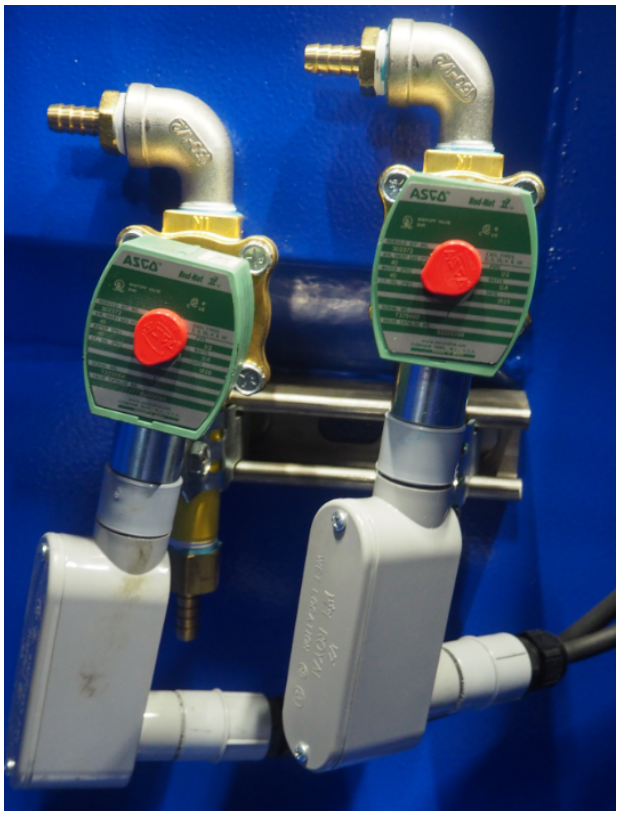

Figure 14: CO_2 Solenoids

6.6. Discharge Valve Installation

The discharge valve has a long shaft, allowing the butterfly valve to be mounted under water in the basin while keeping the actuator above the maximum water level. Secure the valve shaft housing to the tank, then bolt the flange to the drain pipe. Ensure that an overflow tube or outlet is installed to prevent the valve actuator from being immersed in the water. See Figure 12 for a pictorial diagram of the installation.

The valve actuator must be wired to the junction box. A cable has been prewired to the junction box. Remove the cover from the valve actuator. Insert the prewired cable through the cord grip on the valve actuator. Terminate the cable's red, white, black and green wires to the terminals as shown in Figure 16. Ensure the cord grips are tightened to prevent moisture from entering the actuator housing. Reinstall the valve actuator cover and tighten according to the manufacturer's instructions.

Note that there are two discharge valves. The valve located on the left side of the pHAT Box is for basin 1. The valve on the right side is for basin 2.

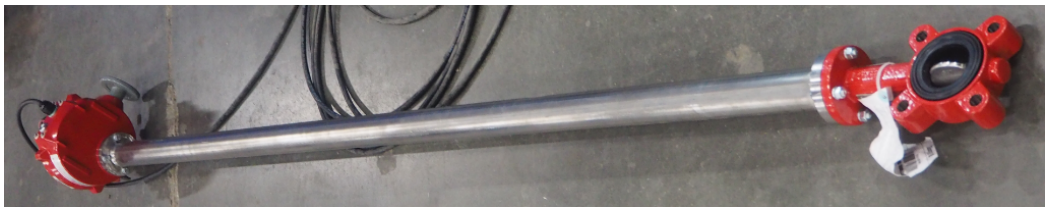

Figure 15: Discharge Valve

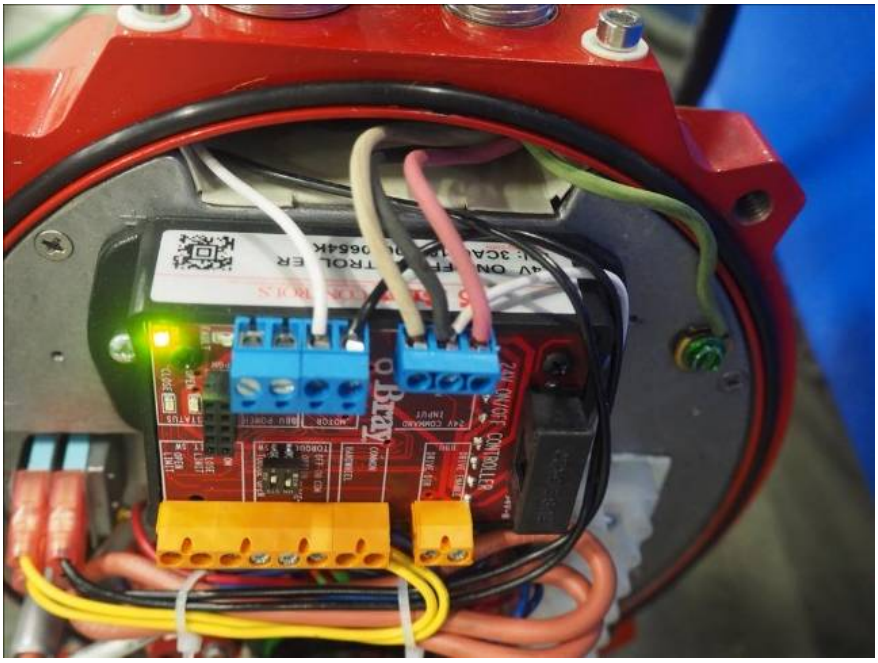

Figure 16: Discharge Valve Actuator Wiring

6.7 Install the CO_2 Bubbler Hose

Note that the pH probes will not read correctly if they are in the path of the CO_2 bubbles rising from the bubbler hose. Choose an installation location for the bubbler hose and the pH probes that avoids the bubbles being too close to the pH probe.

Connect the bubbler hose from basin 1 to the matching solenoid valve in the pHAT Box labeled Tank 1. Do the same for the bubbler hose in basin 2.

6.8 Install and Connect the pH Probes

Note that the pH probes will not read correctly if installed in the path of rising CO_2 bubbles from the bubbler hose. Choose an installation location for the pH probes that avoids the bubbler hose.

Before you unbox the pH probes, note that the boxes are marked **Tank 1** and **Tank 2**. Each of the pH probes has already been assigned to a basin in the sc200. If you mix the probes up, the system will not operate correctly.

Install the pH probe marked Tank 1 in basin one. **Ensure the probe is installed so that the tip (salt bridge) is below the bottom of the discharge valve.** Remove the protective cap and save it for later use.

WARNING: Ensure that the tip of the probe is submerged in water. If the salt bridge dries out, the probe will be damaged.

Feed the pH probe cable through the appropriate hole for the pH 1 or pH 2. Then connect the pH probe to the sc200. See Figure 17.

Install pH probe 2 in basin two and connect it to the sc200.

Figure 17 pH Probe Routing and Termination

6.9 Grounding

Both the solar panels/frame and the pHAT Box must be grounded according to the national electric code and any local electrical codes.

Using the supplied green 8 AWG wire, connect the pHAT Box chassis ground to the solar panel ground clamp. Additional green wire is supplied with the system to ground the system to a ground rod or other ground as required by local electrical codes.

6.10 Connect Solar Panels to the pHAT Box

Wire the two solar panels in series with the cables attached to the solar panels. Connect the negative lead (**–**) of one panel to the positive (**+**) lead of the other panel.

There are two black wires with connectors coming out of the left side of the pHAT Box. See Figure 18. These connect to the solar panels. Connect the black PV lead with the orange tape to the open positive (**+**) terminal on one of the solar panels. Connect the black PV lead of the pHAT Box to the open negative (**–)** terminal of the other solar panel.

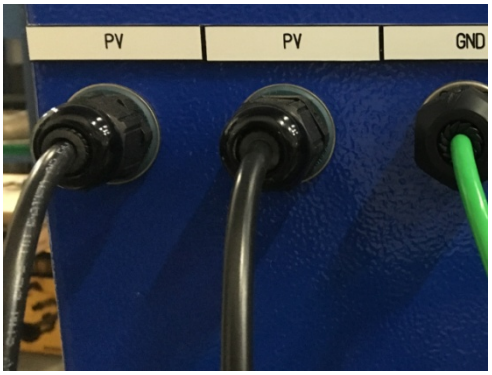

Figure 18 pHAT Box PV Leads

6.11 Power Up the pHAT Box

After all connections have been made, turn on the three circuit breakers in the junction box (see Figure 13). Verify the batteries are charging by checking the charge current and charge watts values on the LCD. (You may have to use the left and right arrow buttons to select the appropriate display.)

The watts being displayed will depend on the amount of sunlight and the state of charge of the batteries. A reading of up to 500 watts is possible. After confirming that the system

is charging, reinstall the cover on the junction box. Ensure the wires are fully inserted inside the box before installing the cover to avoid crushing a wire when tightening the cover screws.

7 Operation of Controllers

7.7 Power Requirements

The pHAT Box system is solar powered. In order to maintain batteries, in extended periods without sunlight or if the solar panels are not connect, an auxiliary charge is included inside the pHAT Box. This charger requires a 120 VAC supply at a maximum of 4 amps. Ensure the equipment is properly grounded.

7.8 Turning on the pHAT Box System

Once the circuit breakers in the junction box are turned on the pHAT Box is powered on. There is no separate ON/OFF switch.

7.9 Setting CO_2 Injection Parameters

These parameters are already set up at the factory, but may need to be changed if either the sc200 or a pH probe is replaced.

The CO_2 injection can be programmed to occur at any interval. The sc200 uses two relays to activate or deactivate CO_2 injection. These relays are linked to the influent and process pH probes. Adjusting the on/off setpoints on the sc200 will affect the target pH range of the effluent water.

The sc200 uses two relays to control the discharge valve positions.

The following table represents a typical relay setup. Consult the sc200 manual for detailed instructions on alarm setup.

Table 1 sc200 relay definition and parameters

Relay	Connection	Description	Function	High Alarm Setpoint	Low Alarm Setpoint	Low Dead Band	High Dead Band	Delay	Fail Safe
A	Linked to tank 1 pH probe	CO_2 solenoid valve 1 on/off	Alarm	8.2	0	0	0	0	No
B	Linked to tank 2 pH probe	CO_2 solenoid valve 2 on/off	Alarm	8.2	0	0	0	0	No
C	Linked to tank 1 pH probe	Discharge valve 1 open/ close	Alarm	8.9	6.0	0.4	0.4	0	Yes
D	Linked to tank 2 pH probe	Discharge valve 2 open/ close	Alarm	8.9	6.0	0.4	0.4	0	Yes

To set parameters for basin 1 CO_2 injection (pH of 8.2 SU), complete the following procedure.

In order to select the pH probe for basin 1, find its serial number (located on the cable label).

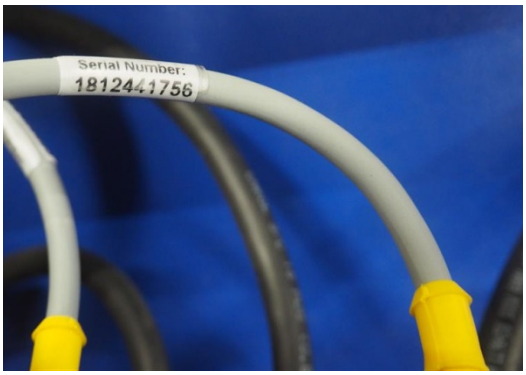

Figure 19 Sample pH Probe Serial Number Label

7.10 Name the Probes

1. With the pHAT Box powered on, press the **Menu** button on the sc200.
2. [redacted]
3.
4.
5.
6.
7.
8.
9.
10.
11.
12. Repeat these steps to name the second probe.

7.10.1 Set Up Relay A & B

1. Press the **Menu** button.
2. Select **sc200 System Setup** and press **Enter**.
3. [redacted]
4.
5.
6.

7. [redacted]
21. Repeat these steps to name the second probe, using Relay B and the pH probe name for basin 2. For example, *"**pHD Tank 2 777**"*.

7.10.2 Set Up Relay C & D

1. Press the **Menu** button.
2. Select **sc200 System Setup** and press **Enter**.
3. [redacted]
22. Repeat these steps for the second probe, using Relay D and the pH probe name for basin 2. For example, *"**pHD Tank 2 777**"*.

7.11 CO_2 Regulator Pressure

The regulator pressure setting is determined by two separate conditions:

- the hydraulic tank head pressure
- the pH of the influent storm water

The anticipated pH of influent storm water is between 9.0 and 10.5 SU. Regulator pressure is initially set up at approximately 20psi. The final configuration will be determined during commissioning based on previously described methods.

7.12 System Logic

- Basin 1 (Tank 1) pH probe: Relay A is active when the pH is 8.2 SU or higher. This injects CO_2 into basin 1.
- Basin 2 (Tank 2) pH probe: Relay B is active when the pH is 8.2 SU or higher. This injects CO_2 into basin 2.
- Basin 1 (Tank 1) pH probe: Relay C is active when the pH is between 6.0 and 8.9 SU. When in this range the basin 1 discharge valve will be open.
- Basin 2 (Tank 2) pH probe: Relay D is active when the pH is between 6.0 and 8.9 SU. When in this range the basin 2 discharge valve will be open.

8 Maintenance

8.7 General Inspection

Perform general inspections monthly and as needed to ensure proper system performance. Use an inspection checklist to document all maintenance.

Wear proper personal protective equipment when working on the equipment.

DANGER: $CO_2$is heavier than air and will collect in the basin. Entering the basin is likely to result in death from suffocation. Never enter the basin or place your head in the basin without proper breathing apparatus (air supplied). Follow OSHA requirements for confined space entry.

DANGER: Battery electrolyte can cause burns or blindness. Wear face body protection when working on or around batteries.

DANGER: Batteries release flammable gas which can explode if ignited. Do not connect or disconnect battery terminals as the resulting spark and ignite the flammable gas. Do not smoke or have an open flame within 10 feet (3 meters) of the pHAT Box.

	I – Inspect **C – Calibrate**		
Maintenance Item	**Startup**	**Monthly**	**Quarterly**

Influent Process/Effluent pH Probe Inspect electronic data recording equipment regularly and reference it against manual grab sample data, then clean and calibrate the probe.	**I**	[1]**C**	
Inspect the electrolyte level in the batteries. Fill with distilled water as required.	**I**		**I**
Inspect the battery terminals for electrolyte leakage and terminal corrosion. Clean up electrolyte and remove corrosion. Wear PPE.			
Inspect and maintain safety of pHAT Box by keeping surroundings free of foliage, obstructions, and potential tripping hazards.	**I**	**I**	
Inspect the fittings and pipes for leaks or excessive wear.	**I**		**I**
Inspect the piping, plumbing, and fittings for leaks, breaks, and potential hazards.	**I**	**I**	
Inspect the CO_2 storage vessels to ensure they are properly secured. Ensure the valves and fittings are tight and free of obvious damage.	**I**	**I**	

8.8 Cleaning

Although the pHAT Box is a durable system able to withstand outdoor conditions, it is imperative that the system remain clean for proper operation and system longevity. Access to the pHAT Box system must remain clear and free of debris and trash so regular inspections can be made.

Clean the pH probes monthly with a soft cloth and clean water. **Do not use cleaning agents or abrasives** as this will damage the glass lens located on the bottom of the probe. Clean the probe carefully to ensure proper probe performance and accuracy.

Replace the pH probe salt bridge and fill solution annually. The frequency of the salt bridge replacement is application dependent. More or less frequent replacement will be appropriate in some applications.

Wear Personal Protective Equipment. Inspect the battery terminals for electrolyte leakage and terminal corrosion. Clean up any electrolyte and remove corrosion.

8.9 Calibration

To ensure proper operation, the pH probes for the pHAT Box must be calibrated monthly or any time that grab samples taken from the effluent sample port do not match the probe readings. The sc200 is capable of four different calibration types. Water Tectonics recommends performing the two-point manual calibration.

Disable the effluent pump by setting the effluent pump switch to the **OFF** position, then set the effluent pump panel main disconnect to the off (**0**) position. Follow the lockout and tagout procedures to ensure the pump cannot be energized.

Drain the conveyance line before removing the water quality monitoring skid pH probe.

Remove the first pH probe and clean the insertion as directed in section 8.8 Cleaning.

[1] Sensor calibration frequency (as required by regulatory agency). Calibrate according to the schedule mandated by your regulatory agency.

To calibrate the pH probes, perform the following steps. Also refer to the Hach DPD1P1 probe documentation.

1. From the Main Menu, select **SENSOR SETUP** and confirm.
2. Select the appropriate sensor if more than one is attached and confirm.
3. [redacted]
4. [redacted]
5. Move the clean probe to Buffer 1 and confirm.
6. Confirm when stable.
7. Move the clean probe to Buffer 2 and confirm.
8. [redacted]
9. Return the probe to the inline probe mount.
10. Restore power to the effluent pump panel by setting the main disconnect switch to the on (**I**) position, then set the effluent pump switch to the **ON** position.

Note: For this calibration two different pH buffer solutions will be needed (e.g., [redacted] or [redacted].

Note: When switching from one buffer solution to the next, rinse the probe thoroughly with deionized water or clean potable water to prevent crossover contamination from one buffer solution to the next.

8.10 CO_2 Replacement

CO_2 is a consumable resource in the pHAT Box system and **must** be replenished when it falls below the preset levels.

9 Troubleshooting

9.7 No Power Available

1. Ensure the circuit breakers in the junction box are turned on.
2. Inspect the batteries as called out in the maintenance section.
3. Charge the batteries using the auxiliary battery charger.

9.8 pH Probes and Grab Samples Do Not Match

1. Calibrate the probes selecting the 2-point manual option and using 4&7 or 7&10 buffer solutions as described in section 8.9Calibration.
2. Clean the probe ends and check for debris build-up around the hanging point as described in section 8.8Cleaning.

9.9 System Is Not Injecting CO_2

1. Ensure the solenoid valve has power when the system is triggered to treat using a multimeter or a proximity voltage detector. A powered solenoid is warm to the touch.
2. Inspect the setpoints for each relay in the sc200 as described in section 7.9 Setting CO2 Injection Parameters
3. Verify that the probes are assigned to pH as described in the Hach sc200 documentation.

4. Inspect the CO_2 levels in the bulk CO_2 storage.
5. Verify the regulator pressure is correct.

9.10 System Is Injecting CO_2 but pH Is High

1. Increase the pressure setting on the regulators.
2. Verify the CO_2 levels in the bulk CO_2 storage.
3. Remain on site until the pH stabilizes at an acceptable level.

10 Related Documentation

10.7 Spare Parts List

The following parts are included separately as spares.

- Two pH probes
- 3/8-inch polyethylene tubing and bubbler hose.

10.8 Third Party Manuals

Refer to the following documentation for more information.

- Hach sc200 Universal Controller Data Sheet
- Hach Differential pH and ORP Sensors Data Sheet
- Midnight Solar charger manual
- Noco Genius gen2 battery charger manual
- CO_2 Gas Supplier Information