Kentucky Hollow Passive AMD Treatment System
Operation and Maintenance Plan
January 2020

Background

Kentucky Hollow is the colloquial name for a drainage that flows on the western border of Pittsburgh Botanic Garden (PBG). The Kentucky Hollow drainage combines with drainage in ditches along McGill Road near the Noblestown Road entrance to the PBG, after which the combination flow is culverted to Robinson Run. The Pittsburgh coal seam occurs in the Kentucky Hollow watershed. The seam was deep mined in the early 1900's and contour strip mined in the 1950's and 60's. The underground mine discharges acidic mine drainage contaminated with aluminum (Al). The drainage emanates from two discharges identified in the Cherep mining permit as MD3 and MD4, and referred to in this project as the Eastern and Western discharges, respectively. Both discharges flow directly into the headwaters of Kentucky Hollow, historically causing degradation to the entire length of the stream. A passive treatment system was installed in 2018-2019. This document is the Operation and Maintenance (O&M) plan for the Kentucky Hollow passive treatment system.

Passive Treatment

The Kentucky Hollow system treats two acidic mine discharges with two parallel Drainable Limestone Beds (DLBs) installed in rectangular concrete tanks. The minewater is collected directly from the existing underground mine discharges (MD3 and MD4) and piped to a box that splits the water equally between the two DLB cells. The minewater is discharged at the surface of each DLB unit through a perforated fountain pipe and flows downward through limestone aggregate to a perforated pipe at the bottom of the each DLB. As water flows through the aggregate, acidity is neutralized, alkalinity is generated, and metals (Al, Fe, and Mn) are precipitated. Water collected from the DLB is piped to a water level control structure that controls water depths in the DLB and discharges routine flow back to the headwaters of Kentucky Hollow. During routine operations, the water level is maintained near the surface of the limestone, maximizing residence time and treatment effectiveness. Once a week, each limestone bed is rapidly drained empty when a gate valve in the water level control structure automatically opens for 1.5 hours. The draining process mobilizes and removes Al solids formed during routine operations and prevents these solids from plugging the limestone and decreasing treatment efficiency. This "flush" flow is conveyed by a 1,250 ft pipeline to a sludge pond that retains the solids and discharges a clean effluent. The two DLB's have flushes staggered by three and a half days so that each flush has residence time in the settling pond before the next flush enters. Photos of the treatment system are given in Appendix A.

System Components

The as-built plans show the layout of the treatment system, which consists of three primary components:

1. AMD Collection. Each AMD discharge emanates from a clay pipe connected directly to the deep mine. The discharges are piped to a flow splitter box on the northern side of the site that was constructed from a custom Agri Drain water level control structure. The rectangular PVC structure is buried in the ground, with several feet left exposed above ground. The pipes connect to the bottom of the box, where water rises up to the elevation of two equivalent riser pipes. Each riser pipe receives flow and conveys it to each DLB.
2. Two Drainable Limestone Beds (DLBs), each treating the AMD with 750 tons of AASHTO #3 high calcite (>90%) Vanport limestone aggregate. Each bed is installed in an open top concrete tank with dimensions of 98 ft length by 30 ft width. The bottom of both tanks is sloped toward the center by 9 inches. The depth of limestone in each tank ranges from 4.8 ft on the influent side, to 5.6 ft on the effluent side. Water enters along the length of the bed through a 95 ft-long perforated 6" diameter pipe placed at the surface, travels through the width of the bed, and empties through a 95 ft long perforated 8" pipe placed at the bottom. The bed is drained empty using an Agri Drain Smart Drainage System (SDS) that consists of a water level control structure with a gate valve that is activated by a programable controller and powered by a solar panel and battery.
3. Settling Pond, which receives the DLB flush effluent and allows metal solids to settle. The flush flow travels to the settling pond in a 1,250 ft-long pipeline. The settling pond discharges into a nearby ravine through a down-turned riser pipe. The pipe is capped, with a hole drilled into the cap that limits the effluent flow rate to approximately 20 gpm. The pond is sized to hold 2 flushes, so as the second flush comes in, the first flush discharges through the outlet pipe. If this pipe becomes plugged, the water level will continue to rise until it discharges through an emergency spillway.

System Inspections

The system should be inspected quarterly. An inspection form is attached to this plan. This form can be used as-is or adapted for use by the inspection personnel. Use the "Notes" column to record any other relevant information about the site, such as signs of vandalism, sample numbers if lab samples are taken, or other information. This information should then be incorporated into a master spreadsheet containing water quality laboratory results that can be shared with others electronically and stored for historical purposes.

A system inspection involves visual observations and simple water sampling. The entire process will require about one hour. The water level control structures are secured with locks with the combination 4-4-6-4. The SDS controller are secured with locks with the combination 3-5-2.

The attached inspection form contains a checklist of items to be noted during a routine inspection. If no problems are apparent, then the inspection is complete. The finding of "no problems" should be recorded and preserved in the project files and entered into the spreadsheet. If problems exist, refer to the attached "Troubleshooting Guide" and maintenance narrative.

Sampling and Flow Measurements

Sampling locations are shown in the as-built drawing. During each inspection, the flow rate into each DLB should be measured. Flow rates are measured by removing the riser pipes on the end of each fountain pipe, waiting ten minutes for the flow to equalize, and then using the timed volumetric (bucket/stopwatch) method to measure the pipe discharge.

Raw, untreated water can be sampled for chemistry out of the fountain pipe. The treated effluent should be sampled where it discharges out of two riser pipes in the headwaters of the wetland. The settling pond should be sampled at its final effluent, when this is discharging.

Each sampling location should be sampled for field parameters, including pH, conductivity, and temperature. Field alkalinity should be measured on all samples with pH > 4.5.

At least twice a year, sampling for laboratory analyses should be conducted. The samples should be analyzed for standard AMD parameters: pH, conductivity, alkalinity, acidity, Fe, Mn, Al, total suspended solids, and sulfate. The laboratory should provide bottles and reagents necessary to properly collect the samples.

Passive Treatment System Inspection Form

Inspector _____ Date _____

Recent weather (wet, dry, cold, hot) _____

Refer to As-Builts for the inspection locations and sampling points included in this form

General Inspection Activities		**Y/N**	**Action if:**
Location	**What to Look For:**		
AMD Collection Systems	Is water entering the DLB?		N
	Are each of the AMD collection areas dry (no seeps)?		N
	Is water is backing up in the plumbing?		Y
Flow splitter box	Is there evidence of vandalism?		Y
	Is water building up in the box?		Y
Drainable Limestone Beds	Is there standing water on top of the limestone?		Y
	Is there water flowing out of the routine effluent pipes?		N
	Is the routine effluent cloudy?		Y
	Is the Smart Drainage System battery charged?		N
	Is the Smart Drainage System gate valve functional?		N
Settling Pond	Is the pond discharging through the outlet channel?		N
Animal Problems	Is there evidence of beaver or muskrat activity affecting the performance of the system?		Y
ATV Problems	Is there evidence of erosion or damage due to ATVs?		Y
Berms	Are berms around the VFP and settling pond competent?		N
	Is woody vegetation becoming established on the berms?		Y
Vegetation	Is vegetation obstructing the flow of water or site access or shading the SDS solar panel?		Y

Miscellaneous Observations: Detail any problems here

Flow and water sampling information

Location	**Flow (gpm)**	**pH**	**Temp**	**Alkalinity**	**Notes**
Raw					
DLB effluent					
Final effluent					

Troubleshooting Guide

Problem	Potential Cause	Solution
Some or all of the AMD is not reaching the DLB	The pipeline is clogged	Clean the pipe to remove obstruction
	The water collection plumbing has failed	Re-construct the AMD collection system.
No flow out of DLB routine effluent pipe	DLB is refilling following flush event	Check again on different day of week or under higher flow conditions
	Outlet pipe blocked or broken	Check for obstruction of outlet pipe. Remove any obstruction or repair pipe
DLB water level is above the top of the limestone	Water level in discharge wetland channel is higher than the DLB effluent pipes	Check for obstruction in effluent wetland channel; clear
	Loss of permeability due to metals solids accumulation.	Adjust SDS to increase frequency of flushing events
	Limestone has been consumed and the aggregate has settled.	Add more limestone to replace the limestone that has dissolved
DLB performance (pH, alkalinity) declines over time	Change in AMD chemistry or flow rate	Review data to determine if the chemistry or flow of the discharge has changed. Consider treatment system modification if change is considered permanent.
	Limestone has been fouled by metals solids	Clean limestone *in situ* and replenish with new limestone
	Limestone is being consumed	Add more limestone to replace the limestone that has dissolved
Damage to pipes, berms or structures	Beaver/muskrat activity is apparent from dams constructed in channels or tunnels through berms	Contact the Pa Game Commission and request that the animals be removed or local trapper that can remove during legal trapping season.
	Vandalism	Repair damage, restrict access to site
Smart Drainage System not functioning	Low battery voltage	Test voltage of battery and replace if necessary. Check solar panel connection and orientation
	Equipment damage	Replace damaged parts
	Inconsistent charging	Removal of vegetation blocking solar panel
	Other problems	Contact manufacturer
Vegetation	Vegetation blocking water flow or site access	Remove vegetation
	extensive woody vegetation on berms	cut or remove

Kentucky Hollow Passive AMD Treatment System Maintenance Narrative

AMD Collection System

Description

Two discharges of acid mine drainage (AMD) are collected directly from the deep mine's clay pipes from which they emerge. A Fernco coupling connects each of the deep mine discharge pipes to an 8" PVC elbow that raises the elevation of the water in the mine pool. A PVC tee is installed above each elbow, with one end of the tee's run connected to the elbow, one end of the run daylighting at the surface, and the branch conveying the flows to the flow splitter box. The Western discharge (MD4) also has a section of flexible tubing connected to the tee which transports 1-2 gpm of raw mine water to the headwaters of the wetland, to prevent the wetland from drying. Both collection areas also contain a capped water-monitoring well that is separate from the collection system plumbing. The collection systems are detailed in the as-built plans. The flow splitter box is an Agri Drain inline water level control structure (WLCS) with all of the boards removed. Water enters each side of the bottom of the structure via the two 8" discharge pipes, upwells about 19", and flows downward into two 4" diameter upturned elbows. The two upturned elbows were installed at the same elevation, thus evenly splitting the upwelling flow. After the flow is split into the two 4" pipes, each pipe expands into a 6" diameter pipe and travels to the DLBs.

Operation and Maintenance

The AMD Collection System should not require routine maintenance. Loss of flow to the treatment system combined with an appearance of surface seeps is an indication of blockage within the AMD Collection Systems. Due to the flexible tubing conveying 1-2 gal/min of the Western discharge into the wetland, some surface water is expected to be present near this discharge's collection system. Additionally, both collection systems (especially the Western discharge) were installed in areas that receive stormwater runoff from the surrounding hillsides. Judgement of collection system performance should not be made immediately after a rain event or based on the routine leakage from the flexible tubing. If acidic surface flows are present outside of these contexts, it is possible that a blockage exists. Water level in the monitoring wells should be compared to the water level in the collection system riser. If the water level in the monitoring well is significantly higher than in the collection system riser, this indicates a buildup of head pressure in the mine pool, and likely a blockage. If blockage is apparent, the cause of the blockage must be identified and removed.

Drainable Limestone Bed (DLB)

Description

Each DLB contains 750 tons of AASHTO #3 limestone aggregate placed in a bed that has a level surface but, because of the sloped tank bottom, is 4.8 to 5.6 ft deep. In routine operations, the bed is flooded and water flows from the inlet to the bottom drain. The water level in the bed is maintained by the Smart Drainage System and the inverts of the effluent pipes in the headwaters of the wetland. Water level is maintained a few inches below the top of the aggregate. The system is periodically drained empty when the SDS gate valve is opened.

Water enters the DLB from the flow distribution structure via a horizontal fountain. The horizontal fountain is a 6" perforated pipe laying on surface of limestone, with an unglued

upturned elbow at the southern end of each DLB. The purpose of the upturned elbow is to flood the pipe so water can be spread through the system via holes in the pipe and also provide an outlet for large flows. The elbow is unglued so that it can be removed for flow measurement, which can occur in the depression beneath the elbow. There is no other plumbing in this area. The horizontal fountain must be level to assure proper water distribution. Cleaning of limestone and/or limestone dissolution may eventually affect support of the plumbing.

Each DLB contains a perforated 6" PVC stand-pipe that allows for the monitoring of water level in the limestone. The monitoring well is not connected to the influent or effluent plumbing and is located at southern end of each DLB, near the inside corner.

Water leaves each DLB cell via a perforated 8" pipe on the bottom of the bed. The 8" outlet pipe is aligned with the long side of the bed next to the inner (middle) concrete wall.

Water level in the DLB is maintained by an Agri Drain Smart Drainage System™ (SDS). The SDS is installed within a water level control structure (WLCS), a PVC box with inlet and outlet pipes connected to its base and a series of boards that divide the interior of the box in half. The water level in the DLB is maintained by the elevation of the final effluent pipes. The elevation of the top boards in the WLCS is approximately 2" higher than the final effluent pipes, causing water to flow to the final effluent pipes under routine flow conditions. The boards in the WLCS must not be lowered to an elevation lower than that of the final effluent pipes, otherwise water will discharge over the top board and flow to the settling pond, rather than the final effluent pipes. It is required under the project's permit conditions that flow be maintained in the channel between the DLB's and the settling pond.

The bottom board in the water level control structure is equipped with an electrically actuated gate valve. When this valve is opened, the DLB drains empty. When this valve is closed, the DLB fills with water. The gate valve is controlled by a computer control unit and powered with a solar panel and battery. Two controllers and solar units are mounted on poles next to the WLCS. The controller boxes are locked (combination is 3-5-2 (spells D-L-B on phone keypad))

Smart Drainage System Operation and Maintenance

Instructions for operating the SDS can be obtained from the AgriDrain Corporation. Operating instructions are available at the end of the document. The SDS uses a computer-controlled linear actuator to open and close a gate valve installed inside the WLCS. A battery provides power to the computer and actuator and charge is maintained by a solar panel. The status of the system is determined from the controller. If the screen has the correct date and time, the power supply is working. Additional information about the power supply is available by scrolling through screens as explained in the instruction manual.

Maintenance needs for the SDS system include replacement of the battery (every 3-5 years), replacement of the controller (every 5-10 years) and replacement of the gate valve actuator (every 3-5 years). Replacement controllers and actuators can be purchased from Agri Drain (https://www.agridrain.com). Replacement batteries can be purchased at hardware stores or online.

The Smart Drainage System is designed to allow the operator to open and close the slide gate based on the desired schedule. The operation of the SDS is explained in the manual attached to this Plan.

DLB Permeability

The water level in the DLB should be just below the limestone surface. Some water may be visible above the limestone due to irregularities in the limestone level, especially under high flow conditions when the water level has risen. If the entire limestone surface is submerged, the discharge stream and outlet plumbing should be inspected for obstructions. If the water level inside the WLCS is lower than the water level in the DLB then there is a permeability problem within the limestone.

DLB Effluent Quality

If the DLB routine effluent is cloudy or milky during normal flow (not during a flush event) then it is likely that aluminum has accumulated within the limestone that must be removed. One cause of this is failure of the automatic flushing system (SDS). Manually flush the bed and troubleshoot the SDS. If the SDS is working properly, begin implementation of DLB minor maintenance (below).

If the effluent of the DLB has pH below 6.0 under normal flow conditions, system monitoring should be increased to at least monthly. Two consecutive months of effluent pH between 5.5 and 6.0 indicates that minor maintenance actions should be taken to improve performance while plans are made for more permanent solutions. Effluent pH below 5.5 indicates that major maintenance is required and should be implemented as quickly as possible. Minor and Major maintenance activities are described below.

DLB Minor Maintenance

Temporarily increasing the frequency of flushing can address both the loss of permeability and declining effluent quality of the DLB. The SDS can be programmed to flush up to three times per week (see instructions provided by manufacturer). Increased flushing frequency will temporarily reduce the quality of the effluent, but it may improve permeability. Once permeability is restored flushing interval can be lengthened to improve effluent quality.

DLB Major Maintenance

If flushing does not improve permeability or treatment performance, then the limestone requires mechanical cleaning. The goal of the cleaning is to remove solids from the limestone bed. Simply mixing the stone and moving the solids to the bottom of the bed where the plumbing is located is NOT sufficient. Care must be taken to ensure that the dislodged solids are removed from the bed. A procedure for mechanically cleaning the limestone can be obtained by Hedin Environmental.

Settling Pond

Description

Each DLB is flushed once per week, and this flush effluent (>1000 gpm) is conveyed to the settling pond in an approximately 1,250 ft-long 8” pipeline. The settling pond has the capacity to hold approximately 2 flushes. Water leaves the settling pond through the tee of a 6” pipe. The

branch of the tee goes vertically into the pond, and the run of the tee extends through the settling pond berm to the final channel. The bottom side of the branch of the tee (where the water enters) is capped, and holes are drilled into the cap. The invert of the tee is placed at an elevation slightly higher than the volume of one flush. When the second flush enters the pond, the water level in the pond rises and begins flowing through the branch of the tee. If this were plugged, and the water level continued to rise, water would enter the top of the tee's branch, which is uncapped. If this were also plugged, the water level would continue to rise until it discharged through the emergency spillway. Metal solids are settled and retained in the settling pond.

It is well-known that the settling pond leaks, and it should not come as a surprise to find an empty settling pond upon inspection. This condition was determined to be satisfactory as long as the pond's berm is stable (no slumping, sliding, etc.) and the leaked water is not creating any downstream problems.

Operation and Maintenance

The settling pond should be inspected for obstruction of the outlet tee by debris, ice, vandalism or rodents. Berms should be inspected for rodent damage and leakage. Removal of trees and other woody type plants should be performed regularly to prevent establishment of these plants. Special attention should be paid to vegetation growth at the outlet of the pond that may obstruct flow. Any damage or obstruction should be repaired or removed promptly.

Sludge Cleanout

The sludge level should be measured at the final effluent tee. The distance between the bottom of the pond and the bottom of the effluent tee is approximately 2.2'. When the sludge has accumulated to 40% of this level, a sludge removal crew should be mobilized to pump out the sludge and dispose of it. The sludge is not hazardous and can be buried or disposed of at landfill or water treatment plant. Before disposal, the possibility of selling the sludge because of its chemical composition should be explored.

Appendix A: Photos

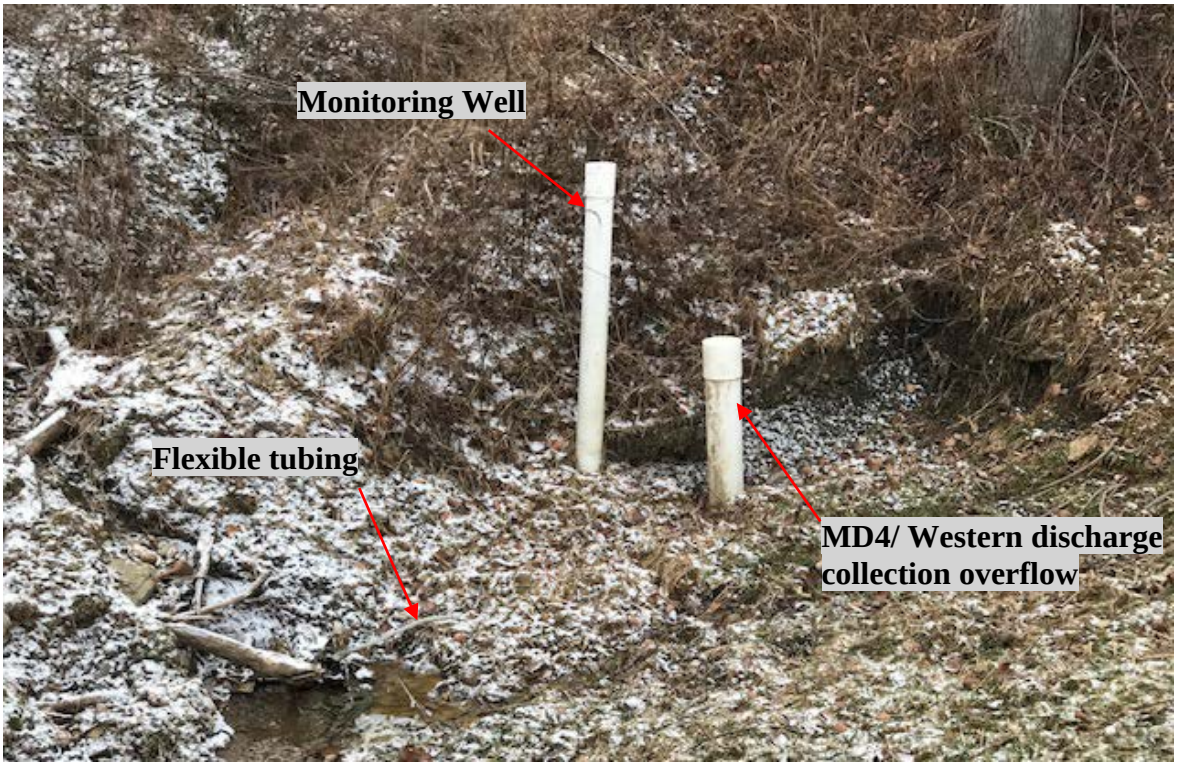


Photo 1. Western discharge collection system

Photo 1a. Flexible tubing delivering 1-2 gal/min of Western discharge raw flow into wetland

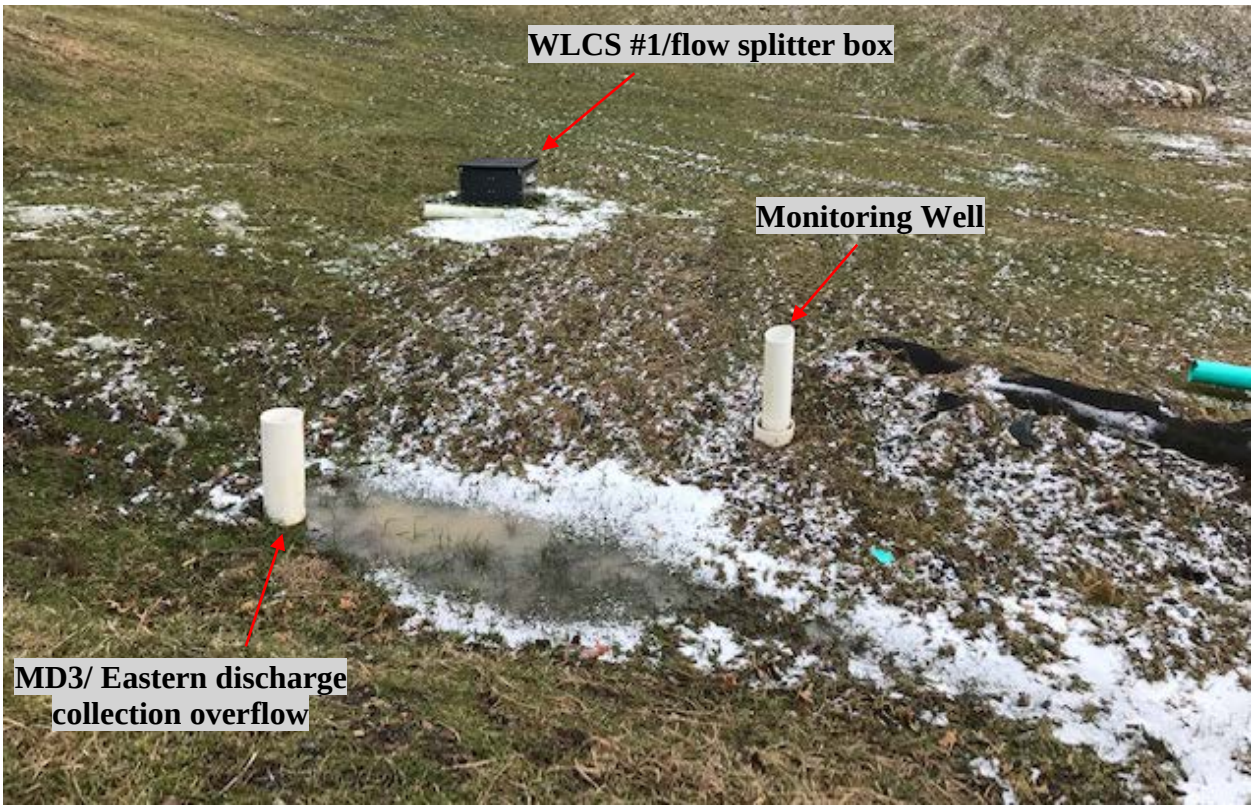


Photo 2. Eastern discharge collection system, WLCS #1

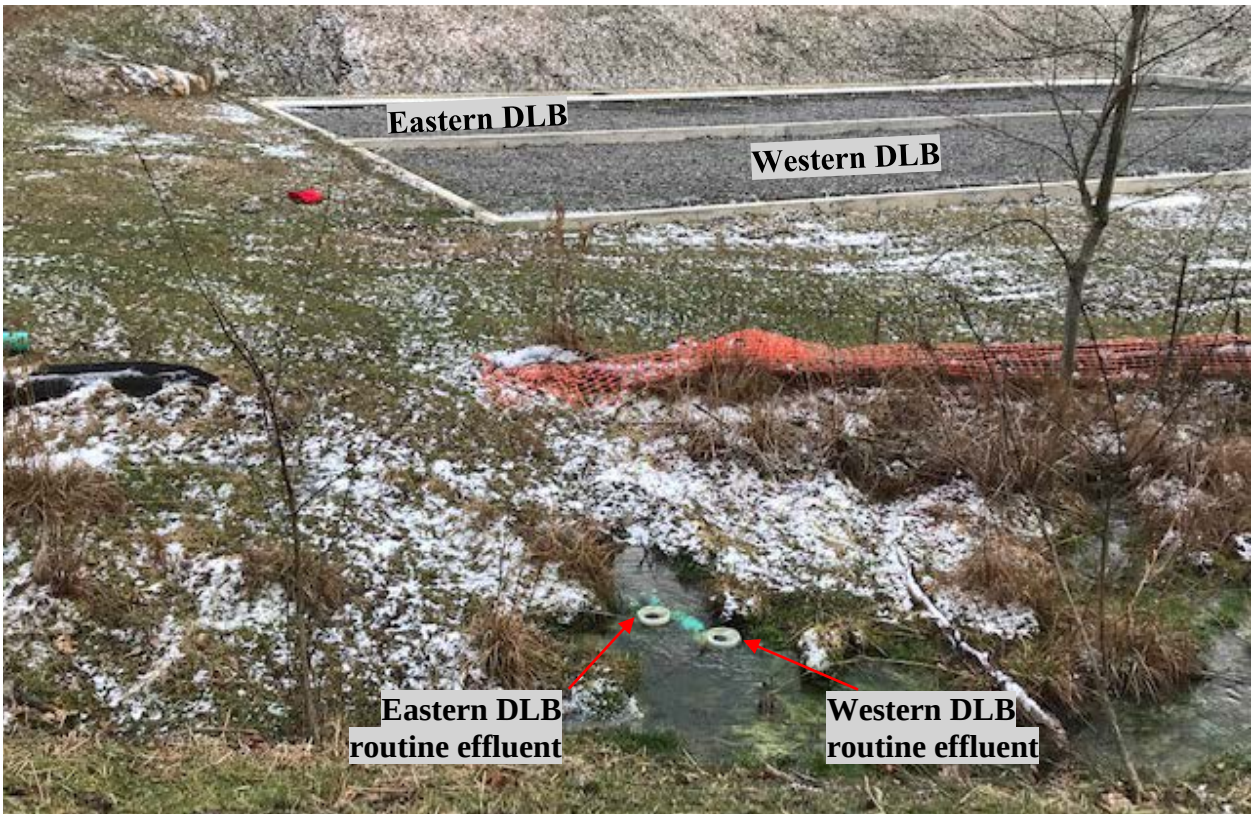


Photo 3. Final effluent pipes, DLBs

Photo 4. Flow splitter box, inside

Photo 4. Installed DLBs.

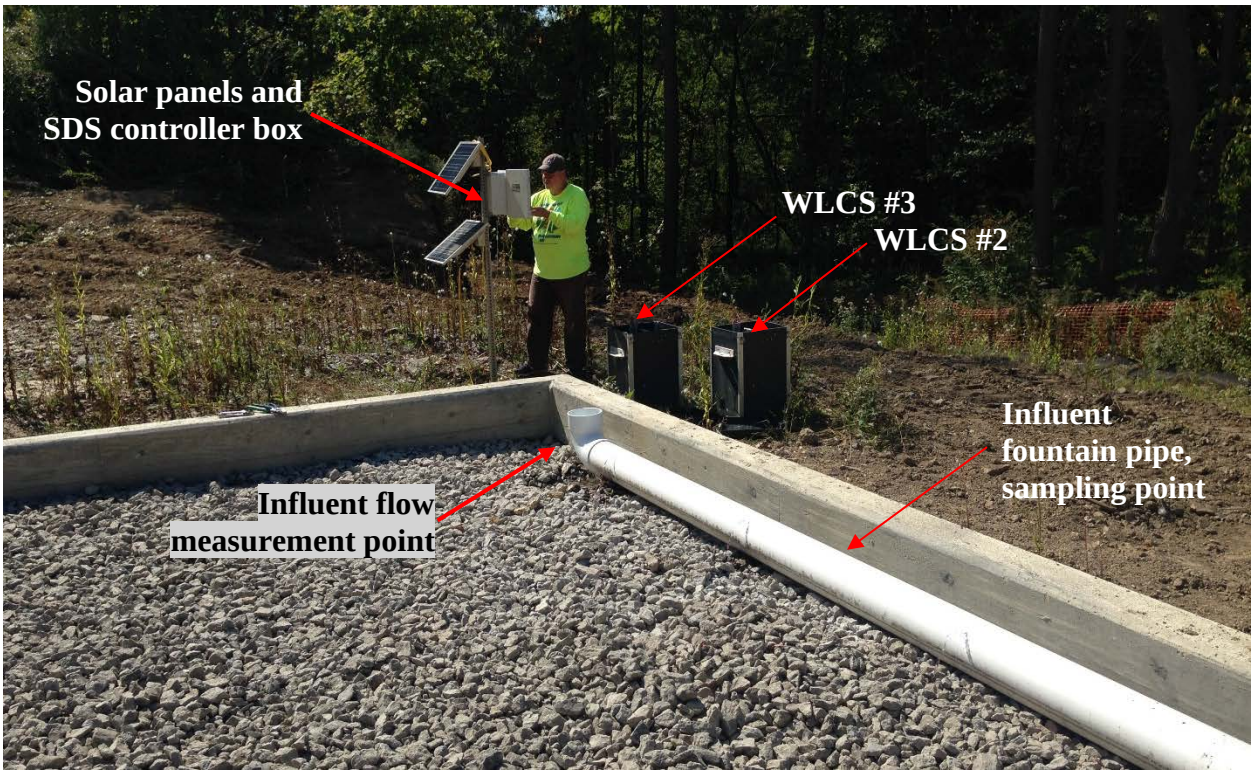


Photo 5. Influent fountain pipe and water level control structures

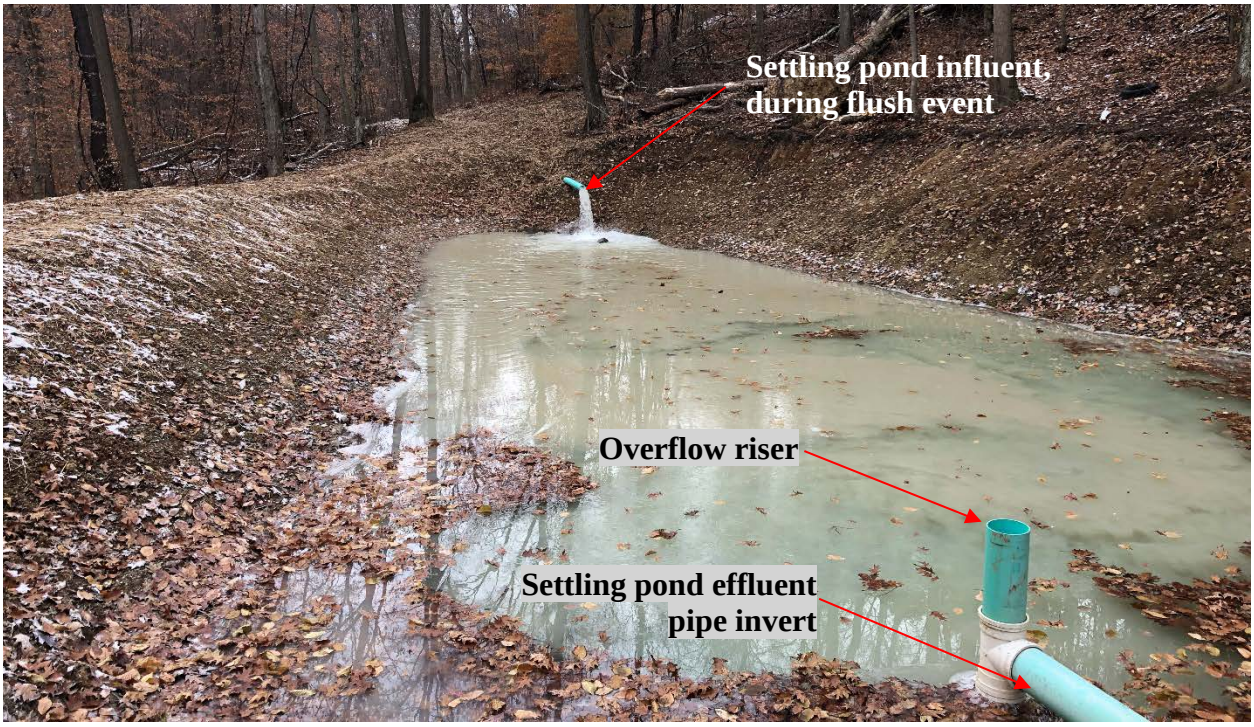
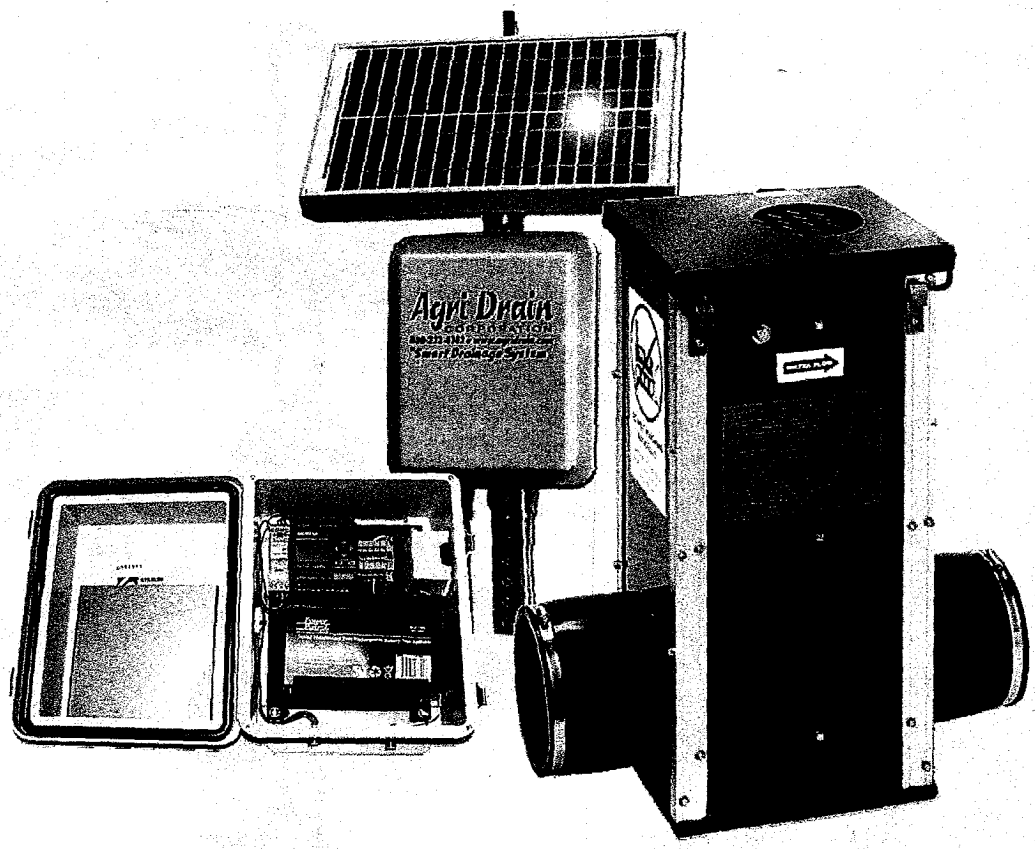


Photo 6. Settling pond

Photo 7. Settling Pond final effluent. Note: picture was taken before pond received its first DLB flush)

OWNERS MANUAL

Mine Reclamation Edition



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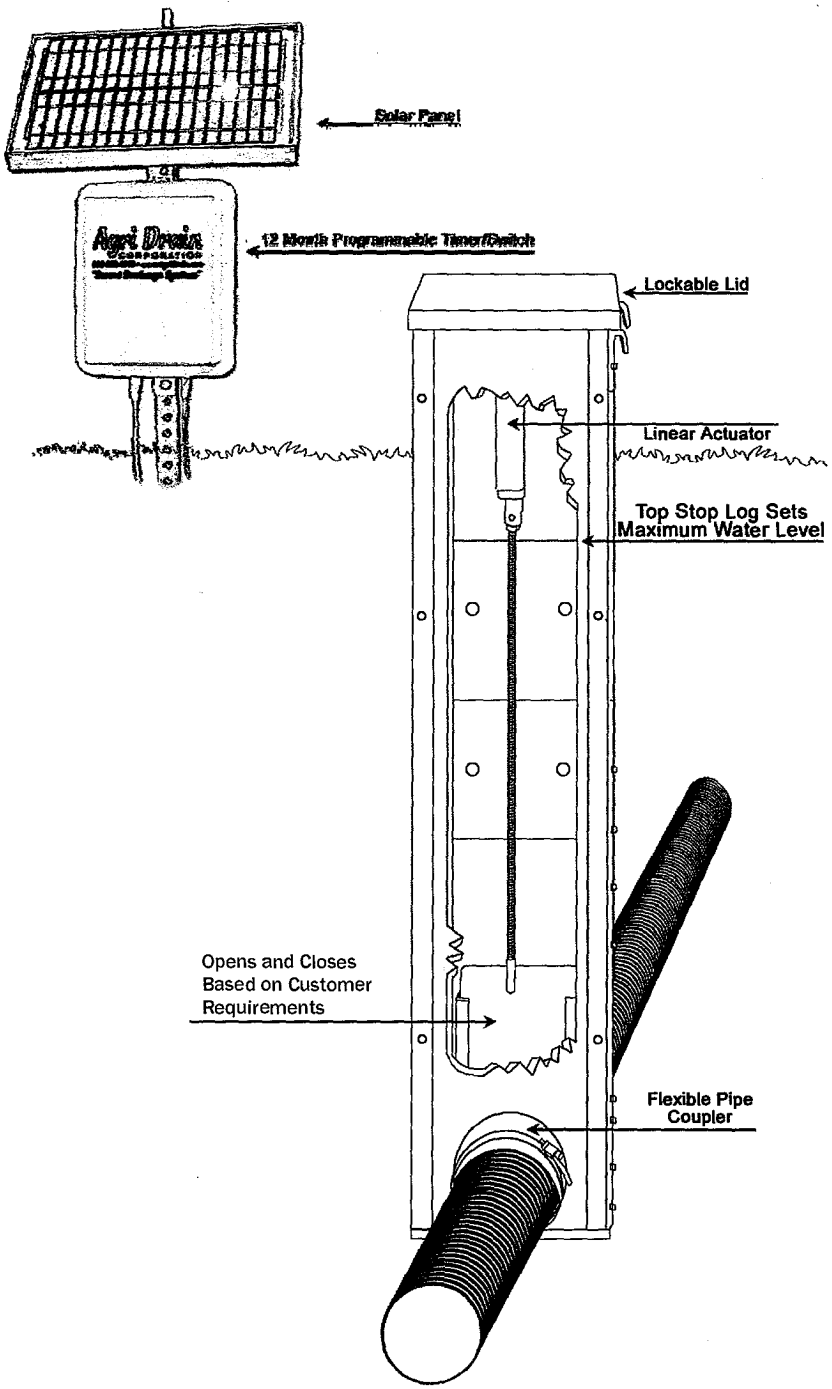


OPERATING PRINCIPLE

The Agri Drain "Smart Drainage System" is designed to allow the operator to open and close the slide gate based on the desired schedule.

The steps required to program the controller for this function are explained in the *"Setting Timers"* section of this manual.

The unit has a solar panel which keeps the battery charged, a controller which is programmed to control the slide gate, and an actuator that raises and lowers the slide gate. The electronic components are housed in a weather tight enclosure.

INSTALLATION OF INLINE WATER CONTROL STRUCTURE

1.)*EXCAVATION AND GRADING*

The structure base, the inlet pipe, and the outlet pipe must be set on firm, flat surfaces of compacted soil or fill sand to provide a solid, stable base. This will prevent settling and reduce stress or misalignment of pipe connections.

2.)*PIPE CONNECTION*

Remove black tape from both inlet and outlet flex couplers exposing the stainless steel clamps. The flex couplers must be placed directly over the outside diameter of the pipes; then secured by tightening the stainless steel clamps as shown in the illustration.

3.)*BACK FILL AND COMPACTION*

Level the structure vertically before placing backfill. Backfill around the control structure by hand in 6" lifts. Hand tamp only - **do not** mechanically compact. **Do not** use a backhoe or blade to place backfill directly against the water control structure.

****Excessive compaction may cause structural damage or failure.**

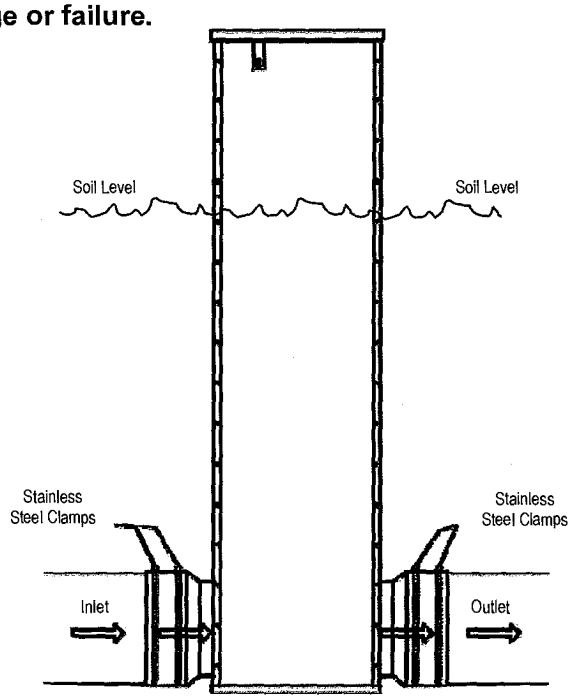
The inline structure may be used for primary or secondary outlet with larger pipe or emergency spillway as primary.

Inline structure removes sub-surface water.

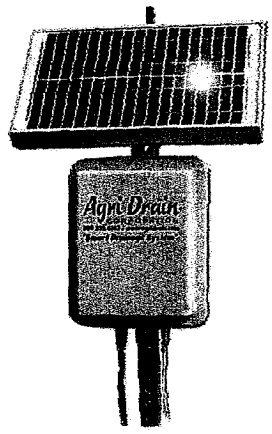
On the inline installation, the inlet end of the pipe should be held off the bottom of the impoundment to allow for siltation and be protected with an inlet guard. The outlet end should be protected with a rodent guard.

In a controlled drainage or sub-surface irrigation application, the structure nearest the outlet should be installed with a minimum of 20' of non-perforated pipe on the down stream end. Anti-seep collars are recommended.

(The above mentioned companion products are available from Agri Drain Corp.)



INSTALLATION OF SOLAR PANEL & CONTROL BOX



Install the Inline water control structure as explained in *"Installation of Inline Water Control Structure"* in this manual.

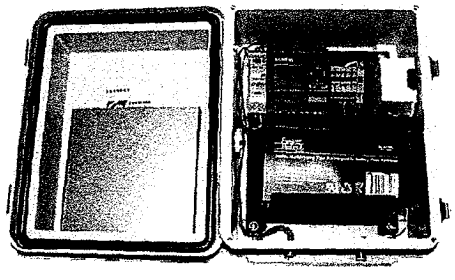
There will be two pieces of square tubing: One 6' piece of 1 3/4" and One 8' piece of 1 1/2". The 6' piece of 1 3/4" should be buried next to the side of the structure that has the receptacle. (Leave about two inches sticking out of the ground.)

- Mount the solar panel and one of the "T" brackets on one end of the 1 1/2" tube using one of the 3/8" bolts and nuts provided.
- Mount the other "T" brackets to the 1 1/2" tube using one of the 3/8" bolts and nuts so that the four holes line up with the four holes on the control box. Use four of the 1/4" bolts and nuts to secure the control box to the "T" brackets. (Make sure the receptacles are on the bottom, facing the ground.)
- Insert the 1 1/2" tube with the control box and solar panel into the 1 3/4" tube in the ground. Make sure the solar panel is facing South so it receives as much sunlight as possible. Insert the remaining 3/8" bolt through the two tubes and tighten down with the nut.
  (The height of the control box and solar panel is determined by placement of the bolt through the two tubes. For start-up and testing, adjust it to a point at or near eye level.)
- Connect the cable from the solar panel to the male receptacle on the control box.
- Connect the male end of the provided cable to the female receptacle on the control box. The other end of the cable connects to the receptacle on the structure.
- Open the control box and remove the packaging material.
- Connect the wires to the battery terminals. The unit is now ready to be programmed and tested.
- Set the clock, time, and date as explained in the *"Set Clock, Time, and Date"* section of this manual.
- Insure the actuator is operating correctly by using the key strokes as explained in the *"Manual Activation"* section.
- Set the timers as explained in the *"Setting Timers"* section.
- Close the control box and set to desired height.

SET CLOCK, TIME, AND DATE

When the unit is first powered up by connecting the battery, it will be necessary to insure that the correct time and date are entered into the control unit. A few seconds after the battery is connected, the screen will display Day, Time, and Date. To set the clock follow the directions below:

- Push ESC key
- Push the Down Arrow to "Set Clock"
- Push the OK key
- Arrow up or down to correct Day
- Arrow Right to set Hour (Military Time)
- Arrow up or down to correct Hour
- Arrow Right to set Minute
- Arrow up or down to correct Minute
- Arrow Right to set Year
- Arrow up or down to correct Year
- Arrow Right to set Month
- Arrow up or down to correct Month
- Arrow Right to set Day
- Arrow up or down to correct Day
- Push the OK key
- Push the ESC key



SETTING TIMERS

From the screen that displays the Day and Time, push ESC then follow directions below:

- Arrow down to "Set Param" and push the OK key
- Arrow up or down until "Open 1" is displayed (This is the open gate timer)
- To program, push the OK key
- Push the Right arrow to move the cursor to the days of the week the gate is to open
- Arrow up or down to set the day
- Arrow Right to On Time (Military Time)
- Arrow up or down to set On Time
- Push the Right arrow to set Off Time (Always set this for one minute later than On Time)
- Push the OK key after the Day, On, and Off Time has been set
- Arrow up or down until "Close 1" is displayed
- Program the Close day and time the same as the "Open 1" directions
- Push the ESC key twice to get back to the screen that displays Day and Time

SMART DRAINAGE SYSTEM ® OPERATIONS

The slide gate movement is controlled by programming the Open and Close timers. Set the Open timer for the day and time the gate needs to open. Set the Close timer for the day and time the gate is to close. When setting the timers always set the Off Time for one minute after the On Time. The signal to move the gates will activate on the On Time and turn off on the Off Time. Set the gate movements to happen at a time of day when there is a chance of optimal sunshine. This will help to keep the battery charged.

MANUAL ACTIVATION

When the slide gate needs to be moved to a different position or tested, it can be activated at any time using the keys on the controller. From the screen that displays the date and time, push the left arrow key. The screen will display ESC+C and four directional arrows. The up arrow is used to raise the gate; the bottom arrow is used to lower the gate. To activate the gate, first push and hold the ESC key and then the arrow for the direction desired. The chosen arrow will be highlighted on the screen. Hold the arrow until the gate stops moving. There is an internal limit switch in the linear actuator that will stop the movement when fully extended or retracted. If the ESC key is held too long before a directional arrow is pressed, another screen will appear. Press the ESC key to get back to the correct screen.

LOW BATTERY

The battery voltage is monitored at all times. If the voltage drops below a certain level, the message "LOW BATTERY" will be displayed on the controller. The date and time that the incident occurred will also be displayed. This message will continue to be displayed until the voltage rises to an acceptable level and the OK key on the controller is pressed. If the battery voltage stays low for too long, the slide gate will move to a safe position.

MONITORING BATTERY VOLTAGE

Timer "Bat Volt" will display the current voltage level of the battery. Access "Bat Volt" using the same key strokes as explained earlier for *"Setting Timers".* When "Bat Volt" is displayed it will look like this:

"Bat Volt"
On = 551
Off = 550
Ax = (See below)

Ax will display the current voltage level of the battery. This value should be between 600 and 725. If the value is not in this range, please consult the factory.

PARTS LIST

Description	Part #
Battery	800218
Solar Panel	800272
Actuator	800298
Actuator Connector	800606
Fuse	800617

CONTACT INFO

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