FINAL
SWMU B-3 BIOREACTOR
OPERATION AND MAINTENANCE MANUAL

Prepared For:

Camp Stanley Storage Activity
Boerne, Texas

November 2010

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ACRONYMS AND ABBREVIATIONS

btoc	below top of casing
BTS	Bioreactor Trench Sump
CC	Cow Creek Formation
CSSA	Camp Stanley Storage Activity
DO	Dissolved oxygen
DOC	Dissolved organic carbon
ft	Feet
GAC	Granular activated carbon
gpm	Gallons per minute
HDPE	High density polyethylene
HOA	Hand off automatic
Hp	Horsepower
HSP	Health and Safety Plan
MPMW	Multi port monitoring well
MSL	Mean sea level
MW	Monitoring well
NTP	Notice to proceed
O&M	Operation and Maintenance
ORP	Oxidation reduction potential
Parsons	Parsons Infrastructure and Technology
PCE	Perchloroethene
PLC	Programmable Logic Controller
psi	Pounds per square inch
PVC	Polyvinyl chloride
RCRA	Resource Conservation and Recovery Act
RTU	Remote Telemetry Unit
SCADA	Supervisory Control and Data Acquisition
SWMU	Solid Waste Management Unit
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality
TOC	Total organic carbon
toc	top of casing
TCE	Trichlorethene
VOC	Volatile organic compound
VC	Vinyl Chloride

SECTION 1 INTRODUCTION

This Operations and Maintenance (O&M) Plan documents the necessary activities to be performed during operation and maintenance of the Solid Waste Management (SWMU) B-3 bioreactor and injection system installed at Camp Stanley Storage Activity (CSSA) in Boerne, Texas.

The purpose of this O&M Plan is to describe the procedures to be followed during normal operation of the system. The Plan provides a detailed description of the injection system, including specifications of system components, data to be collected during normal system operations, system maintenance procedures, and general site maintenance to facilitate effective system operations. The Plan furthermore provides CSSA with a set of procedures for monitoring the equipment used for operating the SWMU B-3 bioreactor as well as monitoring the effectiveness of the bioreactor at reducing the concentrations of VOCs in the aquifer underlying SWMU B-3.

Section 2 provides a description of the pilot study remedial (bioreactor) system in operation at the Site, including a detailed description of the system components. Section 3 describes the system operation and monitoring requirements, Section 4 presents the system maintenance activities to be performed, and Section 5 discusses reporting requirements. The Texas Commission on Environmental Quality (TCEQ) Authorization Letter(s) for the underground injection of VOC impacted groundwater is included in Appendix A. Product manuals and literature of system components are included in Appendix B through J. Field data forms to be used during O&M activities are included in Appendix K.

1.1 HEALTH AND SAFETY

CSSA and Parsons Infrastructure and Technology (Parsons) are committed to performing the O&M activities at the B-3 site in a safe manner. A Health and Safety Plan (HSP) has been prepared that addresses worker safety during performance of the O&M activities at the site. The HSP identifies potential safety hazards associated with the O&M work activities and describes safety procedures that must be implemented to ensure that the work can be completed without incident. A copy of the HSP is maintained at CSSA.

All personnel performing O&M activities at the site must read the HSP to become familiar with the potential work hazards and the safety procedures to be followed. After familiarizing themselves with the HSP, all employees must sign the HSP Acknowledgement Form maintained at CSSA. The procedures presented in the HSP must be followed by Parsons Employees and subcontractors at all times while on CSSA. The HSP will be updated as needed to address new site work hazards or incorporate work tasks as they are identified.

1.2 SITE DESCRIPTION

CSSA is located in northwestern Bexar County about 19 miles northwest of San Antonio, Texas. The installation consists of 4,004 acres immediately east of State Highway 3351 and approximately one-half mile from Interstate Highway 10. Additional background information regarding CSSA is located in CSSA's Environmental Encyclopedia (**Volume 1-1, Background Information Report**).

SWMU B-3 was a landfill area thought to have been used primarily for garbage disposal and trash burning from the 1950's through the 1980s. The trench areas were reportedly closed in 1990-1991. In 1991, chlorinated hydrocarbons were detected in groundwater from Well CS-16, approximately 500 feet north-northwest of SWMU B-3. The VOC concentrations, which were above drinking water standards, prompted several investigations aimed at identifying possible source areas that could be contributing to the contamination. SWMU B-3, along with nearby SWMU O-1 (oxidation pond), was identified as potential sources of groundwater contamination within the inner cantonment.

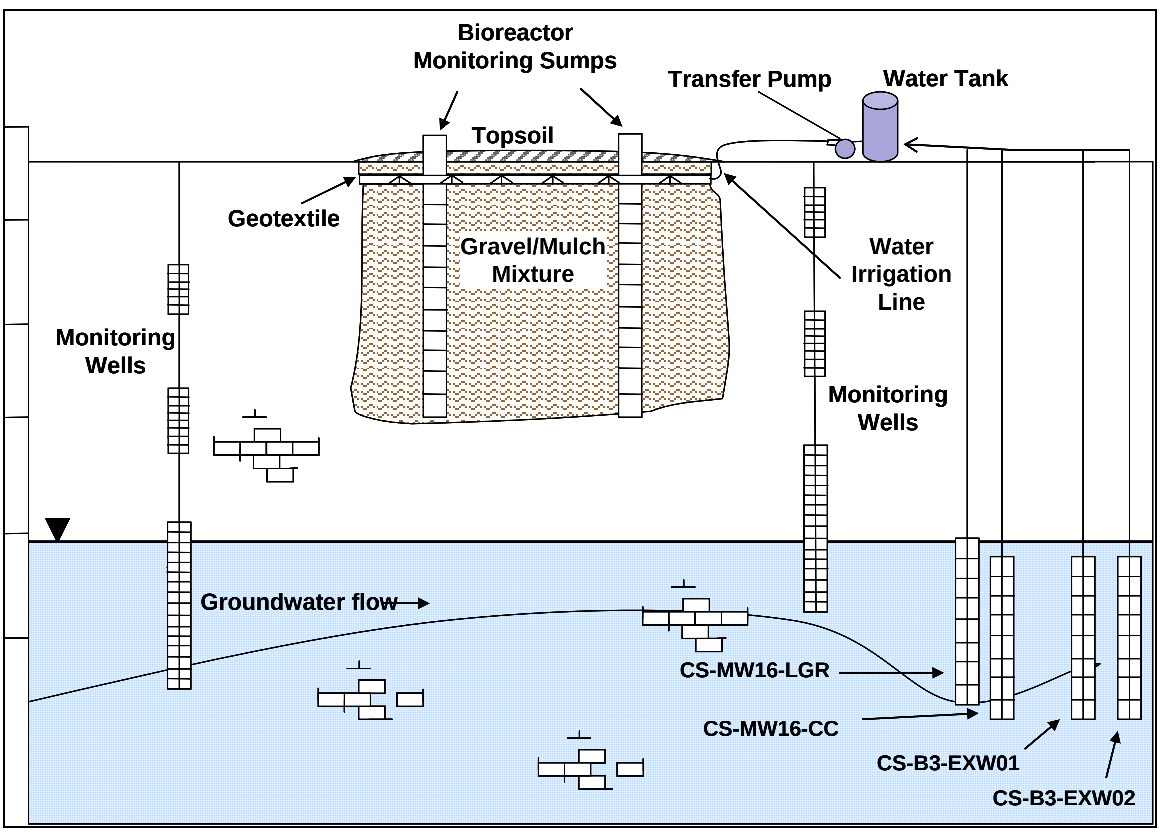
As part of the Resource Conservation and Recovery Act (RCRA) Administrative Consent Order, a pilot study using a bioreactor was conceptualized, designed, and constructed at SWMU B-3. The bioreactor is designed to remediate the affected groundwater and unsaturated zone underlying SWMU B-3. The design included excavation, removal, and offsite disposal of affected soil, debris, and waste contained within six trenches. The waste is believed to be a likely source of contaminants impacting the underlying fractured limestone (bedrock) and groundwater.

Based on the general design of the bioreactor, a request for a Class V Aquifer Remediation Injection Well was submitted to the Industrial and Hazardous Waste Permits Section of the Waste Permits Division at the Texas Commission on Environmental Quality (TCEQ) in May 2006. The permit application was approved July 20, 2006 and TCEQ Authorization Number 5X2600431; WWC 12002216; CN602728206/RN104431655 was assigned to the SWMU B-3 injection system. An amendment to CSSA's Class V Aquifer Remediation Injection permit was authorized by TCEQ letter dated June 25, 2007 for use of a sixth trench at SWMU B-3. TCEQ amended the permit reporting schedule by letter dated July 31, 2008. A copy of the Class V Aquifer Remediation Injection Well permit authorization letter and correspondence related to amendments are presented in Appendix A.

SECTION 2
SYSTEM DESCRIPTION

The general concept (see Figure 2.1) is to pump extracted groundwater from recovery wells CS-MW16-LGR, CS-MW16-CC, and CS-B3-EXW01 to a 5,000-gallon storage tank. Level switches within the storage tank are set to communicate directly with the extraction wells to maintain an available water supply in the tank for subsequent injection into bioreactor trenches. A transfer pump pumps water from the storage tank to the network of pipes buried approximately 1.5 ft below a gravel surface which overlies the SWMU B-3 gravel/mulch filled trenches. Water from the storage tank is sprayed into the gravel/bark mulch mixture in each trench through downward-pointing discharge nozzles located at 10-foot centers along 1.5-inch flexible high density polyethylene (HDPE) pipe. The use of these nozzles allows a more even distribution of injected water along the trench.

Figure 2.1 General Components of the Bioreactor



To prevent the bioreactor from overfilling, a level switch is installed in monitoring sump 1-1 (Trench 1 - sump 1) which will shut down the transfer pump in the event that the water level in trench 1 reaches the high-level shut-off. The level switch high-level shut-off is set at approximately one foot below trench 1 capacity. Sump 1-1 is located in the deepest portion of the bioreactor, west and downslope of the other trenches. Additional transducers may be added to a sump in the remaining trenches to provide simultaneous monitoring locations to assess subsurface flows within the bioreactor.

Water is pumped into selected trenches to saturate a portion of the gravel/tree mulch mixture backfill. The bioreactor capability to reduce contaminants associated with extracted groundwater from CS-MW16-LGR, CS-MW16-CC, CS-B3-EXW01, and CS-B3-XW02 as well as contaminants in the subsurface beneath the bioreactor is assessed through periodic sampling of groundwater monitoring wells, trench sumps, piezometers and multi-port monitoring wells (MPMWs) located in and around SWMU B-3.

2.1 BIOREACTOR CONSTRUCTION

The details associated the construction of the bioreactor are provided in *"B-3 Bioreactor Construction Report"* (Parsons, February 2007).

2.2 MAJOR EQUIPMENT

Equipment was installed to provide control of water flow from the two CS-MW-16 wells, CS-B3-EXW01, and CS-B3-EXW02. The process diagram depicting the equipment and the controls regulating the flow of water through the system is shown in Figure 2.2.

2.2.1 Recovery Well Pumps

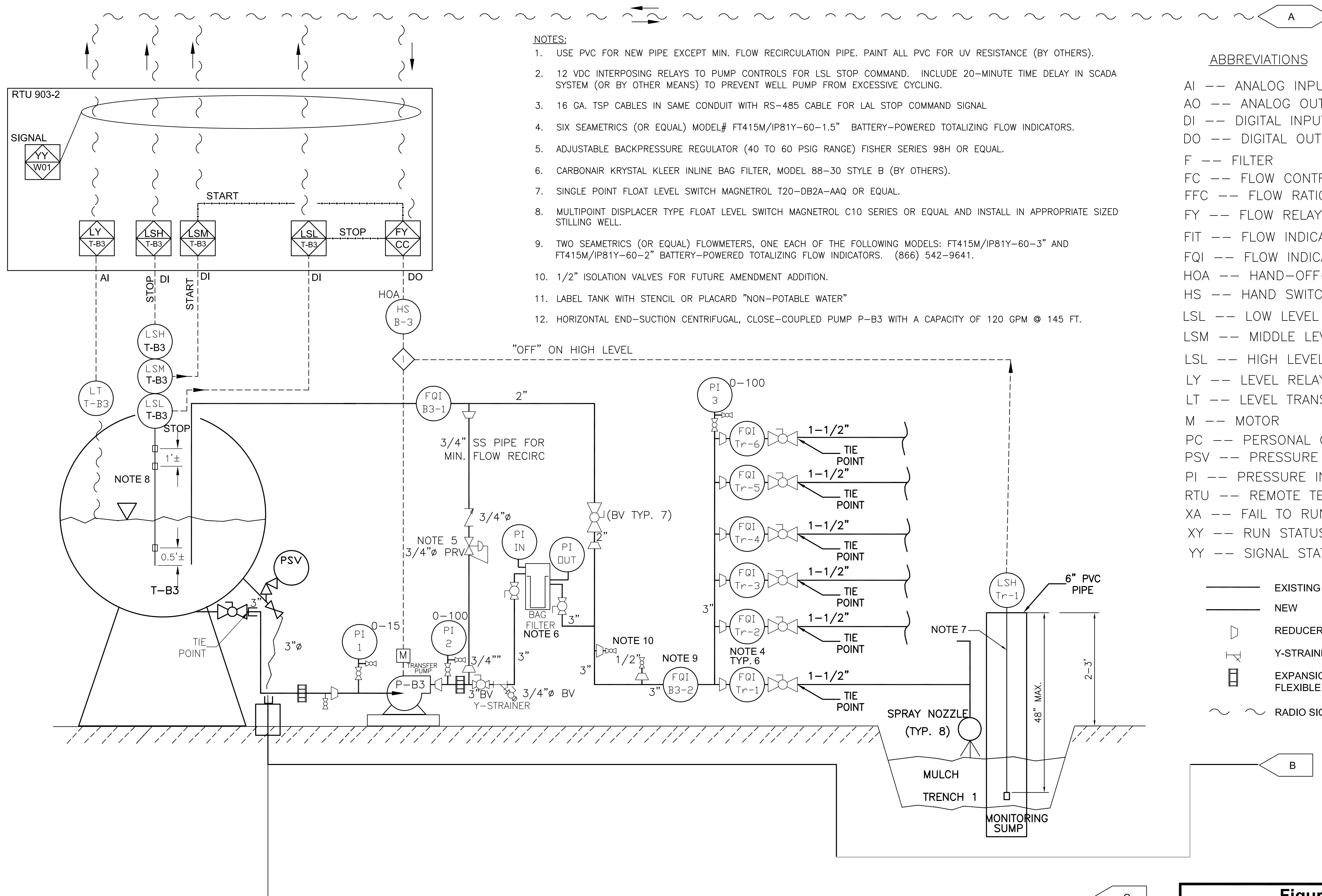
Extraction wells CS-MW16-LGR and CS-MW16-CC utilize submersible pumps installed in 2002. A 1-inch diameter flex-pipe line was installed in CS-MW-16LGR to facilitate water level probe access and access to a QED low-flow pump used for sampling purposes. A 5-horsepowser (hp) pump was installed in CS-B3-EXW01 in 2009. A fourth extraction well was installed to provide additional water to the bioreactor. This new extraction well included a 5-hp pump to extract and transmit groundwater to the bioreactor. These pumps supply recovered groundwater to a 5,000 gallon storage tank, which is ultimately injected into the bioreactor trenches. Transducers are installed in both CS-MW-16 wells, CS-B3-EXW01, and CS-B3-XW02 located near the former oxidation pond O-1 approximately 700 feet south of the trenches.

Both CS-B3-EXW01 and CS-B3-EXW02 are equipped with SymCom PumpSaver 235P motor protection devices. The sensing devices monitor the amperage being used by the pump motor. After an initial calibration by the Operator, if the PumpSaver detects and undercurrent condition (user settable between 10 and 30 percent) or an overcurrent condition of more than 25 percent, the well pump is disabled for a specified time period. This protects the motor from running dry (undercurrent) or pumping too hard (overcurrent). The use of these devices requires that they be calibrated by the Operator using the methods outlined in the product brochure included in Appendix B.

Pump details, including operations and maintenance instructions and parts listing are also provided in Appendix B.

2.2.2 System Transfer Pump

An end suction centrifugal pump manufactured by Price® Pump Co. is installed to transfer water from the storage tank through the bioreactor injection manifold and ultimately into the trenches. The transfer pump cycles on/off automatically depending on the water level detected in the bioreactor and the water level in the storage tank. The pump is connected to the storage tank with a 2-inch suction hose and schedule 80 polyvinyl chloride (PVC) line and is bolted to the concrete pad constructed adjacent to the storage tank. A 1.5-inch line installed from the pump to the bag filter and then from the bag filter to the 3-inch header connects the pump to the distribution system. Since portions of the line between the storage tank and the distribution line are above ground, precautions are taken to prevent line damage during freezing weather conditions. Additional information about the pump is provided in Appendix C.



NOTES:

1. USE PVC FOR NEW PIPE EXCEPT MIN. FLOW RECIRCULATION PIPE. PAINT ALL PVC FOR UV RESISTANCE (BY OTHERS).
2. 12 VDC INTERPOSING RELAYS TO PUMP CONTROLS FOR LSL STOP COMMAND. INCLUDE 20–MINUTE TIME DELAY IN SCADA SYSTEM (OR BY OTHER MEANS) TO PREVENT WELL PUMP FROM EXCESSIVE CYCLING.
3. 16 GA. TSP CABLES IN SAME CONDUIT WITH RS–485 CABLE FOR LAL STOP COMMAND SIGNAL
4. SIX SEAMETRICS (OR EQUAL) MODEL# FT415M/IP81Y–60–1.5" BATTERY–POWERED TOTALIZING FLOW INDICATORS.
5. ADJUSTABLE BACKPRESSURE REGULATOR (40 TO 60 PSIG RANGE) FISHER SERIES 98H OR EQUAL.
6. CARBONAIR KRYSTAL KLEER INLINE BAG FILTER, MODEL 88–30 STYLE B (BY OTHERS).
7. SINGLE POINT FLOAT LEVEL SWITCH MAGNETROL T20–DB2A–AAQ OR EQUAL.
8. MULTIPOINT DISPLACER TYPE FLOAT LEVEL SWITCH MAGNETROL C10 SERIES OR EQUAL AND INSTALL IN APPROPRIATE SIZED STILLING WELL.
9. TWO SEAMETRICS (OR EQUAL) FLOWMETERS, ONE EACH OF THE FOLLOWING MODELS: FT415M/IP81Y–60–3" AND FT415M/IP81Y–60–2" BATTERY–POWERED TOTALIZING FLOW INDICATORS. (866) 542–9641.
10. 1/2" ISOLATION VALVES FOR FUTURE AMENDMENT ADDITION.
11. LABEL TANK WITH STENCIL OR PLACARD "NON–POTABLE WATER"
12. HORIZONTAL END–SUCTION CENTRIFUGAL, CLOSE–COUPLED PUMP P–B3 WITH A CAPACITY OF 120 GPM @ 145 FT.

ABBREVIATIONS

AI –– ANALOG INPUT
AO –– ANALOG OUTPUT
DI –– DIGITAL INPUT
DO –– DIGITAL OUTPUT
F –– FILTER
FC –– FLOW CONTROLLER
FFC –– FLOW RATIO CONTROLLER
FY –– FLOW RELAY
FIT –– FLOW INDICATING TRANSMITTER
FQI –– FLOW INDICATING RECORDER
HOA –– HAND–OFF–AUTO
HS –– HAND SWITCH
LSL –– LOW LEVEL SWITCH
LSM –– MIDDLE LEVEL SWITCH
LSL –– HIGH LEVEL SWITCH
LY –– LEVEL RELAY
LT –– LEVEL TRANSMITTTER
M –– MOTOR
PC –– PERSONAL COMPUTER
PSV –– PRESSURE SAFETY VALVE
PI –– PRESSURE INDICATOR (GAGE)
RTU –– REMOTE TERMINAL UNIT
XA –– FAIL TO RUN ALARM
XY –– RUN STATUS RELAY
YY –– SIGNAL STATUS RELAY

Figure 2.2 (Page 1 of 2)

Bioreactor Pumping System
Process Diagram

CSSA SWMU B3

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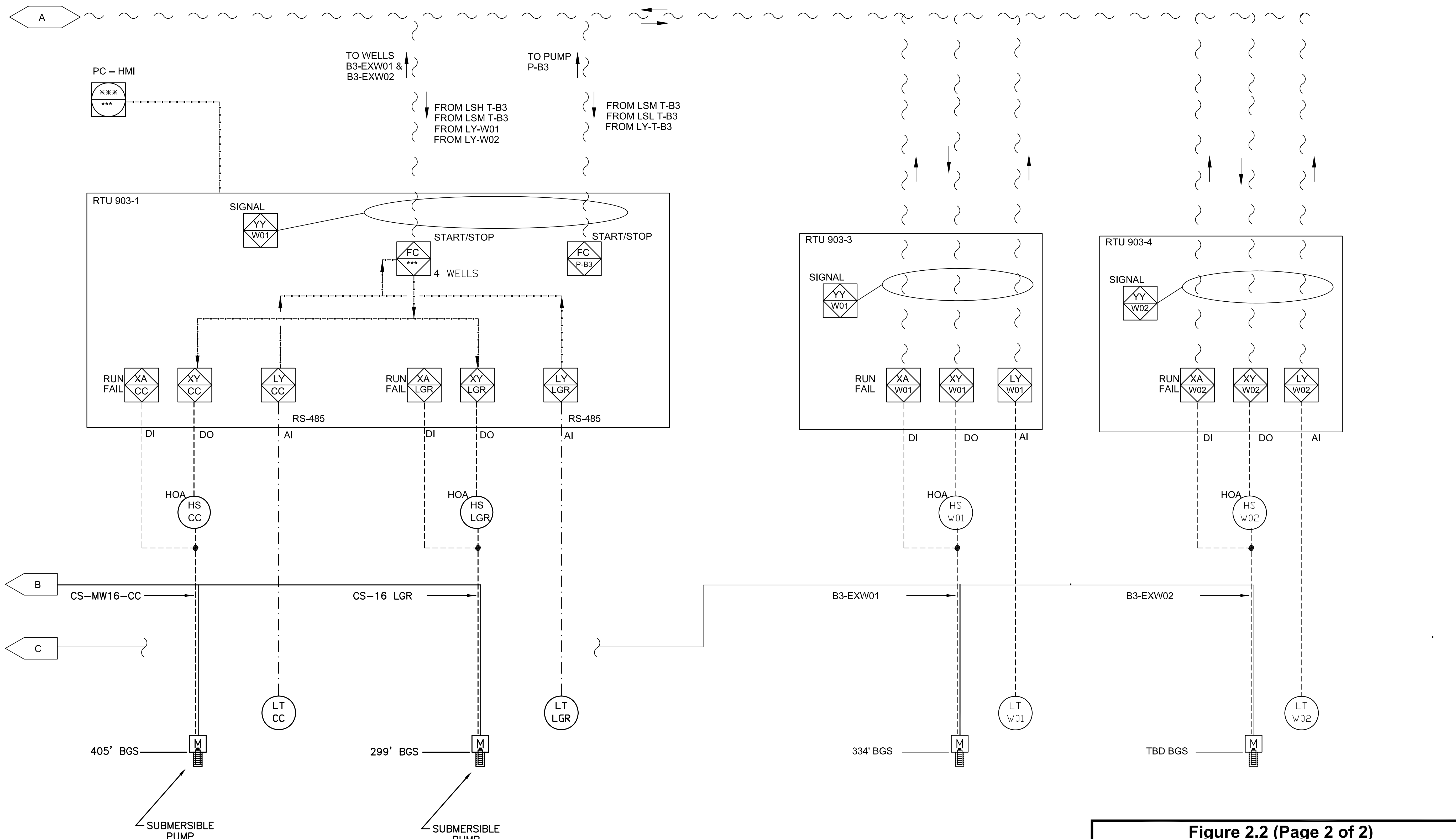
747145.07 B3 P–10M–03–31–10.DWG



747145.07 B3 P-10M-03-31-10.DWG

Figure 2.2 (Page 2 of 2)

Bioreactor Pumping System
Process Diagram

CSSA SWMU B3

PARSONS

2.2.3 Storage Tank

A 5000-gallon former transport tanker was placed on the north side of the bioreactor and secured. The former transport tank serves as temporary storage of ground water from the extraction wells and is the on demand water supply to the bioreactor. Monthly inspections are conducted to examine the condition of the tank and any deficiencies are noted in the field logbook.

2.2.4 Bag Filter System

The water sprayer discharge openings in the bioreactor trenches are small (0.063-inch orifice for 1.7 gallons per minute (gpm) spray nozzles and a 0.094-inch orifice for 2.5 gpm spray nozzles); therefore, it is necessary to remove as much sediment from the injection water as possible to reduce the potential for clogging the spray heads. As shown in Figure 2.2, the bag filter equipment is installed downstream of the transfer pump before the distribution manifold. The bag filter equipment, manufactured by Krystil Klear Filtration® consists of a single chamber with a coarse mesh basket and a bag filter fitted inside the mesh basket. Bag filter replacement should follow the schedule recommended by the manufacturer, or more frequently as determined by use in the field. Additional information about the bag filter equipment is provided in Appendix D.

2.2.5 Eductor for Incorporation of Additive

An eductor system may be included down stream of the bag filter for future use if it is deemed necessary to inject additional additive into the bioreactor. A container of oil or similar microbial enhancement amendment can be placed near the eductor and an intake pipe will be placed in the container to inject the specified dosage. The additive is drawn into the flow system via the eductor as water passes through the piping which then uniformly distributes the additive with injected groundwater.

2.3 TRENCH AND INJECTION PIPING LAYOUT

The details associated with excavation trenches are provided in *"B-3 Bioreactor Construction Report"* (Parsons, February 2007). There are six trenches within SWMU B-3 potentially utilized for injection of extracted groundwater. The injection piping from the transfer piping is constructed of 1.5-inch HDPE piping with pressure type fittings. Brass injection nozzles are located in each trench with orifice openings of 0.063-inch for 1.7 gpm spray nozzles, and a 0.094-inch orifice for 2.5 gpm spray nozzles. Nozzle specifications are provided in Appendix E.

2.4 INSTRUMENTS AND CONTROL

The Bioreactor has been automated to operate with minimal supervision since it was first installed. In March 2010, the Bioreactor automation system was upgraded to provide additional controls and provide connectivity to the CSSA Supervisory Control and Data Acquisition (SCADA) system. The system uses four Remote Telemetry Units (RTU) to control the operation of the Bioreactor System. The RTUs are located at the GAC Shack, the Bioreactor Tank, and extraction wells CS-B3-EXW01 and CS-B3-

EXW02. The RTUs use wireless radios (900 MHz) to communicate commands, status, and data between the Bioreactor components. Ultimately, the data is wireless transferred (VHF radio) back to the SCADA system for viewing at the SCADA workstations located in Buildings 1, 36, 38, and 606. The Bioreactor can be operated from either the control screen located in the GAC Shack or SCADA workstation by an operator with the proper credentials.

The main RTU (903-1) is located inside the GAC Shack, and serves as the hub for the Bioreactor controls. It communicates directly with the slave RTUs at the Bioreactor Tank (RTU 903-2), CS-B3-EXW01 (RTU 903-3), and CS-B3-EXW02 (RTU 903-4) to control the operation of Bioreactor. In addition, the GAC Shack RTU communicates directly with SCADA system to transmit data and receive commands. The 903-1 RTU features touch screen controls to operate the Bioreactor system. The 903-1 RTU also controls the MW16 wells, the weather station and the GAC Shack treatment system.

Slave RTU 903-2 communicates directly with Master RTU 903-1, and controls the functions at the Storage Tank and Transfer Pump. The storage tank is equipped with high, medium, and low level switches which dictate when the wells are activated to fill the tank. The level switches in the tank also control the operation of the transfer pump to convey water from the tank to the trenches. The tank is also equipped with an ultrasonic level meter to monitor the level of water in the tank. The purpose of the ultrasonic meter is to provide an accurate reading of the water level in the tank and to serve as a redundant control in the event if the mechanical switches fail. RTU 903-2 also monitors the high level switch located in Trench 1 (Monitoring Sump 1-1). When the switch indicates that Trench 1 is full to capacity, the production and transfer of water to the trenches ceases until the water level recedes as indicated by the switch.

Slave RTU 903-3 communicates directly with Master RTU 903-1, and controls the operation of extraction well CS-B3-EXW01. This location is equipped with pump controls, pressure transducer, and a water flowmeter. Based on commands given by the Master RTU 903-1, this RTU operates the well pump and communicates the groundwater level and flowrate back to the Master RTU 903-1.

Slave RTU 903-4 communicates directly with Master RTU 903-1, and controls the operation of extraction well CS-B3-EXW02. This location is equipped with pump controls, pressure transducer, and a water flowmeter. Based on commands given by the Master RTU 903-1, this RTU operates the well pump and communicates the groundwater level and flowrate back to the Master RTU 903-1.

Each major component in the system is equipped with a motor control panel that feature **"HAND-OFF-AUTO"** (HOA) switches. For the system to be automated, it is necessary the individual motor control panels at wells CS-MW16-LGR, CS-MW16-CC, CS-B3-EXW01, CS-B3-EXW02, and the Transfer Pump are switched to **"AUTO"**. The control equipment for each of these pumps are located at their respective locations.

Product information for controllers and instruments are provided in Appendix F.

2.4.1 Pressure Gauges and Flow Meters

As required by TCEQ, the monitoring and reporting of flow volumes discharged into the subsurface is and must be reported in scheduled (semi-annual) UIC authorization reports. Instruments to monitor line pressures and volume of injection water are provided for the B-3 bioreactor System. Pressure gauges are located at various locations between the storage tank and the main header as shown in the design drawings in *"B-3 Bioreactor Construction Report"* (Parsons, February 2007.). In addition, flow meters are installed to provide injection volumes in each of the six trenches, as well as extraction volumes from the extraction wells. A K factor of 98.0 is used for flow meters installed on 1.5" lines, and a K factor of 25.4 is used for flow meters installed on 3" lines. The injection manifold containing the six trench injection lines are equipped with FT415 SeaMetrics flow meters to obtain discrete volumes injected into each trench.

Extraction wells CS-B3-EXW01 and CS-B3-EXW02 are equipped with an Endress+Hauser Prowirl 72F flowmeter with SCADA connectivity. Wells CS-MW16-LGR and CS-MS16–CC are equipped with GPI TM150 flowmeters that do not offer SCADA connectivity, and therefore require manual readings.

Product information for the various flow meters is provided in Appendix G**.**

2.4.2 Liquid Level Switches and Meters

Multiple sets of water level indicators are required for the automation system to operate effectively. One set is installed within the storage tank and is comprised of three Magnetrol, model C10, liquid level switches. These switches indicate high, medium, and low levels within the storage tank. Another liquid level meter (Endress+Hauser FMU40) is also installed to provide instantaneous level measurements from within the tank.

One model T20, Magnetrol liquid level switch is installed in Sump 1-1, to communicate the water level within the trench to the control system which, in turn, controls the transfer pump.

Each well is equipped with a pressure transducer to monitor the groundwater level in the borehole. Wells CS-MS16-LGR and CS-MS16–CC are both equipped with In-Situ LevelTroll 500 devices. Extraction wells CS-B3-EXW01 and CS-B3-EXW02 are equipped with an Endress+Hauser WaterPilot FMX167.

Product information for the liquid level switches and level transducers are provided in Appendix H.

2.4.3 SCADA Controls

The SCADA controls are made up of a myriad of components from various manufacturers. The individual components are consolidated into single enclosures to comprise an RTU. In general, the RTUs feature General Electric VersaMax Programmable Logic Controllers (PLC), Weidmuller 900 MHz radios, and Red Lion protocol converters.

Product information for the SCADA controls is provided in Appendix I.

SECTION 3
SYSTEM OPERATION AND MONITORING

3.1 SITE ACCESS

Camp Stanley is an active military installation. Security regulations mandate that the base be informed about any operation that are to take place inside the installation borders. Visitors and subcontractors need to contact the base 48 hours in advance with personal information to obtain entrance permit. Entry to the base occurs through the main gate situated in the south-west corner of the base, on FM 3351. Access related issues are coordinated through the CSSA Environmental Office.

3.2 NORMAL OPERATION PROCEDURES

During normal operation, the system will be pumping groundwater from four wells, CS-MW16-LGR, CS-MW16-CC, CS-B3-EXW01, and CS-B3-EXW02. The extracted groundwater is pumped into the storage tank which is then pumped through a bag filter to remove suspended solids that could cause fouling of the spray nozzles and ultimately into trenches filled with deciduous tree mulch/gravel mixture. The following sections outline the steps in the operation of the bioreactor. The intent of operating and controlling the groundwater recovery system (CS-MW16 and CS-B3-EXW wells) and the bioreactor transfer pumping system (5,000 gallon storage tank) is to maximize the throughput of water to the bioreactor.

3.2.1 Pumping water from Extraction Wells to Storage Tank

Submersible pumps in Wells CS-MW16-CC, CS-MW16-LGR, CS-B3-EXW01, and CS-B3-EXW02 are expected to pump water at a combined, sustainable flow rate ranging between 50 gpm and 200 gpm to the 5,000-gallon storage tank. The estimated ranges of flowrates are highly variable and are dependent upon the condition of the aquifer. A 70 gpm rate is an estimated average rate that may fluctuate depending on which wells are currently operational and aquifer groundwater availability. To ensure the pump will not run dry, each well is equipped with a pressure transducer that is set to signal deactivation of the pump if the water level gets too low during the drawdown phase. The pressure transducers also signal the pump when the water level is high enough for pumping to resume after the recovery phase. The different scenarios controlling the operation of the well pumps (water levels in recovery well and 5,000 gallon storage tank) are identified in Table 3.1.

In addition to the RTU controllers for the extraction wells, there is a separate RTU controller connected to level switches located in the 5,000-gallon storage tank. There is an HOA switch at each pump that should be kept in the automatic mode where both the well transducer and the storage tank level switches control the activation of the pump.

Table 3.1 Scenarios Dictating Activation of the Submersible Pumps at Groundwater Supply Wells

Water Level in Well	Water Level in 5000-gallon Storage Tank	Activation of All or One Extraction Well Based on Water Levels in Well and Storage Tank
1. During drawdown phase and above the low level turn-off depth.	Below the high level turn-off.	**<u>On</u>**
2. During drawdown phase and above the low level turn-off depth.	At the high level turn-off.	Off
3. During recovery phase and above the low level turn-off depth, but also below the high level restart.	Below the high level turn-off.	Off
4. During recovery phase and above the low level turnoff depth.	At the high level turn-off.	Off
5. High level is attained (*i.e.*, completion of recovery phase)	Below the high level turn-off.	**<u>On</u>**
6. High level is attained (*i.e.*, completion of recovery phase)	At the high level turn-off.	Off

Note: Controllers are switches that start or stop operations under certain conditions.

Generally, the controllers associated with the recovery wells will allow recovery well pumps to operate when there is sufficient water in the wells and sufficient volume capacity in the 5,000 gallon storage tank.

3.2.2 Pumping Water from Storage Tank to the Bioreactor

Extracted water stored in the storage tank is pumped to the bioreactor with an end-suction centrifugal transfer pump located between the storage tank and the bioreactor trench manifold. The operation of the transfer pump is controlled by level switches in the storage tank as well as a level switches in bioreactor trench sump 1-1 in Trench 1. This sump is located in the deepest bioreactor trench and should provide a representative water level elevation of the saturated conditions across the base of the bioreactor in Trenches 1 through 6. There is an HOA switch at the transfer pump that should be kept in the automatic mode so that both the sump water level switch and the storage tank level switches control the activation of the transfer pump. The different scenarios controlling the operation of the transfer pump are identified in Table 3.2.

Table 3.2 Scenarios Dictating Activation/Deactivation of the Transfer Pump

Water Level in Bioreactor Sump	Water Level in 5000-Gallon Storage Tank	Response of Transfer Pump Based on Signal from a Sump or a Tank Level Switch
1. Below the high level turn-off switch and water level rising in Trench 1 with transfer pump operating.	Above the low level turn-off.	Continues operating
2. Below the high level turn-off switch and water level rising in Trench 1 with transfer pump operating.	Water level reaches the low level turn-off.	Turns off
3. Below the high level turn-off switch and water level dropping in Trench 1 with transfer pump off.	Water level rising in tank and reaches the medium-level turn-on (switch set just below the high level switch).	Turns on
4. Pump has been off and water level recedes below the sump level switch.	Water level at high-level switch.	Turns on
5. Pump has been on and water rises to the sump level switch.	Water level above low-level turn-off switch.	Turns off

Generally, the controllers at the 5,000 gallon storage tank will operate the transfer pump when there is sufficient volume of water in the 5,000 gallon storage tank and sufficient volume capacity within trench 1.

3.3 SCADA OPERATION PROCEDURES

3.3.1 General Operating Principle

As of March 2010, the Bioreactor components have been incorporated into the SCADA system. Simply stated, the process logic to operate the supply/extraction wells and transfer pump are automated to deliver groundwater to the Bioreactor infiltration trenches. Safeguards have also been included to prevent the extraction wells and transfer pump from running dry, or preventing the Bioreactor Storage Tank and infiltration trenches from overflowing. All systems include "manual override" operation by setting the **"HAND-OFF-AUTO"** (HOA) switches at each motor control panel to **"HAND"**. For the system to operate under automatic control, the HOA switches at the following locations all need to be switched to the **"AUTO"** position:

- CS-MW16-LGR;
- CS-MW16-CC;

- CS-B3-EXW01;
- CS-B3-EXW02; and
- Bioreactor Transfer Pump.

Several criteria must be met for the wells to operate and provide water to the Bioreactor tank:

1. The water level in Trench 1 must be below the mechanical float trigger point installed in Sump 1-1. If the mechanical float in this well is active, the trenches are filled to capacity and therefore no more groundwater will be introduced until the trench water levels recede below the Sump 1-1 mechanical float setpoint.
2. The operation of the transfer pump and supply wells are interlocked with the capacity of the storage tank. The storage tank is equipped with a triple-point (**HIGH-MEDIUM-LOW**) mechanical float with redundant level measurement from an ultrasonic level meter.
    a. The **HIGH** float setpoint is used to turn off the supply wells (Table 3.1). If the water level in the tank is below the **HIGH** float setpoint and the trenches are not full (see item 1) the supply wells will run, assuming the groundwater level has recovered to its' minimum start depth.
    b. The **LOW** float setpoint is used to turn off the transfer pump. This setpoint prevents the transfer pump from running dry (Table 3.2).
    c. The **MEDIUM** float setpoint is used to turn on the transfer pump once the tank has been re-filled by the supply wells to above two-thirds capacity (Table 3.2). The transfer pump will continue to run until the water level decreases to the **LOW** float switch. The **MEDIUM** float setpoint is also used to re-start the wells once the tank level drops below two-thirds capacity.
3. Each well is equipped with a pressure transducer to monitor the water level within the borehole and prevents the well pump from running dry, and also dictates the amount of water level recovery that must occur before the well can be re-started. The **START** and **STOP** setpoints for each well is definable by the Operator via the SCADA interface. Even if the Bioreactor tank controls (**HIGH** float) are calling for the well operation, the well will not actuate if the recovery phase is not complete.

Bioreactor automation process is all controlled locally at the site from the GAC Shack RTU. As previously described, the GAC Shack RTU communicates wireless between the groundwater wells and the Bioreactor tank. Because the automation logic is housed locally at the site, the Bioreactor system does not depend upon interface between the SCADA Master PLC, Server, or Operator Workstations.

Assuming that the motor control HOA switches are in the **"AUTO"** position, the Bioreactor system can manipulated either locally at the GAC Shack, or remotely from any of the SCADA workstations (B1, B36, B38, or B606). The following are descriptions on how to interface with the Bioreactor SCADA Controls.

3.3.2 Local SCADA Control from GAC Shack

The operational programming functions reside in the local PLC located at the GAC Shack RTU. Most functions are internal and have been programmed by the SCADA integrator, Systems Control & Instrumentation (SCI, 210-661-9901). However, limited operational functionality resides with the Bioreactor Operator and includes:

- ***OFF/AUTO Pump Status*** (CS-MW16-LGR, CS-MW16-CC, CS-B3-EXW01, CS-B3-EXW02, and Transfer Pump);
- ***Water Level Operational Setpoints*** (CS-MW16-LGR, CS-MW16-CC, CS-B3-EXW01, and CS-B3-EXW02).

The GAC Shack RTU includes a touchscreen user interface to review the status of the Bioreactor system, and allow the Operator to make changes. Current Operators authorized to manipulate the RTU view screen are:

- ***SCI:*** Richard Fincke;
- ***Parsons:*** Julie Bouch, Samantha Elliott, Scott Pearson, Eric Tennyson.

To add additional users to the system, the user will need to contact Richard Fincke (210-661-9901) for technical support.

To operate the Bioreactor system in **"Automatic"** mode, the Operator will need to ensure that the HOA switches at the selected motor control panels (four groundwater supply wells and transfer pump) are set to **"AUTO"**. It is important to note that not all wells are required to operate Bioreactor in **"Automatic"** mode. As few as one groundwater extraction well could be run and allowed to gravity feed into the trenches if so desired. However, for this discussion all wells and transfer pump will be assumed to be needed for operation.

The GAC Shack RTU viewscreen provides a series of five menus to observe and control the function of the Bioreactor. Figure 3.1 depicts the process logic used to navigate through the menus. The menus are described below. Text within a [box] indicate that button can pressed on the viewscreen.

3.3.2.1 CSSA LOGIN SCREEN

The Login Screen allows the user gain access to the operational submenus. The initial login user name is typically their First Name with a password that is the last four digits of their cell phone number. The SCI system integrator will be responsible for setting up new users on the system.

Once a user has correctly submitted their user name and password, they have the option to continue to the [***CSSA BIOREACTOR SCREEN***] or [***LOG OFF***].

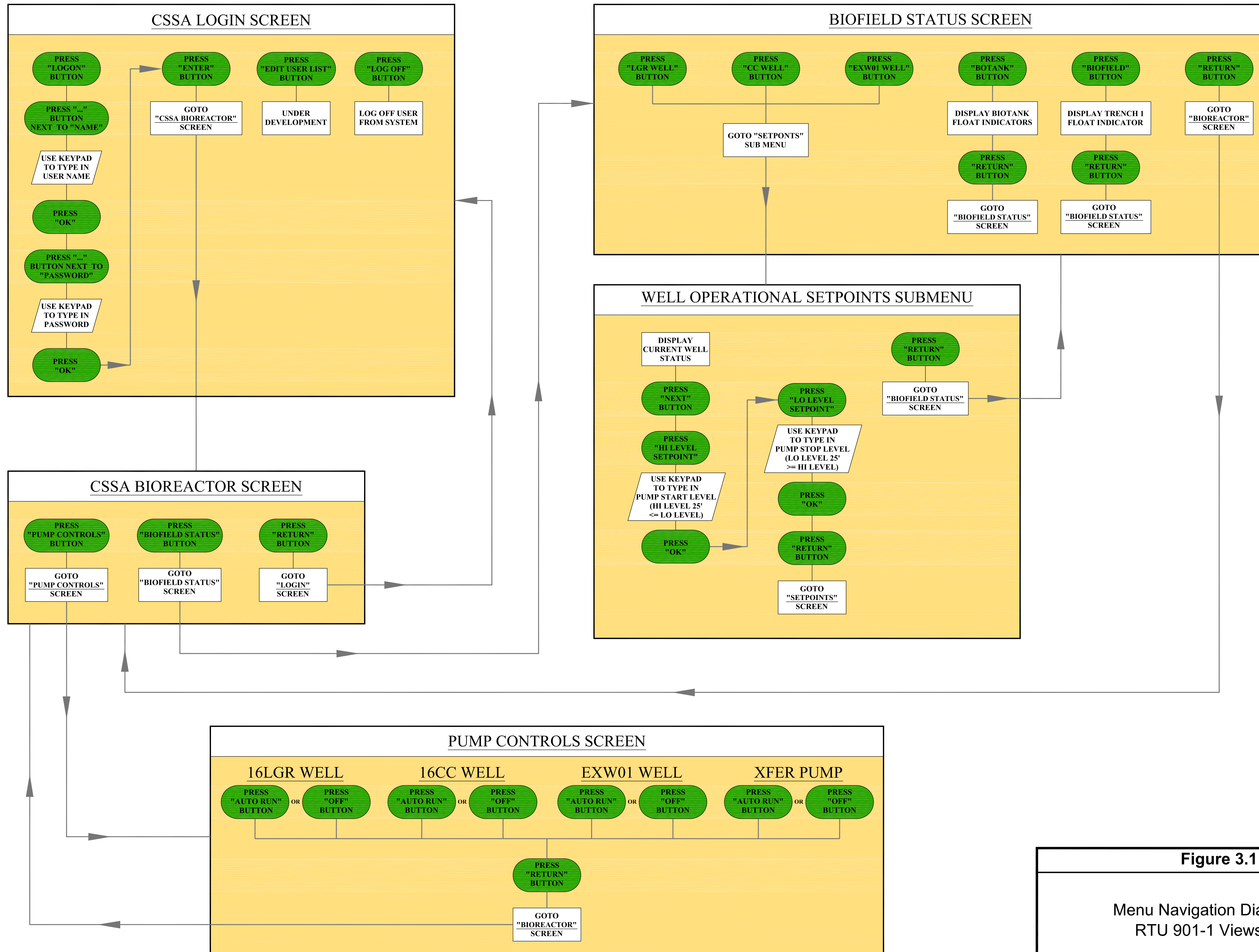


Figure 3.1

Menu Navigation Diagram for RTU 901-1 Viewscreen

746545 B3 SCADA CONTROL CHART.DWG 4/1/10

3.3.2.2 CSSA BIOREACTOR SCREEN

This is the top level menu on the viewscreen controls. This allows the user to either navigate to the ***PUMP CONTROLS SCREEN***, ***BIOFIELD STATUS SCREEN*****,** or press ***RETURN*** to redirect to the ***LOGIN SCREEN***.

3.3.2.3 PUMP CONTROLS SCREEN

This screen allows the user to toggle the status of each pump associated with the Bioreactor. Each pump may be selected to either be in the ***AUTO RUN*** position or ***OFF*** position. Pressing the toggle for each pump will result in a change of color on the viewscreen toggle switch. For each pump, the toggle position displayed in the color "**RED**" indicates the current setting for that pump. For the setting to have any effect, it is imperative that the **HOA** switch for that pump is in the "**AUTO"** position. The pumps will actuate when all the level setpoint criteria are met as outlined in Section 3.3.1.

Once the pump controls are in their desired state, press the ***RETURN*** button to redirect back to the ***CSSA BIOREACTOR SCREEN***.

3.3.2.4 BIOFIELD STATUS SCREEN

This viewscreen displays the status for each component of the Bioreactor system. From this screen the user can access the ***WELL OPERATIONAL SETPOINTS SUBMENU*** (described below), or view the status of ***BIOTANK*** or ***BIOFIELD*** (Sump 1-1) Float switches (HIGH or LOW level indicators). Press the ***RETURN*** button to redirect back to the ***CSSA BIOREACTOR SCREEN***.

3.3.2.5 WELL OPERATIONAL SETPOINTS SUBMENU

This submenu is accessed from the ***BIOFIELD STATUS SCREEN*** and is used to display the current status of each groundwater supply well. For each given well, the current water level and water temperature (if available) is displayed. If the well has attained its low level setpoint and is in the recovery phase, the "Low Level" indicator will illuminate in the color "**RED**". Pressing the ***NEXT*** button will give the user access to change the ***START*** and ***STOP*** point for a given well. These user inputs are important because they can affect the operation of the pump. The numbers inputted here represent a specific groundwater level in that well as measured from Below Top of Casing (BTOC).

- ***STOP***: The corresponding water level in the well at which the well pump will be turned off. It is imperative that the ***STOP*** water level be at a depth above the well pump to prevent it from running dry. These depths need to be less than the following:
    - CS-MW16-LGR ***STOP*** < 290 feet BTOC;
    - CS-MW16-CC ***STOP*** < 390 feet BTOC;
    - CS-B3-EXW01 ***STOP*** < 330 feet BTOC;
    - CS-B3-EXW02 ***STOP*** < TBD feet BTOC;

- ***START***: The corresponding water level in the well at which the well pump will turn on. It is imperative that the ***START*** water level be at a depth at least 25 feet less than the ***STOP*** position and at no time should the ***START*** depth be greater than the ***STOP*** depth. The Operator should have working knowledge of the current static water level of the aquifers. If a ***START*** level is set at a depth less than the static water level, the pump will never run. In general, these depths need to follow the general guidelines:
  - ***START*** must be greater than STATIC Water Level (measured by Operator)
  - ***START*** must be at least 25 feet less than the ***STOP*** value;
  - STATIC < ***START*** < (***STOP***-25);
  - CS-MW16-LGR Example:
    - Measured Static Water Level = 235 feet BTOC
    - ***START*** = 265 feet BTOC
    - ***STOP*** = 290 feet BTOC

Once the operational setpoints are established for each well, the Operator can press the Return button to redirect back to the ***CSSA BIOFIELD STATUS SCREEN***.

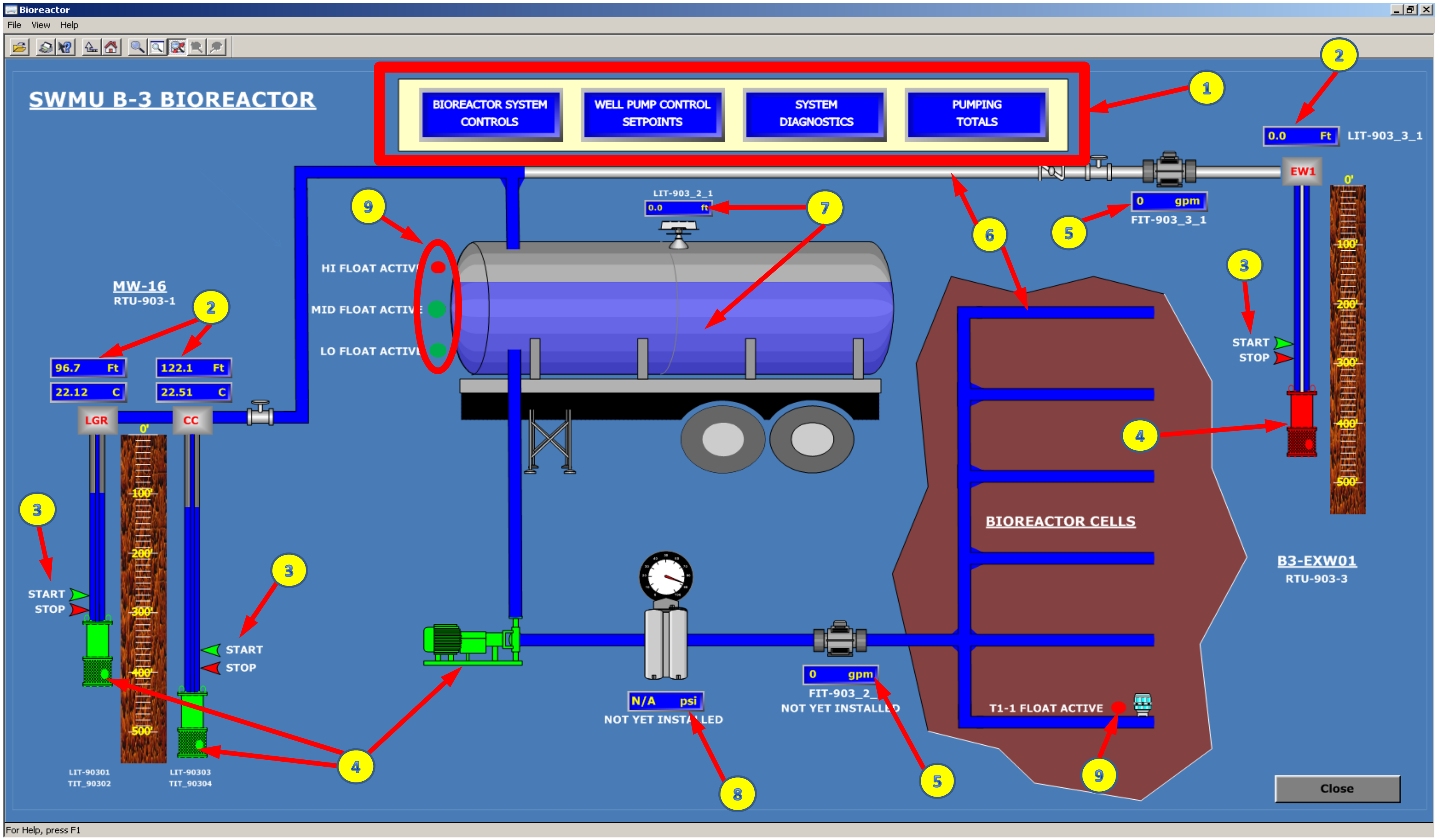
3.3.3 Remote SCADA Control from Workstations

The Operator can also display the Bioreactor status and access controls from any of the SCADA workstations at CSSA (B1, B36, B38, and B606). The Operator must have login and password credentials already established by the SCADA integrator (SCI). The BIOREACTOR screen is accessed from the left column of the ***MAIN MENU***. Real-time data from the Bioreactor is updated on the workstation approximately every three minutes due to the polling cycle of the VHF radio communications. Feedback on commands issued to the Bioreactor from a workstation may take as long as five minutes to indicate on the workstation screen because of the established VHF radio polling cycle.

3.3.3.1 MAIN BIOREACTOR SCREEN

Figure 3.2 is a screen capture from the SCADA workstation. The ***BIOREACTOR*** screen displays the physical layout of the current wellfield, storage tank, transfer pump, and infiltration trenches. The ***BIOREACTOR*** screen provides access to control menus as well as graphically displaying information about the system. Key features of the ***BIOREACTOR*** screen are enumerated on Figure 3.2 as listed below:

Figure 3.2
Bioreactor Monitoring Screen on CSSA SCADA



1. Links to related Bioreactor Screens
2. Moniitoring Well Water Level and/or Water Temperature
3. Well Pump Start/Stop Level Indicators
4. Pump Status (Green = Running, Red = Stop)
5. Water Flow Rate Indicator
6. Water Transmission Through Pipe (Blue = Water Flowing, White = No Water Flow)
7. Storage Tank Status (Measured Water Column Height and Visual Indicator)
8. Bag Filter Differential Pressure Meter (Optional Item not yet Installed)
9. Float Switch Status (Green = Water Level >Switch Depth, Red = Water Level < Swtich Depth)

1 ***Submenu Bar:*** Each button navigates to one of four Submenus.

2 ***Well Transducer***: Provides water level and/or water temperature from each Bioreactor supply well. The current water level of the well is graphically shown in the wellbore.

3 ***START/STOP Indicators***: Displays the current ***START*** and ***STOP*** setpoints for each well. The water level in the borehole is graphically approximate to the currently established ***START/STOP*** setpoints.

4 ***Pump Status Indicator***: When a pump is running it is displayed in the color "**GREEN**". When a pump is off it is displayed in the color "**RED**".

5 ***Water Flowmeter***: The current flowrate is displayed from CS-B3-EXW01. In the future, other wells and the Transfer Pump will have a similar functionality.

6 ***Water Flow Indication***: When water is being transmitted through pipe segments in the system, empty pipes turn the color "**BLUE**" to indicate water flow.

7 ***Storage Tank***: The status is of water storage tank is displayed. The height of the water in the tank as measured by the ultrasonic level meter is displayed at the top of the tank. Additionally, the tank is graphically filled in the color "**BLUE**" to a level proportional to the current level of the tanks capacity.

8 ***Differential Pressure***: In the future, the differential pressure across the Bag Filtration Unit will be displayed.

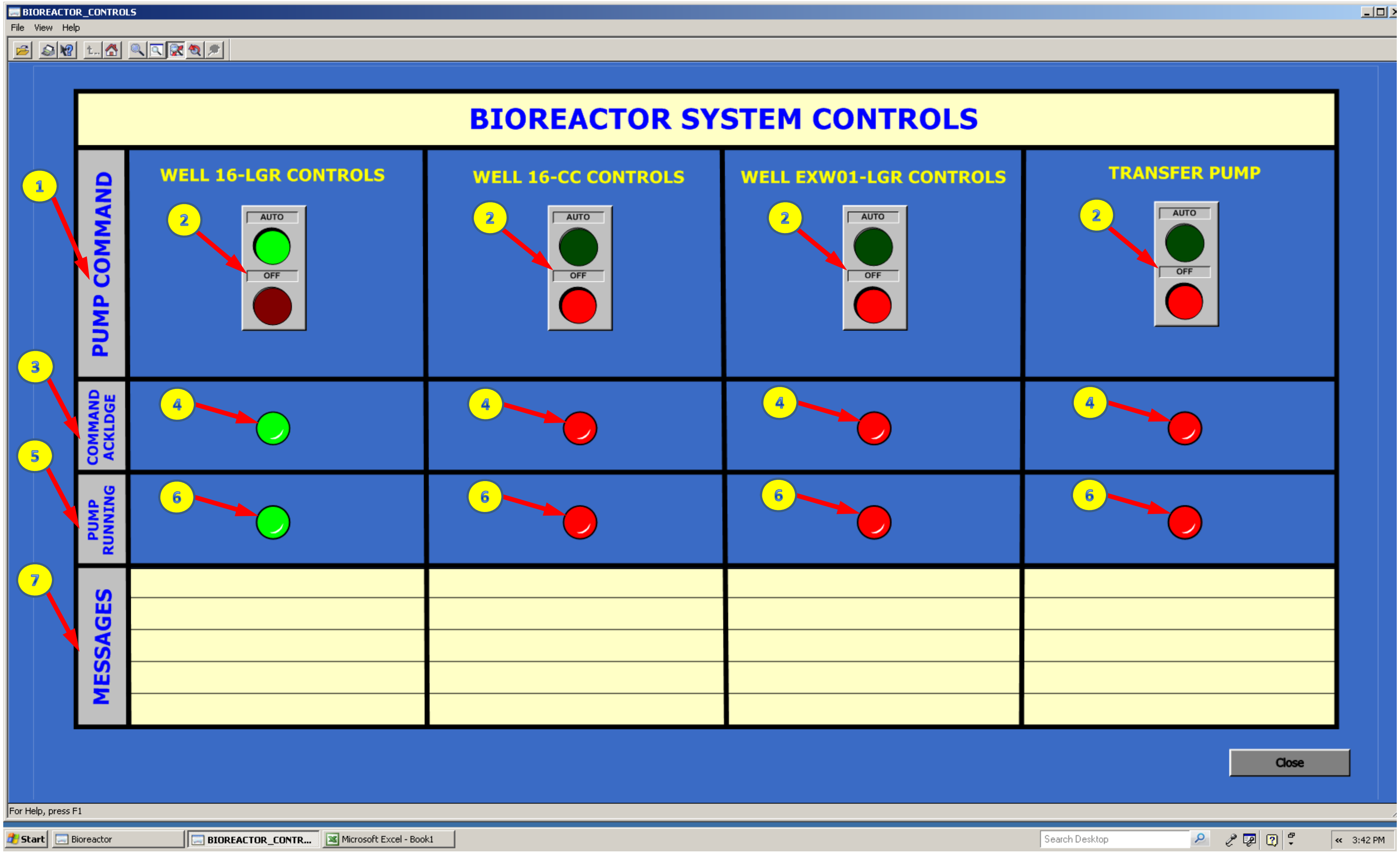
9 ***Float Switch Indicators***: The status of the mechanical float meters in the storage tank and Sump 1-1 are graphically displayed. If a switch is activated by the current level of the water, it is displayed in the color "**GREEN**". If the switch is not activated by the water level, the color is "**RED**".

Pressing the CLOSE button will return you to the Bioreactor Main Screen.

3.3.3.2 BIOREACTOR SYSTEM CONTROLS SCREEN

This interactive screen is accessed from the Submenu bar, and allows the Operator to control the operation of the water supply pumps and transfer pump (Figure 3.3). The functionality of this screen is very similar to the ***PUMP CONTROLS SCREEN*** (Section 3.3.2.3) at the GAC Shack RTU viewscreen. For each well, the control, status, and available messages are presented on this screen. Once again, for these functions to take effect, it is imperative that the **HOA** switch at each motor control panel is set to **"AUTO"**. Key features of the ***BIOREACTOR SYSTEM CONTROLS*** screen are enumerated on Figure 3.3 as listed below:

Figure 3.3
Bioreactor System Controls Screen on CSSA SCADA



1. Pump Control (Auto or Off)
2. Pump Control Toggles (Green = Auto, Red = Off)
3. Command Acknowledge Indicators (Green = RTU under Run Command, Red = RTU under Stop Con
4. Command Acknowledge Indicators (Green = RTU under Run Command, Red = RTU under Stop Con
5. Pump Status
6. Pump Running Indicator (Green = Runnning, Red = Stop)
7. System Messages and Alarms

1 ***Pump Command***: This row displays the current pump command status for each well or transfer pump.

2 ***AUTO/OFF Toggle Switch***: This screen allows the user to toggle the status of each pump associated with the Bioreactor. Each pump may be selected to either be in the **"AUTO"** position (indicated in the color "**GREEN**" or "**OFF**" position (indicated in the color "**RED**"). Using the mouse to the toggle the switch for each pump will result in a change of color. For the setting to have any effect, it is imperative that the **HOA** switch for that pump is in the "**AUTO"** position. The pumps will actuate when all the level setpoint criteria are met as outlined in Section 3.3.1.

3 ***Command Acknowledge***: This row confirms that the Pump Command has been received by the GAC Shack RTU. If a pump is toggled to **"AUTO"**, a receipt of this command result in a change of color from "**RED**" to "**GREEN**", indicating that system is ready to pump if the float switch criteria given in section 3.3.1 is met.

4 ***Command Acknowledge Indicators***: These indicators will illuminate "**GREEN**" when a pump is switched to "**AUTO**". The indicators remain "**RED**" if the GAC Shack RTU has not received a command to switch the pumps to "**AUTO**". If a pump is switched to "**AUTO**" and the indicator does not turn "**GREEN**" within six minutes, this indicates that there is a problem at the GAC Shack RTU.

5 ***Pump Running***: This row of indicators display whether a pump is currently running.

6 ***Pump Running Indicators***: If the indicator is the color "**RED**", the pump is not running. If the indicator is the color "**GREEN**" the pump is the color "**GREEN**". If the Pump Running Indicator is "**RED**" and pump is set to **"AUTO"** and Command Acknowledged Indicator is "**GREEN**", this means that either the well has achieved at ***STOP*** water level, or the Bioreactor Tank is full.

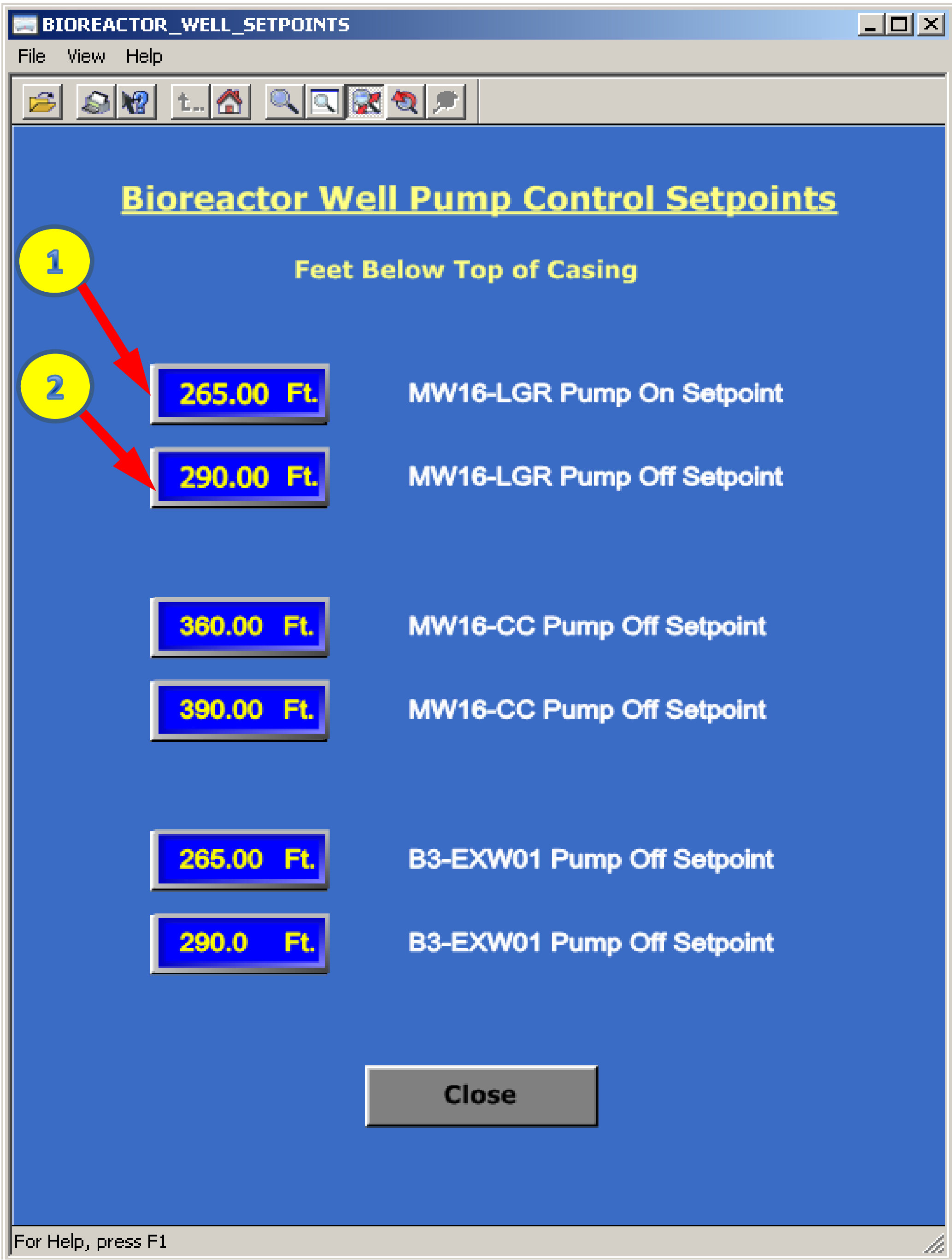
7 ***Messages***: Status messages for each pump will display in this section. Messages may include "Low Level", "Loss of Power", or Pump Fail".

Pressing the [CLOSE] button will return you to the Bioreactor Main Screen.

3.3.3.3 WELL PUMP CONTROL SETPOINTS SCREEN

This interactive screen is accessed from the Submenu bar, and allows the Operator to transmit operational well setpoints for the water supply wells (Figure 3.9). The functionality of this screen is very similar to the ***WELL OPERATIONAL SETPOINTS SUBMENU*** at the GAC Shack RTU viewscreen. From this screen the Operator can program the ***START/STOP*** water levels for each water supply well:

Figure 3.4
Well Pump Control Setpoints Screen on CSSA SCADA



1 Required Water Level in Well to Start Pump (Feet Below Top of Casing)

2 Low Water Level Cut-off to Stop Pump (Feet Below Top of Casing)

1 ***START***: The corresponding water level in the well at which the well pump will turn on. It is imperative that the ***START*** water level be at a depth at least 25 less than the ***STOP*** position, and at no time should the ***START*** depth be greater than the ***STOP*** depth. The Operator should have working knowledge of the current static water level of the aquifers. If a ***START*** level is set at a depth less than the static water level, the pump will never run. In general, these depths need to follow the general guidelines:

a. ***START*** must be greater than STATIC Water Level (measured by Operator)

b. ***START*** must be at least 25 less than the ***STOP*** value;

c. STATIC < ***START*** < (***STOP***-25);

d. CS-MW16-LGR Example:

i. Measured Static Water Level = 235 feet BTOC

ii. ***START*** = 265 feet BTOC

iii. ***STOP*** = 290 feet BTOC

2 ***STOP***: The corresponding water level in the well at which the well pump will be turned off. It is imperative that the ***STOP*** water level be at a depth above the well pump to prevent it from running dry. These depths need to be less than the following:

a. CS-MW16-LGR ***STOP*** < 290 feet BTOC;

b. CS-MW16-CC ***STOP*** < 390 feet BTOC;

c. CS-B3-EXW01 ***STOP*** < 330 feet BTOC;

d. CS- B3-EXW02 ***STOP*** < TBD feet BTOC;

Pressing the CLOSE button will return you to the Bioreactor Main Screen.

3.3.3.4 SYSTEM DIAGNOSITCS SCREEN

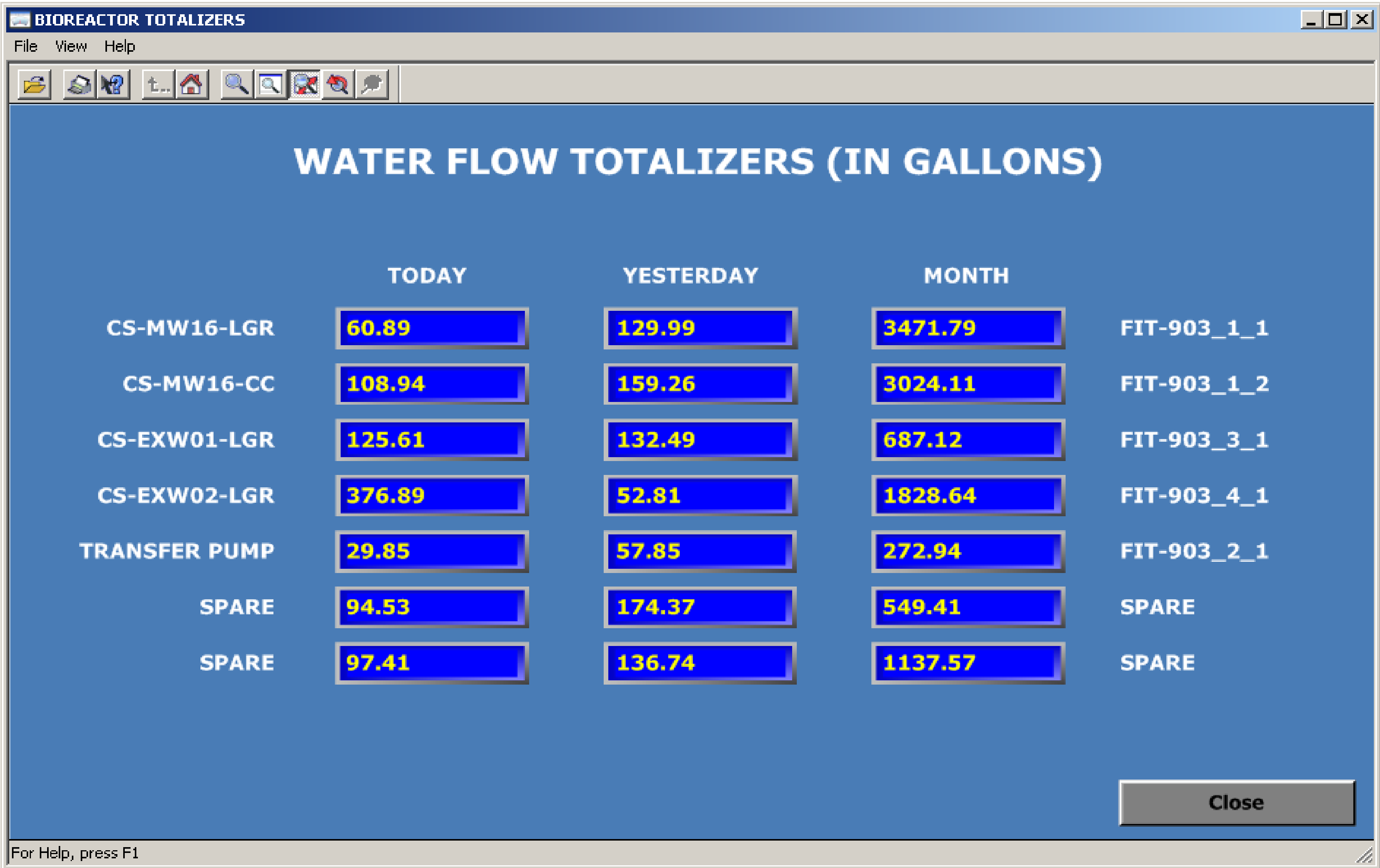
This screen is currently under development. Information useful for the SCADA integrator will be displayed here.

3.3.3.5 PUMPING TOTALS SCREEN

This static screen is accessed from the Submenu bar, and allows the Operator to view statistics about the volume of water pumped at the Bioreactor system (Figure 3.5). The screen displays the current (TODAY), YESTERDAY, and MONTH totals pumped at the Bioreactor. The screen is configured to display multiple flowmeter statistics planned for future expansions. However, currently pumping volumes from CS-B3-EXW01 is currently available.

Pressing the CLOSE button will return you to the Bioreactor Main Screen.

Figure 3.5
Bioreactor Flowmeter Totals on CSSA SCADA



3.4 LOCKOUT/TAGOUT

When the system is being shut down to perform any electrical or piping service it is necessary to follow the lockout/tagout procedure to prevent potential injuries, prevent exposure to contaminated materials, and reduce the potential for spillage of contaminated groundwater. Maintenance and repair activities requiring lockout/tagout procedures include work on the RTUs, submersible pumps, pressure transducers, storage tank, and bag filter system. Each time a lockout/tagout becomes necessary, the authorized person shall log the activity to be performed, the name of the person carrying out the activity, the date, and the time in the Logout/Tagout Log form included in Appendix J; after completing the maintenance activity the authorized person shall proceed to file the filled out tag used during the activities in the Lockout/Tagout folder, to be preserved as a safety record.

Phase I – Locking, Blocking or Releasing Energy:

- The authorized person notifies all affected people on site that a lockout/tagout procedure is ready to begin.
- The authorized person will turn off the power to the system and lockout the power switch.
- The authorized person releases or restrains all stored energy (*i.e.* venting residual pressure in the filter, or closing the valve upstream of the section of piping affected to isolate it before performing the necessary work)
- All locks and tags are checked for defects. If any are found, the lock or tag is discarded and replaced.
- The authorized person places a personalized lock or tag on the energy isolating device.
- The authorized person tries to start the system to ensure that it has been isolated from its energy source. The system is then de-energized again after this test. If the work to be performed is of an electrical nature, it will be necessary to test the affected components with a volt-meter to ensure that they are not energized.
- The system is now ready for service or maintenance.

Phase II – Returning the System to Normal Operation:

- The authorized person checks the system to be certain no tools have been left behind.
- All safety guards are checked to be certain that they have been replaced properly, if applicable.
- All affected people on site are notified that the system is about to go back into normal operation.
- The authorized person performs a secondary check of the area to ensure that no one is exposed to danger.

- ♦ The authorized person removes the lock and/or tag from the energy isolating device and restores energy to the system.

3.5 SYSTEM MONITORING

System operation monitoring will be performed to measure the effectiveness of the groundwater recovery and treatment processes and to assess performance and maintenance requirements for the system components. Periodic monitoring and sampling will also be implemented to assess the effectiveness of the bioreactor to treat the contaminants in the groundwater being pumped to the trench, and treat the contaminants present in the materials surrounding and underlying the excavation trenches.

Data to be collected monthly (12 months per year) for compliance with UIC requirements of the groundwater recovery and bioreactor operations include:

- water elevation measurements;
- injection volumes;
- system pressure readings; and
- contaminant concentrations from the injection water, active trench sumps, and the upper most saturated zone at four multi-point monitoring wells including:
  - ✓ Volatile Organic Compounds (VOCs - PCE, TCE, *cis*-1,2-DCE, *trans*-1-2 DCE, VC, and ethene),
  - ✓ Total Dissolve Solids (TDS),
  - ✓ and pH;

Performance monitoring measurements for weekly, monthly, and quarterly efforts may include water quality measurements, a minimal analytical suite, a full analytical suite, and additional analyses (dissolved hydrogen, and DNA).

<u>Water Quality Analyses:</u> conducted weekly at all trench sumps with saturated thicknesses exceeding 1 foot, UGR wells monthly.

- Temperature
- Specific Conductivity
- Oxidation Reduction Potential (ORP)
- Dissolved Oxygen (DO)
- pH

<u>Minimal Analytical Suite:</u> collected from active trench sumps and uppermost saturated zone of 4 MPMWs (LGR-03B zone) during the monthly events (8 per year), and collected from peripheral shallow UGR wells, and 23 MPMW zones excluding the LGR-03B zone during the quarterly events (4 per year).

- VOCs
- TDS
- Ferrous Iron, Manganese
- Methane, Ethane, Ethene

- Carbon Dioxide
- Total Metals (Arsenic)

Full Analytical Suite: collected from active trench sumps, uppermost saturated zone of 4 MPMWs (LGR-03B zone), four extraction wells, and four monitoring wells during the quarterly events (4 per year).

- VOCs
- TDS
- Ferrous Iron, Manganese
- Methane, Ethane, Ethene
- Carbon Dioxide
- Total Metals (Arsenic)
- Dissolved Organic Carbon (DOC)
- Total Organic Carbon (TOC)
- Anions (Sulfate and Chloride)
- Sulfide

Additional Analyses: collected from one sump per active trench, one extraction well (CS-MW16-LGR), and one monitoring/extraction well during the quarterly events (4 per year), precipitation data is downloaded from a CSSA weather station quarterly.

- Dissolved Hydrogen
- Dehalococcides populations, including vcrA reductase, TCE reductase, BAV1 – Q
- Total rainfall

The methods for collecting the data listed above and the end use of the data are described in the following sections.

3.5.1 Monitoring of Treatment within the Bioreactor

To evaluate the contaminant concentrations of bioreactor injection water (the water in the storage tank), a water sample is collected from a sampling port located prior to the injection nozzles at the trench injection line manifold. In addition, water samples are collected from the bioreactor sumps monthly in accordance with this O&M plan's monitoring schedule. Water levels and water quality measurements will be recorded weekly for all sufficiently saturated (greater than 1 foot saturated thickness) bioreactor sumps. Transducers may be installed in at least one sump per trench to measure simultaneous fluctuating water levels in the bioreactor. A summary of the monitoring (both performance and regulatory monitoring) and sample collection schedule is presented in Table 3.3. Additional details such as proper sample collection methods are provided in the CSSA Sampling and Analysis Plan and associated amendments (Parsons, December 2005) which include additional details associated with the test methods such as container type(s) and preservative(s).

3.5.2 Monitoring the Treatment of Zones Underlying the Bioreactor

Four Multi-Port Monitoring Wells (MPMW) or Westbay® wells were installed around B-3 to monitor the groundwater infiltrating through the underlying formations at SWMU B-3. The multi-port wells allow discrete samples from distinct hydrostratigraphic zones be collected from a single location. A representative sample can be collected from up to nine, discrete monitoring zones. These zones are sealed at the top and bottom with permanent well packers to evaluate migration patterns of treated groundwater moving away from the bioreactor to the underlying aquifer. Locations of the four MPMW wells are shown in Figure 3.6. A summary of the discrete intervals and the sample port depths relative to the top of casing (TOC) is provided in Table 3.4. A cross section (Figure 3.7) depicts the location of each sample port relative to elevation and within the subsurface. Water levels are determined in each zone by lowering a pressure probe that locks into the selected zone sample port. The probe is connected to a data logger at the surface which records zone pressures. Pressures are converted to water levels via the following formula:

$$Water\ Level = \frac{D-(P-A)}{0.4335}$$

Where D = depth of sample port below reference point
P = pressure of zone
A = Atm pressure at well head

A summary of the monitoring and samples to be collected is presented in Table 3.6. Appendix J provides a copy of the Westbay® monitoring well operations and repair manual.

3.5.3 Monitoring of Surrounding Monitor Wells

In addition to monitoring water levels and collecting samples from the MPMWs, samples are collected from four monitoring wells and all intervals of the four MPMWs that surround the site on a quarterly basis. The locations of these four wells and the MPMW's are shown in Figure 3.8. Additional piezometers set in the Upper Glen Rose formation will be installed for monitoring bioreactor influence in the shallow portions of the vadose zone. One piezometer, CS-MW27 is installed, and another eight piezometers are scheduled for installation in May, 2010. Water levels will be collected on a weekly basis. Figure 3.9 shows a topographical survey of the bioreactor and the trench sump locations. The list of monitoring wells is identified in Table 3.5.

3.5.4 Monitoring the Upper Glen Rose

Nine shallow (less than 45 foot) piezometers installed in the Upper Glen Rose (UGR) formation around the bioreactor provide sample locations to monitor the lateral influence from bioreactor activities. Water samples from these piezometers will be collected monthly for the first six months following installation. Sample frequency will be reevaluated after the initial six month period. Field parameter information will be collected during the monthly sampling events to determine if the reaction zone created by the bioreactor is expanding, contracting, or remaining stable. The piezometers are labeled B3-MW-26-UGR through B3-MW-34-UGR.

Table 3.3
Class V Aquifer Remediation Injection Well Permit #5X2600431
Sampling and Monitoring Schedule for the B3 Bioreactor Pilot Study
Boerne, Texas

	Sampling or Monitoring Location	Parameter(s)	Sampling Frequency	Reporting Frequency
Current Regulatory Req.	Flow meters (6) for each trench on downstream side of the header and one flow meter on the upstream side of the header	Injection volume	Monthly (record)	Semi-Annual
	Pressure gages (4) on both sides of the transfer pump, at the bag filter and on the header	Pressure on the transfer pump	Monthly (record)	Semi-Annual
	Sampling port (1) on the upstream side of the distribution header	- pH (field) and TDS (lab) - VOCs (a)	Monthly	Semi-Annual
	Trench sumps (7) (b)	- pH, water level (field) and TDS (lab) - VOCs (a)	Quarterly	Semi-Annual
	MPMWs (4 – LGR-03B zone) (b)	- TDS (lab) - VOCs (a)	Quarterly	Semi-Annual
Performance sampling	Trench sumps (7) (b) MPMWs (4 – LGR-03B zone)	- MEE + CO2 - Ferrous Iron - Manganese - Metals (As)	Monthly	Quarterly
	Trench sumps (7) (b) MPMWs (4 – LGR-03B zone) Extraction Wells (4) Monitoring Wells (4)	- MEE + CO2 - Ferrous Iron - Manganese - Metals (As) - Total organic carbon (TOC) - Dissolved organic carbon (DOC) - Sulfide - Anions (sulfate and chloride)	Quarterly	Quarterly
	Trench sumps (3), one per active trench Monitoring wells (CS-MW16-LGR and TBD)	- Dehalococcoides populations (DNA) - Dissolved Hydrogen	Quarterly	Quarterly
	MPMWs (23 – *excluding* LGR-03B zone) UGR wells (9)	- VOCs (a) - TDS (lab) - MEE + CO2 - Ferrous Iron - Manganese - Metals (As)	Quarterly	Quarterly
Performance monitoring	Trench sumps (7) (b)	- Temperature - Specific Conductivity - Dissolved Oxygen (DO) - Oxidation Reduction Potential (ORP)	Weekly	Quarterly
	UGR wells (9)	- Water Level - Temperature - Specific Conductivity - pH - Dissolved Oxygen (DO) - Oxidation Reduction Potential (ORP)	Monthly	Quarterly

Notes: (a) Standard list of VOCs tested at CSSA
(b) Bioreactor trench sumps (BTS) include: Trench 1 – 1-1, 1-2 and 1-3; Trench 2 – 2-1 and 2-2; Trench 3 – 3-1 and 3-2; Trench 4 – 4-1; Trench 5 – 5-1 and 5-2; Trench 6 – 6-1 and 6-2. Samples are collected from all trench sumps which includes the injection of CS-MW16-CC and -LGR, and B3-EXW-01and -02 groundwater.
Multi-port monitoring wells (MPMW) include: CS-WB05 (9 sampling ports), CS-WB06 (6 sampling ports), CS-WB07 (6 sampling ports) and CS-WB08 (6 sampling ports).
Surrounding monitor wells include: CS-MW1-LGR, CS-B3-MW01-LGR, CS-MW2-LGR (as needed) and CS-D-LGR.
Surrounding extraction wells include: CS-MW16-LGR, CS-MW16-CC, B3-EXW-01, and B3-EXW-02.
Surrounding UGR wells include: B3-MW26-UGR through B3-MW34-UGR.

Table 3.4
List of Multi-Port Monitoring Wells

Well	Elevation (a) (Top of Casing)	Zone	Interval (Ft. BTOC)	Elevation (Ft MSL)		Sampling Port (b) (Ft BTOC)	
				Top of Interval	Base of Interval	Primary	Secondary
CS-WB05	1242.93	LGR-01	32 - 109	1210.93	1133.93	99	
		LGR-02	114 - 192	1128.93	1050.93	182	
		LGR-03	197 - 272	1045.93	970.93	216	262
		LGR-04A	277 - 286	965.93	956.93	277	
		LGR-04B	291 - 342	951.93	900.93	329	
		BS-01	347 - 390	895.93	852.93	362	
		CC-01	395 - 444	847.93	798.93	432	
		CC-02	449 - 482	793.93	760.93	460	
CS-WB06	1235.20	UGR-01	12 - 30	1223.20	1205.20	20	
		LGR-01	35 - 103	1200.20	1132.20	93	
		LGR-02	108 - 184	1127.20	1051.20	174	
		LGR-03	189 - 270	1046.20	965.20	207	260
		LGR-04	275 - 335.5	960.20	899.70	320	
CS-WB07	1235.13	UGR-01	9 - 24	1226.13	1211.13	14	
		LGR-01	29 - 100	1206.13	1135.13	90	
		LGR-02	105 -185	1130.13	1050.13	175	
		LGR-03	190 - 267	1045.13	968.13	208	257
		LGR-04	272 - 336.75	963.13	898.38	318	
CS-WB08	1253.26	UGR-01	12 - 48	1241.26	1205.26	38	
		LGR-01	53 - 125	1200.26	1128.26	115	
		LGR-02	130 - 203	1123.26	1050.26	193	
		LGR-03	208 - 283	1045.26	970.26	228	273
		LGR-04	288 - 357.5	965.26	895.76	341	

Notes:
BTOC - Below Top of Casing
(a) Top of Casing (TOC) elevations surveyed by Baker and Associates located in San Antonio, Texas.
(b) For each well there is one zone where both the upper (primary) and lower (secondary) portions are monitored.

Table 3.5
List of Surrounding Monitoring Wells

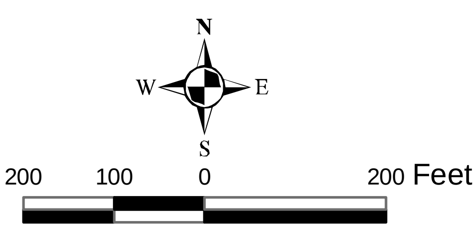
Well ID	TOC Elev. (Ft MSL)	Screen Interval Depth below TOC (Ft bgs)	Pump Depth (Ft bgs)	Pump Elevation (Ft MSL)	Depth to LGR/BS Contact (Ft bgs)	Planned Performance Monitoring Frequency
CS-MW1-LGR	1220.73	288 – 313	300	920.73	319	Baseline + Quarterly
CS-MW2-LGR	1237.08	318 – 343	330	907.08	347	Baseline + As Needed
CS-MW-D-LGR	1257.27	296 – 321	283	974.27		Baseline + Quarterly
CS-B3-MW01	1242.84	277 - 287	284	958.84		Baseline + Quarterly

bgs = below ground surface
MSL = mean sea level

Table 3.6
B-3 O&M Monitoring Schedule

	Recurrence Interval	Activity
Performance Requirement	Weekly	Trench Sumps and MPMWs Water Level Measurements
	Monthly	Trench Sumps, Uppermost Interval (LGR 03B) of WB-05 thru WB-08 Performance Sampling (metals only)
	Quarterly	Trench Sumps, MPMWs, and Surrounding Wells Performance Sampling
Regulatory Requirement	Monthly	Headers and Flow Meter Measurements
	Monthly	Transfer Pump and Filter Pressure Readings
	Monthly	Sampling Port Monitoring (pH, TDS, VOCs)
	Monthly	Trench Sumps Sampling (ph, TDS, VOCs)
	Monthly	Uppermost Saturated Interval (LGR 03B) MPMWs Sampling (TDS, VOCs)

Aerial Photo Date: 2003



Creeks (Dashed where intermittent)
Water Well Locations
SWMU Boundary
Westbay Wells

Figure 3.6

SWMU B-3
MPMW Locations
Camp Stanley Storage Activity

Parsons

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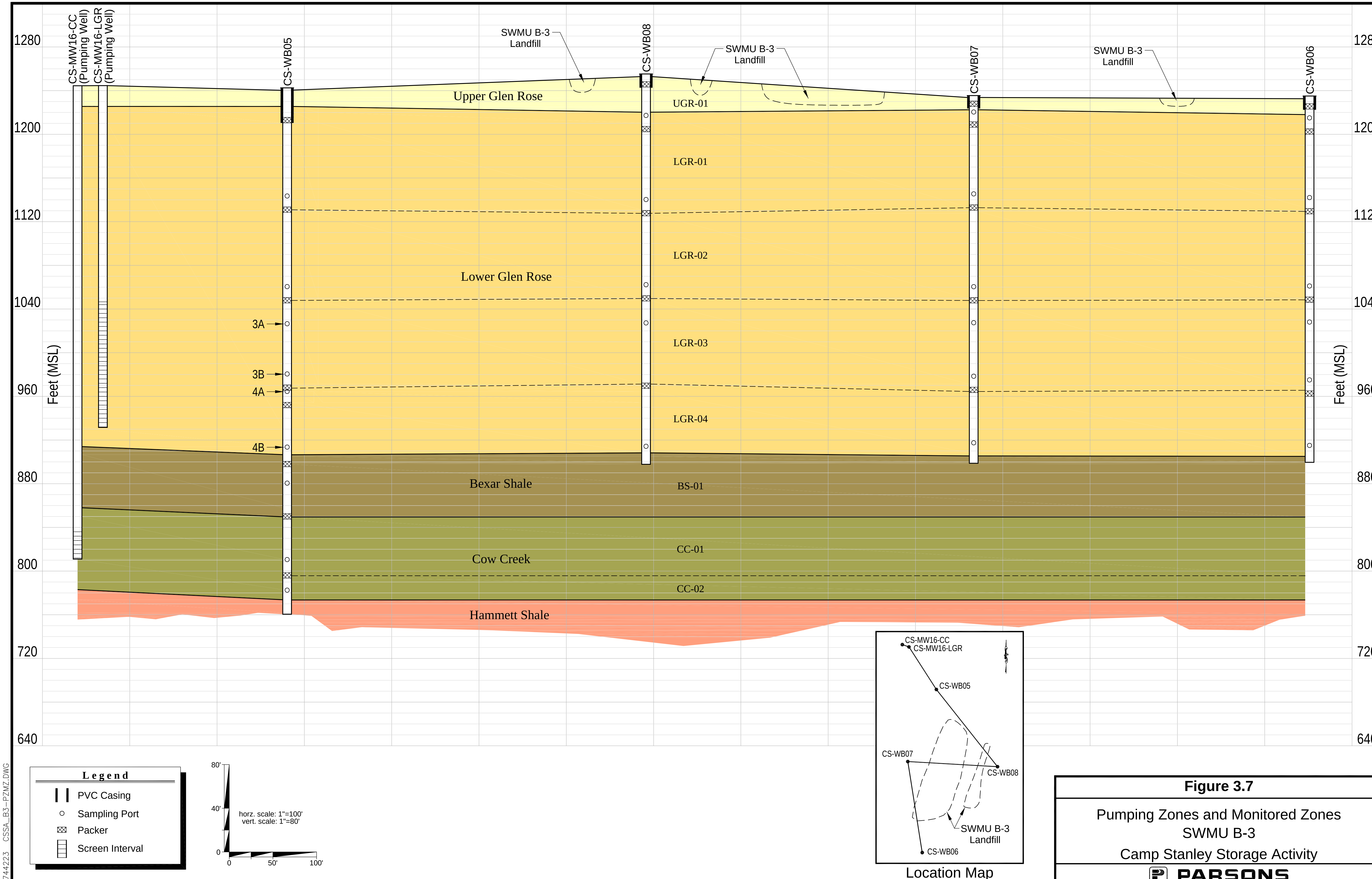
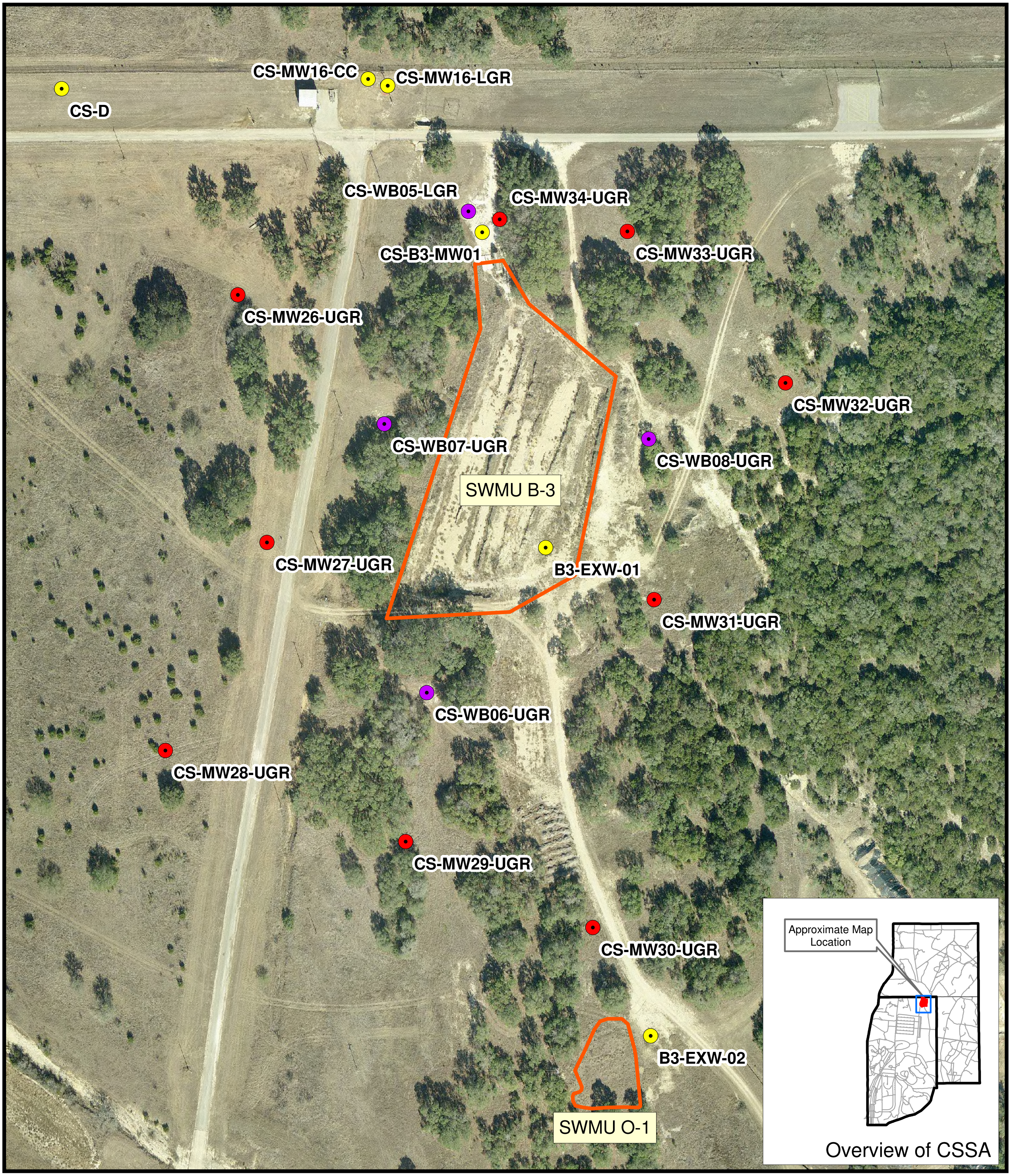


Figure 3.7

Pumping Zones and Monitored Zones
SWMU B-3
Camp Stanley Storage Activity

PARSONS



Aerial Photo Date: 2009

N
W E
S

200 100 0 200 Feet

- UGR Monitoring Well Location
- Westbay Multi-port Well
- Supply/Monitoring Well
- SWMU Boundary

Figure 3.8

SWMU B-3
Monitoring Locations
Camp Stanley Storage Activity

PARSONS

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Figure 3.9

B-3 Site Survey Map

Camp Stanley Storage Activity

PARSONS

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SECTION 4
SYSTEM MAINTENANCE

4.1 BIOREACTOR INSPECTION

The bioreactor will be inspected weekly to determine if the components are operating properly. Future plans call for the possible installation of equipment to monitor the equipment remotely. Items to include in the inspection include the following:

- Condition of all visible piping;
- Condition of berms identifying any erosional features that may be indicative of surface drainage not being collected in the bioreactor;
- Readings will be collected from pressure gages, flow meters and water levels in the bioreactor sumps weekly;
- Conditions of the storage tank;
- Replacement of bag filter, as necessary.

A System Operation and Monitoring logbook will be maintained documenting all maintenance activities associated with bioreactor system operations, as well as, documenting monthly system inspections.

4.2 MAINTENANCE

To reduce the potential for unexpected equipment shutdown, a maintenance schedule will be incorporated based on the required maintenance specified by the equipment manufacturers.

4.2.1 Bag Filter Replacement

The filters in the bag filtration system must be replaced when they become plugged with particulates. The filters will be replaced when the pressure drop across the filter increases and negatively impacts the capacity of the transfer pump due to high head loss within the treatment system. To prevent the pressure drop across the filter from exceeding safe levels, the filters will be changed if the pressure drop is determined to be 12 pounds per square inch (psi) or greater during a weekly site visit. Spare filters will be stored in the GAC building at CSSA Outfall 002. The procedure for replacing the filter follows:

1. Turn off the system and initiate lockout/tagout procedures in Subsection 3.2.3.
2. Close the ball valve before and after the filter system to isolate the filter from further flow.
3. Carefully bleed off residual pressure inside the filter vessel by slowly opening the vent on the top of the vessel. Think Safety!
4. Loosen the retaining lugs and remove the lid from the top of the vessel.
5. Replace used filters with new ones and place used filters in 55-gal container.

6. Realign the vessel lid and tighten the retaining lugs.
7. Open the ball valves before and after the filter system.
8. Turn the recovery system back on.
9. Check the filter vessel for leaks.

Replacement of the bag filters will be documented on the System Operation and Maintenance Form (Appendix K) to reflect the replacement date of the filters, new filter sizes, and condition of the old filters.

4.2.2 Recovery Pump Maintenance

Pump maintenance will be performed to maintain optimum pump operation, maximize pump life, and to repair pump problems. During the pump maintenance events, each pump will be removed from its well, inspected for wear and damage, and any necessary/recommended repairs made to ensure optimal performance. Pump maintenance may be performed when determined necessary based on pump performance, such as diminishing groundwater yield. Additionally, any time a recovery well will be idled for periods greater than 1 month, the pump in that well will either be operated for at least two hours each month or removed from the well. This is done to prevent accumulation of calcium or iron precipitation on the idle pump components which may foul the pump and/or shorten the pump life.

During the pump maintenance, worn or malfunctioning components will be repaired or replaced. Two spare groundwater pumps are stored in the treatment compound to minimize system down time during such maintenance events. In the event that a pump malfunctions, it will be pulled for service and repaired, as necessary, and a spare pump will be installed in its place. The faulty pump will become a spare after it is repaired.

In the event that a pump must be removed from a well, the following procedures requiring a two-man crew will be followed:

1. Turn off power and initiate lockout/tagout procedures per Subsection 3.3.
2. Disconnect the pipe coupling in the discharge pipe within the well box.
3. Loosen the bolts in the well seal on top of the recovery well so the discharge pipe easily moves through the opening in the seal.
4. Lift the pump from the well by hand until the first flush-thread pipe connection is observed in the discharge pipe.
5. One crew member will secure the discharge pipe below the pipe joint using a pipe wrench while the other crew member loosens and removes the top section of pipe.
6. Care must be taken to secure and manage the electrical cables and steel support cables that attach to the pressure transducer and the pump. These wires/cables should be secured to the discharge pipe by plastic cable ties which must be cut and removed to manage the wiring and cable. CAUTION: The transducer cable includes an internal vented tube. Careful handling of this cable is necessary to prevent pinching or kinking of the cable which may damage and obstruct the vent tube.

7. Continue to remove sections of the pipe while managing the wires and cables, until the last section of pipe is brought to the surface. Carefully lay the pump and pipe next to the well without allowing dirt to plug the pump head.
8. Make necessary repairs to pump or transducer.
9. Carefully reinsert the pump in the well.
10. Reinstall the pump assembly in the well by reversing the removal instructions. New cable ties should be used to re-secure the transducer and pump lead wires to the discharge pipe as it reinserted into the well. CAUTION: Carefully insert the pump and piping assembly into the well without pinching or kinking the transducer cable which could block the internal vent tube.
11. Turn the system back on.

4.3 SPILL PREVENTION AND CONTAINMENT PLAN

To reduce the potential for offsite drainage from the site, the following guidelines will be incorporated:

1. Construction of a berm along the western side of the site to help retain water in the bioreactor;
2. Maintain a stand of vegetation along the west side of Trench 1 to reduce the potential for the development of erosional features along the west side of the site;
3. Precautions, such as storm water diversion berms, will be taken to prevent overfilling of the bioreactor with stormwater runoff; and
4. Level controller located in trench 1 monitoring sump 1 which will cease injection of water upon reaching high level.

4.4 SITE MAINTENANCE

During each visit, the following activities will take place:

- The site will be inspected to ensure no obstructions are present that could impact normal operation.
- The area around the treatment area and bioreactor will be inspected. Ensure that access to the compound is clear of tree branches and debris.
- Buried water and electrical lines will be inspected to ensure that the lines are still properly covered, and that no apparent leaks are present.

See the System Operation and Monitoring Form in Appendix K for a list of necessary activities to perform during each site visit.

SECTION 5
REPORTING REQUIREMENTS

Since the bioreactor design called for the discharge of affected water from all extraction wells into the subsurface via a buried water distribution system, it was necessary to apply for a Class V Aquifer Remediation Injection Well Permit through the Industrial and Hazardous Waste Permits Section of the Waste Permits Division at the TCEQ. The permit application was accepted on July 20, 2006 and the following TCEQ Authorization Number was assigned to the SWMU B-3 injection system: No. 5X2600431; WWC 12002216; CN602728206/RN104431655. A copy of the authorization letter and subsequent revisions of the authorization letter indicating modifications to the injection permit are presented in Appendix A.

As stated in the letter, there are four requirements that must be met as set by the Remediation Division and the UIC rules provided by 30 Texas Administrative Code (TAC) Chapter 331.

Requirement 1. All injection wells are to be constructed to meet the standards provided in 30 TAC 331.132 and completed well logs or construction diagrams submitted to the UIC Permits Team, Industrial and Hazardous Waste Permits Section, at mail code MC-130 upon completion. Since a subsurface water distribution system instead of an injection well was proposed and accepted in the permit application, this requirement is not applicable to the B3 bioreactor.

Requirement 2. Operational and status changes shall be reported to and approved by the UIC Permits Team. Any changes to the operation of the B3 bioreactor not presented in a monitoring report can be provided to the UIC Permits Team via a letter.

Requirement 3. Closure (plugging) of injection wells, points and/or trenches shall comply with the standards provided in 30 TAC 331.133. Closure reports including plugging reports and injection well monitoring data (injection volumes, pressures and results) shall be submitted to the UIC Permits Team, Industrial and Hazardous Waste Permits Section, at mail code MC-130 within 60 days of completion of injection or plugging activities. If closure activities do proceed in the future for SWMU B-3, then the most suitable option for closure of the trenches, and the recommended option will be presented to the UIC Permits Team. The volume of water (cumulative) as well as the chemical data results will be presented in each monitoring report submitted to the UIC Permits Team. Additional discussion on the chemical data monitoring is presented in Requirement 4.

Requirement 4. Injection volumes, pressures, and concentrations of contaminants (including selected VOCs, pH and total dissolved solids) in the injected groundwater shall be sampled bimonthly at the point of re-injection (prior to fluids being released into the trenches) and submitted to the UIC Permits Team, Industrial and Hazardous Waste Permits Section, at mail code MC-130 on a monthly basis. The concentration of contaminants in the trench bioreactor monitoring sumps and the surrounding monitoring wells shall be sampled monthly and submitted to the UIC Permits Team, Industrial and Hazardous Waste Permits Section, at mail code MC-130 on a quarterly basis. The twice monthly and monthly monitoring and sampling program is presented in Section 4. The sampling and monitoring program will adhere to Requirement 4.

Table 5.1 outlines the monitoring and reporting activities scheduled during months 31 through 43 of the O&M period.

Table 5.1
B-3 O&M Activities Outline Months 31 – 43

	Month	Monday	Tuesday	Wednesday	Thursday	Friday	Week	Reporting
Quarter 15	November, 2010 Month 43	1	2	3	4	5	184	
		8	9	10	11	12	185	
		15	16	17	18	19	186	
		22	23	24	25	26	187	
		29	30				188	
	December, 2010 Month 44			1	2	3		
		6	7	8	9	10	189	Quarter 14 Performance Report
		13	14	15	16	17	190	
		20	21	22	23	24	191	
		27	28	29	30	31	192	
	January, 2011 Month 45	3	4	5	6	7	193	
		10	11	12	13	14	194	
		17	18	19	20	21	195	
		24	25	26	27	28	196	
		31					197	
Quarter 16	February, 2011 Month 46		1	2	3	4		
		7	8	9	10	11	198	
		14	15	16	17	18	199	
		21	22	23	24	25	200	
		28						
	March, 2011 Month 47		1	2	3	4	201	
		7	8	9	10	11	**202**	Quarter 15 Performance Report
		14	15	16	17	18	203	
		21	22	23	24	25	204	
		28	29	30	31		205	
	April, 2011 Month 48					1		
		4	5	6	7	8	206	
		11	12	13	14	15	207	
		18	19	20	21	22	208	
		25	26	27	28	29	209	
Quarter 17	May, 2011 Month 49	2	3	4	5	6	210	
		9	10	11	12	13	211	
		16	17	18	19	20	212	
		23	24	25	26	27	213	
		30	31				**214**	B3 UIC Bi-Annual Report
	June, 2011 Month 50			1	2	3		
		6	7	8	9	10	215	
		13	14	15	16	17	216	Quarter 16 Performance Report
		20	21	22	23	24	217	
		27	28	29	30		218	
	July, 2011 Month 51					1		
		4	5	6	7	8	219	
		11	12	13	14	15	220	
		18	19	20	21	22	221	
		25	26	27	28	29	222	
Quarter 18	August, 2011 Month 52	1	2	3	4	5	223	
		8	9	10	11	12	224	
		15	16	17	18	19	225	
		22	23	24	25	26	226	
		29	30	31			227	
	September, 2011 Month 53				1	2		
		5	6	7	8	9	228	
		12	13	14	15	16	**229**	Quarter 17 Performance Report
		19	20	21	22	23	230	
		26	27	28	29	30	231	
	October, 2011 Month 54	3	4	5	6	7	232	
		10	11	12	13	14	233	
		17	18	19	20	21	234	
		24	25	26	27	28	235	
		31					237	
Quarter 19 (partial)	November, 2011 Month 55		1	2	3	4		
		7	8	9	10	11	238	
		14	15	16	17	18	239	
		21	22	23	24	25	240	
		28	29	30			**241**	B3 UIC Bi-Annual Report
	December 2011				1	2		
		5	6	7	8	9	242	Quarter 18 Performance Report

Monthly Sampling and UIC Sampling
Quarterly Sampling
Semi-Annual UIC Report submittal
Quarterly Performance Report
Annual Performance Report