FINAL ISTT DESIGN

ADDENDUM

IN-SITU THERMAL TREATMENT
FRONTIER FERTILIZER NPL SITE
Davis, CA
Submittal #0012
Final RAMP
Specification 01400, Paragraph 1.5

CONTRACT NO: EP-S9-08-04
Task Order 002
CH2M Hill Project 384210.FD.01
P.O. 932338
PO Revision 5
CES Project #78-0033

Prepared for:

CH2M HILL
2485 Natomas Park Dr. Suite 600
Sacramento, CA 95833
T: (916) 920-0300 F: (916) 920-8463

Prepared by:

Current Environmental Solutions
P.O. Box 531139
Grand Prairie, TX 75053-1139
Tel: (972) 262-7855 Fax:(972) 262-6655

August 20, 2010

Subcontractor's Approval Stamp
Project Name: *ISTT Frontier Fertilizer, Davis, CA*
Submittal No: *0007* ***Specification No:*** *01400* ***Paragraph****: 1.5*
This submittal has been reviewed, checked and approved for compliance with Contract Documents.
Reviewer(s): *James J. Malot P.E.(PE#CA59088)*
Approval Date: *8/4/2010*

FINAL DESIGN REPORT
ADDENDUM
IN-SITU THERMAL TREATMENT
FRONTIER FERTILIZER NPL SITE
Davis, CA

1.0INTRODUCTION 1
1.1 Available Power Discussion 1
2.0DESIGN BASIS AND COMPONENTS OF ISTT 2
2.3 Process Flow 2
2.4 Performance Monitoring Components 9
2.5 Heating Electrodes 9
2.6 Power Supply Unit (PSU) 10
2.11 Operational Strategy 11
4.0ISTT DESIGN SPECIFICATIONS 12

Tables

Table 2 Process Stream Analysis
Table 3 Treatment Campaigns
Table 5 Thermocouple Device List

Figures

Figure 3E: Cap/Shallow Electrode Detail
Figure 5: Electrode Layout
Figure 8A: Cap Layout
Figure 8B: Cap and Air Inlet Detail
Figure 9: Process and Instrumentation Diagram
Figure 9B: Equipment Layout
Figure 10: Wellhead Detail
Figure 11 A,B,C: Piping Layout per Stage
Figure 12: Treatment Campaigns
Figure 13: Equipment Layout
Figure 14: Utility Location Plan
Figure 15: Electrical One-Line
Figure 16 A, B: Fence Construction Details

Appendices

Appendix A Model Output

CES Project 78-0033 CH2M HILL Project 384210.FD.01
CH2M Hill Contract No. EP-S9-08-04, Task Order: 0002

Copyright © 2010 Current Environmental Solutions, All Rights Reserved

ABBREVIATIONS AND ACRONYMS

Amp	Ampere
APCD	Air Pollution Control District
BGS (or bgs)	Below Ground Surface
BMP	Best Management Practice
BTU/HR	British Thermal Units/Hour
BTV	Base Treatment Volume
C	Degrees Centigrade or Celsius
Cal/EPA	California Environmental Protection Agency
CCR	California Code of Regulations
CEM	Continuous Emissions Monitor
CES	Current Environmental Solutions, LLC
CIH	Certified Industrial Hygienist
CFR	Code of Federal Regulations
CLIN	Contract Line Item Number
CMP	Contingency Management Plan
COC	Compound of Concern
CTO	Contract Task Order
CY	Cubic Yards
DBCP	Dibromochloropropane
DCDQCR	Daily Chemical Data Quality Control Report
DCP	Dichloropropane
DOT	Department of Transportation
DNAPL	Dense Non-Aqueous Phase Liquid
DQO	Data Quality Objectives
DTSC	Department of Toxic Substances Control
DTV	Final Designated Treatment Volume (same as ISTT Volume)
DVE	Dual (Phase) Vacuum Extraction
EDB	Ethylene Dibromide
EPA	(United States) Environmental Protection Agency
EPP	Environmental Protection Plan
ERH	Electric Resistance Heating
ESQ	Environmental, Safety, and Quality

Copyright © 2010 Current Environmental Solutions, All Rights Reserved

EW	Groundwater Extraction Well
FRP	Fiberglass Reinforced Plastic
FS	Feasibility Study
FSP	Field Sampling Plan
FSS	Field Services Supervisor
FT	Feet/foot
GAC	Granular Activated Carbon
GAL	Gallons
GPW	Groundwater Pumping Wells
HASP	Health and Safety Plan
HDPE	High Density Polyethylene
HG	Mercury
HSVE	Horizontal Soil Vacuum Extraction
ID	Inside Diameter
IN	Inch
ISTT Volume	In-Situ Treatment Volume (same as DTV)
KJ/MOL	Kilo-joules/mole
KVA	Kilo-Volt-Amp
KW	Kilowatt
KW-HRS	Kilowatt-hours
ISTT	In-Situ Thermal Treatment
LDR	Land Disposal Restriction
LPGAC	Liquid Phase Granular Activated Carbon
MW	Monitoring Well
MPE	Multi-Phase Extraction (same as DVE)
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
OD	Outside Diameter
OMP	Operation and Maintenance Plan
P	Page
PC	Performance Criteria
PG&E	Pacific Gas & Electric Company
PHA	Process Hazard Analysis
PLC	Programmable Logic Controller
PM	Project Manager

Copyright © 2010 Current Environmental Solutions, All Rights Reserved

PMP	Process Monitoring Plan
PO	Purchase Order
PPE	Personal Protective Equipment
PRG	Preliminary Remediation Goal
PSU	Power Supply Unit
PWD	Public Works Department
QAPP	Quality Assurance Project Plan
RAMP	Remedial Action Management Plan
RAO	Remedial Action Objectives
RCRA	Resource Conservation and Recovery Act
RDA	Remote Data Acquisition
RFP	Request For Proposal
RT (or FT)	Remediation Technician/Field Technician
RWQCB	Regional Water Quality Control Board
SAP	Sampling and Analysis Plan
SCR	Silica Control Rectifier
SCADA	System Control and Data Acquisition
SPEC	Specification
SPH	Six-Phase Heating
SSHO	Site Health and Safety Officer
STLC	Soluble Threshold Limit Concentration
SOP	Standard Operating Procedure
SMP	Site Management Plan
SQCC	Subcontractor Quality Control Plan
SQFT	Square Feet
SQRT	Square Root
SVE	Soil Vacuum Extraction
SVOC	Semivolatile Organic Compound
TC	Thermocouple
TCLP	Toxicity Characteristic Leaching Procedure
TCP	Trichloropropane
TD	Total Depth
TMW	Temperature Monitoring Well
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbon

Copyright © 2010 Current Environmental Solutions, All Rights Reserved

TSDF	Treatment, Storage, and Disposal Facility
TTLC	Total Threshold Limit Concentration
USDA	U.S. Department of Agriculture
VEU	Vacuum Extraction Unit
VOC	Volatile Organic Compound
VMP	Vapor Monitoring Piezometer
VPGAC	Vapor Phase Granular Activated Carbon
WMP	Waste Management Plan

Copyright © 2010 Current Environmental Solutions, All Rights Reserved

FINAL DESIGN ADDENDUM IN-SITU THERMAL TREATMENT FRONTIER FERTILIZER NPL SITE DAVIS, CA

1.0 INTRODUCTION

This document is an Addendum to the Final Design component of the Remedial Action Management Plan for the In-Situ Thermal Treatment (ISTT) remedy using Electric Resistive Heating (ERH) at the Frontier Fertilizer National Priorities List (NPL) site (the "Site") in Davis, California. That design document was presented in September of 2009. This addendum presents changes to the design and document text to reflect the increase in the power capacity that the utility, Pacific Gas and Electric, is committing to provide to the site. As proposed in the final design document, shallow electrodes have also been installed in selected areas to increase heating above 6 feet depth.

This document includes only those sections of text of the Final Design that have been changed to reflect these new conditions.

1.1 Available Power Discussion

Pacific Gas & Electric (PG&E) is the utility that owns the electrical distribution lines adjacent to the Site. As of December of 2009, PG&E identified that they can deliver 3 MW continuously. Their initial commitment to provide 1MW and up to 5MW off peak season, was utilized in planning for the Final Design submitted in September, 2009. However, for the ISTT process, a year-round constant power is desirable.

This addendum to the design is based on continuous 2.5 MW of delivered power to provide 4000 amps of 480V, 3 phase power. The ISTT system is designed to deliver 45W/yd^3 to the subsurface while reserving sufficient power for the treatment process equipment. That power capacity requires a minimum of 2 treatment campaigns, each estimated to last about a half-year. The 1MW design would have required 6 treatment campaigns. The equipment mobilization schedule will result in an initial campaign stage utilizing 1MW, before transitioning to 2.5 MW and expanded treatment to encompass multiple campaigns. Therefore, the ISTT treatment will have three stages. The amended design includes shallow soil heating with a network of additional shallow electrodes starting at 2 ft bgs. in selected areas of treatment Zones 1&2. With the exception of the shallow electrodes, the subsurface ISTT system component design will remain unchanged regardless of available power, but the aboveground treatment system components will be scaled-up to facilitate application of additional available power. To utilize 2.5 MW of continuous power, additional ISTT system components, such as six more step-down transformers and two additional power supply units, would be necessary, along with process equipment to manage increased flow rates of soil gas and ground water.

CES Project 78-0033 CH2M HILL Project 384210.FD.01
CH2M Hill Contract No. EP-S9-08-04, Task Order: 0002
Copyright © 2010 Current Environmental Solutions, All Rights Reserved

2.0 DESIGN BASIS AND COMPONENTS OF ISTT

[Spec. 01400-1.3.8 and -1.5.1]

2.1.3 Deviations from the 30% RAMP Design ERH Numerical Model

- **Upper Heated Layer:** Due to the low concentrations of COCs in the upper 10 feet of most of the DTV and the energy limitations of heating the upper few feet of soil, the first heated layer of the soil in the final design electrode array starts at 6 feet, which would allow temperatures to be expected to reach boiling below 10 ft. and not necessarily above that depth. During electrode installation, selected soil cuttings were placed in those areas of historical shallow contamination (portions of zones 1&2) , raising grade approximately 1 foot. Shallow electrodes, installed to 7 ft depth in those areas, and operated as needed from existing electrodes, will now be utilized to heat the shallow zone less than 10ft. bgs to temperatures of 90 +/- 10 degrees C.

- **Power:** The original 1MW design assumed the available power at the site is 1,000KVA, which provides 1,200 amps at 480 volts and 3-phase power. This power constraint significantly changed the design and operations as the volume that can be treated at any one time, as the rate of cleanup is correlated to the energy input into the subsurface. As a result, the cleanup is anticipated to begin using 1MW service to treat Campaign 1 and proceed from Campaign 1 into the balance of the ISTT volume using 2.5 MW service following a rolling campaign approach to treat the entire ISTT volume (the Designated Treatment Volume).

  Cleanup approach: The approach developed using 1 MW of continuously available power included six sequential treatment campaigns. With the availability of 2.5MW, the cleanup is anticipated to begin using 1MW service to treat Campaign 1 and proceed in subsequent campaigns using 2.5 MW service following a rolling campaign approach to treat the entire DTV. Campaigns can now be combined with some overlap, and cleanup time will be reduced from the six campaign periods for 1MW. For the purposes of clarity, this design revision uses the term "stages" to represent combinations of "campaigns" to describe the treatment train being considered for the 2.5 MW design.

2.3 Process Flow
[Spec. 01400-1.5.1.A.2]

The ISTT process as applied by CES basically superimposes the process of Dual Vacuum Extraction (DVE) with Electric Resistive Heating (ERH). The 1MW design incorporated one 750kw ERH equipment setup, while the 2.5MW design has two additional PSU setups and one additional SVE system setup: however, the site may need two additional SVE setups, depending upon actual subsurface steam and vapor extraction conditions encountered. For example, if the steam production rates were too high for the two condenser

Copyright © 2010 Current Environmental Solutions, All Rights Reserved

system to handle at the design energy density, then a third condenser system would be installed. However, the vapor handling portion of the ERH equipment system will be installed and available to operate so that if the flow rate in the DVE wells requires more flow to maintain an adequate hydraulic radius of influence, then third VEU would be activated and operated. This approach is judged to provide sufficient back up and redundancy for efficient operations of the ISST. The components of these processes include the following process equipment:

1. Electrodes/DVE wells (111). There is no change to the description or function of the main 111 electrodes that were the basis of the 1MW/ six campaign design. However, shallow ("Puppy/Cap") electrodes were added to the field installation plan to more aggressively heat the vadose zone and achieve soil temperatures of 90 +/- 10C. To this extent, 125 shallow electrodes were installed in December 2009 from 2-7 feet bgs in selected areas of Zones 1 & 2. Figure 3E shows this "Cap" electrode design and Figure 5 shows the layout of all the electrodes as constructed.

2. Temperature Monitoring Wells (TMW) (19). Nineteen TMWs were installed within the DTV. Figures 6 and 7 show the details of the TMWs for Zones 1 through 4 and Zones 5 through 7, respectively. TMWs were changed from native fill at the top to gravel with a 2ft. cement plug at the top. In addition, 11 monitoring points or extraction wells just outside of the DTV will contain thermocouples installed in them to aid in verifying that hydraulic control is being maintained during ISTT. These can also be seen on Figure 5. Each TMW contains several thermal couples, which are connected to TMP Boxes as shown in Table 5.

3. Groundwater monitoring wells (28). No change from 1MW design, except that two wells (GG-3 and EE-1 had to be abandoned since they were too close to the electrodes).

4. Hopper Tank: The amended 2.5 MW design will add one additional 400 gallon vacuum rated steel tank (total 2), primarily for sediment removal, with impingement plate and level controls, high level shutdown switches and transfer pump.

5. Air-Water Separator (AWS): The amended 2.5 MW design will add one additional AWS with another potential unit installed as backup (total 3) 150-gallon units for additional water removal with demister pad. Unit is made of steel, has tangential entry, impingement plate and level controls, high level shutdown switches and transfer pump (on pump skid).

6. Settling Tank: The settling tank has been removed from the design as further evaluation deemed these to be redundant to the hopper tanks.

7. Coalescer: The amended 2.5 MW design will add one additional coalescer with another installed as backup (total 3) 150-gallon units for additional water removal. Units are made of steel, have a tangential entry, and are elevated to drain back to condensate pumps.

8. Vacuum Extraction Unit (VEU): The amended 2.5 MW design will add one additional VEU with another potential unit installed as backup (total of three) 40-horsepower, Duroflow Model 4512, positive displacement blowers, or equivalent. These units have the capacity of about 500scfm at 12 in. Hg. at the pump inlet. They will be provided complete with exhaust silencers and contained within a sound reducing enclosure. Adding VEU's of similar capacity and design provides both flexibility and redundancy to the treatment process.

Copyright © 2010 Current Environmental Solutions, All Rights Reserved

9. Power Supply Units (PSU): The 2.5MW design will add two additional PSUs. (total 3). Each 750 kW PSU is custom made by CES. Each PSU controls the output power to one 750 KVA or three 250 KVA output transformers and set of electrodes. The power supply consists of three independent 3-phase silicon controlled rectifiers rated at 350 amps at 480 VAC. The power controller permits three zone operation with each zone operated at constant voltage, constant power and constant current or constant subsurface temperature. The output of each rectifier is connected to a field located 3-phase isolation transformer.

10. System Control and Data Acquisition (SCADA) unit: No change from 1MW design

11. Transformers: The amended 2.5 MW design will add six additional 250 KVA output transformers, which are matched to each PSU, for distribution of power phases to electrodes. These will be placed in the field and moved as needed for each campaign to minimize line losses as they distribute power to lower voltages and higher amperage that goes to the individual electrodes.

12. Condenser/Cooling Tower Skid: The amended 2.5 MW design will add one additional (total 2) Condenser/Cooling Tower components. Each unit is skid mounted with a plate heat exchanger, 100-ton capacity cooling tower, condensate separators and transfer pumps. This size of condenser is matched with the 750KW PSU with some additional capacity. The model indicates power loading to the field of 410KW to 520KW, of which about 65% is used to generate steam later on in the process. This translates to a condenser sizing of 61 tons of cooling each (410kw x 65% x 3414 BTU/hr x ton/15000BTU/hr = 61 tons of cooling). Two 100 ton capacity units will therefore provide 30-60% excess capacity to deal with spikes in steam production that may occur in localized areas. If a third condenser is required to meet the cooling requirements, then a third 100-ton condenser unit will be installed and operated at that time.

13. Brine and drip skids: Custom made units by CES, for controlled supply of electrolyte solution to electrode to maintain conductivity. The projected average flow of wetting solution to the electrodes is about 0.09 gpm total or about 0.2 gal/hr per electrode.

14. Vapor Phase Granular Activated Carbon (VPGAC): The amended 2.5 MW design will add six additional VPGAC units. There will be three VPGAC Units in series for each PSU system. Each VPGAC Unit consists of two 1000-pound vessels in parallel, which is equivalent to one 2000-pound VPGAC Unit; therefore, a total 12,000 pounds of VPGAC provides carbon treatment for recovered soil vapor. The discharge from primary unit is processed through a secondary unit and then a tertiary unit to provide two levels of backup treatment. Each Unit has more than adequate adsorptive capacity for each campaign since there is expected to be a total of 35kg of COCs to be removed from the entire DTV. The tertiary carbon set will provide 200% backup in line so that if breakthrough does occur in the first set of carbon vessels, it will be captured on the second or third set of carbon Units. This provides a high degree of assurance that potential emissions are minimized. Each unit of 1000 pounds has a maximum flow capacity of 500 scfm, which calculates to an empty bed contact time of four seconds. At the 2.5MW design flow rates there is about 9 seconds of empty bed contact time. If a third SVE system is required then three more (primary, secondary and tertiary) carbon Units (total 6 additional 1000 lb vessels) will be installed and operated at that time.

15. Liquid Phase Granular Activated Carbon (LPGAC): The direct discharge to EPA groundwater treatment system (GWTS) has been eliminated from 1MW design. The ERH process water (including groundwater extracted from the ISTT Volume) will be pretreated and sent directly via a 1.25" PE pipe

Copyright © 2010 Current Environmental Solutions, All Rights Reserved

to the 1" PVC inlet of the existing groundwater treatment system for additional treatment with the other extracted groundwater. Empty bed contact time for these units are about 25 minutes.

16. Poly Holding Tank: 5,000 gallon polyethylene tank with high-high level shut down controls and pump controllers to reuse treated water throughout the system via the SCADA.

17. Site Cap. The majority of Zones 1 and 2 indicate shallow (<10ft) soil contamination that will need to remain adequately heated to carry contaminants into the cap for capture. This area will be insulated above the gravel and plastic liner and covered with another liner to reduce heat losses in this area. Figure 8A shows the layout of the cap, including the areas that are insulated and Figure 8B shows the construction details of the cap.

These components collectively comprise the ISTT system and are shown on a process and instrumentation diagram (P&ID) in Figure 9. Note that Figure 9 shows the process flow for the anticipated two ERH equipment setup systems, while Figure 9B shows the layout of the equipment, including the potential backup setups where appropriate.

2.3.1 Process Flow Analysis

The characteristics of various process streams shown on the P&ID are summarized in Table 2. Table 2A is for a single PSU equipment setup used in Stage 1. Table 2B is for a three-PSU equipment setup that will be used for Stages 2 and 3. This tracks the maximum flows (water, vapor, steam), pressures, temperatures and COC concentrations that are expected throughout the process. The maximums are shown since the process is highly variable and the process equipment must be designed to handle the maximums as well as expected turndown ratios for each process stream. These data are primarily obtained from the numerical model output (Appendix A).

Copyright © 2010 Current Environmental Solutions, All Rights Reserved

				TABLE 2A								
				PROCESS STREAM ANALYSIS								
ISTT REMEDIATION												
Frontier Fertilizer Superfund Site			**CAMPAIGN 1: 0-44 FT bgs**									
			Typical of Stage 1									
			Design Flows -Maximum									
Process Stream ID	Description	Pipe (type, size, rating)	Air Flow (scfm)	Water Flow (gpm)	Steam Flow (scfm)	COC Concentration (mg/l)	Temperature (oC)	Pressure (psia)	Other	Other units	Maximum Turn down (%)	Comments
A	Power to Electrodes	1/0 insulated copper cable							vary	Volts	100%	
									235	Amps		max rating
B	DVE extraction Well	0.5"TFE	6	0.1	12	0.13	<110	11.8	7	wells	100%	6"Hg vacuum
C	SVE Extraction Well	1.5"max steam hose	5	0	12	0.13	<110	14.2	20	wells	100%	1"Hg vacuum
D	Vapor/Water Separator--Vapor Out	6" CPVC, Sch.80	96	0	321	0.13	100	11.3			100%	7"Hg vac.
E	Condenser Vapor Out	6" CPVC, Sch.80	128	0	0	0.13	35	10.8	100	%Rel.Humidity	100%	8"Hg vac.
F	Cap Vent Out	4" CPVC, Sch.80	256	0	0	n/a	80	10.8	30	%Rel.Humidity	100%	1"Hg vac.
G	VGAC In Primary	6" PVC	384	0	0	0.04	39	10.8	53	%Rel.Humidity	100%	8"Hg vac.
H	VGAC Out Primary	6" PVC	384	0	0	0.005	39	10.3	53	%Rel.Humidity	100%	9"Hg vac.
I	VGAC Out Secondary	6" PVC	384	0	0	0	39	9.8	53	%Rel.Humidity	100%	10"Hg vac.
J	VGAC Out Tertiary	6" PVC	384	0	0	0	39	8.8	53	%Rel.Humidity	100%	11"Hg vac.
K	Stack --VEU Out	6" Steel, Sch.40	400	0	0	0	122	14.9			60%	
L	Vapor/Water Separator--Water Out	2" CPVC, Sch.80	0	1.20	0	0.70	100	11.2			100%	Batch basis
M	Condenser Water Out	1" CPVC Sch.80	0	2.13	0	2.1	35	11.2			100%	
N	Hopper out	1.5" steam hose	0	10	0	0.5	35	29.7			100%	Batch basis
O	LGAC In Primary	1.5" braided PVC	0	10	0	0.5	35	24.7			100%	Batch basis
P	LGAC Out Primary	1.5" braided PVC	0	10	0	0	35	19.7			100%	Batch basis
Q	LGAC Out Secondary	1.5" braided PVC	0	10	0	0	35	14.8			100%	Batch basis
S	Make-up Water to Condenser	1" PVC, Sch.40	0	10			35	24.7			100%	Batch basis
T	Drip stand out to each electrode	1/4" PE tubing	0	0.25	0	0	35	24.7			100%	Batch basis, variable based on electrode current
U	Solids from Hopper	solids to DOT drum	0	0	0	0	35	14.7	40	% solids	100%	Batch basis

Copyright © 2010 Current Environmental Solutions, All Rights Reserved

TABLE 2b
PROCESS STREAM ANALYSIS

ISTT REMEDIATION
Frontier Fertilizer Superfund Site

CAMPAIGN 1,2,3: 0-84 FT bgs
Typical of Stages 2 and 3

			Design Flows -Maximum									
Process Stream ID	Description	Pipe (type, size, rating)	Air Flow (scfm)	Water Flow (gpm)	Steam Flow (scfm)	COC Concentration (mg/l)	Temperature (oC)	Pressure (psia)	Other	Other units	Maximum Turndown (%)	Comments
A	Power to Electrodes	4/0 insulated copper cable							varies	Volts	100%	
									360	Amps		max rating
B	DVE extraction Well	0.5"TFE	6	0.05	14	0.07	<110	11.8	16	wells	100%	6"Hg vacuum
C	SVE Extraction Well	1.5" max steam hose	5	0	13	0.07	<110	14.2	36	wells	100%	1"Hg vacuum
D	Vapor/Water Separator--Vapor Out	6" CPVC, Sch.80	514	0	695	0.07	100	11.3			100%	8"Hg vac.; flow split between 2 AWS
E	Condenser Vapor Out	6" CPVC, Sch.80	327	0	0	0.07	35	10.8	100	%Rel.Humidity	100%	9"Hg vac.
F	Cap Vent Out	4" CPVC, Sch.80	336	0	0	n/a	80	13.7	30	%Rel.Humidity	100%	2"Hg vac.
G	VGAC In Primary	6" CPVC, Sch.80	850	0	0	0.04	40	10.8	64	%Rel.Humidity	100%	9"Hg vac.; flow split between 2 racks of carbon
H	VGAC Out Primary	6" CPVC, Sch.80	850	0	0	0.005	40	10.3	64	%Rel.Humidity	100%	10"Hg vac.
I	VGAC Out Secondary	6" CPVC, Sch.80	850	0	0	0	40	9.8	64	%Rel.Humidity	100%	11"Hg vac.
J	VGAC Tertiary Out	6" CPVC, Sch.80	850	0	0	0	40	8.8	64	%Rel.Humidity	100%	12"Hg vac.
K	Stack --VEU Out	10" Steel, Sch.40	850	0	0	0	179	14.9			60%	
L	Vapor/Water Separator--Water Out	2" CPVC, Sch.80	0	2.45	0	0.38	100	11.2			100%	Batch basis
M	Condenser Water Out	1" CPVC Sch.80	0	4.95	0	1.1	35	11.2			100%	
N	Hopper out	1.5" Steam Hose	0	10	0	0.7	35	29.7			100%	Batch basis
O	LGAC In Primary	1.5"braided PVC	0	10	0	0.7	35	24.7			100%	Batch basis
P	LGAC Out Primary	1.5"braided PVC	0	10	0	0	35	19.7			100%	Batch basis
Q	LGAC Out Secondary	1.5"braided PVC	0	10	0	0	35	14.8			100%	Batch basis
S	Make-up Water to Condenser	1" CVC, Sch.40	0	10			35	24.7			100%	Batch basis
T	Drip stand out to each electrode	1/4" PE tubing	0	0.56	0	0	35	24.7			100%	Batch basis, variable based on electrode current
U	Solids from Hopper	solids to DOT drum	0	0	0	0	35	14.7	40	% solids	100%	Batch basis

Copyright © 2010 Current Environmental Solutions, All Rights Reserved

2.3.2 Piping Plan

There are two distinct vapor/steam capture mechanisms employed at this site. The primary vapor/steam capture system includes the SVE and DVE wells at each electrode. The secondary system is the site cap venting system. Since each well is planned for vapor and steam extraction under vacuum, the extraction wells which are co-located with the electrodes are connected to the central VEU via manifolds at each electrode wellhead. Each wellhead includes an SVE or DVE well, shallow vent pipe and electrodes with wetting tubes. Figure 10 shows the construction details of the SVE and DVE wellheads.

The DVE wellheads are designed to extract water and vapor (including steam) from the well, while the SVE wells just handle vapor and steam. The shallow cap (see well construction details, Fig 3E, and 8B) wells are designed to allow fresh air to enter at the wellhead, or through air inlet vents, and sweep through the gravel layer, collect any COC vapors and steam (if present), and be collected at the adjacent electrode where another vacuum manifold is connected to the shallow well. Since the subsurface heating will be performed in three distinct Stages representing a combination of one or more of the original six 1MW design treatment Campaigns, only the extraction manifold for Stages 1 and 2 will be installed, and then it will be moved to Stage 3 at the time the electric cabling and PSU's are demobilized from one stage and connected to Stage 3.

The manifolds are sized to handle the maximum expected flow per well, with about 50% additional capacity built into the piping system, at a target velocity of about 30 ft/second. Figures 11A, B and C show the layout of the piping manifold from each electrode to the process equipment area for Stages 1, 2 and 3, respectively. As more electrode wells are connected to the manifold, the size of the manifold increases to handle the additional combined flow. The manifold is designed to handle flow of vapors, water and steam simultaneously, with flexible wellhead connections, short runs and open supports to accommodate thermal expansion.

The materials selected for the wellheads, manifolds and process components are primarily CPVC, PVC and FRP, so corrosion should not be a factor. Since there is no particular industry guideline for ISTT, the selected materials were based primarily on manufacturer specifications and field experience as to how they previously held-up under the process temperature, pressure, vacuum, and contaminants (if prior art was established) as well as other conditions, such as expected sun and weather resistance, and project duration.

Fluids and materials collected by the SVE/DVE manifold includes a combination of water, vapor, air, sediment and steam and must pass through two vapor/liquid/solids separators and a condenser prior to treatment by activated carbon. The cap vent system using the shallow wells is usually relatively dry and cool since ambient air is allowed to enter to sweep out the vapors present and is carried directly to the carbon units for treatment. The relatively cool and dry cap vent manifold system is combined with the humid condensed vapor stream to provide a less humid vapor stream to the carbon so that COC removal efficiencies are higher. The two systems are manually balanced during the process as the dynamics of vapor and steam flow change over the 30-day period that characterizes the transition from soil temperatures near 80C to boiling.

Applicable specifications (e.g. materials, temperature, pressure and vacuum ratings, torque specifications, etc) for the wellheads and manifold materials will be obtained to the extent possible and furnished to CH2M Hill construction manager prior to their installation. Inspection checks for any used components will be recorded in the O&M and Materials Inspection Log contained in the O&M Plan to verify and record that the component is appropriate for its intended use and function.

Copyright © 2010 Current Environmental Solutions, All Rights Reserved

2.4 Performance Monitoring Components [Spec. 01400.1.3.2]

2.4.1.4 Monitoring Groundwater Containment

Hydraulic control will be monitored by monitoring the temperature of groundwater near but outside the treatment volume. If warmer water is not moving out from the treatment volume, then groundwater temperature will not rapidly increase outside of the treatment volume, but may show a very slow, steady increase due to heat conduction. Thermocouples have been installed in the perimeter wells and pumping wells as shown in Figure 5.

2.4.5.3 Air Emissions

All process stream vapors will be treated for COCs using the GAC vessels and discharged out the stack of the VEU. CES, CH2M HILL and EPA will coordinate with the local Air Quality Management District to comply with applicable requirements. Discharge will be at a height of 10 feet through a 6" stack for Stage 1 and through a common 10 inch stack in Stages 2 and 3. It is anticipated that stack emissions will be non-detect for COCs and the routine monitoring will verify that the treatment process is effective.

2.4.6 Process Logic and Control

Figure 9 (P&ID) contains the interlock control function of the ISTT process components. Interlock controls are designed to operate or shut-down system components. Sensors which do not have control functions are for monitoring and recording purposes only. The data recorded by these sensors will be collected (typically hourly) by the SCADA system and recorded in the ISTT process data log.

2.5 Heating Electrodes [Spec. 01400-1.3.2]

The ERH design for the DTV will use 111 electrodes, divided into four groups from 27 to 36 electrodes that will be used to treat six different soil volumes in treatment campaigns combined into three stages. The ERH numerical model derives the number of electrodes based on an optimum spacing for power density for the treatment volume, size of electrodes, soil conductivity and phasing of power. Figure 12 shows the electrode layout and the combinations of electrodes that represent each treatment campaign. With 2.5 MW power, the individual campaigns can be combined into 3 stages, with stage 1 being the 1MW startup campaign in zone 1. Shallow electrodes will be utilized as needed in Campaigns 1 and 2. Field data obtained during operations will be evaluated to determine shallow electrode utilization to achieve temperatures of 90 +/- 10C in the vadose zone. The following Table 3 shows the original six 1MW treatment campaigns now assigned as “Stages” for 2.5 MW power, but the ISTT design and equipment allows for operational flexibility to allow CES, CH2M HILL and EPA to adjust the treatment campaigns as necessary. The well and electrode counts shown in Table 3 are anticipated starting points based on the design, but these counts may change slightly in the field based on data derived during operations.

Copyright © 2010 Current Environmental Solutions, All Rights Reserved

Table 3 –Treatment Campaigns

Treatment Campaign	Zones Heated	Depths Heated	DVE Electrode / Wells	SVE Electrode / Wells	Shallow Electrodes
1	Zone 1 + few electrodes/wells in Zone 2 for phase balancing and hydraulic control	0 to 40 ft.	7-11	20	54
2 Stage 2	Most of deep portion of Zone 2	44 to80 ft.	9-10	17	
3 Stage 2	Most of shallow portion of Zone 2	0 to 44 ft.	9-10	17	55
4 Stage 3	Most of deep portion of Zone 3, southern portion of Zone 7 and remainder of Zone 2	44 to80 ft.	7-8	27	
5 Stage 3	Most of shallow portion of Zone 3, and remainder of Zone 2	15 to 44 ft. 0 to 44 ft.	7-8	27	16
6 Stage 3	Remainder of Zone 7 Zone 6 Zone 5 Zone 4	44 to80 ft 25 to 80 ft. 25 to 60 ft. 15 to 60 ft.	7-9	17	

Note: Sum of the number of DVE and SVE electrodes indicated above that may be operated at different times and may not add up to the total number of electrodes (111) due boundary conditions and overlap of campaigns in various stages.

2.6 Power Supply Unit (PSU) [Spec. 01400-1.3.2]

The PSUs are equipped with a completely remote addressable control system. Though CH2M HILL and EPA will be provided access to the data screens, only qualified CES personnel will be permitted to alter operational configurations. Each of the three PSUs will deliver an average of 410 to 510 kW to the subsurface treatment volume to achieve 45W/yd^3 distribution. The PSUs can deliver three (3) to six (6) separate electrical phases to the electrodes. Each PSU requires 1,200 amps of 480 V, 3-phase power to service the DTV. The DTV was originally divided into six treatment volumes based on utilizing 1MW of power to do six treatment campaigns. With the availability of 2.5 MW of power, the first treatment campaign will be powered by one PSU, and two subsequent stages will be powered by three PSUs, custom built by CES.

PG&E proposed two transformers (1000 KVA and 2500 KVA) for two service connections (panels) with a combined total ampacity of 4200 amps. However, a maximum of 3600 A can be supplied by PG&E, and of that, about 3300 A would be the maximum usable by the ERH equipment: 900 A per PSU, about 50 A for each VEU and 100A for all other equipment. Accordingly, three PSUs installed after Stage 2 and their ancillary equipment is expected to use a maximum of 2950 A. Staying within this limit corresponds to

Copyright © 2010 Current Environmental Solutions, All Rights Reserved

operating each PSU at an average of 625 kW at a power factor of > 0.83. (For reference, the numerical models were performed at about 525 kW per PSU, corresponding to a design basis of 45 W/yd^3.) The power factor is controlled by a manual tap setting on each transformer. As the soil load changes during heating, the target power factor determines how often the transformer taps need to be adjusted to match the load. The presence of the panel with separate breakers (for PSUs and VEUs) performs an averaging function so that the > 0.83 power factor target is a composite value of all 9 transformers, meaning individual tap settings can run well below 0.83 power factor at full current and not exceed the 3000 A panel limit, and not cause any fuses to blow or circuit breakers to trip (or the PG&E switch to open).

Considering the potential impact in overall treatment time and operational flexibility, the addition of supplemental shallow heating electrodes and insulated cap will speed the overall process, so that the need to make up for downtime by running higher than modeled power (525 kW) will be reduced. Power levels up to 750 kW per PSU will still be possible, but would require more diligence (less flexibility) to properly match and balance loads than if the fully usable 3300 A were available. Therefore, the EPA selected one 2500 KVA transformer and service from PG&E to provide the basis for this 2.5MW design.

2.11 Operational Strategy

2. Heat the DTV in three Stages, starting with Campaign 1 and utilizing 1 MW service as outlined in Section 2.5 until diminishing returns are observed, which will be further evaluated by the project team through vapor, temperature and groundwater monitoring. Stage 2 will combine Campaigns 2&3, utilizing 2.5MW service and the additional PSUs and the other equipment required, Stages 1&2 include utilization of shallow electrodes for heating the vadose zone. Operation (timing) of shallow electrodes depends on 1) local resistivity (heating rate), and 2) local temperature trends (heating requirement) as compared to the rest of the electrode array (below 6 ft bgs). Once centroid heating in the main array has been established, power can be shifted to cap electrodes. Electrode segments are taken on and off line (time sequenced) to achieve roughly uniform energy deposition as needed to expedite the initial heat up of the entire campaign volume to treatment temperatures at all performance-point locations. Once performance points have reached target temperature, further power delivery is managed between 1) bringing the lagging upper, perimeter and lower temperature points up to target temperatures, 2) temperature maintenance and steam production in the performance region as need to achieve diminishing returns, and 3) expanding the treatment volume (via rolling campaigns). Because of light dissolved phase contamination and other factors, focused heating in lagging regions, including 0 to 7 ft bgs, will be the priority once all performance points are at target temperature. The cap electrodes would be energized as needed after the region from 10 ft bgs and below are up to temperature. All electrode segments are subject to numerous operational constraints such as power limitation, phase balance, and cable size. The cap electrodes have a maximum average power rating of 300 W/ft, which is more than sufficient for rapid heating. Above that power density they dry out. Because the cap and all other electrodes operate as parallel resistors, this places a constraint on operating voltage and therefore can limit overall power delivery. As a result, cap electrodes shall be connected as needed and as determined by electrical safety and cable capacity.

Copyright © 2010 Current Environmental Solutions, All Rights Reserved

3. As target temperatures (i.e., the boiling point of water or more than 100C, and 90+/-10C <10ft bgs) and energy input are evaluated, these data will be used to optimize power distribution and treatment. Decisions to terminate heating and/or direct heating to the more problematic zones (i.e., areas indicating lower temperatures) will be made by the operations team based on the available operations data. This facilitates energy conservation as well as the opportunity for sampling groundwater.

4.0 ISTT DESIGN SPECIFICATIONS

[Spec. 01400-1.5.1C and D]

4.1.2 ISTT System Drawings

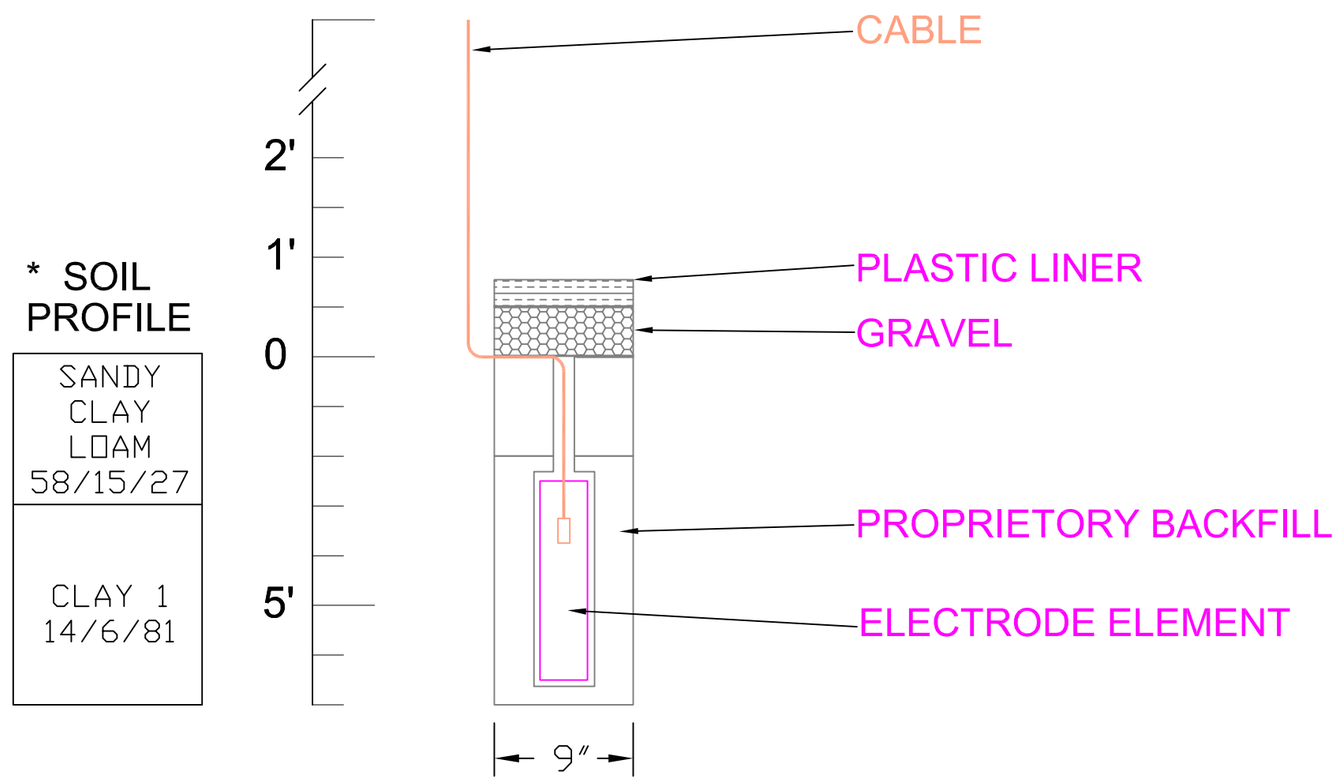
The following figures have been updated from the 1MW design and included in this addendum:

Figure 3E:	Cap Electrode Detail
Figure 5:	Electrode Layout
Figure 8A:	Cap Layout
Figure 8B:	Cap and Air Inlet Detail
Figure 9:	Process and Instrumentation Diagram
Figure 9B:	Equipment Layout
Figure 10:	Wellhead Detail
Figure 11A,B,C:	Piping Layouts per Stage
Figure 12:	Treatment Campaigns
Figure 13A,B,C:	Equipment Layouts
Figure 14:	Utility Location Plan
Figure 15:	Electrical One-Line
Figure 16A,B:	Fence Construction Details

Copyright © 2010 Current Environmental Solutions, All Rights Reserved

CAP ELECTRODE

* Soil Profile corresponds to USDA soil classifications used in ERH model with percent sand/silt/clay shown below soil type.



CURRENT ENVIRONMENTAL SOLUTIONS
316 AVOCET AVE
DAVIS, CA 95616

CH2M HILL Contract: EP-S9-08-04 Task Order: 002 Project Number: 384210.FD.01

Copyright 2010 Current Environmental Solutions. All Rights Reserved

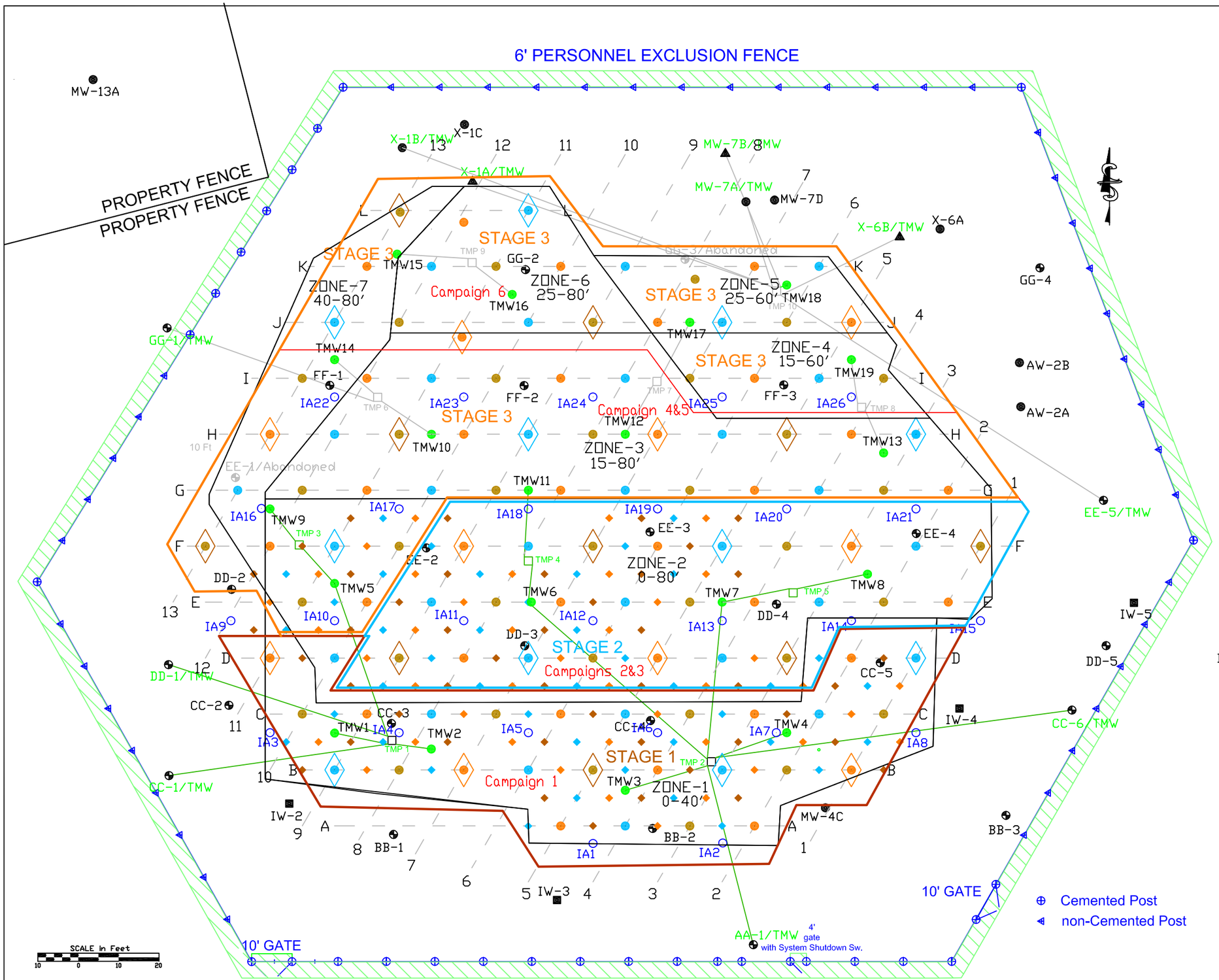
Scale: NTS
Date: 05/12/2010
Drawn By: Mike OBrien
Designed By: William Heath
Approved By: Jim Malot PE
PE #CA59088 _____

SHALLOW ELECTRODE ZONES 1&2

ISTT, FRONTIER FERTILIZER NPL SITE

Project# 78-0033

Figure# 3E



NOTES:

Total Heated Area 26719sf

Stage 1
Zone1 0-40 3 Segments 1(12),2,3
Stage 2
Zone2 0-80 5 Segments 1(12),2,3,4,5
Zone3 15-80 5 Segments 1(8),2,3,4,5
Stage 3
Zone4 15-60 4 Segments 1(8),2,3,4
Zone5 25-60 3 Segments 2,3,4
Zone6 25-80 4 Segments 2,3,4,5
Zone7 40-80 3 Segments 3,4,5

Electrodes (111) @ 16' Spacing
- A Phase Electrodes (37)
- B Phase Electrodes (38)
- C Phase Electrodes (36)
- A Phase Star Electrodes (10)
- B Phase Star Electrodes (10)
- C Phase Star Electrodes (11)

Cap Electrodes (125) @ 8' Spacing
- A Phase Cap Electrodes (44)
- B Phase Cap Electrodes (41)
- C Phase Cap Electrodes (40)
- Thermowell (19)
- Air Vent (26)

***/TMW are existing Monitor wells converted to read Temperature
- TMP Boxes
- TMW Wire Stage 1&2
- TMW Wire Stage 3
- Ground Mats

CURRENT ENVIRONMENTAL SOLUTIONS

316 AVOCET AVE
DAVIS, CA 95616

CH2M HILL Contract: EP-S9-08-04 Task Order: 002 Project Number: 384210.FD.01

Copyright 2010 Current Environmental Solutions. All Rights Reserved

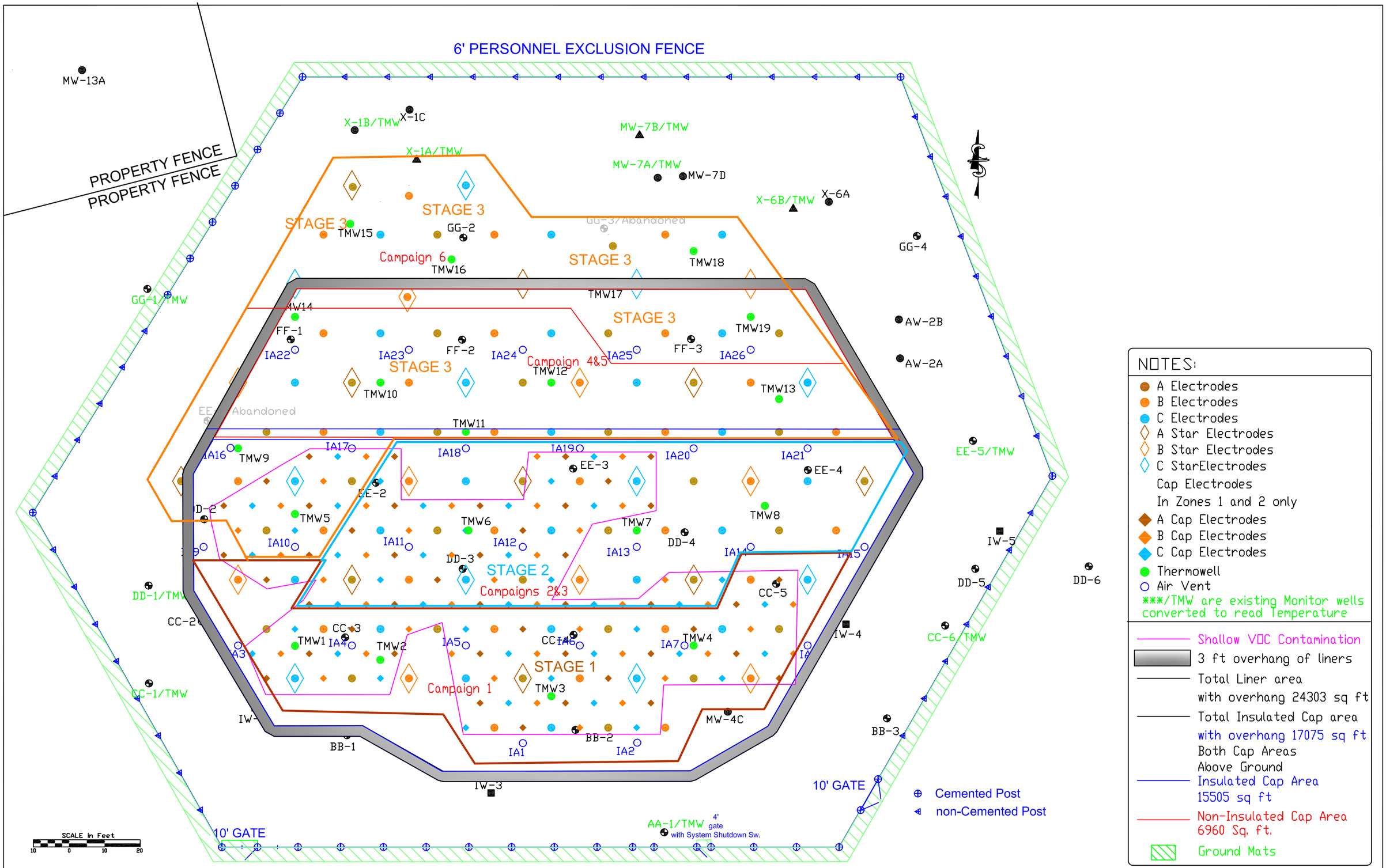
Scale: as shown
Date: 05/13/2010
Drawn By: Mike OBrien
Designed By: William Heath
Approved By: Jim Malot PE
PE #CA59088 _____

ELECTRODE LAYOUT

ISTT, FRONTIER FERTILIZER NPL SITE

Project# 78-0033

Figure# 5



CURRENT ENVIRONMENTAL SOLUTIONS

316 AVOCET AVE
DAVIS, CA 95616

CH2M HILL Contract: EP-S9-08-04 Task Order: 002 Project Number: 384210.FD.01

Copyright 2010 Current Environmental Solutions. All Rights Reserved

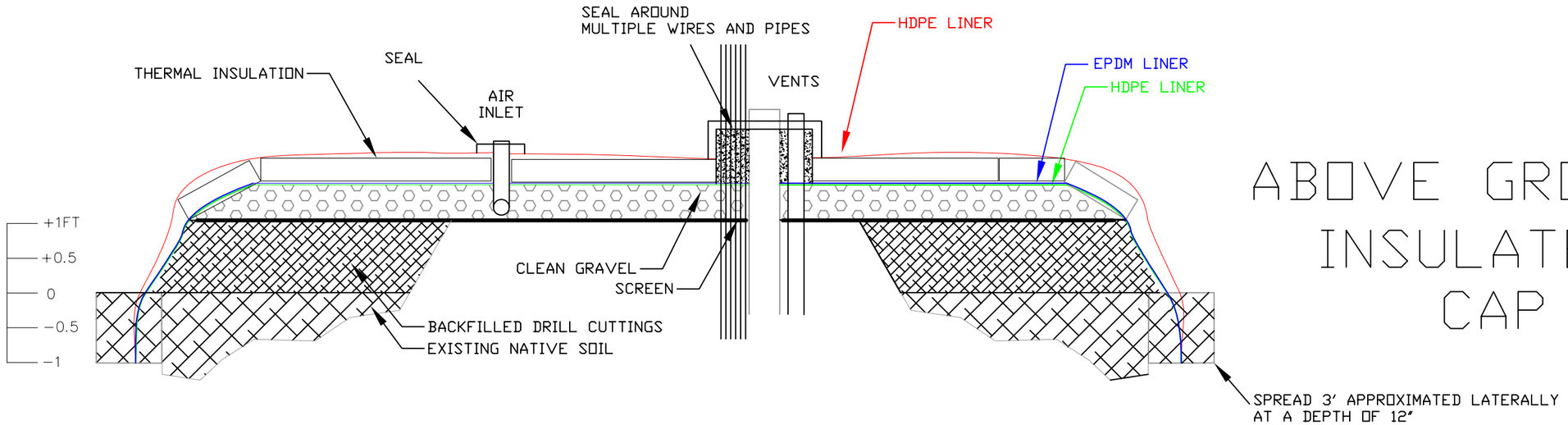
Scale: as shown
Date: 05/13/2010
Drawn By: Mike OBrien
Designed By: William Heath
Approved By: Jim Malot PE
PE #CA59088

CAP LAYOUT

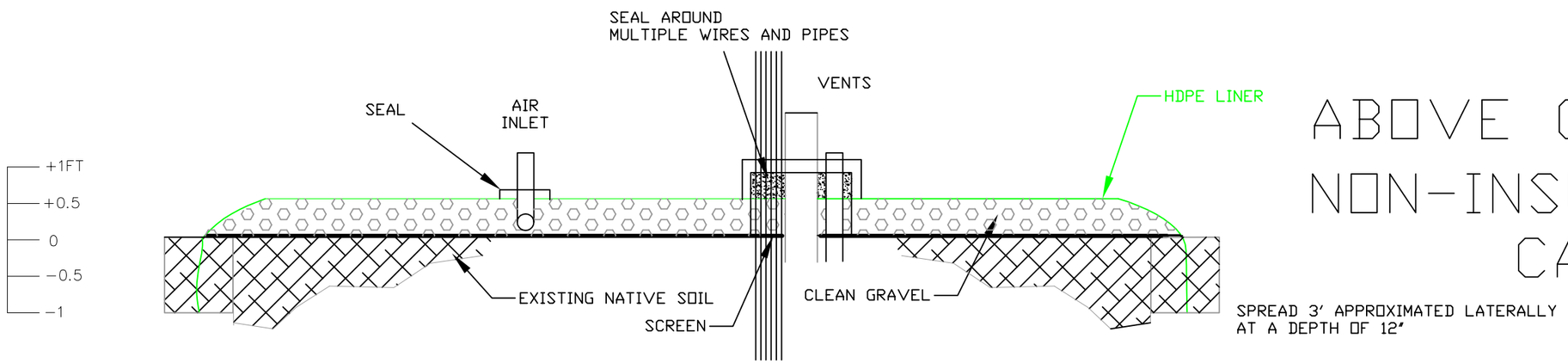
ISTT, FRONTIER FERTILIZER NPL SITE

Project# 78-0033

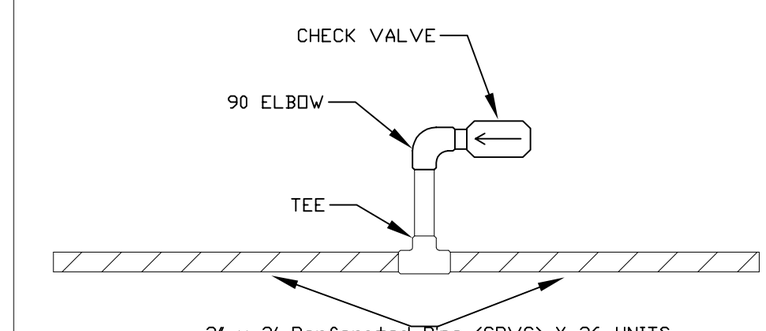
Figure# 8A



ABOVE GROUND INSULATED CAP



ABOVE GROUND NON-INSULATED CAP



AIR INLET DETAIL
(SIDE VIEW)

TOTAL AREA BOTH CAPS 24304 FT^2
INCLUDING 3 FT EXTENSION TAPERED AND BURIED 1 FT.

INSULATED CAP AREA 15505 FT^2
NON-INSULATED CAP AREA 6960 FT^2

CURRENT ENVIRONMENTAL SOLUTIONS
316 AVOCET AVE
DAVIS, CA 95616

CH2M HILL Contract: EP-S9-08-04 Task Order: 002 Project Number: 384210.FD.01

Copyright 2010 Current Environmental Solutions. All Rights Reserved

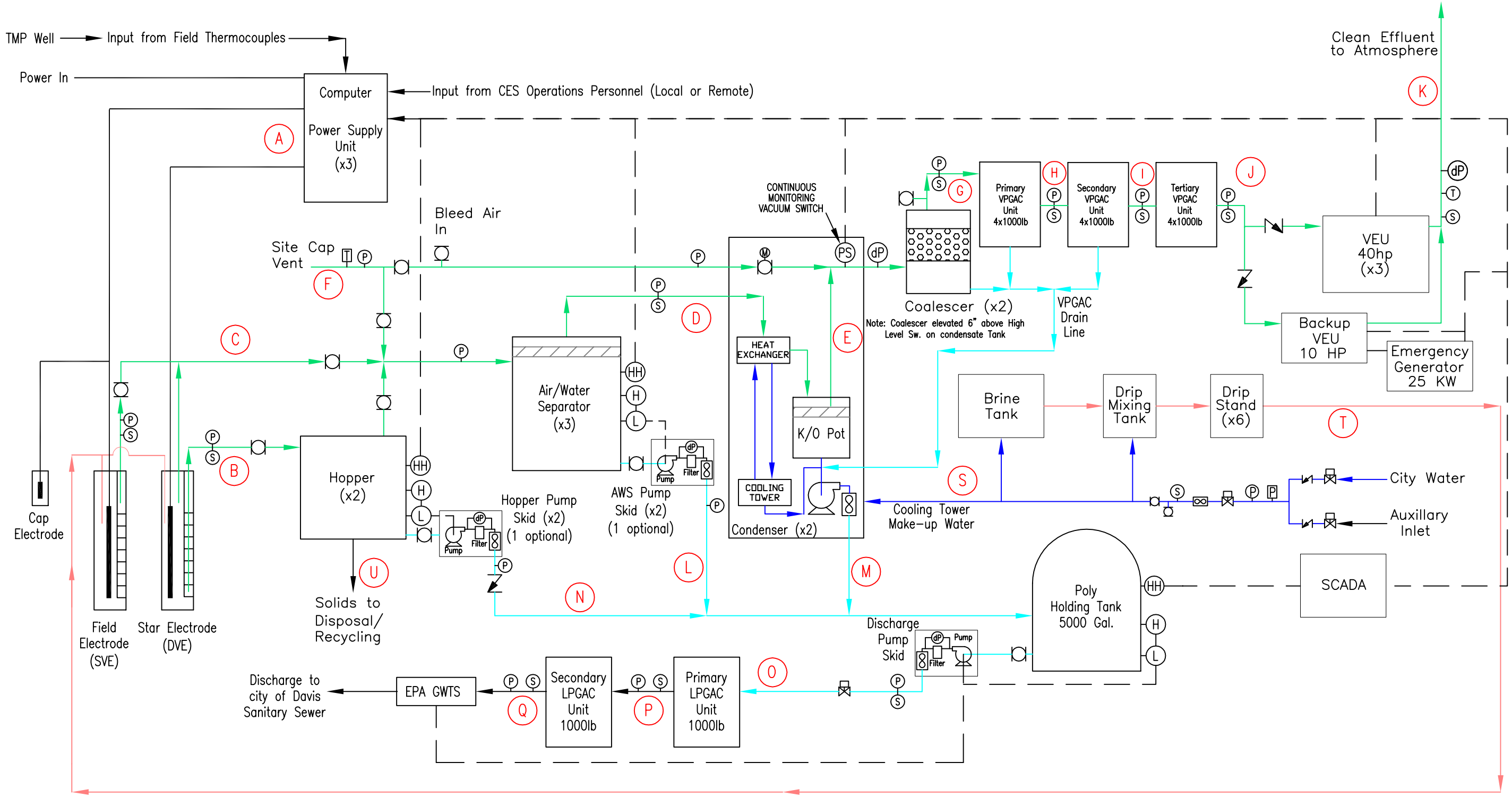
Scale: NTS
Date: 05/12/10
Drawn By: Mike OBrien
Designed By: William Heath
Approved By: Jim Malot PE
PE #CA59088

CAP AND AIR INLET DETAIL

ISTT, FRONTIER FERTILIZER NPL SITE

Project# 78-0033

Figure# 8B



LEGEND

- (P) Pressure Indicator
- (T) Temperature Indicator
- (S) Sample Port
- [T] Temperature Transmitter
- (dP) Differential Pressure Indicator
- (TS) Temperature Switch
- (HH) High High Liquid Level Sensor
- Solenoid Valve
- (H) High Liquid Level Sensor
- (L) Low Liquid Level Sensor
- (PS) Pressure Switch
- [P] Pressure Transmitter
- Ball Valve
- Check Valve
- Totalizing Flow Meter
- (M) Actuated Valve
- VEU Vacuum Extraction Unit
- VPGAC Vapor Phase Granular Activated Carbon
- LPGAC Liquid Phase Granular Activated Carbon
- — — Electrical Shut Down Interlocks
- Centrifical Pump
- Demister (optional)
- Rock
- Pump Skid
- (A)-(T): See Process Stream Analysis Table

CURRENT ENVIRONMENTAL SOLUTIONS
316 AVOCET AVE
DAVIS, CA 95616

CH2M HILL Contract: 384210.fd.01

Copyright 2010 Current Environmental Solutions. All Rights Reserved

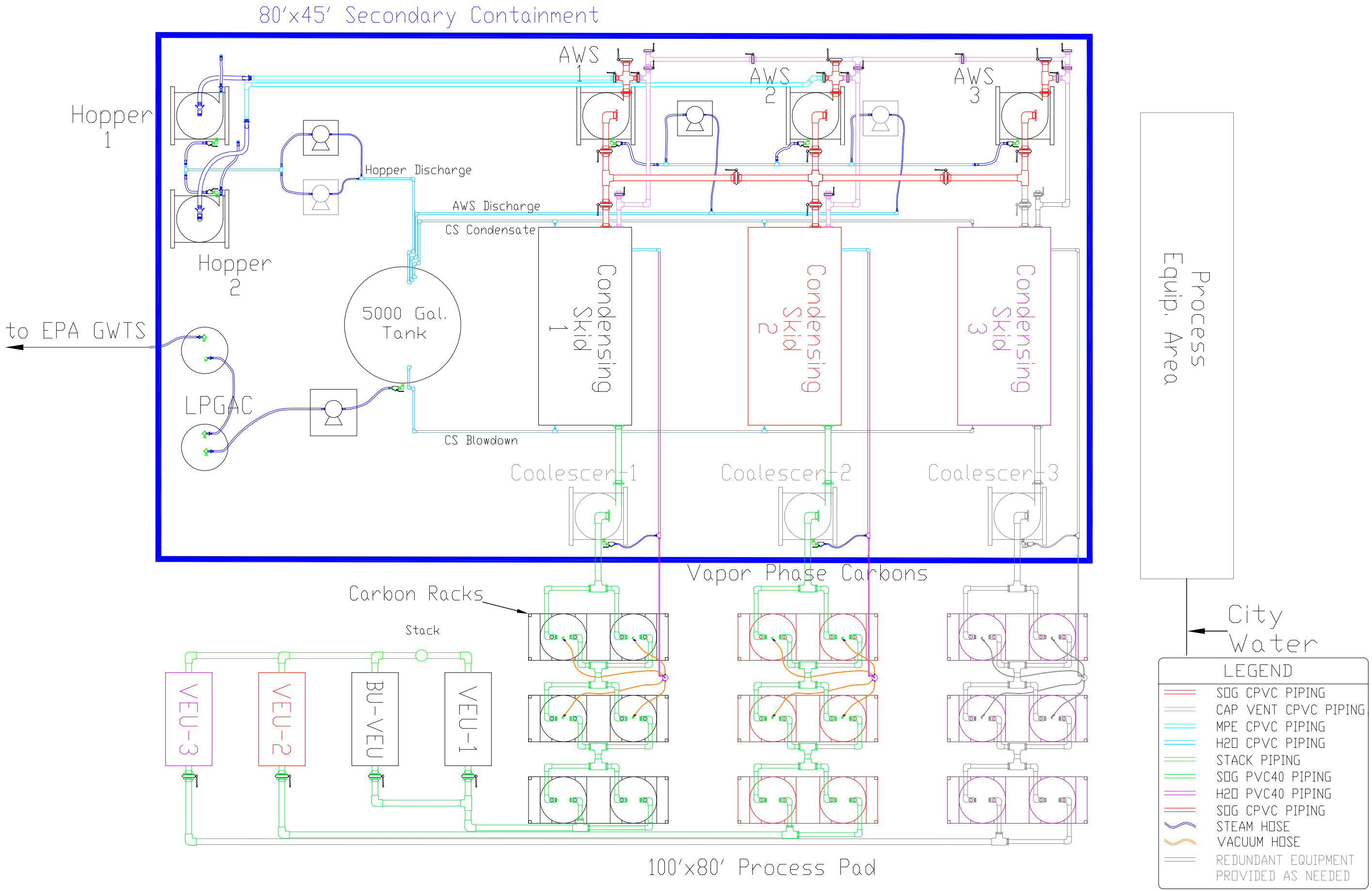
Scale: NTS
Date: 8/23/2010
Drawn By: M.O'Brien
Designed By: William Heath
Approved By: Jim Malot PE
PE #CA59088

PROCESS AND INSTRUMENTATION DIAGRAM

ISTT, FRONTIER FERTILIZER NPL SITE

Project# 78-0033

Figure# 9A



CURRENT ENVIRONMENTAL SOLUTIONS

316 AVOCET AVE
DAVIS, CA 95616

CH2M HILL Contract: EP-S9-08-04 Task Order: 002 Project Number: 384210.F.D.01

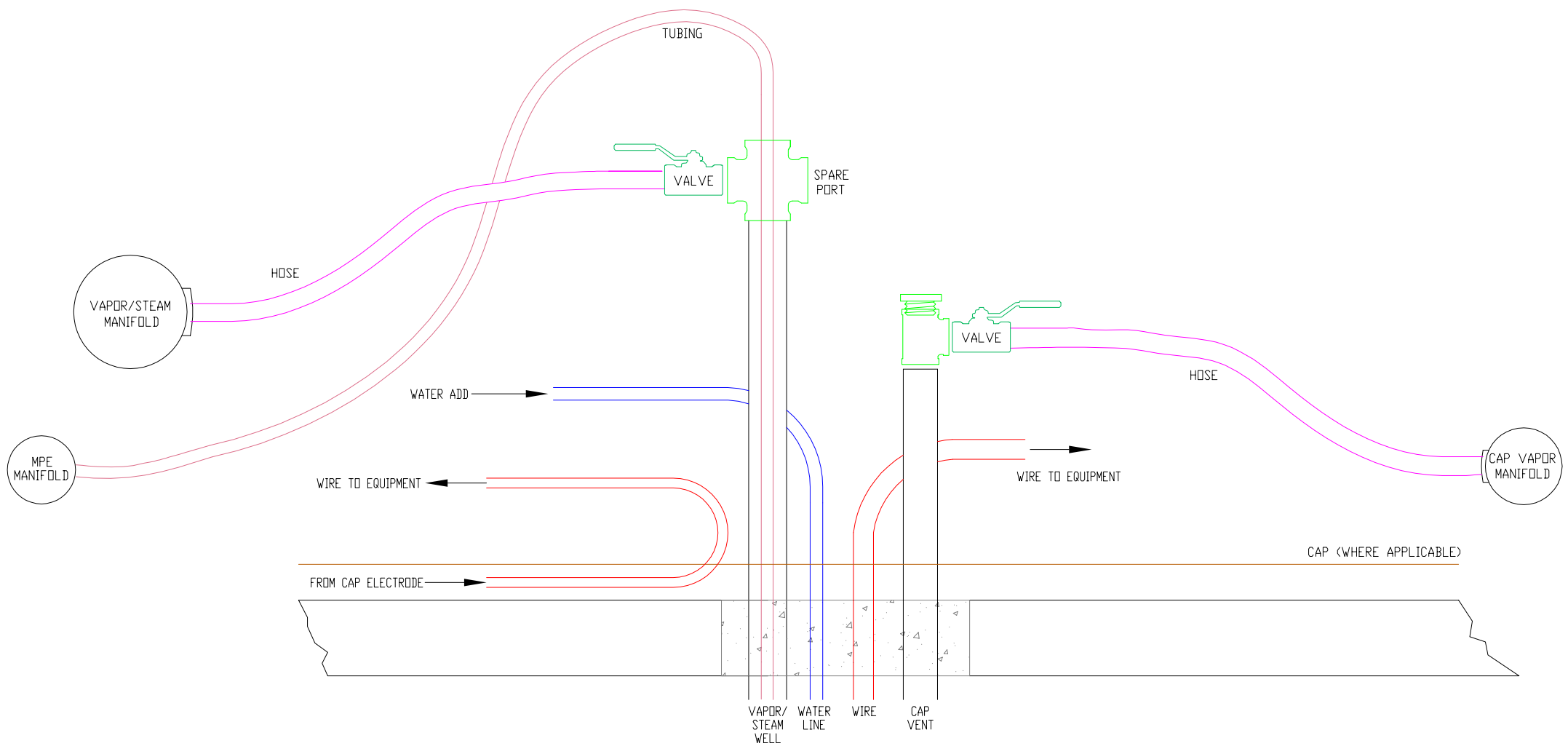
Copyright 2010 Current Environmental Solutions. All Rights Reserved

Scale: 1"= 8'
Date: 8/23/10
Drawn By: R.Somosky
Designed By: William Heath
Approved By: Jim Malot PE
PE #CA59088

PROCESS AND INSTRUMENTATION DIAGRAM
EQUIPMENT PIPING SUPPLEMENT
ISTT, FRONTIER FERTILIZER NPL SITE

Project# 78-0033

Figure# 9B



CURRENT ENVIRONMENTAL SOLUTIONS

316 AVOCET AVE
DAVIS, CA 95616

CH2M HILL Contract: 384210.fd.01

Copyright 2010 Current Environmental Solutions. All Rights Reserved

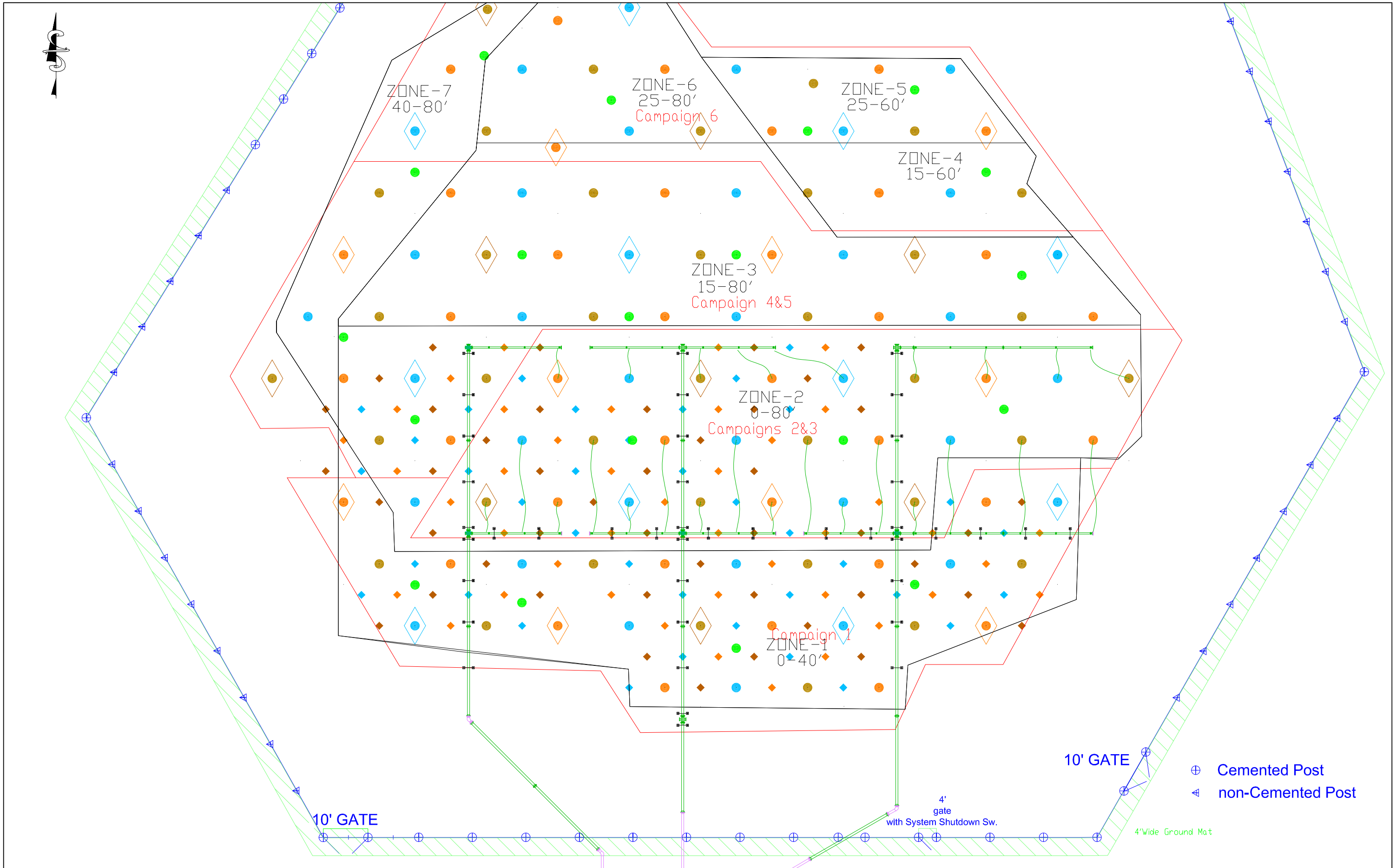
Scale: NTS
Date: 05/10/2010
Drawn By: R.Somosky
Designed By: William Heath
Approved By: Jim Malot PE
PE #CA59088

WELLHEAD DETAIL

ISTT, FRONTIER FERTILIZER NPL SITE

Project# 78-0033

Figure# 10



CURRENT ENVIRONMENTAL SOLUTIONS

316 AVOCET AVE
DAVIS, CA 95616

CH2M HILL Contract: 384210.fd.01

Copyright 2010 Current Environmental Solutions. All Rights Reserved

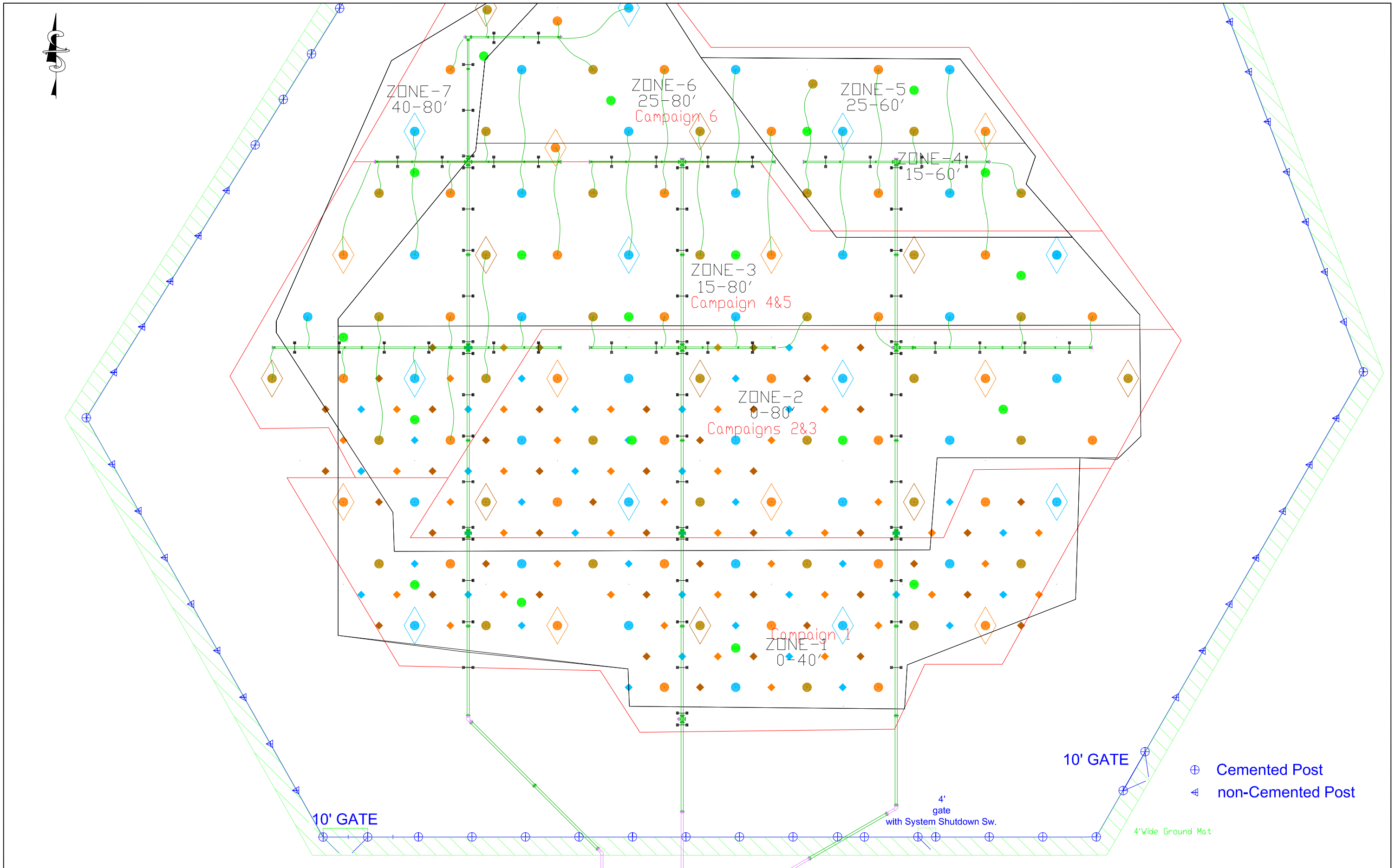
Scale: 1"=20'
Date: 05/11/2010
Drawn By: R.Somosky
Designed By: William Heath
Approved By: Jim Malot PE
PE #CA59088

PIPE LAYOUT_CAMPAIGNS 2-3

ISTT, FRONTIER FERTILIZER NPL SITE

Project# 78-0033

Figure# 11A



CURRENT ENVIRONMENTAL SOLUTIONS

316 AVOCET AVE
DAVIS, CA 95616

CH2M HILL Contract: 384210.fd.01

Copyright 2010 Current Environmental Solutions. All Rights Reserved

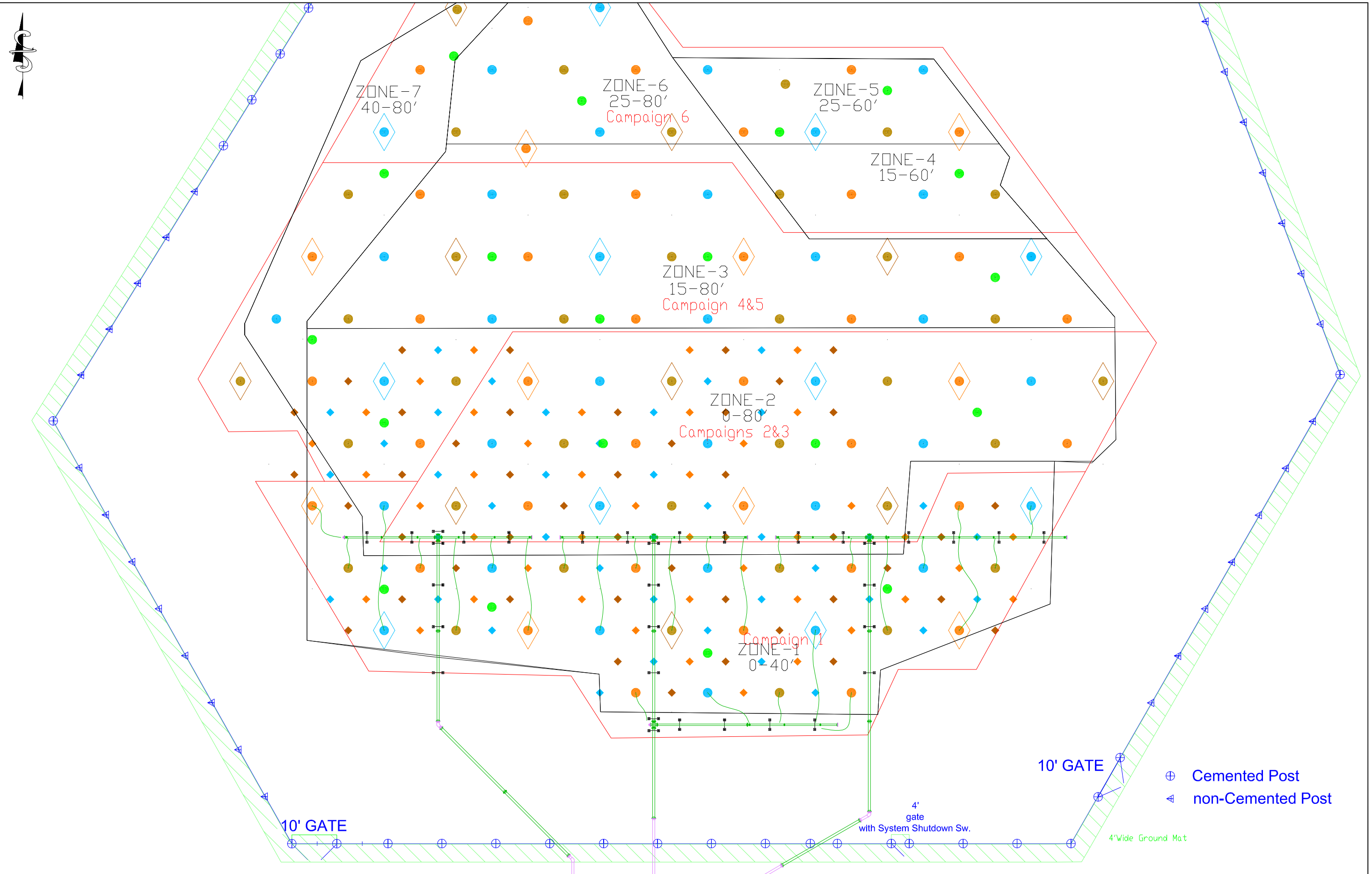
Scale: 1"=20'
Date: 05/11/2010
Drawn By: R.Somosky
Designed By: William Heath
Approved By: Jim Malot PE
PE #CA59088 _____

PIPE LAYOUT_CAMPAIGNS-4-5-6

ISTT, FRONTIER FERTILIZER NPL SITE

Project# 78-0033

Figure# 11B



CURRENT ENVIRONMENTAL SOLUTIONS

316 AVOCET AVE
DAVIS, CA 95616

CH2M HILL Contract: 384210.fd.01

Copyright 2010 Current Environmental Solutions. All Rights Reserved

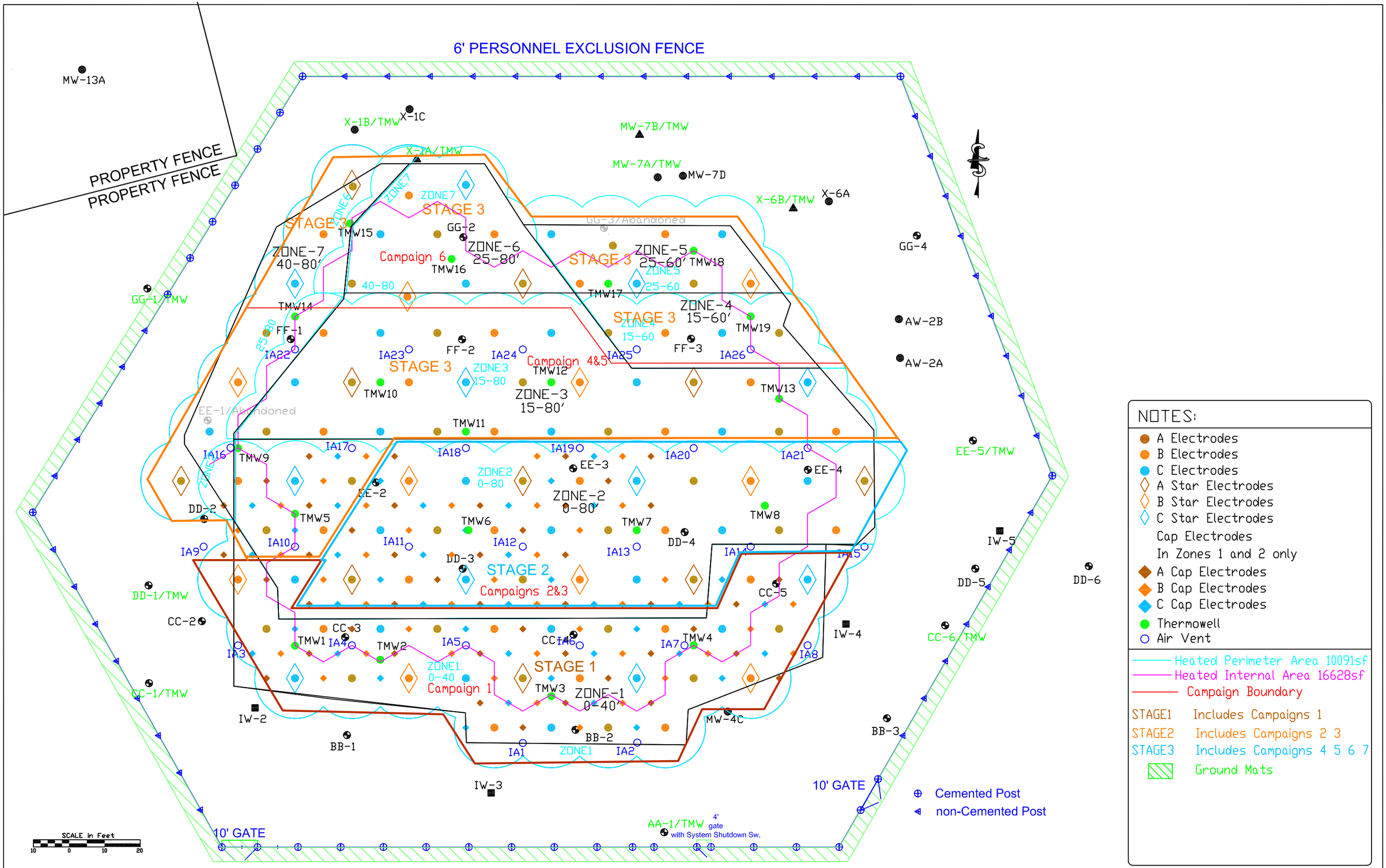
Scale: 1"=20'
Date: 05/11/2010
Drawn By: R.Somosky
Designed By: William Heath
Approved By: Jim Malot PE
PE #CA59088

PIPE LAYOUT_CAMPAIGN-1

ISTT, FRONTIER FERTILIZER NPL SITE

Project# 78-0033

Figure# 11C



CURRENT ENVIRONMENTAL SOLUTIONS

316 AVOCET AVE
DAVIS, CA 95616

CH2M HILL Contract: EP-S9-08-04 Task Order: 002 Project Number: 384210.FD.01

Copyright 2010 Current Environmental Solutions. All Rights Reserved

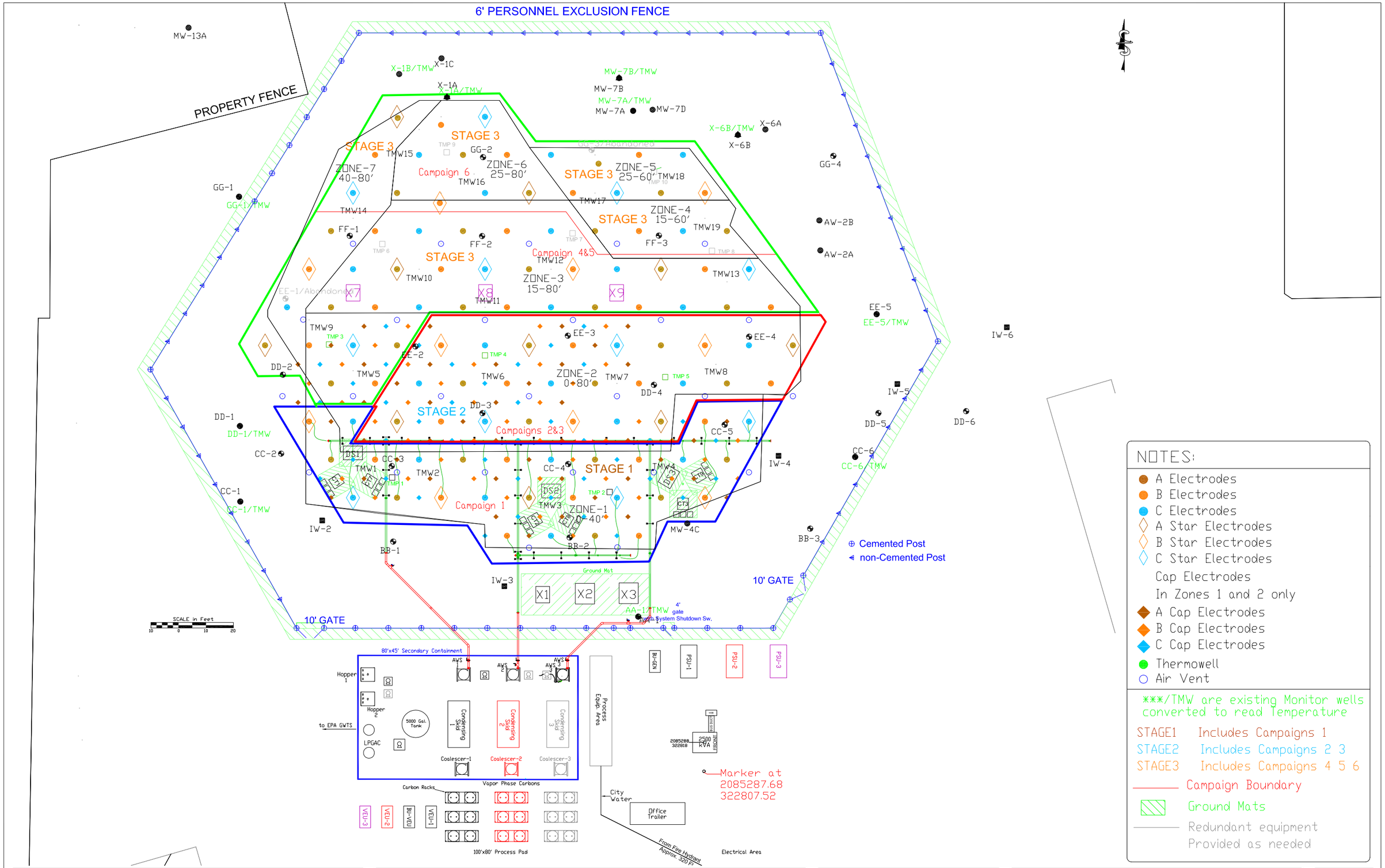
Scale: as shown
Date: 05/13/2010
Drawn By: Mike O'Brien
Designed By: William Heath
Approved By: Jim Malot PE
PE #CA59088 _____

TREATMENT STAGES

ISTT, FRONTIER FERTILIZER NPL SITE

Project# 78-0033

Figure# 12



NOTES:

- A Electrodes
- B Electrodes
- C Electrodes
- A Star Electrodes
- B Star Electrodes
- C Star Electrodes
- Cap Electrodes In Zones 1 and 2 only
- A Cap Electrodes
- B Cap Electrodes
- C Cap Electrodes
- Thermowell
- Air Vent

***/TMW are existing Monitor wells converted to read Temperature

STAGE1 Includes Campaigns 1
STAGE2 Includes Campaigns 2 3
STAGE3 Includes Campaigns 4 5 6

Campaign Boundary

Ground Mats

Redundant equipment Provided as needed

CURRENT ENVIRONMENTAL SOLUTIONS

316 AVOCET AVE
DAVIS, CA 95616

CH2M HILL Contract: EP-S9-08-04 Task Order: 002 Project Number: 384210.FD.01

Copyright 2010 Current Environmental Solutions. All Rights Reserved

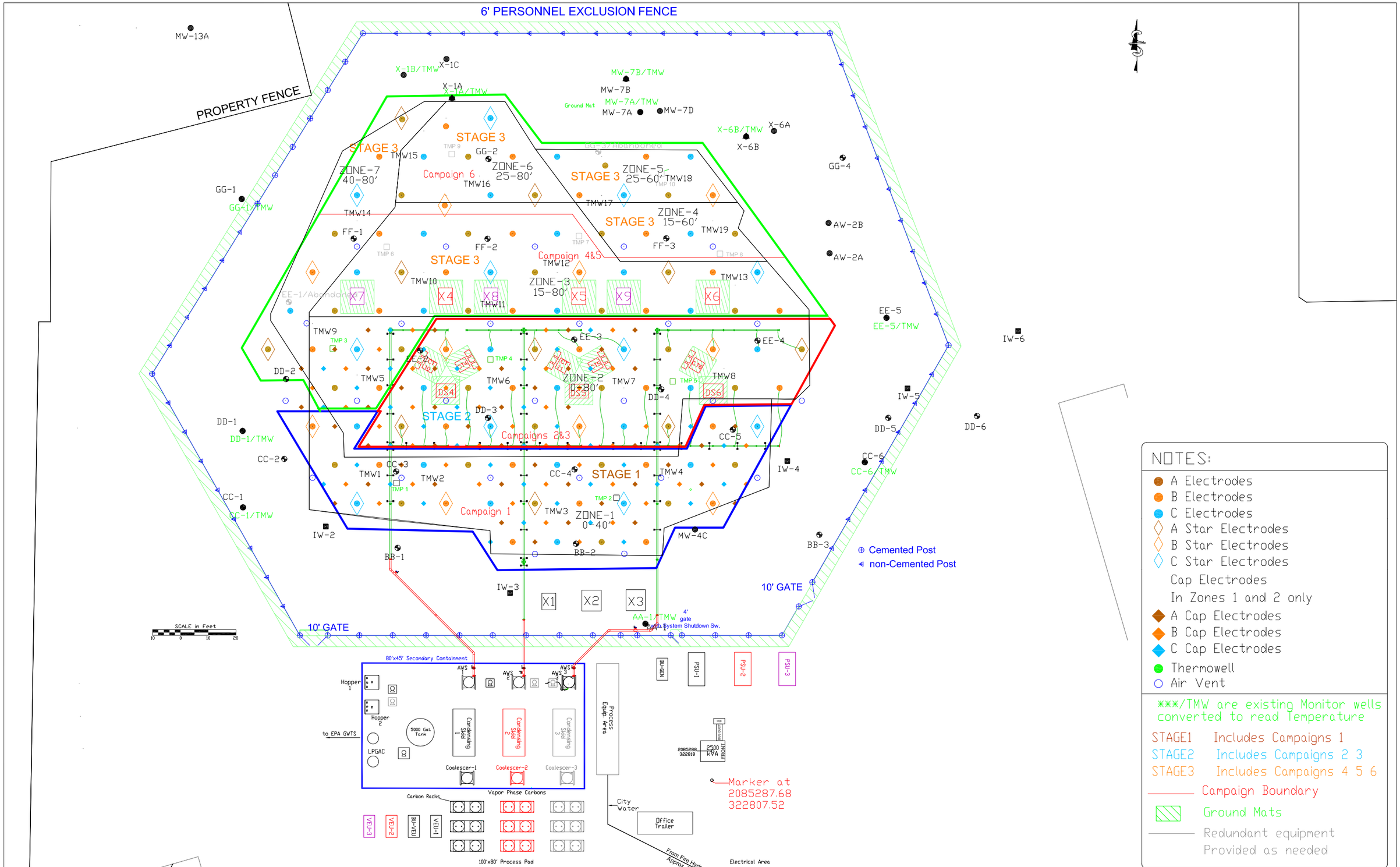
Scale: as shown
Date: 8/23/2010
Drawn By: R.Somosky
Designed By: William Heath
Approved By: Jim Malot PE
PE #CA59088 _____

EQUIPMENT LAYOUT STAGE 1

ISTT, FRONTIER FERTILIZER NPL SITE

Project# 78-0033

Figure# 13A



CURRENT ENVIRONMENTAL SOLUTIONS

316 AVOCET AVE
DAVIS, CA 95616

CH2M HILL Contract: EP-S9-08-04 Task Order: 002 Project Number: 384210.F.D.01

Copyright 2010 Current Environmental Solutions. All Rights Reserved

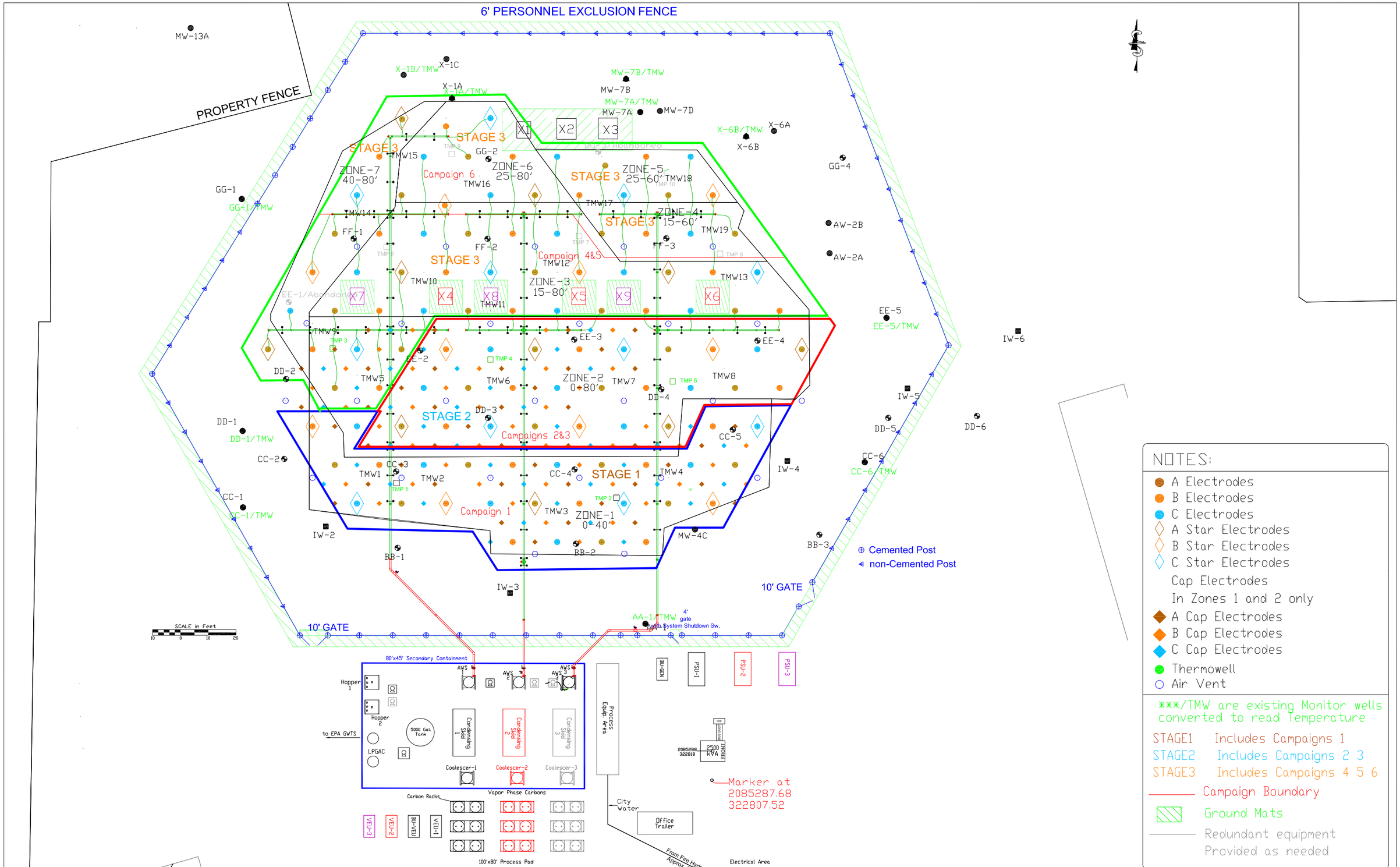
Scale: as shown
Date: 8/23/2010
Drawn By: R.Somosky
Designed By: William Heath
Approved By: Jim Malot PE
PE #CA59088 _____

EQUIPMENT LAYOUT STAGE 2

ISTT, FRONTIER FERTILIZER NPL SITE

Project# 78-0033

Figure# 13B



CURRENT ENVIRONMENTAL SOLUTIONS

316 AVOCET AVE
DAVIS, CA 95616

CH2M HILL Contract: EP-S9-08-04 Task Order: 002 Project Number: 384210.F.D.01

Copyright 2010 Current Environmental Solutions. All Rights Reserved

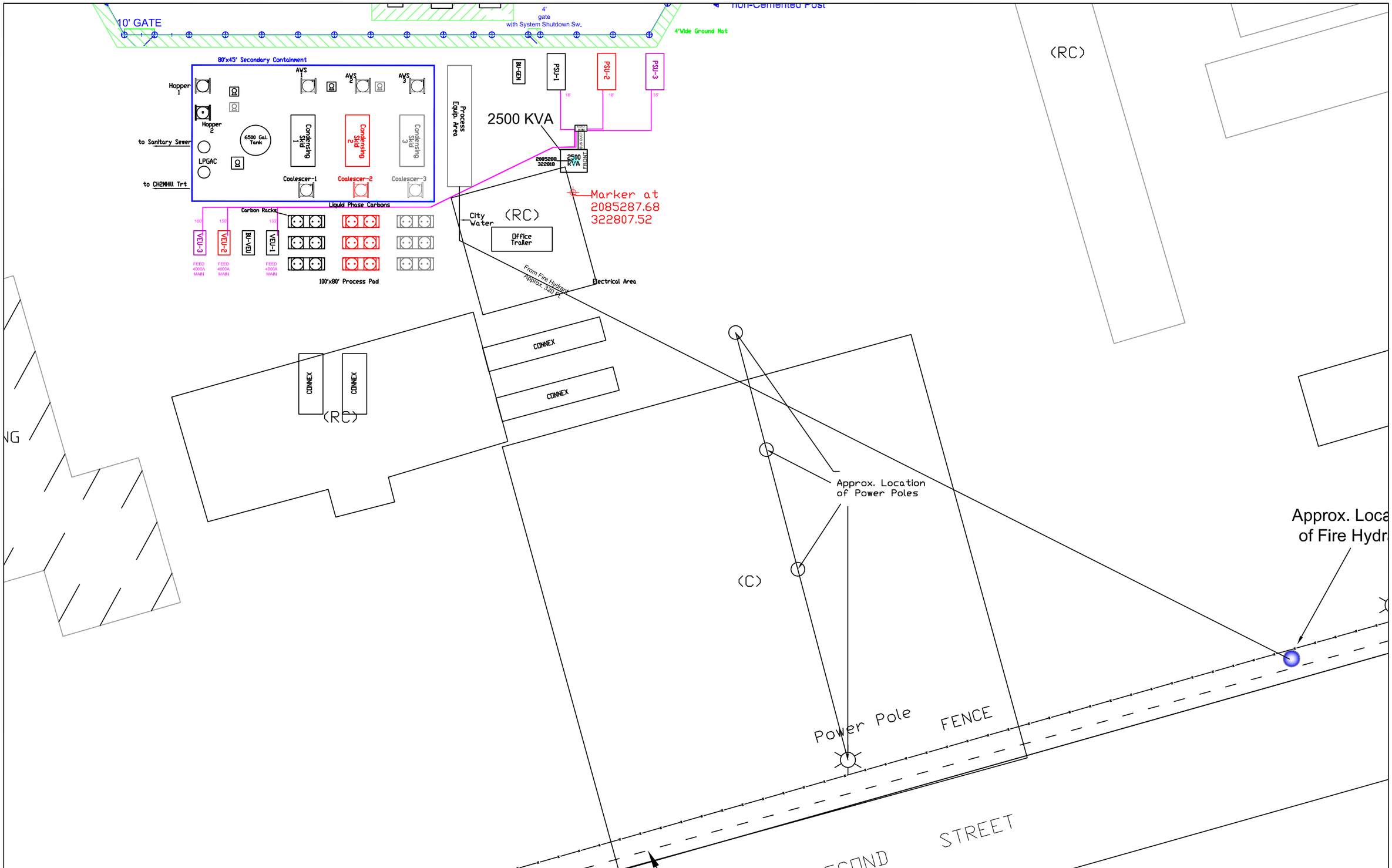
Scale: as shown
Date: 8/23/2010
Drawn By: R.Somosky
Designed By: William Heath
Approved By: Jim Malot PE
PE #CA59088 _____

EQUIPMENT LAYOUT STAGE 3

ISTT, FRONTIER FERTILIZER NPL SITE

Project# 78-0033

Figure# 13C



CURRENT ENVIRONMENTAL SOLUTIONS
316 AVOCET AVE
DAVIS, CA 95616

CH2M HILL Contract: EP-S9-08-04 Task Order: 002 Project Number: 384210.F.D.01

Copyright 2010 Current Environmental Solutions. All Rights Reserved

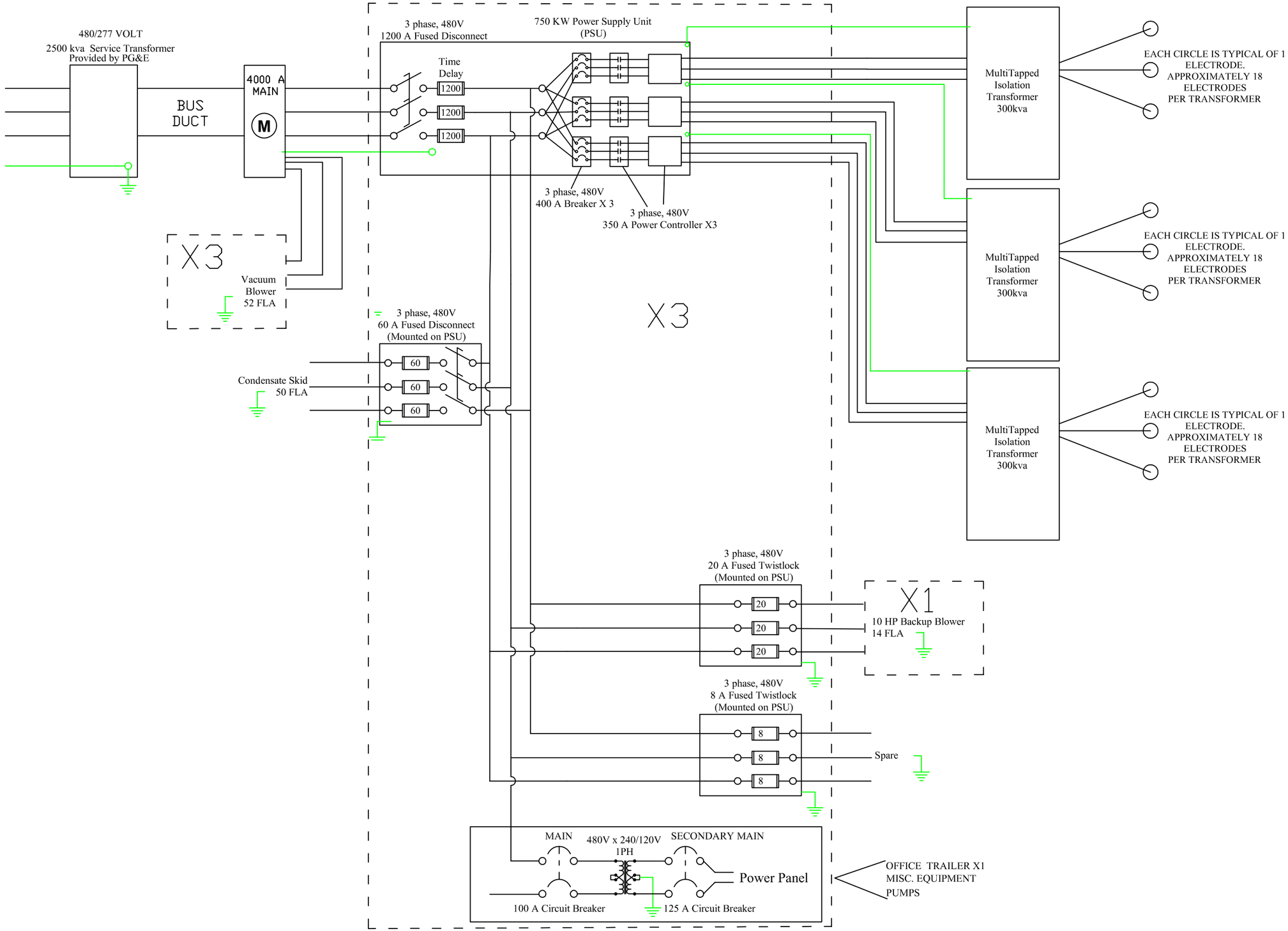
Scale: NTS
Date: 05/18/2010
Drawn By: Mike O'Brien
Designed By: William Heath
Approved By: Jim Malot PE
PE #CA59088 _____

UTILITY LOCATION PLAN

ISTT, FRONTIER FERTILIZER NPL SITE

Project# 78-0033

Figure# 14



CURRENT ENVIRONMENTAL SOLUTIONS

316 AVOCET AVE
DAVIS, CA 95616

CH2M HILL Contract: EP-S9-08-04 Task Order: 002 Project Number: 384210.F.D.01

Copyright 2010 Current Environmental Solutions. All Rights Reserved

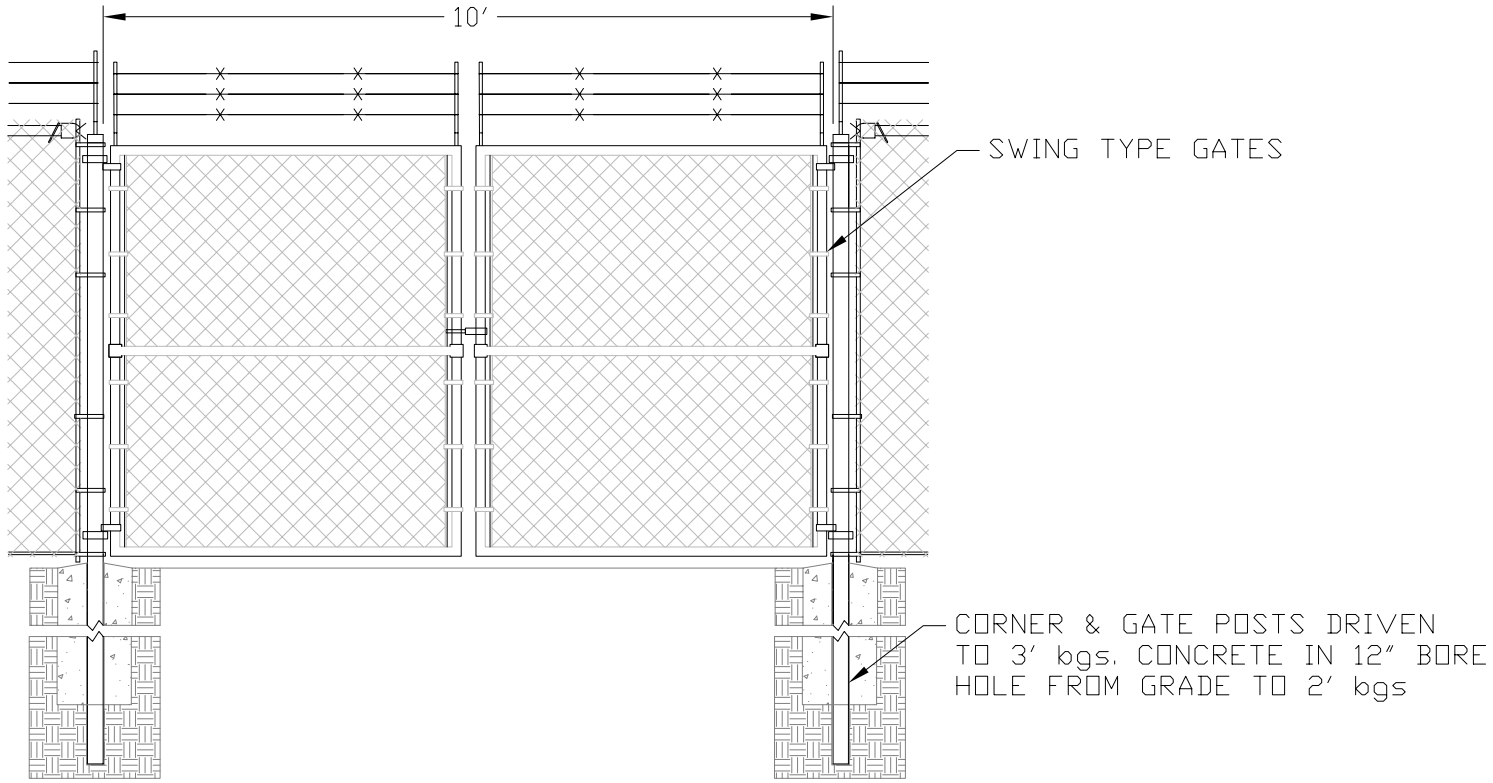
Scale: NTS
Date: 05/11/10
Drawn By: Mike O'Brien
Designed By: William Heath
Approved By: Jim Malot PE
PE #CA59088 _____

ELECTRICAL ONE-LINE

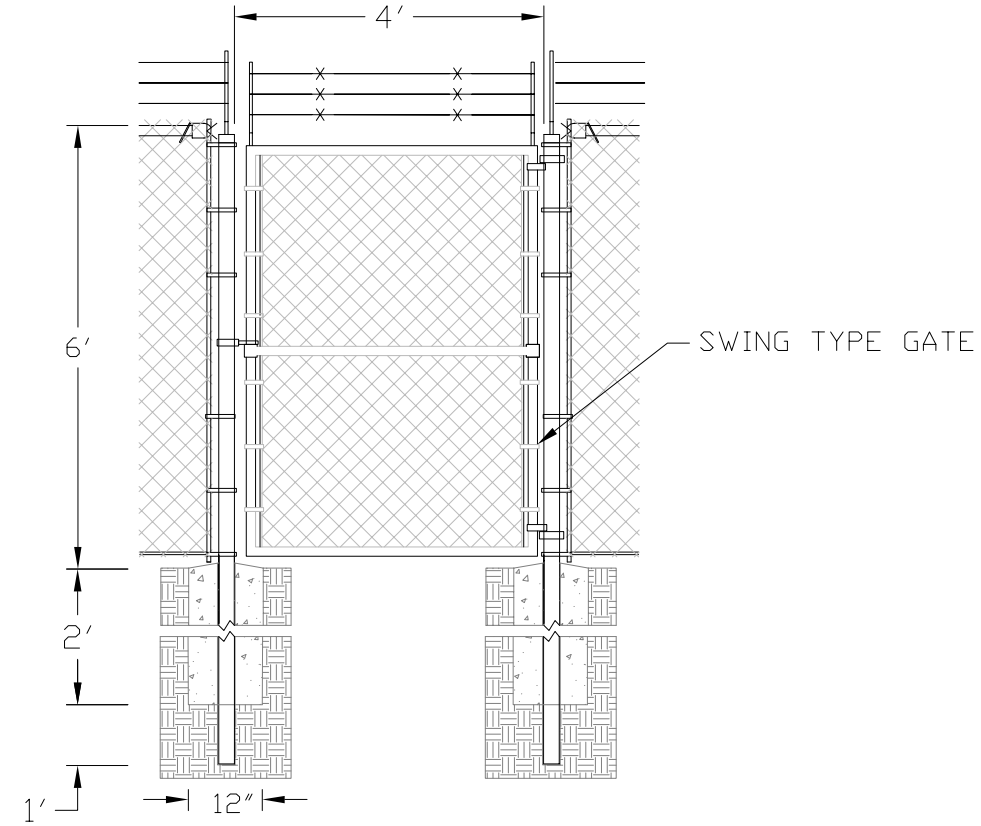
ISTT, FRONTIER FERTILIZER NPL SITE

Project# 78-0033

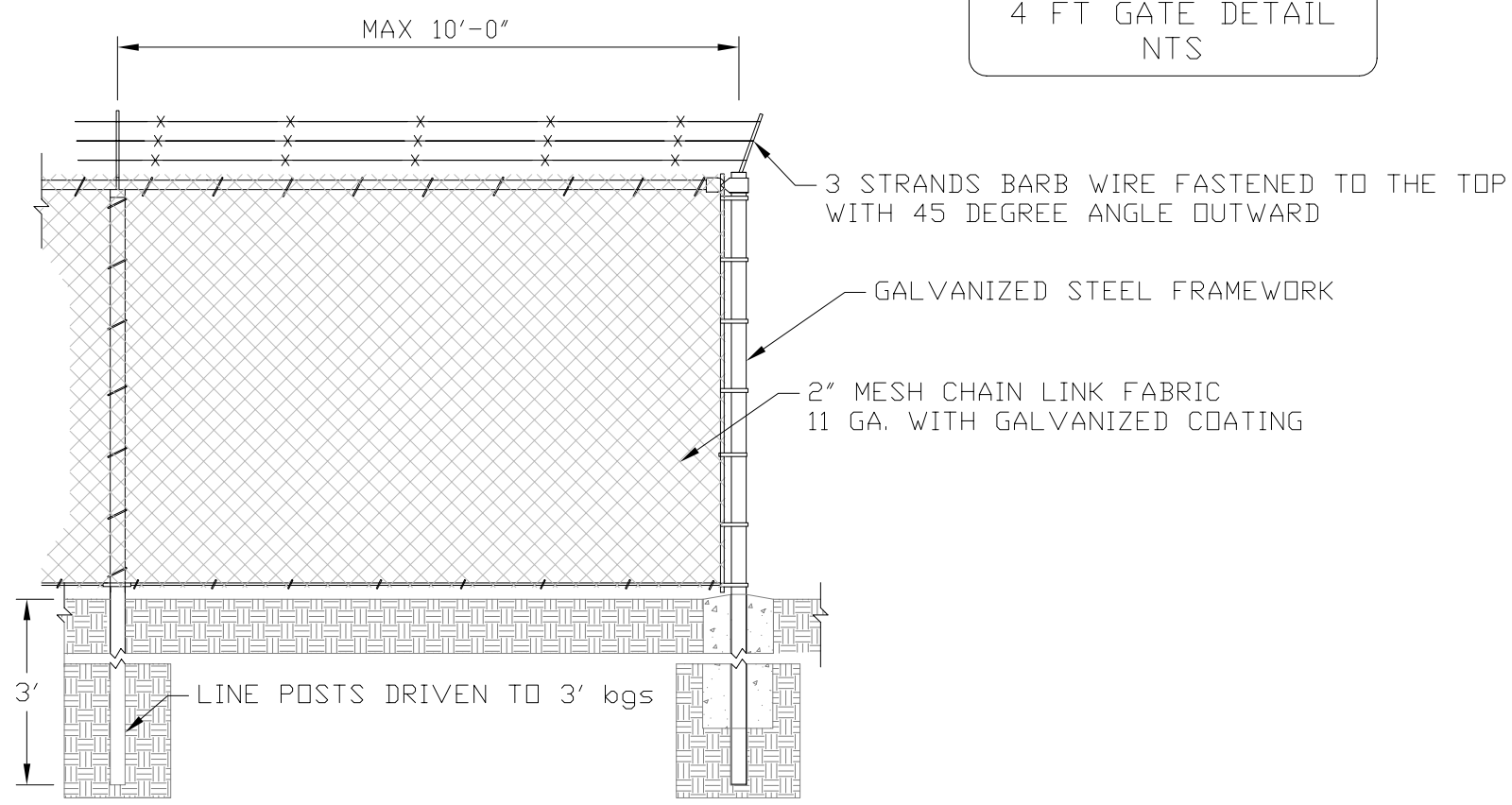
Figure# 15



10 FT GATE DETAIL
NTS



4 FT GATE DETAIL
NTS



FENCE SECTION DETAIL
NTS

CURRENT ENVIRONMENTAL SOLUTIONS

316 AVOCET AVE
DAVIS, CA 95616

CH2M HILL Contract: 384210.fd.01

Copyright 2010 Current Environmental Solutions. All Rights Reserved

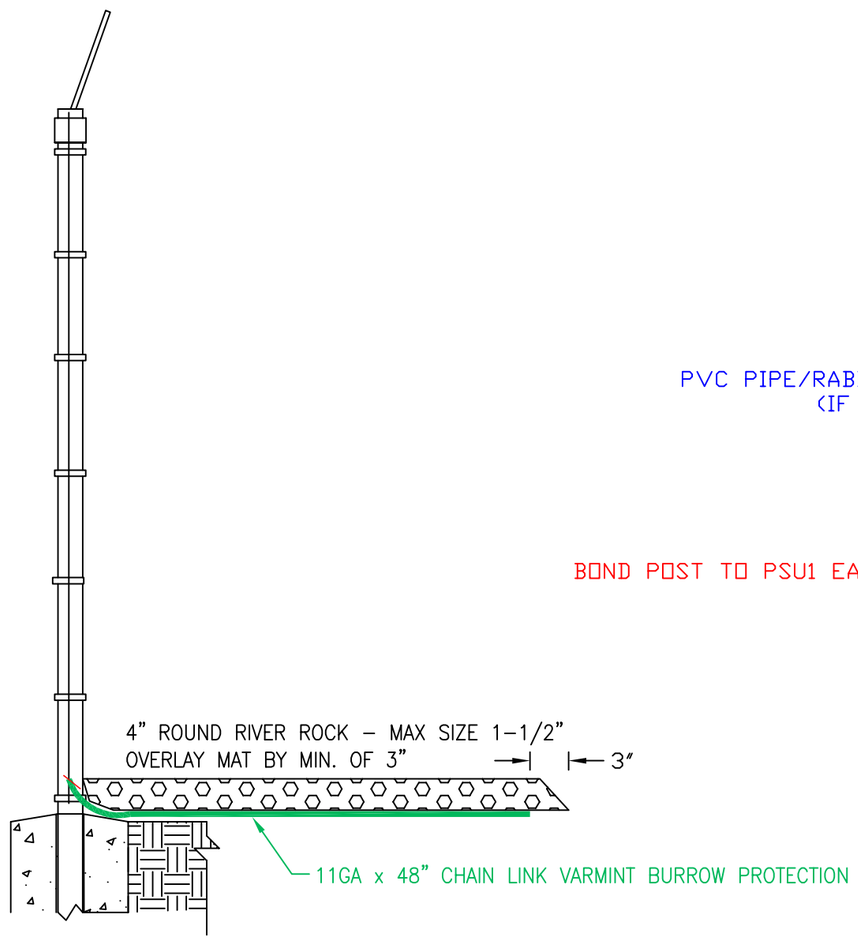
Scale: NTS
Date: 5/13/2010
Drawn By: R.Somosky
Designed By: William Heath
Approved By: Jim Malot PE
PE #CA59088 _____

FENCE CONSTRUCTION DETAIL

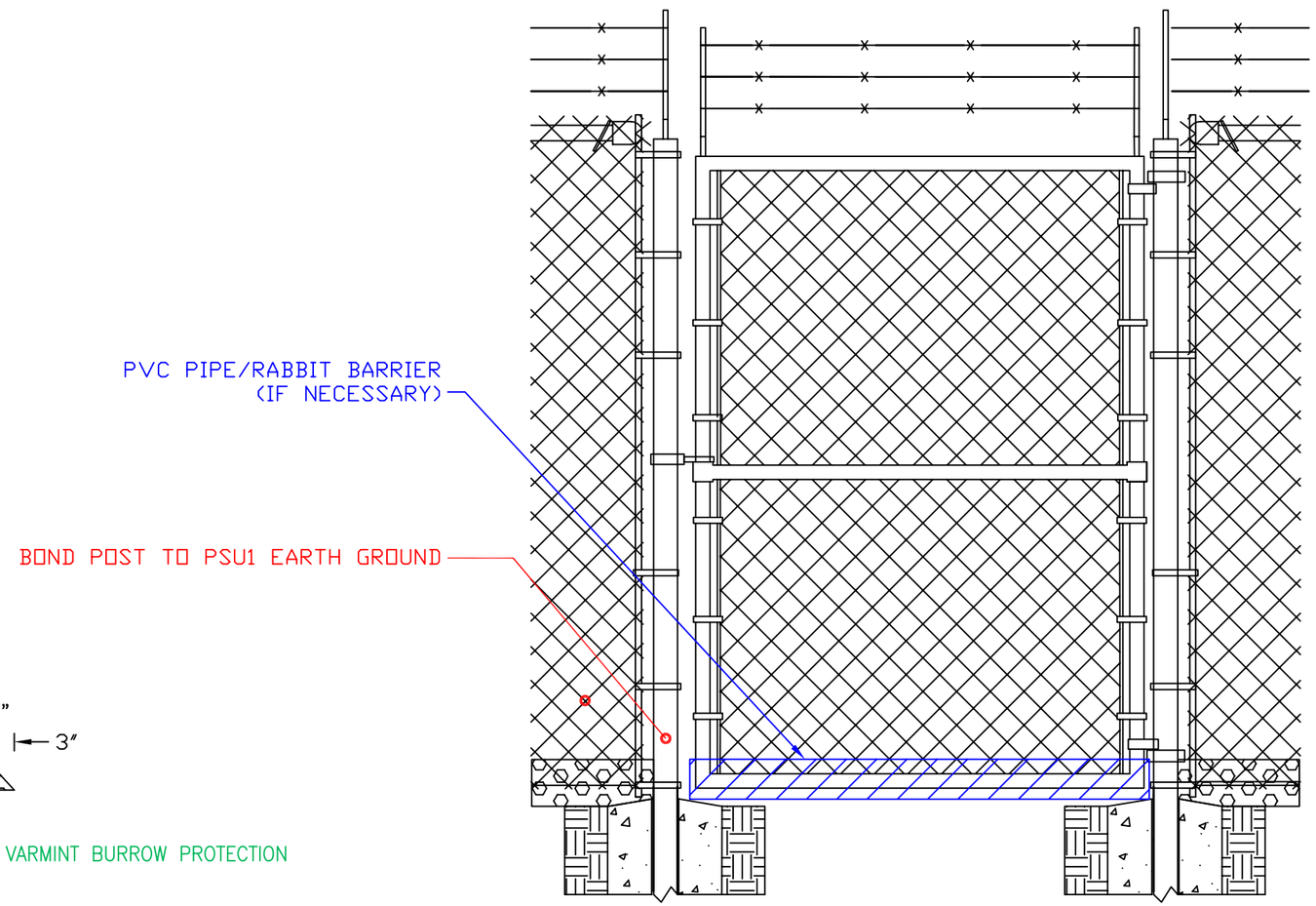
ISTT, FRONTIER FERTILIZER NPL SITE

Project# 78-0033

Figure# 16A



SIDE VIEW
NTS



FRONT VIEW
GATE AREA
NTS

CURRENT ENVIRONMENTAL SOLUTIONS

316 AVOCET AVE
DAVIS, CA 95616

CH2M HILL Contract: 384210.fd.01

Copyright 2010 Current Environmental Solutions. All Rights Reserved

Scale: NTS
Date: 8/23/2010
Drawn By: M.OBrien
Designed By: William Heath
Approved By: Jim Malot PE
PE #CA59088 _____

FENCE GROUNDING & VARMINT DETERRENT DETAIL

ISTT, FRONTIER FERTILIZER NPL SITE

Project# 78-0033

Figure# 16B

APPENDIX A

ISTT Frontier Fertilizer, Davis, CA

PRE-FINAL RAMP : Typical 0 to 40 FT EDB

Campaign 1

CES Project: 78-0033

Prepared for:

CH2MHill
2485 Natomas Park Dr.
Suite 600
Sacramento, CA 95833
T: (916) 920-0300
F: (916) 920-8463

Contract: EP-S9-08-04
CH2M Hill Proj: 384210.ID.01
Submittal: 006
Specification: 01400
Revision: 2
RAMP: PRE-FINAL
Treatment Zone: 0 to 40 FT BGS

Site Specifics & Design Overview

State?	CA
Site Zip Code?	65803
Six Phase Heating Treatment Area (ft^2):	5,941
Shape of Treatment Area (circle, rectangle, oval):	rectangle
Treatment Area Length (ft):	120
Treatment Area Width/Diameter (ft):	44
Treatment Area Perimeter (ft):	328
Shallow Extent of Six Phase Heating (ft):	6
Deep Extent of Six Phase Heating (ft):	42
Typical Depth to Groundwater (ft):	26
Treated Volume (yd^3):	8,361
Compare to Excavation Option (tons):	11,100
Annual Rainfall (in):	15
Groundwater Flow Velocity (ft/day):	0.01
Ambient Air Temperature(˚C):	27
Ambient Groundwater Temperature (˚C):	17
Proposed Treatment Temperature (˚C):	115
Treat Sequentially as # Sections:	1
Per-cent of site under building/pavement?	0%
What per-cent of cover material is concrete?	0%
What per-cent of site is public access?	0%
Is this a single array pilot test?	no
Vapor Extraction Required?	yes
Are Vents in Same Boreholes as Electrodes?	yes
Insulating Surface Cover Required?	yes
Impermeable Surface Seal Required?	yes
Separate Electrode Interval for Saturated Zone ?	no
Does Vadose Zone Need to be Pre-Heated?	no
Does Vadose Zone Need to be Pre-Dried?	no
Air Sparging?	no
Multiphase Extraction Required?	yes
Account for In Situ Degradation?	yes
Degradation Mechanism:	hydrolysis

Copyright(C) 2009
Current Environmental Solutions
All rights reserved

Site Hydrogeology

Layer Model	Soil Type	Top, ft bgs	Thickness, ft	Zone	Hydraulic Conduct. cm/sec
Upper Layer 1	Sandy Clay Loam	0.0	3.0	Vadose	3.53E-04
Upper Layer 2	Clay	3.0	3.0	Vadose	1.08E-04
Heated Layer 1	Clay	6.0	7.2	Vadose	1.08E-04
Heated Layer 2	Clay	13.2	6.8	Vadose	1.08E-04
Heated Layer 3	Clay	20.0	6.0	Vadose	1.08E-04
Heated Layer 4	Clay2	26.0	9.0	Saturated	2.73E-05
Heated Layer 5	Sandy Clay	35.0	7.0	Saturated	7.34E-05
Lower Layer 1	Sandy Clay	42.0	5.0	Saturated	7.34E-05
Lower Layer 2	Sandy Clay	47.0	5.0	Saturated	7.34E-05

Layer Model	Groundwater Conductivity 25˚C (µS/cm):	Soil Resitivity (ohm-m)	Soil TOC (wt %)	Soil TPH (mg/kg)	Sorption Coefficient (Kd, L/Kg)
Upper Layer 1	1,733.3	76.1	0.09%	0	0.04
Upper Layer 2	1,733.3	26.2	0.09%	0	0.05
Heated Layer 1	1,733.3	26.0	0.09%	0	0.05
Heated Layer 2	1,733.3	24.8	0.09%	0	0.05
Heated Layer 3	2,600.0	16.8	0.09%	0	0.05
Heated Layer 4	2,600.0	18.0	0.09%	0	0.05
Heated Layer 5	2,080.0	22.2	0.09%	0	0.05
Lower Layer 1	2,080.0	22.2	0.09%	0	0.05
Lower Layer 2	2,080.0	22.2	0.09%	0	0.05

Layer Model	Intrinsic Permeability (cm2)	Soil Moisture Content (wt %)	Soil Total Porosity	Soil Dry Density (kg/L)	Soil Wet Density (kg/L)
Upper Layer 1	3.25E-09	9.1%	39.6%	1.63	1.79
Upper Layer 2	9.99E-10	22.6%	46.0%	1.46	1.88
Heated Layer 1	9.99E-10	23.3%	46.0%	1.46	1.90
Heated Layer 2	9.99E-10	24.8%	46.0%	1.46	1.94
Heated Layer 3	9.99E-10	27.8%	46.0%	1.46	2.02
Heated Layer 4	2.51E-10	22.7%	37.8%	1.68	2.17
Heated Layer 5	6.76E-10	23.1%	38.4%	1.66	2.16
Lower Layer 1	6.76E-10	23.1%	38.4%	1.66	2.16
Lower Layer 2	6.76E-10	23.1%	38.4%	1.66	2.16

Layer Model	Specific Yield (dimless)	Layer Transmissivity (m2/sec)	Sand Fraction (%)	Silt Fraction (%)	Clay Fraction (%)
Upper Layer 1	0.16	3.23E-06	58%	15%	27%
Upper Layer 2	0.05	9.92E-07	14%	6%	81%
Heated Layer 1	0.05	2.38E-06	14%	6%	81%
Heated Layer 2	0.05	2.25E-06	14%	6%	81%
Heated Layer 3	0.05	1.98E-06	14%	6%	81%
Heated Layer 4	0.06	7.48E-07	20%	30%	50%
Heated Layer 5	0.14	1.57E-06	49%	13%	37%
Lower Layer 1	0.14	1.12E-06	49%	13%	37%
Lower Layer 2	0.14	1.12E-06	49%	13%	37%

Copyright(C) 2009
Current Environmental Solutions
All rights reserved

Contaminant Properties

Controlling Contaminants:	DBCP	EDB	DCP	TCP
Contaminant CAS Number:	96-12-8	8003-07-04	78-87-05	96-18-4
Contaminant Molecular Weight (g/mol):	236.36	187.88	112.99	147.44
ıtaminant Boiling Temperature at 1 atm (°C):	196.0	131.6	96.8	156
Vapor Pressure (mmHg @25C)	0.6	11	53.3	3.1

Total Contaminant Mass (lb):	20
Total Contaminant Volume (gallons):	1

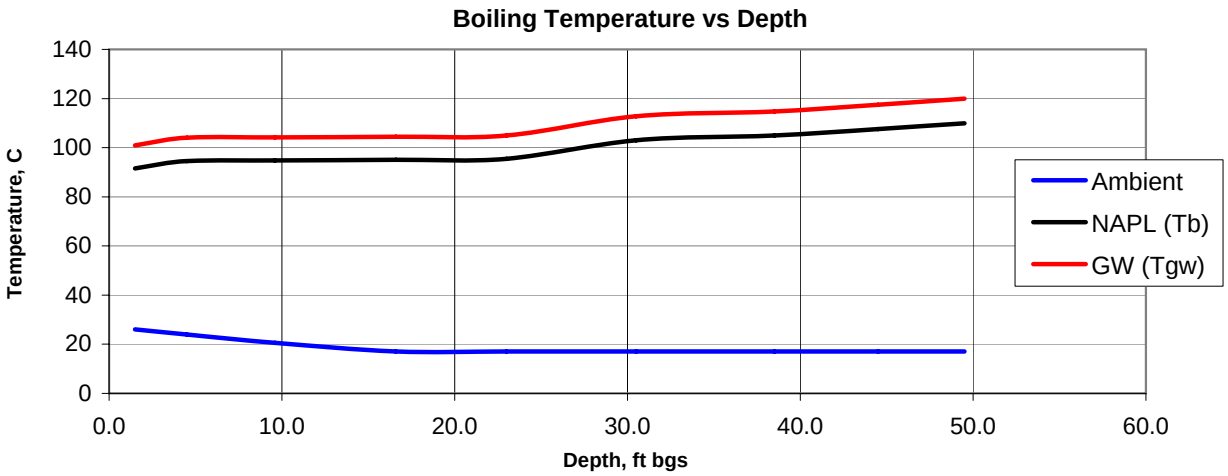
	Ambient (at 17°C)	Heated (at 115°C)
Weighted Ave.(W/A) Contaminant Water Solubility (mg/l):	4503.0	5850.0
W/A Contaminant Vapor Pressure (Torr):	8.6	475.6
W/A Contaminant Henry's Constant (mg/L air / mg/L aq):	0.03	0.43
W/A Contaminant NAPL Density (kg/L):	2.185	1.983
W/A Contaminant NAPL Dynamic Viscosity (cP):	1.811	0.584
W/A Contaminant NAPL Kinematic Viscosity (cSt):	0.829	0.294

Contaminant Distribution and Cleanup Targets

	Heated Layer 1	Heated Layer 2	Heated Layer 3	Heated Layer 4	Heated Layer 5
Zone:	Vadose	Vadose	Vadose	Saturated	Saturated
Volume (yd^3):	1,406.1	1,328.0	1,171.8	1,757.7	1,367.1
Initial Soil Concentrations, Dry Basis (mg/kg)					
Peak:	61	15	2	1	1
Average:	4	1	0	0	0
Target:	0.01	0.01	0.01	0.01	0.01
Initial Groundwater Concentrations (µg/L)					
Estimated Ave:	n/a	n/a	n/a	360	354
Target:	n/a	n/a	n/a	0	0
Initial Mass Distribution (lb)					
NAPL present?:	no	no	no	no	no
Sorbed:	2.4	0.8	0.0	0.1	0.1
Dissolved:	11.3	3.7	0.2	0.4	0.3
Vapor:	0.1	0.0	0.0	0.0	0.0
NAPL:	0.0	0.0	0.0	0.0	0.0
Total Mass:	13.8	4.6	0.3	0.5	0.4
Initial Saturations (v/v)					
Water	33.6%	35.7%	39.9%	37.6%	38.0%
Air	12.5%	10.4%	6.1%	0.2%	0.5%
NAPL	0.0%	0.0%	0.0%	0.0%	0.0%

Copyright(C) 2009
Current Environmental Solutions
All rights reserved

Estimated Treatment Temperatures & Pressure



	GW (˚C) Boiling Temperature	NAPL (˚C) Boiling Temperature	Ambient (˚C) Subsurface Temperature	Pressure at Boiling mm Hg	Layer Midpoint ft bgs
Upper Layer 1	100.9	91.5	26.0	784	1.5
Upper Layer 2	104.0	94.6	24.0	876	4.5
Heated Layer 1	104.2	94.7	20.6	881	9.6
Heated Layer 2	104.5	95.0	17.0	889	16.6
Heated Layer 3	105.0	95.5	17.0	905	23.0
Heated Layer 4	112.8	103.1	17.0	1,178	30.5
Heated Layer 5	114.8	105.0	17.0	1,257	38.5
Lower Layer 1	117.4	107.6	17.0	1,370	44.5
Lower Layer 2	119.9	110.0	17.0	1,484	49.5

Electrode Design Specifications

Number of Vertical Heating Intervals:	1	
Electrode and Extraction Well Terminations:	100% above grade	
Number of Temperature Monitoring Wells:	11	
Soil Cuttings from Electrode Installation:	56.1	tons
Average Wetting Rate (all Electrodes):	0.14	gpm
Total Volume of Drip Water Added:	40,243	gallons
Total Amount of Electrolyte Required:	2,507	Lb

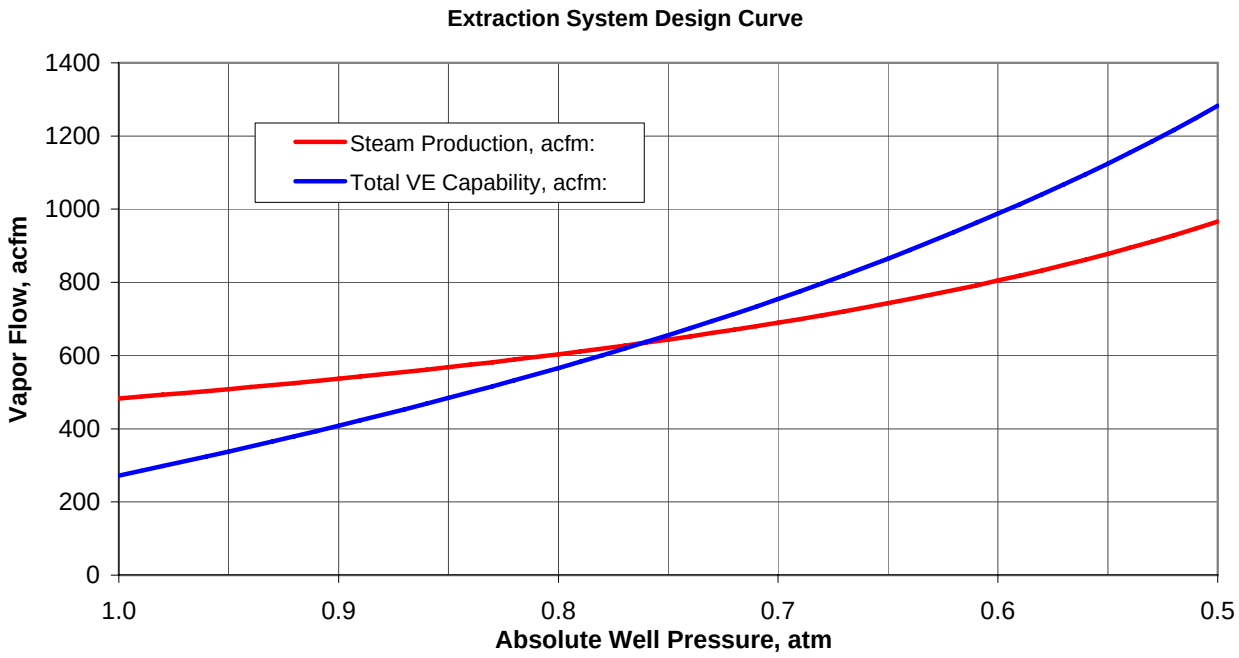
	Primary	Upper
Electrode Diameter (inches):	3.0	n/a
Borehole Diameter (inches):	12.00	n/a
Array to Electrode Ratio (D/d):	32	n/a
Distance between Electrodes (ft):	16.0	n/a
Total Number of Electrodes:	27	n/a
Depth to Top of Electrode (ft):	6.0	n/a
Total Depth of Electrode (ft):	44.0	n/a
Conductive Zone Length (ft):	38.0	n/a
Length of Electrode in Vadose Zone (ft):	20.0	n/a
Length of Electrode in Groundwater (ft):	18.0	n/a
Number of Drip Intervals per Primary Electrode:	3	n/a
Electrode Drill Cuttings (tons):	56.1	n/a

Copyright(C) 2009
Current Environmental Solutions
All rights reserved

Extraction System Design

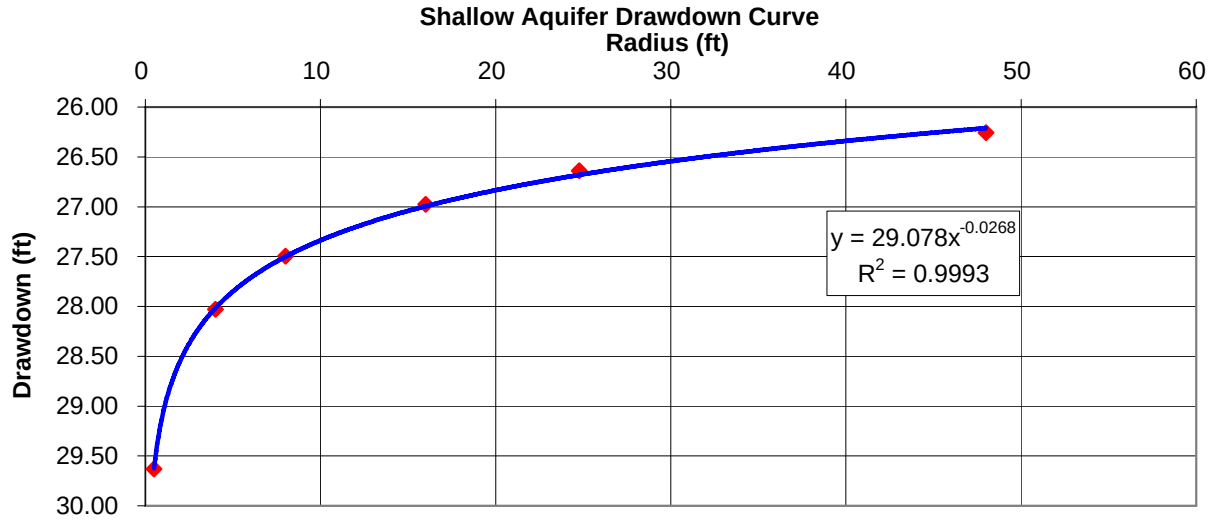
Design Extraction Vaccum:	0.77	atm
Well Vacuum:	7	in. Hg
Peak Steam Production Rate:	321	scfm
Peak Air Flow Rate:	77	scfm
Vapor Extraction Design Flow Rate:	340	scfm
Recommended Blower Vacuum:	10	in. Hg
Vapor Extraction Blower:	30	hp
SVE/DVE Wells Co-Located with Electrodes?	yes	
Average Condensate Production Rate:	2.84	gpm
Total Condensate Produced:	341,900	gallons
Peak Vapor Extraction Rate:	0.0	lb/day
Peak In Situ Degradation Rate:	0.7	lb/day
Average Total Cleanup Rate:	0.1	lb/day
Final Extraction Rate:	0.0	lb/day
Soil Cuttings from VE Well Installation:	0.0	tons
Vapor Treatment Method:	carbon	
Secondary Acid Gas Stack Scrubber:	not required	

	Shallow/VE	Horizontal	Deep/DVE
Type of Vents Required:	yes	yes	yes
Vent Spacing (ft):	16	32	16
Number of Vents:	27	5	27
Wellbore/Trench Diameter (in.):	12.00	12.00	12.00
Screened Length per Vent (ft):	23.0	30.0	18.0
Peak Design Flow per Vent (acfm):	14.6	12.5	5.7
Wellscreen Diameter (in.):	3.0	1.0	3.0
Well Drill/Trenching Cuttings (tons):	0.0	0.0	0.0



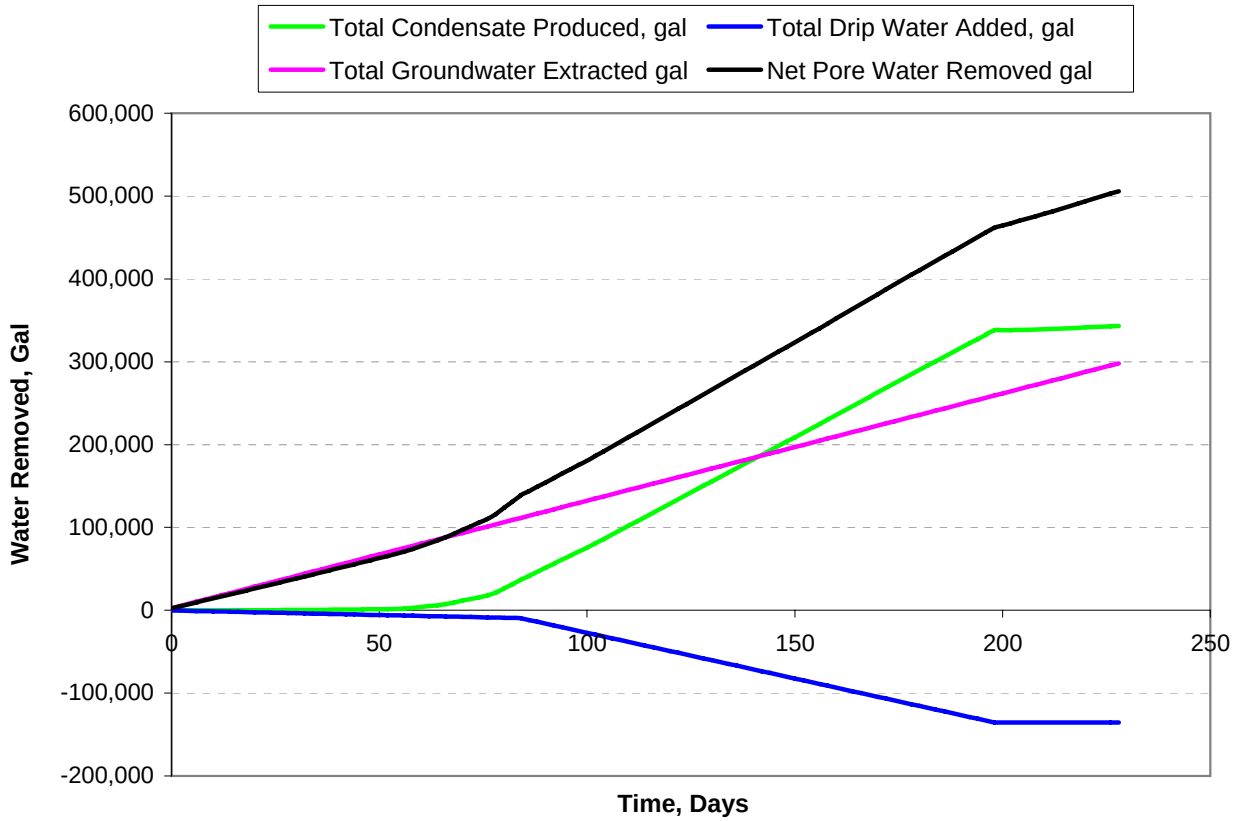
Copyright(C) 2009
Current Environmental Solutions
All rights reserved

Groundwater Extraction & Overall Water Balance



Typical Depth to Groundwater: 26 ft bgs

			Peak (gpm)
Total Groundwater Extracted:	298,080	gallons	0.9
Total Condensate Produced:	341,900	gallons	1.9
Total Volume of Drip Water Added:	40,243	gallons	1.04
Total NAPL Extracted:	0	lb	

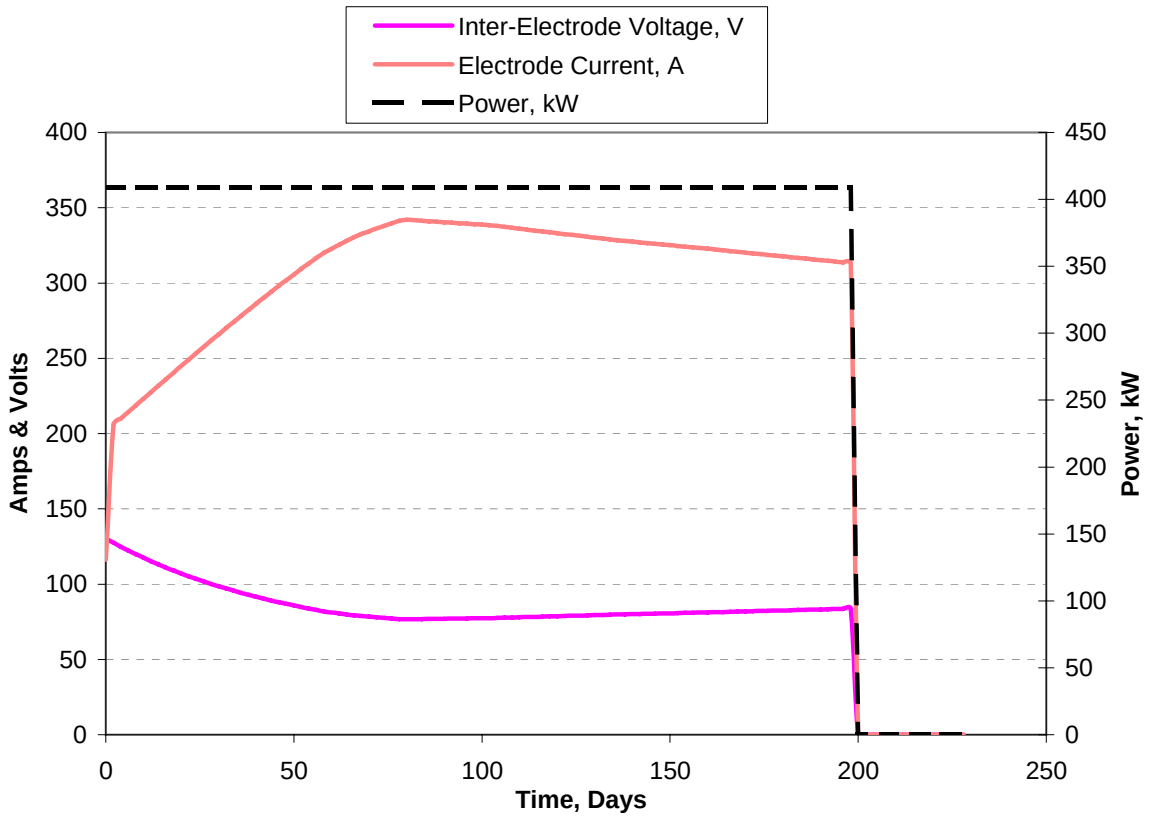


Copyright(C) 2009
Current Environmental Solutions
All rights reserved

Estimated Treatment Time & Energy Requirements

Time to Pre-Heat/Dry Vadose Zone:	0	days
Time to Heat-up Site:	85	days
Time to Treat Site:	115	days
Extra Time for Multiphase Extraction:	0	days
Total Treatment Time:	200	days
Subsurface Energy Estimate:	1,961,900	kW-hr
Subsurface Energy Density:	248	kw hr/yd3
Total Energy Estimate:	2,139,246	kW-hr

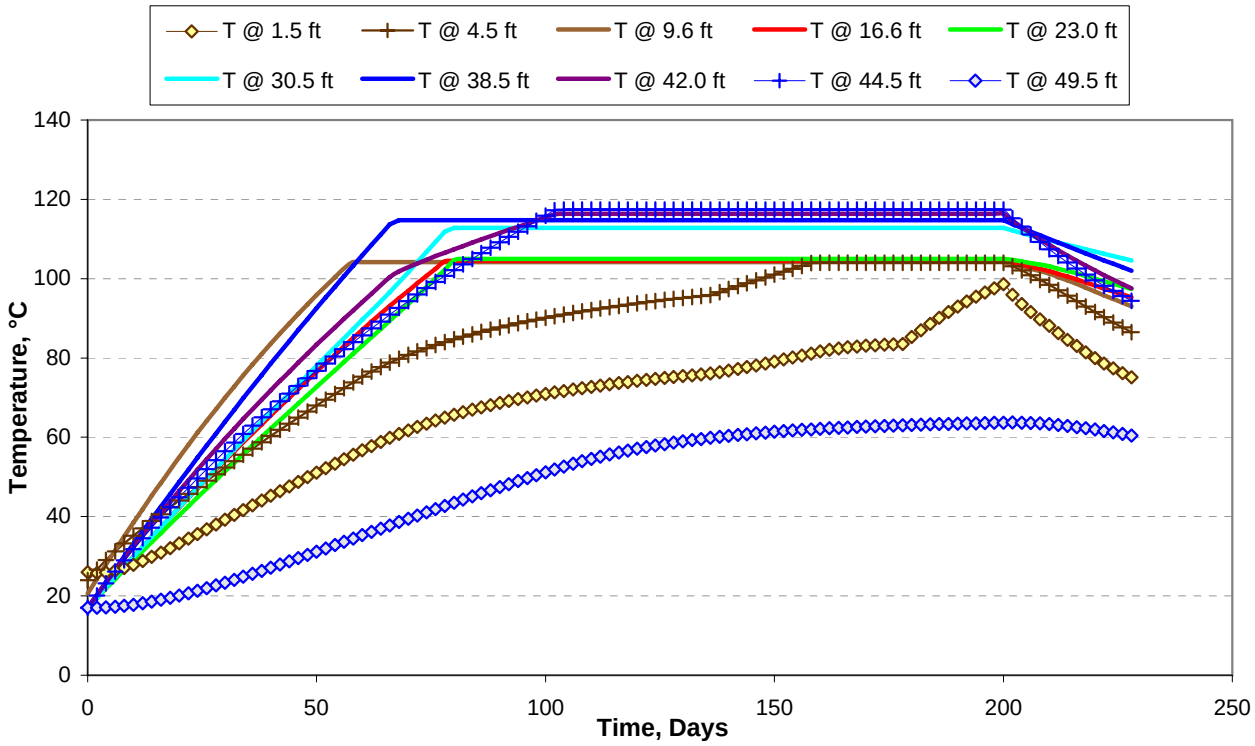
Power Supply Specifications & Electrical Requirements



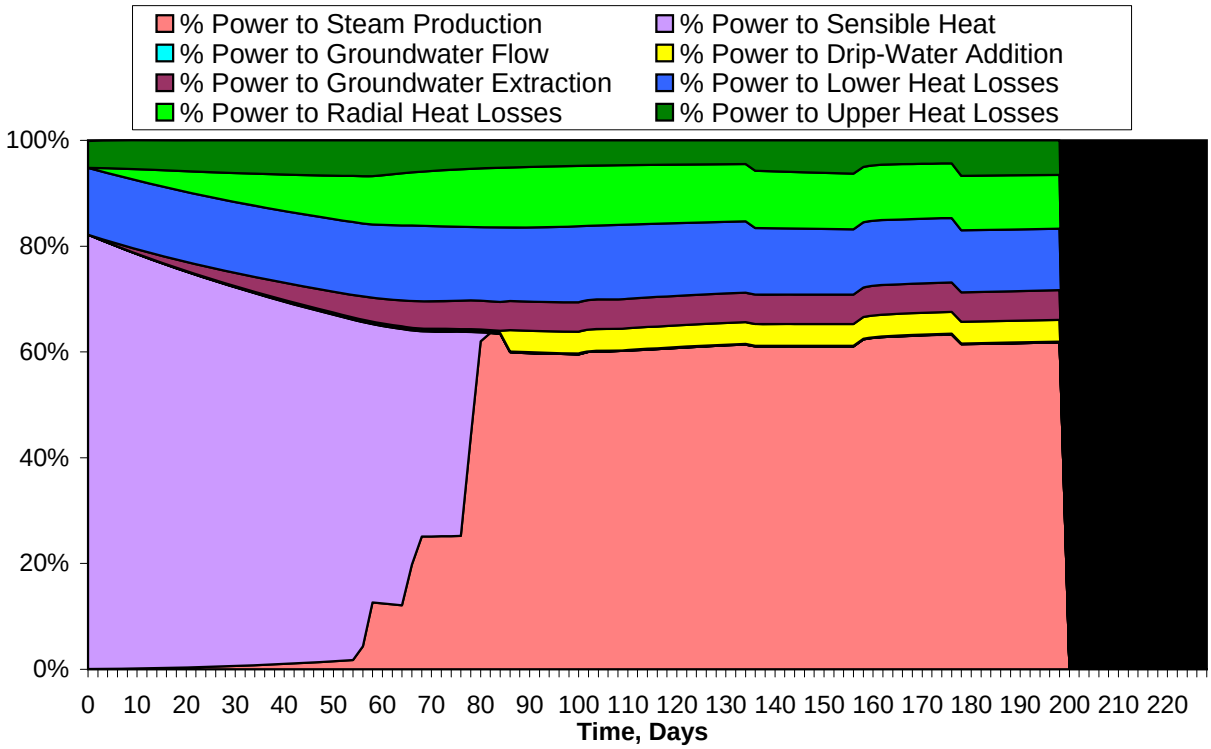
Site Electrical Power Requirement:	1,000	kW
Site Service Requirement at 480V, 3-Phase:	1,100	Amps
Power Supply Rating:	750	kW
Peak Electrode Voltage:	130	Volts
Peak Phase Current:	3,078	Amps
Number of Electrode Phases:	3	

Copyright(C) 2009
Current Environmental Solutions
All rights reserved

Predicted Subsurface Temperature Trends

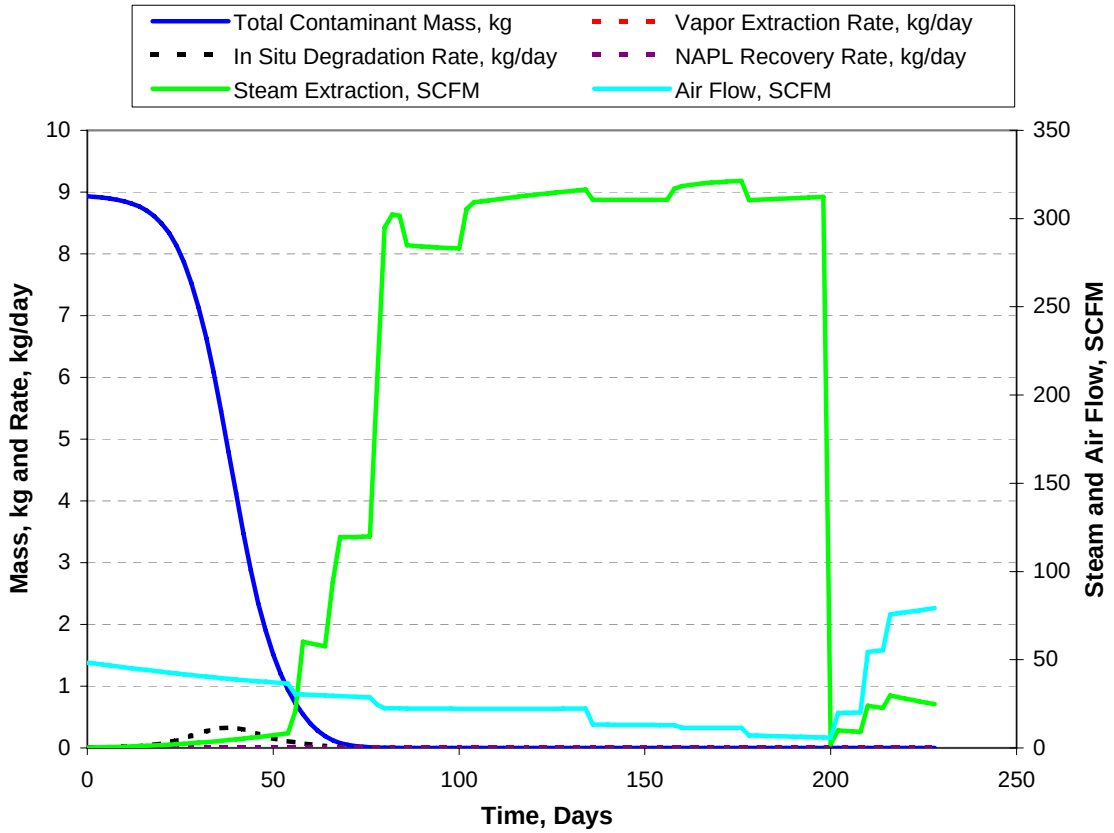


Estimated Subsurface Energy Distribution

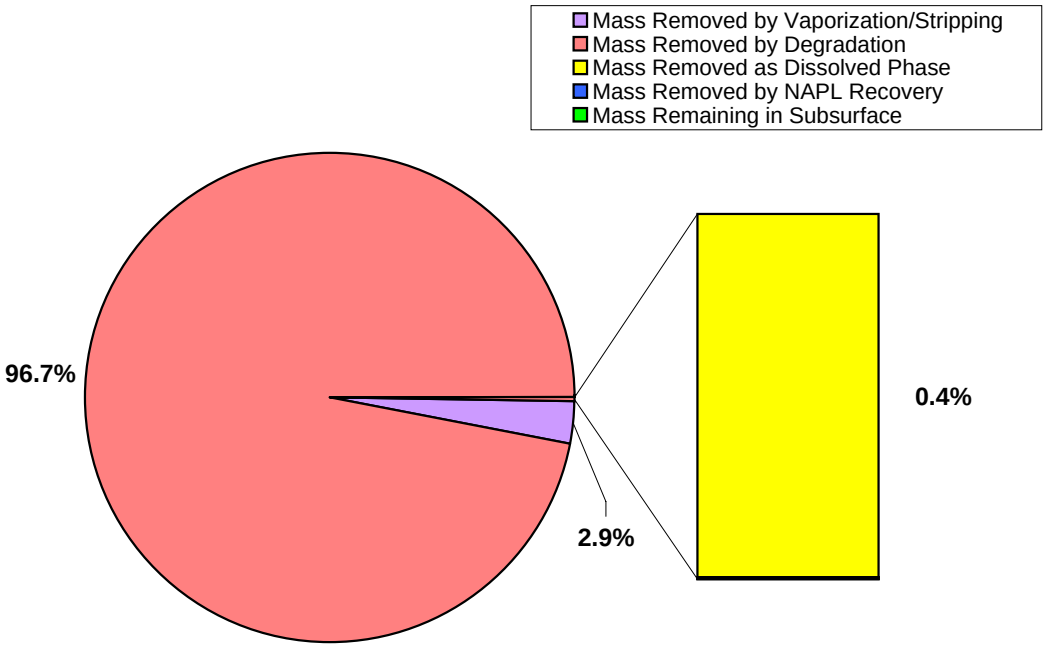


Copyright(C) 2009
Current Environmental Solutions
All rights reserved

Projected Treatment Performance and Removal rates

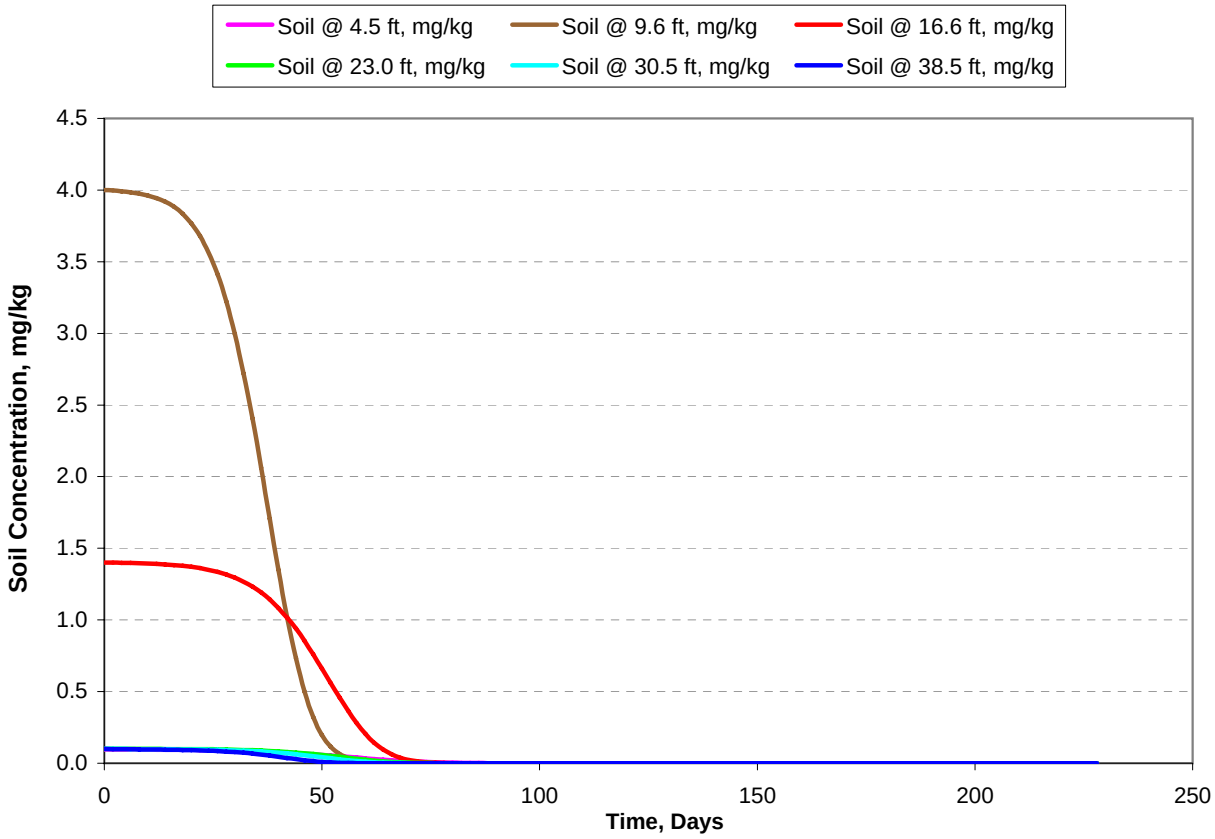


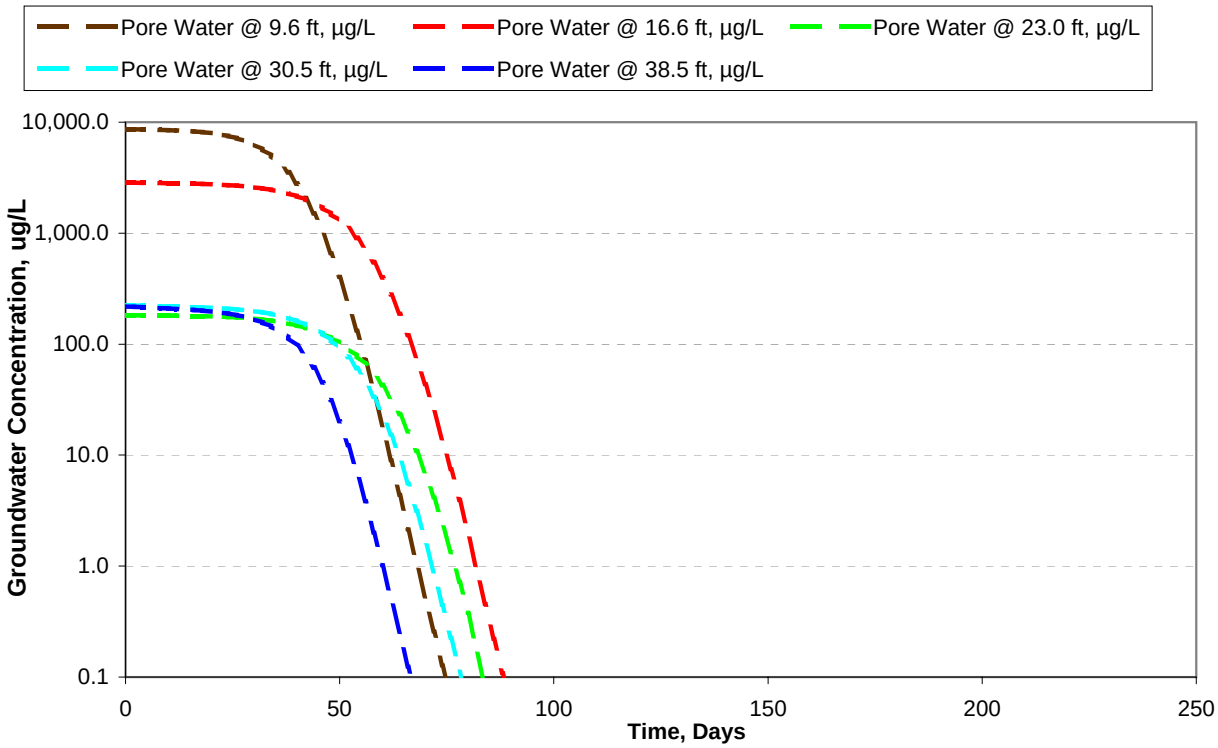
Contaminant Fate Projection



Copyright(C) 2009
Current Environmental Solutions
All rights reserved

Predicted Soil and Groundwater Concentrations





Copyright(C) 2009
Current Environmental Solutions
All rights reserved

ISTT Frontier Fertilizer, Davis, CA

Campaign 2&3- 6-84 FT EDB

CES Project: 78-0033

Prepared for: CH2MHill
2485 Natomas Park Dr.
Suite 600
Sacramento, CA 95833
T: (916) 920-0300
F: (916) 920-8463

Contract: EP-S9-08-04
WA No:
CH2M Hill Proj: 364476-AI-01
Submittal 7
Specification 01400
RAMP Final Addendum

Site Specifics & Design Overview

State?	CA
Site Zip Code?	65803
Six Phase Heating Treatment Area (ft^2):	6,825
Shape of Treatment Area (circle, rectangle, oval):	rectangle
Treatment Area Length (ft):	130
Treatment Area Width/Diameter (ft):	43
Treatment Area Perimeter (ft):	347
Shallow Extent of Six Phase Heating (ft):	6
Deep Extent of Six Phase Heating (ft):	82
Typical Depth to Groundwater (ft):	26
Treated Volume (yd^3):	19,716
Compare to Excavation Option (tons):	23,100
Annual Rainfall (in):	15
Groundwater Flow Velocity (ft/day):	0.01
Ambient Air Temperature(˚C):	27
Ambient Groundwater Temperature (˚C):	17
Proposed Treatment Temperature (˚C):	132
Treat Sequentially as # Sections:	1
Per-cent of site under building/pavement?	0%
What per-cent of cover material is concrete?	0%
What per-cent of site is public access?	0%
Is this a single array pilot test?	no
Vapor Extraction Required?	yes
Are Vents in Same Boreholes as Electrodes?	yes
Insulating Surface Cover Required?	yes
Impermeable Surface Seal Required?	yes
Separate Electrode Interval for Saturated Zone ?	no
Does Vadose Zone Need to be Pre-Heated?	no
Does Vadose Zone Need to be Pre-Dried?	no
Air Sparging?	no
Multiphase Extraction Required?	yes
Account for In Situ Degradation?	yes
Degradation Mechanism:	hydrolysis

Copyright(C) 2008
Current Environmental Solutions
All rights reserved

Site Hydrogeology

Layer Model	Soil Type	Top, ft bgs	Thickness, ft	Zone	Hydraulic Conduct. cm/sec
Upper Layer 1	Sandy Clay Loam	0.0	3.0	Vadose	3.53E-04
Upper Layer 2	Clay	3.0	3.0	Vadose	1.08E-04
Heated Layer 1	Clay	6.0	8.0	Vadose	1.08E-04
Heated Layer 2	Clay	14.0	12.0	Vadose	1.08E-04
Heated Layer 3	Clay2	26.0	20.0	Saturated	2.73E-05
Heated Layer 4	Clay	46.0	20.0	Saturated	1.08E-04
Heated Layer 5	Sandy Clay	66.0	16.0	Saturated	7.34E-05
Lower Layer 1	Clay	82.0	5.0	Saturated	1.08E-04
Lower Layer 2	Sandy Clay	87.0	5.0	Saturated	7.34E-05

Layer Model	Groundwater Conductivity 25˚C (µS/cm):	Soil Resitivity (ohm-m)	Soil TOC (wt %)	Soil TPH (mg/kg)	Sorption Coefficient (Kd, L/Kg)
Upper Layer 1	2,080.0	65.8	0.09%	0	0.20
Upper Layer 2	2,080.0	23.7	0.09%	0	0.20
Heated Layer 1	2,080.0	23.6	0.09%	0	0.22
Heated Layer 2	2,600.0	18.5	0.09%	0	0.24
Heated Layer 3	2,600.0	18.0	0.09%	0	0.24
Heated Layer 4	2,600.0	13.7	0.09%	0	0.24
Heated Layer 5	2,080.0	22.2	0.09%	0	0.24
Lower Layer 1	2,080.0	15.5	0.09%	0	0.24
Lower Layer 2	2,080.0	22.2	0.09%	0	0.24

Layer Model	Intrinsic Permeability (cm2)	Soil Moisture Content (wt %)	Soil Total Porosity	Soil Dry Density (kg/L)	Soil Wet Density (kg/L)
Upper Layer 1	3.25E-09	9.1%	39.6%	1.63	1.79
Upper Layer 2	9.99E-10	22.6%	46.0%	1.46	1.88
Heated Layer 1	9.99E-10	23.4%	46.0%	1.46	1.90
Heated Layer 2	9.99E-10	26.0%	46.0%	1.46	1.97
Heated Layer 3	2.51E-10	22.7%	37.8%	1.68	2.17
Heated Layer 4	9.99E-10	31.9%	46.0%	1.46	2.14
Heated Layer 5	6.76E-10	23.1%	38.4%	1.66	2.16
Lower Layer 1	9.99E-10	31.9%	46.0%	1.46	2.14
Lower Layer 2	6.76E-10	23.1%	38.4%	1.66	2.16

Layer Model	Specific Yield (dimless)	Layer Transmissivity (m2/sec)	Sand Fraction (%)	Silt Fraction (%)	Clay Fraction (%)
Upper Layer 1	0.16	3.23E-06	58%	15%	27%
Upper Layer 2	0.05	9.92E-07	14%	6%	81%
Heated Layer 1	0.05	2.64E-06	14%	6%	81%
Heated Layer 2	0.05	3.97E-06	14%	6%	81%
Heated Layer 3	0.06	1.66E-06	20%	30%	50%
Heated Layer 4	0.05	6.61E-06	14%	6%	81%
Heated Layer 5	0.14	3.58E-06	49%	13%	37%
Lower Layer 1	0.05	1.65E-06	14%	6%	81%
Lower Layer 2	0.14	1.12E-06	49%	13%	37%

Copyright(C) 2008
Current Environmental Solutions
All rights reserved

Contaminant Properties

Controlling Contaminants:	DBCP	EDB	DCP	TCP
Contaminant CAS Number:	96-12-8	8003-07-04	78-87-05	96-18-4
Contaminant Molecular Weight (g/mol):	236.36	187.88	112.99	147.44
ıtaminant Boiling Temperature at 1 atm (°C):	196.0	131.6	96.8	156
Vapor Pressure (mmHg @25C)	0.6	11	53.3	3.1

Total Contaminant Mass (lb):	28
Total Contaminant Volume (gallons):	2

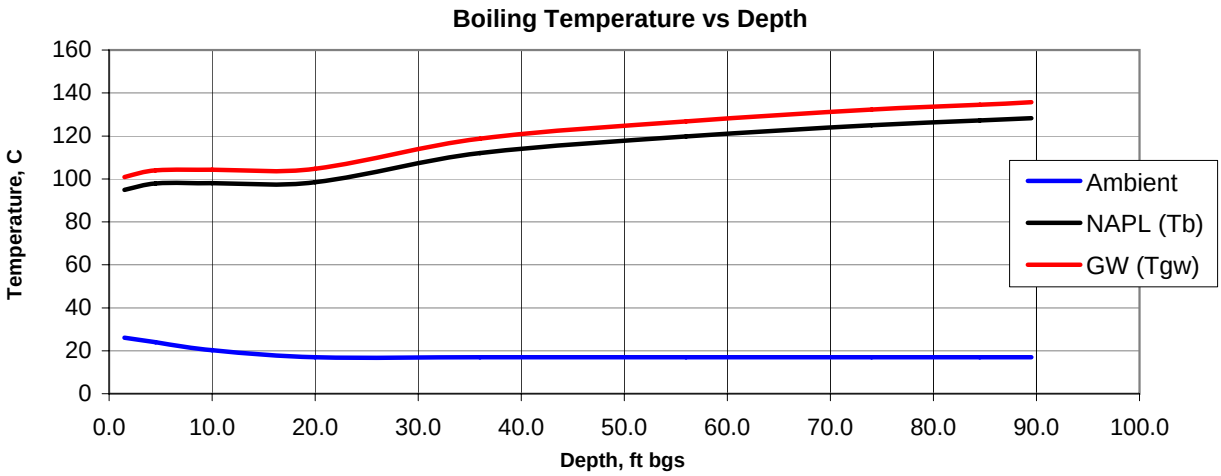
	Ambient (at 17°C)	Heated (at 132°C)
Weighted Ave.(W/A) Contaminant Water Solubility (mg/l):	11932.7	5150.3
W/A Contaminant Vapor Pressure (Torr):	3.5	525.2
W/A Contaminant Henry's Constant (mg/L air / mg/L aq):	0.00	0.36
W/A Contaminant NAPL Density (kg/L):	2.252	1.990
W/A Contaminant NAPL Dynamic Viscosity (cP):	1.864	0.493
W/A Contaminant NAPL Kinematic Viscosity (cSt):	0.827	0.248

Contaminant Distribution and Cleanup Targets

	Heated Layer 1	Heated Layer 2	Heated Layer 3	Heated Layer 4	Heated Layer 5
Zone:	Vadose	Vadose	Saturated	Saturated	Saturated
Volume (yd^3):	1,668.7	2,503.1	4,171.9	4,171.9	3,337.5
	Initial Soil Concentrations, Dry Basis (mg/kg)				
Peak:	61	15	2	1	1
Average:	4	1	0	0	0
Target:	0.01	0.01	0.01	0.01	0.01
	Initial Groundwater Concentrations (µg/L)				
Estimated Ave:	n/a	n/a	218	182	216
Target:	n/a	n/a	0	0	0
	Initial Mass Distribution (lb)				
NAPL present?:	no	no	no	no	no
Sorbed:	8.0	4.1	0.6	0.4	0.5
Dissolved:	8.4	4.5	0.6	0.6	0.5
Vapor:	0.0	0.0	0.0	0.0	0.0
NAPL:	0.0	0.0	0.0	0.0	0.0
Total Mass:	16.4	8.6	1.2	1.0	0.9
	Initial Saturations (v/v)				
Water	33.7%	37.4%	37.6%	45.9%	38.0%
Air	12.4%	8.6%	0.2%	0.1%	0.5%
NAPL	0.0%	0.0%	0.0%	0.0%	0.0%

Copyright(C) 2008
Current Environmental Solutions
All rights reserved

Estimated Treatment Temperatures & Pressure



	GW (˚C) Boiling Temperature	NAPL (˚C) Boiling Temperature	Ambient (˚C) Subsurface Temperature	Pressure at Boiling mm Hg	Layer Midpoint ft bgs
Upper Layer 1	100.9	94.9	26.0	784	1.5
Upper Layer 2	104.0	97.9	24.0	876	4.5
Heated Layer 1	104.2	98.1	20.3	881	10.0
Heated Layer 2	104.7	98.5	17.0	896	20.0
Heated Layer 3	118.7	112.0	17.0	1,428	36.0
Heated Layer 4	126.7	119.7	17.0	1,834	56.0
Heated Layer 5	132.3	125.1	17.0	2,164	74.0
Lower Layer 1	134.5	127.2	17.0	2,310	84.5
Lower Layer 2	135.7	128.3	17.0	2,391	89.5

Electrode Design Specifications

Number of Vertical Heating Intervals:	1	
Electrode and Extraction Well Terminations:	100% above grade	
Number of Temperature Monitoring Wells:	12	
Soil Cuttings from Electrode Installation:	125.6	tons
Average Wetting Rate (all Electrodes):	0.56	gpm
Total Volume of Drip Water Added:	160,438	gallons
Total Amount of Electrolyte Required:	9,993	Lb

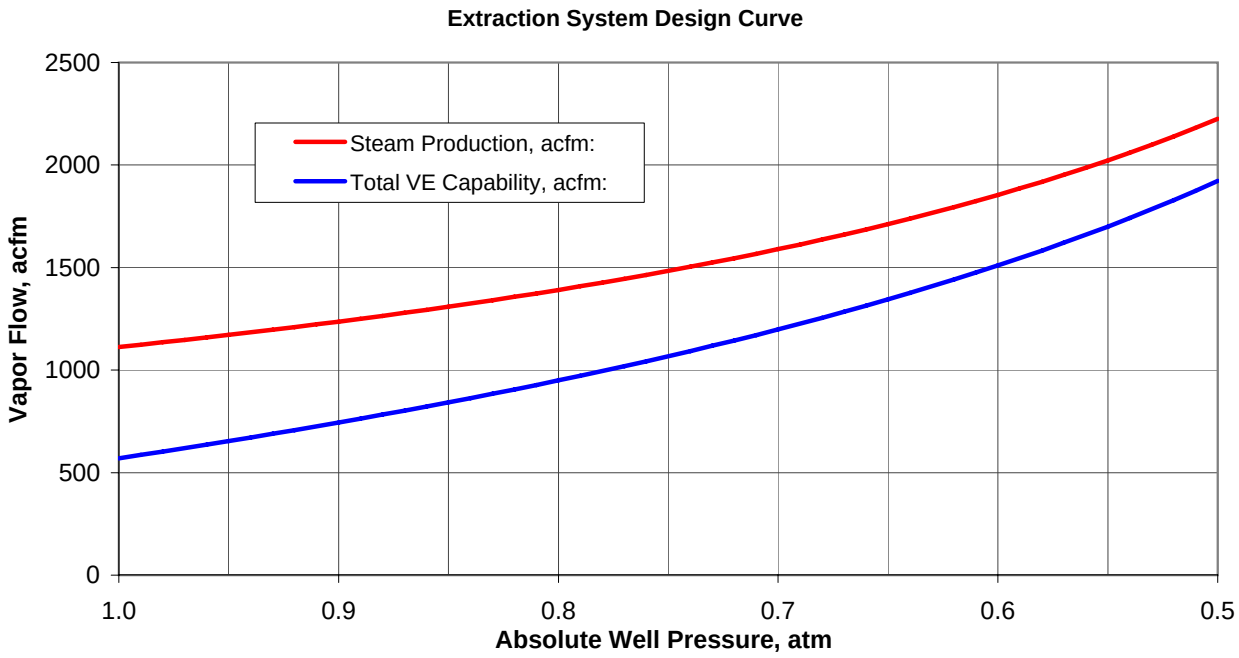
	Primary	Upper
Electrode Diameter (inches):	3.0	n/a
Borehole Diameter (inches):	12.00	n/a
Array to Electrode Ratio (D/d):	32	n/a
Distance between Electrodes (ft):	16.0	n/a
Total Number of Electrodes:	30	n/a
Depth to Top of Electrode (ft):	6.0	n/a
Total Depth of Electrode (ft):	84.0	n/a
Conductive Zone Length (ft):	78.0	n/a
Length of Electrode in Vadose Zone (ft):	20.0	n/a
Length of Electrode in Groundwater (ft):	58.0	n/a
Number of Drip Intervals per Primary Electrode:	5	n/a
Electrode Drill Cuttings (tons):	125.6	n/a

Copyright(C) 2008
Current Environmental Solutions
All rights reserved

Extraction System Design

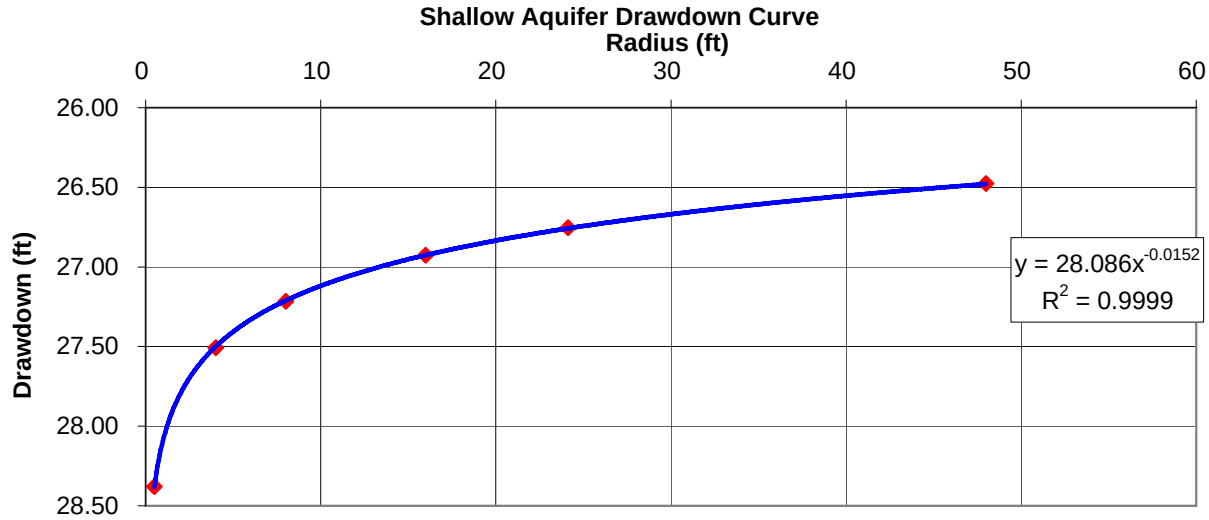
Design Extraction Vaccum:	0.80	atm
Well Vacuum:	6	in. Hg
Peak Steam Production Rate:	695	scfm
Peak Air Flow Rate:	46	scfm
Vapor Extraction Design Flow Rate:	850	scfm
Recommended Blower Vacuum:	10	in. Hg
Vapor Extraction Blower:	80	hp
SVE/DVE Wells Co-Located with Electrodes?	yes	
Average Condensate Production Rate:	4.03	gpm
Total Condensate Produced:	550,000	gallons
Peak Vapor Extraction Rate:	0.1	lb/day
Peak In Situ Degradation Rate:	0.6	lb/day
Average Total Cleanup Rate:	0.1	lb/day
Final Extraction Rate:	0.0	lb/day
Soil Cuttings from VE Well Installation:	0.0	tons
Vapor Treatment Method:	carbon	
Secondary Acid Gas Stack Scrubber:	not required	

	Shallow/VE	Horizontal	Deep/DVE
Type of Vents Required:	yes	yes	yes
Vent Spacing (ft):	16	32	16
Number of Vents:	30	5	30
Wellbore/Trench Diameter (in.):	12.00	12.00	12.00
Screened Length per Vent (ft):	23.0	30.0	58.0
Peak Design Flow per Vent (acfm):	13.4	11.0	14.2
Wellscreen Diameter (in.):	3.0	1.0	3.0
Well Drill/Trenching Cuttings (tons):	0.0	0.0	0.0



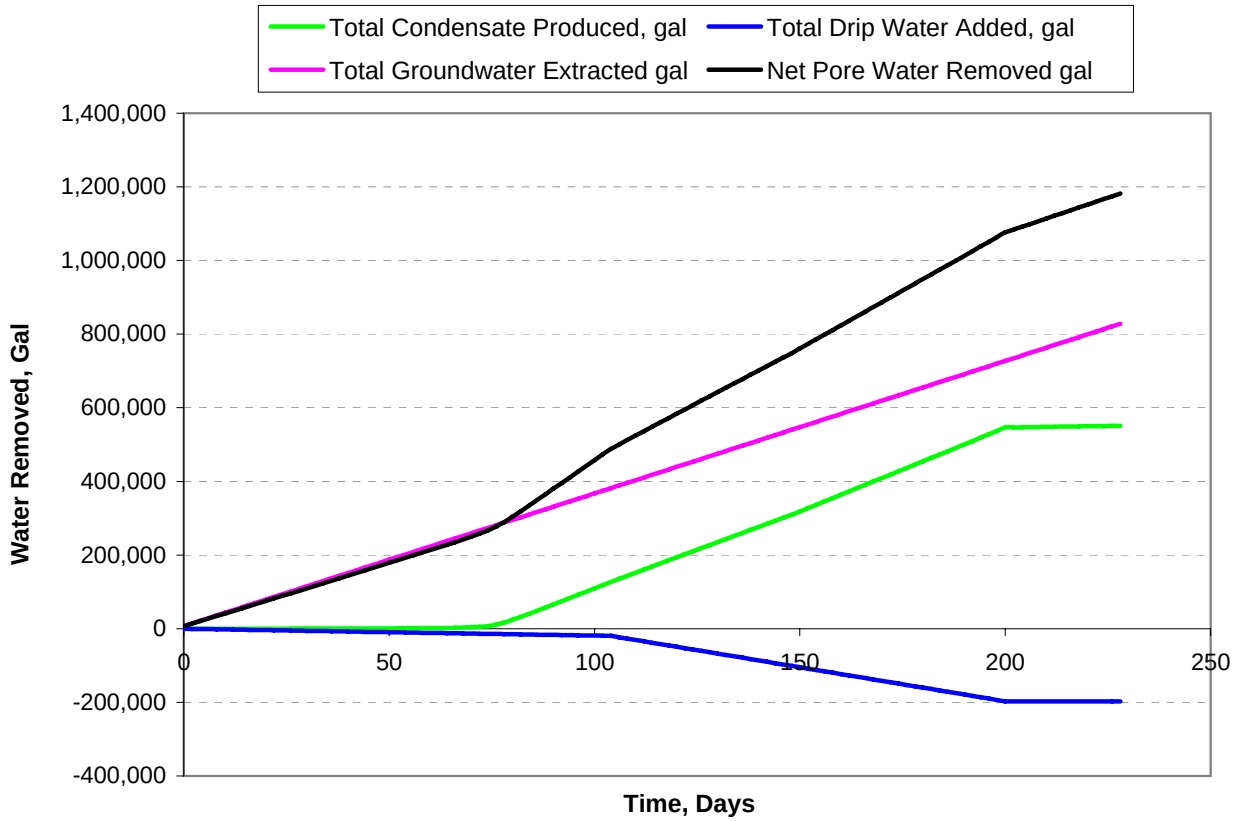
Copyright(C) 2008
Current Environmental Solutions
All rights reserved

Groundwater Extraction & Overall Water Balance



Typical Depth to Groundwater: 26 ft bgs

Total Groundwater Extracted:	828,000	gallons
Total Condensate Produced:	550,000	gallons
Total Volume of Drip Water Added:	160,438	gallons
Total NAPL Extracted:	0	lb

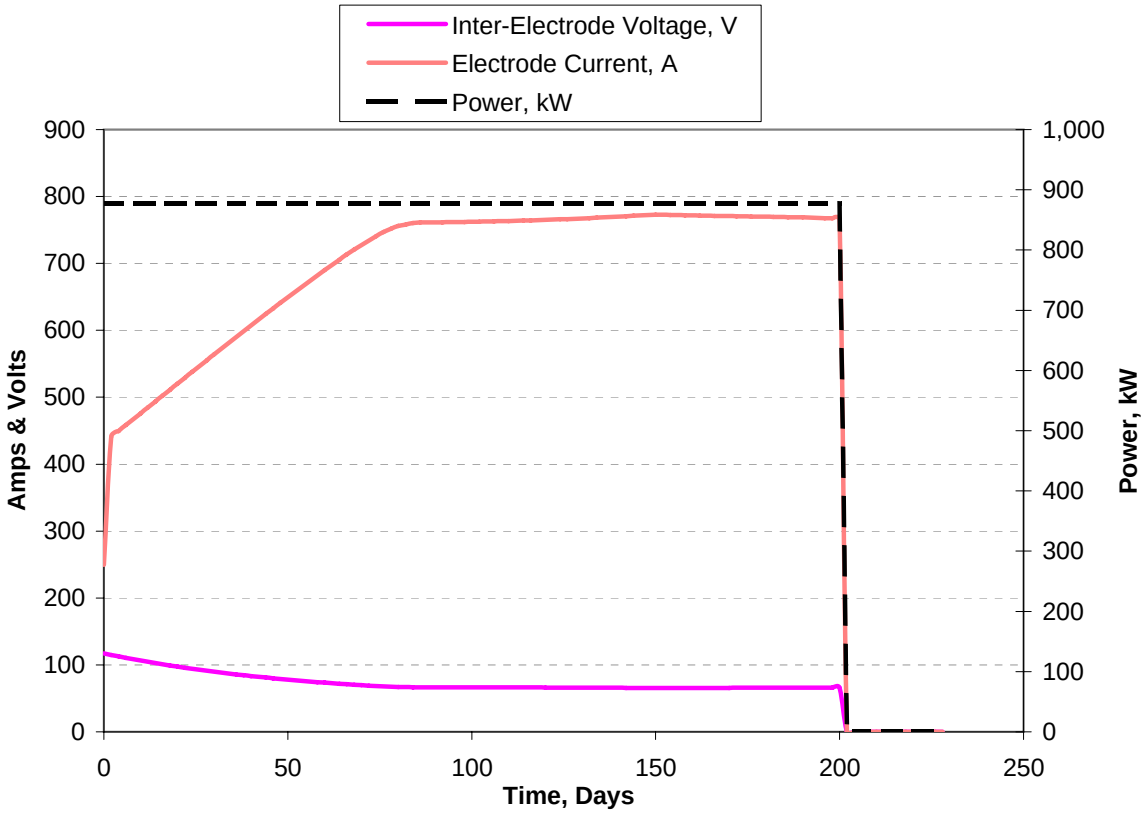


Copyright(C) 2008
Current Environmental Solutions
All rights reserved

Estimated Treatment Time & Energy Requirements

Time to Pre-Heat/Dry Vadose Zone:	0	days
Time to Heat-up Site:	106	days
Time to Treat Site:	94	days
Extra Time for Multiphase Extraction:	0	days
Total Treatment Time:	200	days
Subsurface Energy Estimate:	4,254,200	kW-hr
Subsurface Energy Density:	221	kw hr/yd3
Total Energy Estimate:	4,682,944	kW-hr

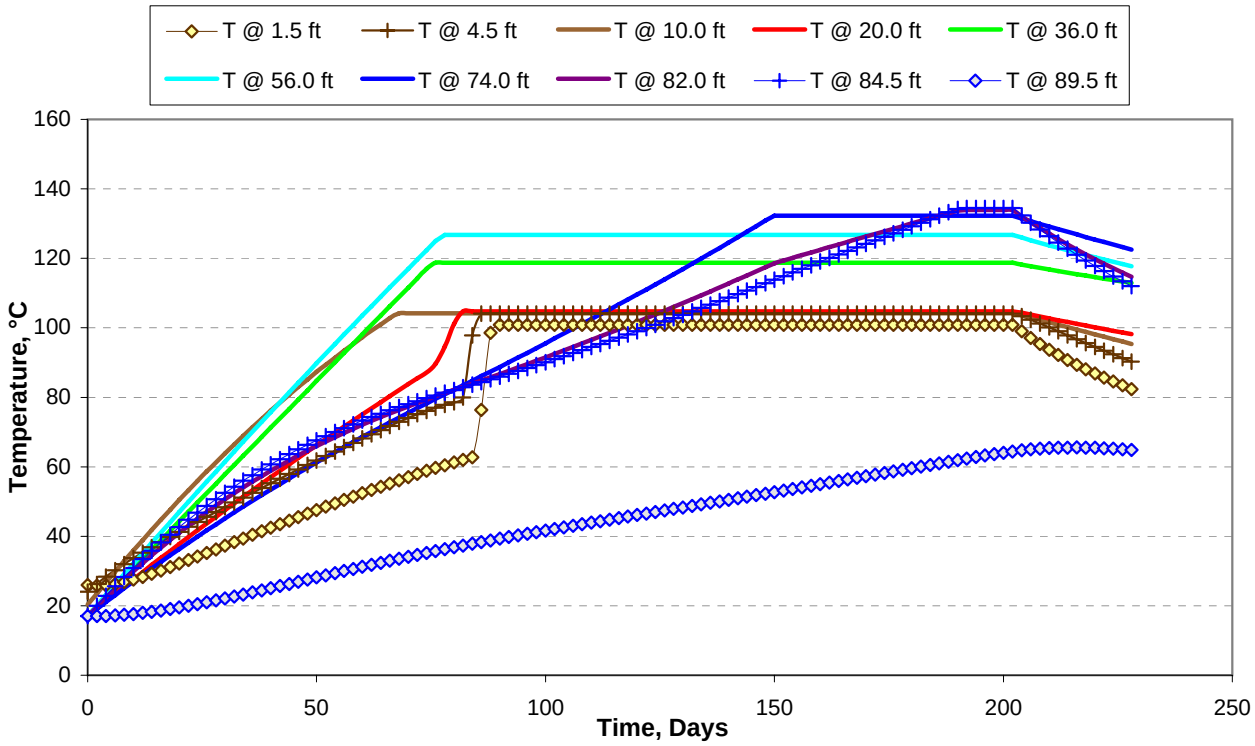
Power Supply Specifications & Electrical Requirements



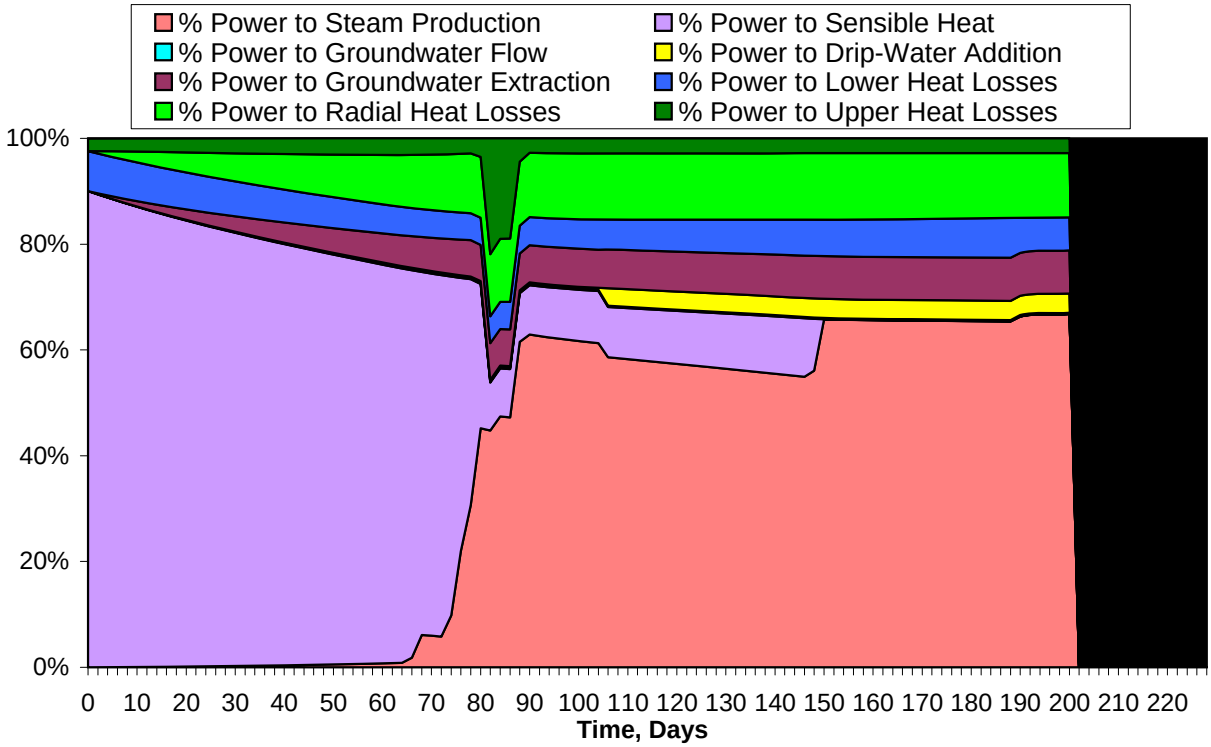
Site Electrical Power Requirement:	1,700	kW
Site Service Requirement at 480V, 3-Phase:	2,000	Amps
Power Supply Rating:	1500	kW
Peak Electrode Voltage:	117	Volts
Peak Phase Current:	7,729	Amps
Number of Electrode Phases:	3	

Copyright(C) 2008
Current Environmental Solutions
All rights reserved

Predicted Subsurface Temperature Trends

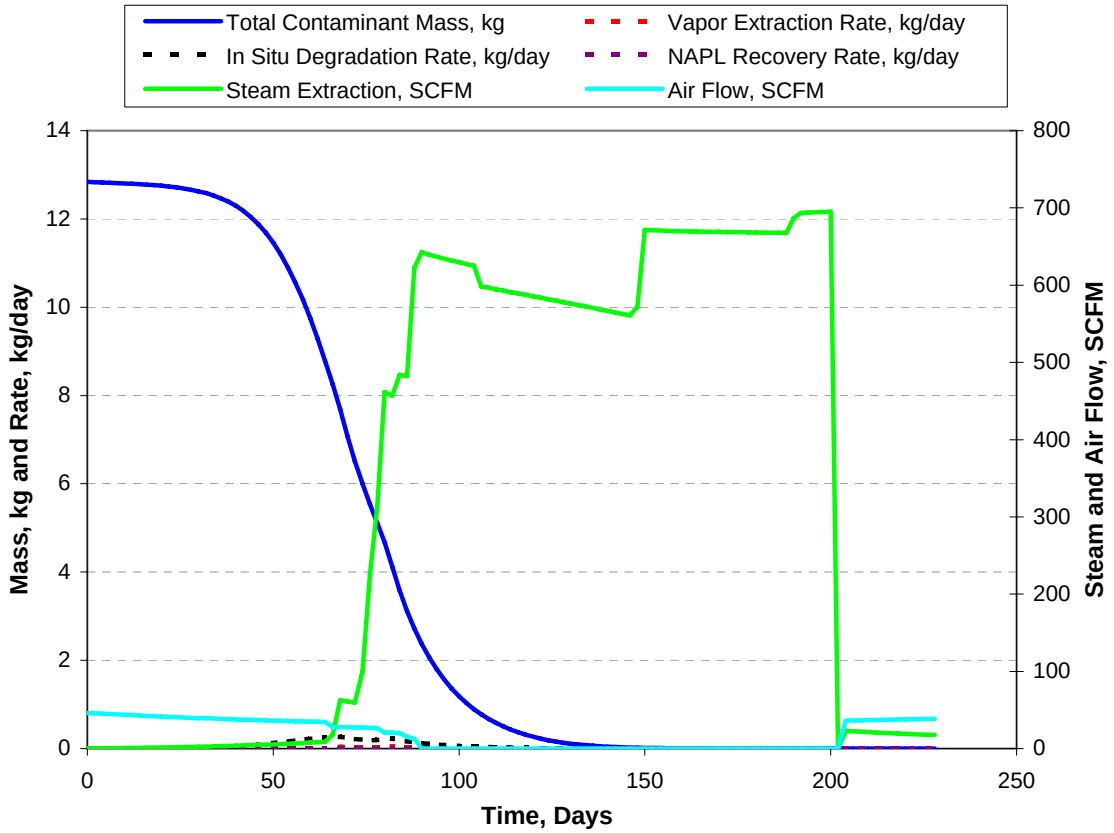


Estimated Subsurface Energy Distribution

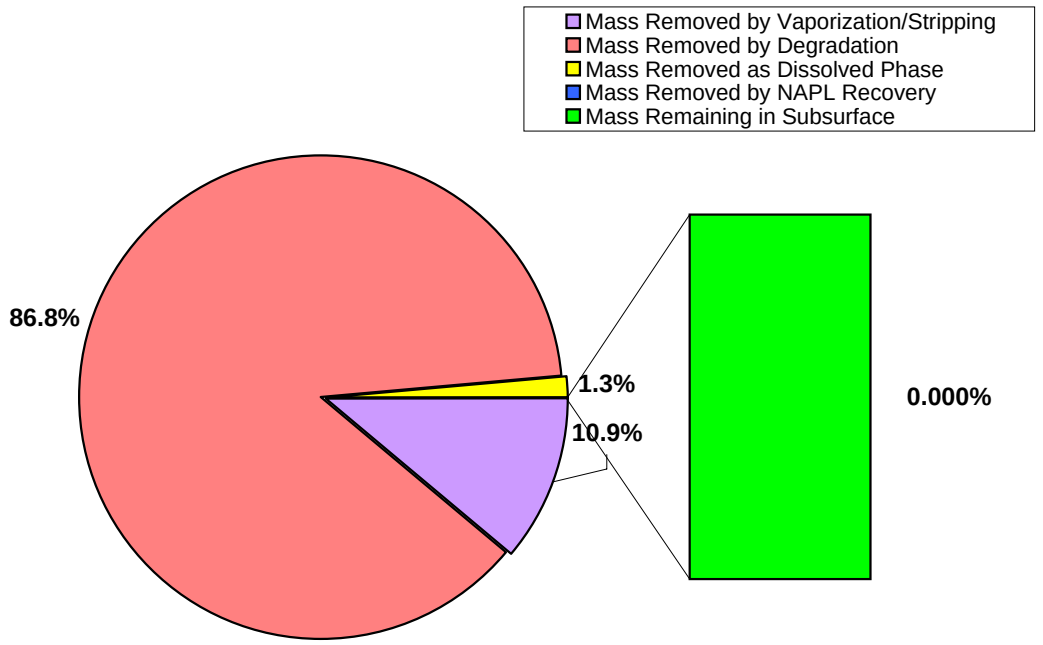


Copyright(C) 2008
Current Environmental Solutions
All rights reserved

Projected Treatment Performance and Removal rates

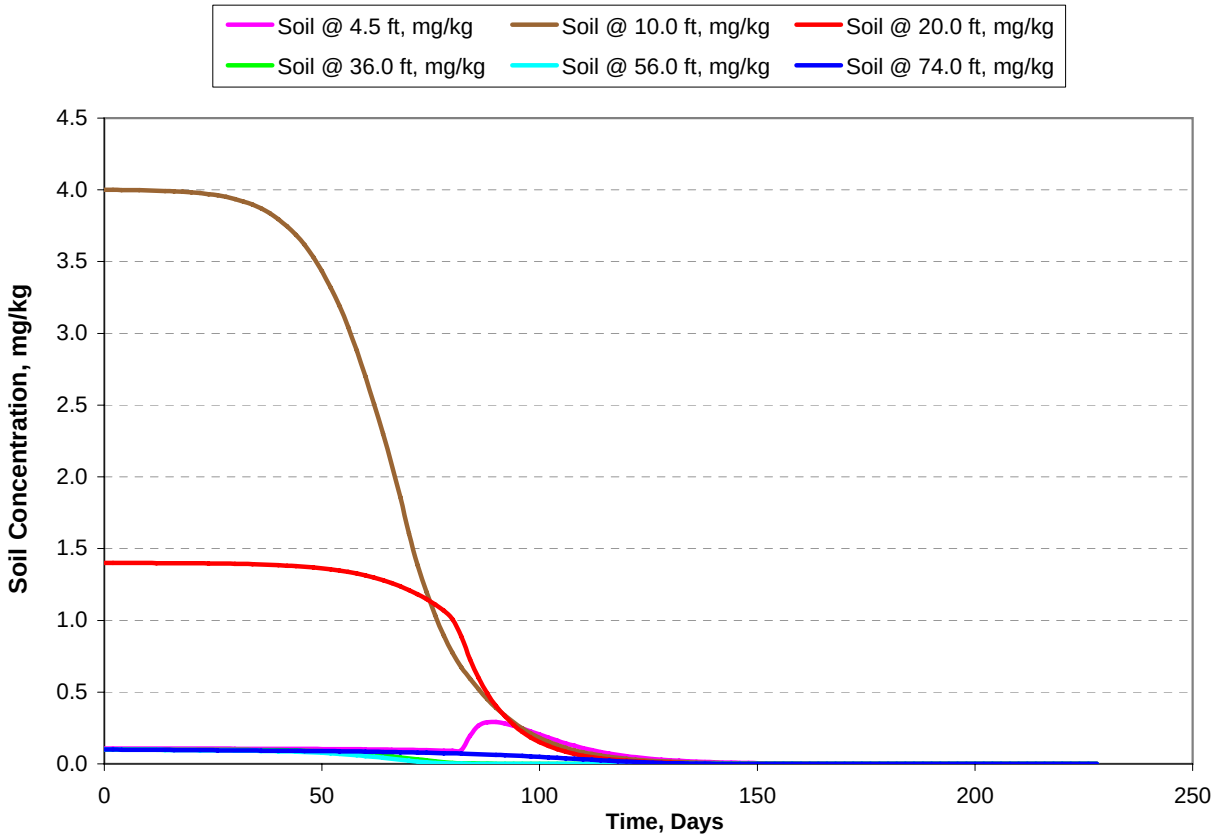


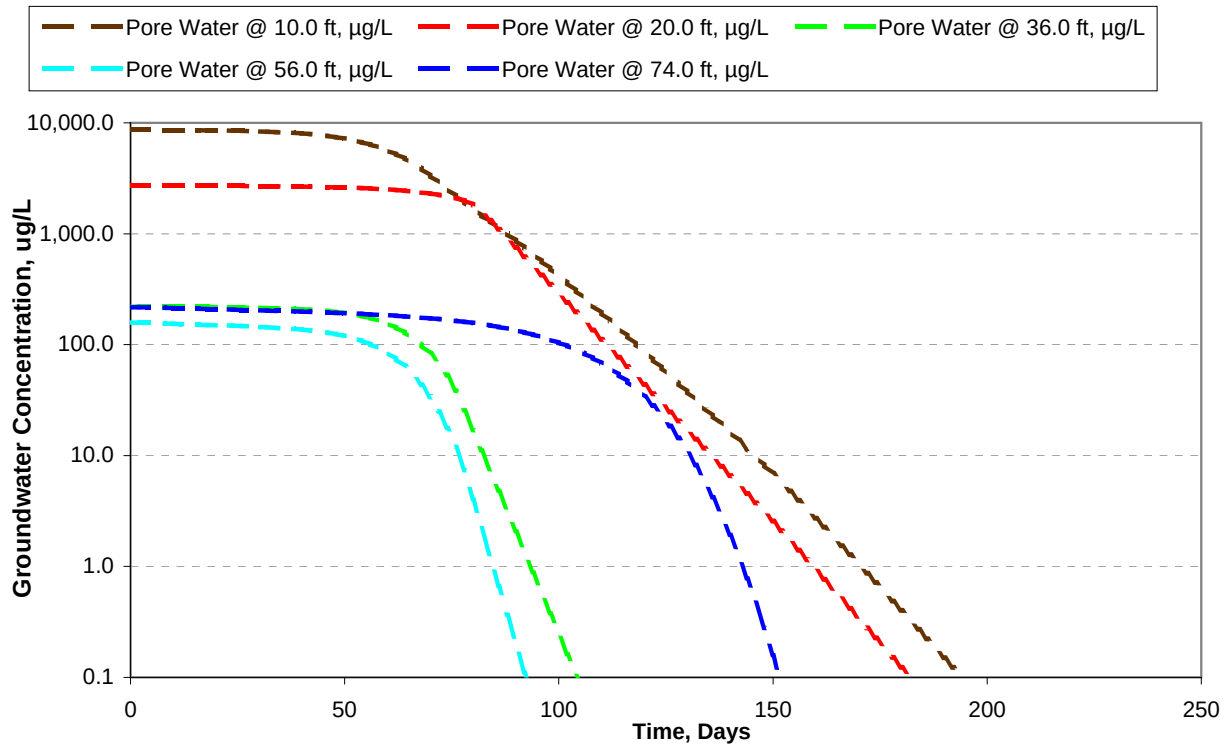
Contaminant Fate Projection



Copyright(C) 2008
Current Environmental Solutions
All rights reserved

Predicted Soil and Groundwater Concentrations





Copyright(C) 2008
Current Environmental Solutions
All rights reserved