Fourth Five-Year Review Report for the Teledyne Wah Chang Superfund Site

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Region 10

December 28, 2012

Fourth Five-Year Review Report for the Teledyne Wah Chang Superfund Site

Prepared by

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Region 10

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ACRONYMS

µg	microgram
µrem/hour	micro-roentgen equivalent man per hour
ARARs	Applicable or Relevant and Appropriate Requirements
ARS	Ammonium Recovery System
ATI	Allegheny Technologies, Inc.
AWQC	Ambient Water Quality Criteria
bgs	below ground surface
BNSF	Burlington Northern Santa Fe Railroad
CB	catch basin
CCA	Crucible Cleaning Area
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
CIC	Community Involvement Coordinator
cisDCE	cis 1,2 Dichloroethene
cm/sec	centimeters per second
COC	contaminant of concern
CoGen	Co-Generation
CRP	Chlorinated Residue Pile
CSM	conceptual site model
CT	cooling tower
CVOC	chlorinated volatile organic compound
CWD	Central Wastewater Drain
CWTS	Central Wastewater Treatment System
cy	cubic yards
DCA	dichloroethane
DCE	dichloroethene
ODEQ	Oregon Department of Environmental Quality
DNAPL	dense non-aqueous phase liquid
EISB	Enhanced In-Situ Bioaugmentation
EER	Environmental Evaluations Report
EFSC	Energy Facility Siting Council
ELCR	excess lifetime cancer risk

EPA	U.S. Environmental Protection Agency
ESD	Explanation of Significant Differences
EW	extraction wells
fpd	feet per day
GAC	granular activated carbon
GEM	gamma-emitting material
GETS	Groundwater Extraction and Treatment System
gpm	gallons per minute
HI	Hazard Index
I-5	Interstate 5
IDW	investigation derived waste
LRSP	Lower River Solids Pond
MCL	maximum contaminant levels
MCLG	maximum contaminant level goals
mg/kg	milligram per kilogram
mg/kg/day	milligram per kilogram per day
mg/L	milligram per liter
mgd	million gallons per day
MIBK	methyl isobutyl ketone
Msl	mean sea level
MNA	monitored natural attenuation
MRRP	Magnesium Resource Recovery Pile
NCP	National Oil and Hazardous Substances Contingency Plan
NGVD	National Geodetic Datum
NON	Notice of Noncompliance
NORM	naturally occurring radioactive materials
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
O&M	operation and maintenance
OAR	Oregon Administrative Rule
OPRD	Oregon Parks and Recreation Department
OU	operable unit
PAH	polycyclic aromatic hydrocarbon
PCA	tetrachloroethane

PCB	polychlorinated biphenyl
PCE	tetrachloroethene
pCi	picoCuries
ppb	parts per billion
PRG	Preliminary Remediation Goal
PVC	polyvinyl chloride
RA	Remedial Action
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RD/RA	Remedial Design/Remedial Action
RFA	RCRA Facility Assessment
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SAP	Sampling and Analysis Plan
SDWA	Safe Drinking Water Act
SEA	South Extraction Area
SF	slope factors
SOW	Scope of Work
SVOC	semi-volatile organic compound
SWMU	Solid Waste Management Unit
TCA	trichloroethane
TCE	trichloroethene
TCLP	toxicity characteristic leaching procedure
TDS	total dissolved solids
TOPO	Task Order Project Officer
TSCA	Toxic Substance Control Act
TWC	Teledyne Wah Chang
VC	vinyl chloride
VOC	volatile organic compound
WMP	Willamette Memorial Park

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site Name: Teledyne Wah Chang		
EPA ID: ORD050955848		
Region: 10	**State:** OR	**City/County:** Millersburg/ Linn

SITE STATUS	
NPL Status: Final	
Multiple OUs? YES	**Has the site achieved construction completion?** Yes

REVIEW STATUS
Lead agency: EPA **If "Other Federal Agency" was selected above, enter Agency name:**
Author name (Federal or State Project Manager): Ravi Sanga
Author affiliation: US EPA Region 10
Review period: 1/28/2012 – 1/08/2013
Date of site inspection: 6/6/2012 - 6/8/2012
Type of review: Statutory
Review number: 4
Triggering action date: January 08, 2008
Due date *(five years after triggering action date)*: 1/08/2013

Issues/Recommendations

OU(s) without Issues/Recommendations Identified in the Five-Year Review:

OU1

Issues and Recommendations Identified in the Five-Year Review:

OU(s):2	**Issue Category: Remedy Performance** **Issue:** Extraction Area –From Wah Chang's annual progress summaries and an independent review of Wah Chang's data, EPA determined that although GETS has reduced the concentrations of radium and other COCs in groundwater, low pH conditions persist that are contributing to COCs above ROD cleanup levels. Therefore it is unlikely that ROD cleanup levels will be achieved in the 15-year time frame without using a different treatment technology.			
	Recommendation: Evaluate the use of basic solution (lime) groundwater flushing as a new RA to raise groundwater pH and decrease the mobility of inorganic constituents. Wah Chang has submitted a treatability study for the lime groundwater flushing and if EPA determines that this technology is feasible, EPA expects to issue an ESD before the end of 2013 to implement the remedy.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	12/31/2015
OU(s):2	**Issue Category: Remedy Performance** **Issue:** Extraction Area **–** Although a source was never determined**,** Wah Chang implemented EISB as a pilot project under EPA oversight and VOCs were not detected in the SEA in 2011. Following EPA approval, Wah Chang shut down extraction wells in April 2011. The groundwater data needs to be assessed for potential reestablishment of a dissolved plume.			
	Recommendation: Wah Chang must continue to monitor groundwater biannually under EPA oversight for 5 years following shutdown of extraction wells in the SEA in 2011 to assess whether the dissolved plume is reestablishing itself.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	12/31/2016
OU(s):2	**Issue Category: Remedy Performance** **Issue:** Fabrication Area – Wah Chang implemented EISB in the CCA and EPA is currently evaluating its effectiveness.			
	Recommendation: Wah Chang must continue additional performance monitoring to determine if cleanup levels will be achieved by 2017, which is the time frame specified in the ROD.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	12/31/2017

Issues/Recommendations (continued)

OU(s):2	**Issue Category: Remedy Performance** **Issue:** Fabrication Area - Wah Chang implemented EISB in the ASA in 2009 and EPA is currently evaluating its effectiveness. However, Wah Chang's release of DNAPL and/or high chemical concentrations in the ASA is an additional source area not encountered during the RI/FS, and it is unlikely that ROD cleanup levels will be achieved in the 15-year time frame without additional remedial actions.			
	Recommendation: Wah Chang must continue additional performance monitoring to determine if ROD cleanup levels will be achieved. Treatment of the plume is successfully reducing dissolved phase chlorinated solvents. However geochemical evidence in the form of high dissolved concentrations in the source area indicate a DNAPL source remains that will require removal or more aggressive treatment.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	12/31/2015

OU(s):2	**Issue Category: Remedy Performance** **Issue:** Farm Ponds Area – Based on Wah Chang's annual groundwater progress summaries and an independent review of Wah Chang's data, EPA noted that VOCs significantly and unexpectedly decreased to below ROD cleanup levels and was concerned about possible plume migration. In 2012, Wah Chang removed potential source material with EPA oversight since the drop in concentrations was unexplained.			
	Recommendation: Wah Chang excavated and removed the potentially contaminated berms and collected groundwater samples to confirm groundwater conditions. EPA expects to review these data in 2013 to determine whether the extent of the dissolved plume requires additional assessment.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	12/31/2014

OU(s):2	**Issue Category: Monitoring** **Issue:** Wah Chang's method reporting limits for some VOCs (PCE and VC) in surface water samples exceed the AWQC.			
	Recommendation: Wah Chang must reduce the method reporting limits for PCE and VC in surface water samples to enable identification of COCs in surface water.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	12/31/2014

Issues/Recommendations (continued)

OU(s):2	**Issue Category: Monitoring**			
	Issue: Ground-water monitoring constituents have been reduced over time since the RI/FS. Contaminants may have migrated over this time period and monitoring points should be reassessed.			
	Recommendation: Wah Chang must submit a work plan to EPA in 2013 and conduct a round of Sitewide sampling for wells and parameters included in the original RI/FS using current analytical technology.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	12/31/2014
OU(s):2	**Issue Category: Monitoring**			
	Issue: During decommissioning of well SS in the Farm Ponds Area, Wah Chang discovered the well was not properly constructed. The contractor that installed well SS, Schoen Electric and Pump, also installed other Site wells.			
	Recommendation: Wah Chang must submit a report to EPA documenting whether any of the wells being used for CERCLA Site investigations were installed by Schoen Electric and Pump. If improperly constructed wells are being used, Wah Chang must prepare a work plan for EPA approval and replace these wells with wells are compliant with well construction regulations.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	12/31/2013
OU(s):2	**Issue Category: Institutional Controls**			
	Issue: EPA has determined that Wah Chang needs to provide additional information on the status of the Institutional Control instruments to verify that all institutional controls required by EPA's decision documents are in place.			
	Recommendation: Wah Chang must verify the status of deed restrictions requiring that land use at the Site remain industrial, and whether deed restrictions for groundwater use and land use are in place for the properties Wah Chang recently purchased east of Old Salem Road. Wah Chang must also provide EPA with their site maintenance plan documenting areas of subsurface PCB and radionuclide contamination.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	12/31/2013
OU(s):2	**Issue Category: Monitoring**			
	Issue: Surface Water – EPA noted from Wah Chang's annual progress summaries and an independent review of Wah Chang's data that VOCs have been detected in surface water at the site sporadically in past years. However, EPA believes that since the 2008 FYR, elevated concentration of VOCs observed in PW-78A may indicate migration of contaminated groundwater to Murder Creek.			

Issues/Recommendations (continued)				
	Recommendation: Wah Chang must add surface water sample locations in the vicinity of PW-78A in Murder Creek to evaluate the potential for contaminated groundwater to be released to surface water.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	12/31/2014
OU(s):2	**Issue Category: Remedy Performance** **Issue:** Sediment – Additional information on PCB concentrations in sediment is needed to determine if the RA for sediment is functioning as intended.			
	Recommendation: Wah Chang must resubmit an appropriate Work Plan to EPA for approval and conduct sediment sampling and analysis in a manner consistent with the approved Work Plan.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	12/31/2014
OU(s):3	**Issue Category: Operations and Maintenance** **Issue:** The SOW and Consent Decree do not incorporate requirements of the 2001 Soil ESD regarding overall cleanup during decommissioning and other factors.			
	Recommendation: Prior to plant decommissioning, EPA and ODEQ will amend the SOW of the 1997 Consent Decree to incorporate applicable requirements of the 2001 Soil ESD for plant decommissioning.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	01/07/2018
OU(s):3	**Issue Category: Operations and Maintenance** **Issue:** The Mayor of Millersburg indicated that tilling for agricultural purposes was being conducted on the SAA. Although the RI/FS determined that agricultural practices did not pose a risk to human health or the environment, EPA is revisiting the issue since it has been 17 years since the soil radionuclide data were collected and the original evaluation did not address risks to agricultural workers from soil resuspension due to tilling.			
	Recommendation: Wah Chang must collect and analyze soil samples for radium by the end of calendar year 2013 so EPA can reevaluate, in 2014, the risk to human health and the environment from the disturbance/resuspension of soil and remaining levels of radionuclides in soils. Given that the earlier testing did not demonstrate human health risk, the City may continue to use the property for agricultural activities although it is suggested by EPA that ground disturbing activities that may resuspend soil should be limited. Following EPA's reassessment of the contaminated soils, should there be an indication of human health risk to those exposed to these soils under current agricultural practices, EPA will share those results with the City of Millersburg and discuss appropriate actions for future use of the property.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
Yes	Yes	PRP	EPA	12/31/2014

Issues/Recommendations (continued)				
OU(s):3	**Issue Category: Monitoring**			
	Issue: There is uncertainty in the location of the CoGen Building with respect to the overall soil radiation footprint left behind after Wah Chang's remedial actions in the Sand Unloading Area. EPA Institutional Controls require that anyone constructing future buildings use radon-resistant construction methods if those buildings are located on top of radioactive contamination.			
	Recommendation: Wah Chang, under EPA oversight, must retest indoor air for radon in the CoGen Building by the end of calendar year 2013, and based on the results of radon concentrations, EPA may require further testing or actions.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	12/31/2014

Protectiveness Statement(s)		
Operable Unit: OU1	*Protectiveness Determination:* Protective	*Addendum Due Date (if applicable):*
Protectiveness Statement: The remedy for OU1 is protective of human health and the environment, and exposure pathways that could result in unacceptable risks are being controlled.		
Operable Unit: OU2	*Protectiveness Determination:* Short-term Protective	*Addendum Due Date (if applicable):*

Protectiveness Statement:

The remedy at OU2 is currently protective of human health and the environment in the short term. Progress to meet the groundwater RAOs is being made through an operating GETS enhanced with EISB. ICs are in place preventing exposure to contaminants of concern above cleanup goals through on-site and off-site deed restrictions on groundwater use, zoning, and access controls. In order for the remedy to be considered protective in the long term, Wah Chang must obtain and provide to EPA further information on groundwater pH conditions and COC concentrations, and verify that all ICs instruments required by EPA's decision documents are in place. Long term protectiveness will be obtained when Wah Chang and EPA take the actions described below:

- Wah Chang must implement buffer solution treatment under EPA oversight to the groundwater source area contamination in the FMA stemming from acidic pH conditions and resulting in concentrations of COCs that remain above ROD cleanup levels. Groundwater quality conditions in the FMA are unlikely to achieve RAOs within the estimated 15-year time frame. EPA will evaluate the effectiveness of additional remedial actions in the FMA as data become available. EPA expects this action to be completed and data available to assess effectiveness in 2016.
- Since Wah Chang's annual progress summaries and EPA's independent review of Wah Chang's data indicate that no VOCs have been detected in groundwater in the SEA and that ROD cleanup levels have been met, EPA considers the SEA protective in the short term. EPA-required ICs are in place at the Site for use of groundwater, and the Site is still zoned for General Industrial use by the City of Millersburg. Long term protectiveness will require Wah Chang under EPA oversight to assess the mobilization of solvents from the source area after oxygen has stopped the reductive dechlorination of dissolved chlorinated solvents. This assessment will consist of long-term ground-water monitoring. EPA will reassess the effectiveness of EISB in the SEA based on Wah Chang's groundwater monitoring data that will be submitted annually through 2016.
- EPA has determined that due to elevated concentrations of VOCs in the ASA and CCA, Wah Chang must continue to monitor geochemical conditions to evaluate the effectiveness of EISB and reductive dechlorination. In 2014, EPA will reassess the effectiveness of the EISB based on the groundwater data collected by Wah Chang and will make a decision whether the remedy will meet ROD cleanup levels in the 15-year time frame specified in the ROD or whether additional treatment will be required. However, Wah Chang's release of DNAPL and/or high concentrations of VOCs in the ASA is an additional source area not encountered during the RI/FS that will likely require more aggressive remediation. Wah Chang must assess the source of DNAPL in the ASA and provide data to EPA by 2014.
- EPA has observed increased concentrations of VOCs in well PW-78A (close to Murder Creek). The current downstream surface water sampling is located 200 feet from the anticipated discharge point of groundwater in the vicinity of this well. Under EPA oversight, Wah Chang must collect additional seepage and surface water samples in the vicinity of well PW-78A so EPA can evaluate the potential for release of contaminated groundwater to the creek. EPA expects to evaluate additional data by 2013.

Protectiveness Statement(s) (continued)

- Since the 2008 FYR, Wah Chang's annual progress summaries and EPA's independent review of Wah Chang's data showed increasing CVOC concentrations in groundwater in the Farm Ponds Area indicating that ROD performance standards may not be met. However, EPA noted recent unexplained declines in concentrations. In 2012 Wah Chang completed excavation of the berm material that may have acted as a source of groundwater contamination, and collected confirmation samples of groundwater. EPA will evaluate the results of the completion report in 2013 to assess whether additional actions are required.
- Wah Chang must conduct additional sampling and analysis of PCBs in sediments to ensure that the remedy for sediments is protective. EPA will evaluate additional data in 2013.
- Wah Chang must submit a report to EPA documenting whether any of the wells being used for CERCLA Site investigations were installed by Schoen Electric and Pump. If improperly constructed wells are being used, Wah Chang must prepare a work plan for EPA approval and replace these wells with wells that are compliant with well construction regulations.
- Wah Chang must verify the status of deed restrictions requiring that land use at the Site remain industrial, and whether deed restrictions for groundwater use and land use are in place for the properties Wah Chang recently purchased east of Old Salem Road. Wah Chang must also provide EPA with their site maintenance plan documenting areas of subsurface PCB and radionuclide contamination.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
OU3	Protectiveness Deferred	01/07/2018

Protectiveness Statement:
A protectiveness determination of the remedy at OU3 cannot be made at this time until further information is obtained associated with exposure to radionuclides from resuspension due to tilling in the Soil Amendment Area. Further information will be obtained by taking the following actions:

- Under EPA oversight, Wah Chang must collect samples of SAA soil and test for radiological contamination by the end of calendar year 2013 so EPA can reevaluate in 2014 the risk to human health and the environment from the disturbance/resuspension of soil to evaluate whether human health and the environment are protected under the existing remedy.

Excavation of contaminated soil was completed and ICs are in place in the form of deed restrictions that prevent human exposure to remaining soils in the main plant of the site. Additionally, for the remedy to be protective in the long term, EPA and Wah Chang need to take the following actions to ensure protectiveness:

- Prior to plant decommissioning, EPA and ODEQ will amend the SOW of the 1996 Consent Decree to incorporate applicable requirements of the 2001 Soil ESD for plant decommissioning.
- Under EPA oversight, Wah Chang must retest for radon in the CoGen Building by the end of calendar year 2013 due to uncertainty in the location of the CoGen Building with respect to the overall soil radiation footprint remaining after Wah Chang's remediation of the Sand Unloading Area. Based on the results, EPA may require additional testing of radon in indoor air or radon mitigation.

Sitewide Protectiveness Statement (if applicable)	
For sites that have achieved construction completion, enter a sitewide protectiveness determination and statement.	
Protectiveness Determination: Protectiveness Deferred	*Addendum Due Date (if applicable):* *01/07/2018*

Protectiveness Statement:
EPA has determined that there is not enough information to evaluate protectiveness, primarily in the area of the Site that has agricultural activities (SAA). Therefore, the Sitewide protectiveness determination is deferred until the following additional information is evaluated. Wah Chang must collect and analyze soil samples for radium so EPA can reevaluate the risk to human health from the disturbance/resuspension of soil. Given that the earlier testing did not demonstrate human health risk, the City may continue to use the property for agricultural activities including tilling the soil although it is suggested by EPA that ground disturbing activities that may resuspend soil should be limited. Following EPA's reassessment of the contaminated soils, should there be an indication of human health risk to those exposed to these soils under current agricultural practices, EPA will share those results with the City of Millersburg and discuss appropriate actions for future use of the property.

Progress to meet the groundwater RAOs is being made through an operating GETS enhanced with EISB. ICs are in place preventing exposure to contaminants of concern above cleanup goals through zoning ordinances and access controls and on-site and off-site deed restrictions on groundwater use. In order to ensure long term protectiveness, Wah Chang must provide further information on pH conditions and groundwater COC concentrations following remedy enhancements so that EPA can evaluate the ability of the OU2 remedy to meet RAOs within the 15-year time frame specified in the ROD (2017). In addition, Wah Chang must confirm that all IC instruments required by EPA's decision documents are in place for all parcels of property that could be affected by contaminated groundwater. Wah Chang must verify the status of deed restrictions requiring that land use at the Site remain industrial, and whether deed restrictions for groundwater use and land use are in place for the properties Wah Chang purchased east of Old Salem Road. Wah Chang must also provide EPA with their site maintenance plan documenting areas of subsurface PCB and radionuclide contamination.

EPA Required Institutional Controls are in place requiring that anyone constructing future buildings on the Teledyne Wah Chang Main Plant must conduct an assessment to determine whether radon levels could pose an unacceptable risk to building occupants and implement radon resistant construction and controls and radon testing if required. Since the CoGen building was not constructed using radon resistant construction methods and is located in an area where residual radioactive contamination may exist, Wah Chang must resample indoor air radon in this building to ensure long term protectiveness of human health, and depending on the results, EPA may require additional sampling and radon mitigation.

EXECUTIVE SUMMARY

This report presents the findings of the Fourth Five-Year Review for the Teledyne Wah Chang (Wah Chang) Superfund Site (Site) located in Millersburg, Oregon. The purpose of this review is so EPA can confirm that the remedy continues to be protective of human health and the environment. This Five-Year Review was conducted in accordance with the U.S. Environmental Protection Agency's June 2001 Comprehensive Five-Year Review Guidance.

Wah Chang is an operating zirconium and other non-ferrous metals manufacturing plant; it employs approximately 1,100 people. The Site is located in the industrial-based community of Millersburg, Oregon, approximately 2 miles north of downtown Albany and approximately 20 miles due south of Salem, Oregon. The Site is adjacent to the Willamette River, with portions of the property within the river's 100- and 500-year flood plains.

SITE FEATURES

Site features include:

- The Main Plant, which is composed of:
  - ➢ The Extraction Area: a 40-acre triangular-shaped parcel located south of Truax Creek including the Feed Makeup Area (FMA) and South Extraction Area (SEA).
  - ➢ The Fabrication Area: a 50-acre parcel located north of Truax Creek and south of Murder Creek including the Acid Sump Area (ASA) and Crucible Cleaning Area (CCA).
- The Farm Ponds Area: a 75- acre parcel north of the Main Plant. Four 2.5-acre storage ponds at one time held the plant's wastewater treatment lime solids. The farm ponds, historically used to hold wastewater treatment lime solids, are located approximately 0.75-mile north of the main plant.
- The Solids Area: a 20-acre parcel west of the Fabrication Area. It contains the Lower River Solids Pond (LRSP), Schmidt Lake, Chlorinated Residue Pile (CRP), and the Magnesium Resource Recovery Pile (MRRP). This area received solids from Wah Chang's wastewater treatment system.
- The Soil Amendment Area: an approximately 40-acre parcel of property currently owned by the City of Millersburg, but part of the Site. In 1975 and 1976, Wah Chang applied lime solids from the LRSP in an ODEQ-permitted action as a soil enhancement to the Soil Amendment Area. In the early 1990s the property was exchanged with the City of Millersburg for a piece of property contiguous with Wah Chang's Farm Ponds Area.

Site features are linked to Wah Chang's manufacturing process and support or have supported zirconium and/or non-ferrous metal production. Wah Chang's zirconium manufacturing process involves a number of physical, chemical and electrochemical steps that concentrate zircon, hafnium, vanadium, niobium, titanium, and radioactive byproduct such as uranium and thorium. Current and historic waste management programs include process wastewater treatment, lime solid storage, solid waste management, hazardous waste management, and radioactive waste management.

BASIS FOR TAKING ACTION – SLUDGE PONDS OPERABLE UNIT (OU1)

The basis for EPA taking action was prompted by EPA's concerns that the unlined sludge ponds were located in the Willamette River floodplain and that hazardous materials from the Sludge Pond Operable Unit (OU1) would migrate to soil, surface water, and groundwater. This led to EPA formally placing Wah Chang on the National Priorities List (NPL) in October 1983. The Record of Decision (ROD) for OU1 was signed by EPA on December 28, 1989 (EPA 1989). Remedial actions have consisted of removal, solidification, and off-site disposal of sludge material with the intent to effectively reduce risk to human health and the environment, and to ensure that contaminants are not transported to groundwater, surface water and/or air. On June 30, 1993, EPA issued a Certification of Completion for the Sludge Ponds Operable Unit remedial action to Wah Chang.

GROUNDWATER AND SEDIMENT OPERABLE UNIT (OU2)

Remedial actions for OU2 identified in the ROD (EPA 1994) and subsequent ESDs consist of a groundwater extraction and treatment system (GETS) with enhanced in-site bioaugmentation (EISB) in the SEA, ASA and CCA; monitored natural attenuation (MNA): treatment or removal of subsurface source material near the Feed Makeup Building: slope erosion protection along the banks of Truax Creek: sediment removal: and Sitewide actions including institutional controls.

The findings of the Fourth Five-Year Review indicate that the groundwater remedy has been implemented and is currently being evaluated for its effectiveness. Data indicate that estimated excess lifetime carcinogenic and non-carcinogenic risk to human health in groundwater has been reduced in the Main Plant Area since the initiation of the GETS system. However, opportunities for optimizing GETS are being conducted and/or discussed between EPA and Wah Chang. Institutional controls are required to prevent on-site and off-site use of contaminated groundwater and to ensure that site use remains industrial. Institutional controls, required by EPA, still need to be verified.

The Fourth Five Year Review identified the following issues:

Groundwater

- Groundwater monitoring constituents have been reduced since the RI/FS. Contamination may have migrated over this period and monitoring points must be reassessed.
- During decommissioning of well SS in the Farm Ponds Area, Wah Chang discovered that Well SS was not properly constructed, and the contractor that installed well SS, Schoen Electric and Pump, also installed other wells at the Site (Section 6.8.2.2). Wah Chang must verify all wells installed by Schoen Electric and Pump under EPA oversight and if replacement wells are needed, Wah Chang must install replacement wells under EPA approval.
- EPA has determined that Wah Chang needs to provide additional information on the status of the Institutional Control instruments to verify that all institutional controls required by EPA's decision documents are in place (Section 7.2.1.4).

Extraction Area (Sections 6.8.1.2 and 7.2.1.1)

- From Wah Chang's annual progress summaries and an independent review of Wah Chang's data, EPA determined that although GETS has reduced the concentrations of radium and other COCs in groundwater, low pH conditions persist that are contributing to COCs above ROD cleanup levels. Therefore it is unlikely that ROD cleanup levels will be achieved in the 15-year time frame without using a different treatment technology (Section 6.8.1).

- Wah Chang implemented EISB as a pilot project under EPA oversight and VOCs were not detected in the SEA in 2011. Following EPA approval, Wah Chang shut down extraction wells in April 2011, although a source was never determined. The groundwater data needs to be assessed for potential reestablishment of a dissolved plume.

Fabrication Area (Sections 6.8.1.3 and 7.2.1.1)

- EISB has been implemented in the CCA and EPA is currently evaluating its effectiveness (Section 6.8.1).
- Wah Chang completed EISB in the ASA in 2009 and EPA is currently evaluating its effectiveness. However, Wah Chang's release of DNAPL and/or high chemical concentrations in the ASA is an additional source area not encountered during the RI/FS, and it is unlikely that ROD cleanup levels will be achieved in the 15-year time frame without additional remedial actions.

Farm Ponds Area (Sections 6.8.2.2 and 7.2.1.1)

- Based on Wah Chang's annual progress summaries and an independent review of Wah Chang's data, EPA noted VOCs significantly and unexpectedly decreased to below ROD cleanup levels and EPA was concerned about possible plume migration. In 2012, Wah Chang removed potential source material since the drop in concentrations was unexplained.

Surface Water (Sections 6.8.1.3 and 7.2.1.2)

- Wah Chang's laboratory method reporting limits for some VOCs (PCE and VC) in surface water samples exceed the AWQC.
- EPA noted from Wah Chang's annual progress summaries and an independent review of Wah Chang's data that VOCs have been detected in surface water at the Site sporadically in past years. However, EPA believes that since the 2008 FYR, elevated concentration of VOCs observed in PW-78A may indicate migration of contaminated groundwater to Murder Creek.

Sediment (Section 7.2.1.5)

- Additional information on PCB concentrations in sediment is needed from Wah Chang so EPA can determine if the RA for sediment is functioning as intended.

OU3 – SURFACE AND SUBSURFACE SOIL

Remedial actions for OU3 identified in the ROD (EPA 1995) combined source removal with institutional controls to reduce risk to human health and the environment posed by contamination in surface and subsurface soils at the Site.

The Fourth Five Year Review identified the following issues:

- The SOW and Consent Decree do not incorporate requirements of the 2001 Soil ESD regarding overall cleanup during decommissioning and other factors.
- The Mayor of Millersburg indicated that tilling for agricultural purposes was being conducted on the SAA. Although the RI/FS determined that agricultural practices did not pose a risk to human health or the environment, EPA is revisiting the issue since it has been

17 years since the soil radionuclide data were collected and the original evaluation did not assess risks to agricultural workers from soil resuspension due to tilling.

- There is uncertainty in the location of the CoGen Building with respect to the overall soil radiation footprint left behind after Wah Chang's remedial actions in the Sand Unloading Area. EPA Institutional Controls require that anyone constructing future buildings use radon-resistant construction methods if those buildings are located on top of radioactive contamination.

PROTECTIVENESS STATEMENTS

OU1 – SLUDGE PONDS

The remedy for OU1 is protective of human health and the environment, and exposure pathways that could result in unacceptable risks are being controlled.

OU2 – GROUNDWATER AND SEDIMENT

The remedy at OU2 is currently protective of human health and the environment in the short term. Progress to meet the groundwater RAOs is being made through an operating GETS enhanced with EISB. ICs are in place preventing exposure to contaminants of concern above cleanup goals through on-site and off-site deed restrictions on groundwater use, zoning, and access controls. In order for the remedy to be considered protective in the long term, Wah Chang must obtain and provide to EPA further information on pH conditions and COC concentrations, and verify that all IC instruments required by EPA's decision documents are in place. Long term protectiveness will be obtained when Wah Chang and EPA take the actions described below:

Wah Chang must implement buffer solution treatment under EPA oversight to the groundwater source area contamination in the FMA stemming from acidic pH conditions and resulting in concentrations of COCs that remain above ROD cleanup levels. Groundwater quality conditions in the FMA are unlikely to achieve RAOs within the estimated 15-year time frame specified in the ROD. EPA will evaluate the effectiveness of additional remedial actions in the FMA as data become available. EPA expects this action to be completed and data available to assess effectiveness in 2016.

Since Wah Chang's annual progress summaries and EPA's independent review of Wah Chang's data indicate that no VOCs have been detected in groundwater in the SEA, and that ROD cleanup levels have been met, EPA considers the SEA protective in the short term. EPA-required ICs are in place at the Site that prevents human use of groundwater, and the Site is still zoned for General Industrial use by the City of Millersburg. Long term protectiveness will require Wah Chang under EPA oversight to assess the mobilization of solvents from the source area after oxygen has stopped the reductive dechlorination of dissolved chlorinated solvents. This assessment will consist of long-term ground-water monitoring. EPA will reassess the effectiveness of EISB in the SEA based on Wah Chang's groundwater monitoring data that will be submitted annually through 2016.

EPA has determined that due to elevated concentrations of VOCs in the ASA and CCA, Wah Chang must continue to monitor geochemical conditions to evaluate the effectiveness of EISB and reductive dechlorination. In 2014, EPA will reassess the effectiveness of the EISB based on the groundwater data collected by Wah Chang and will make a decision whether the remedy will meet ROD cleanup levels in the 15-year time frame specified in the ROD or whether additional treatment will be required. However, Wah Chang's release of DNAPL and/or high concentrations of VOCs in the ASA is an additional source area not encountered during the RI/FS that will likely require more aggressive remediation. Wah Chang must assess the source of DNAPL in the ASA and provide data to EPA by 2014.

EPA has observed increased concentrations of VOCs in well PW-78A (close to Murder Creek). The current downstream surface water sampling is located 200 feet from the anticipated discharge point of groundwater in the vicinity of this well. Under EPA oversight, Wah Chang must collect additional seepage and surface water samples in the vicinity of well PW-78A so EPA can evaluate the potential for release of contaminated groundwater to the creek. EPA expects to evaluate additional data by 2013.

Since the 2008 FYR, Wah Chang's annual progress summaries and EPA's independent review of Wah Chang's data showed increasing CVOC concentrations in groundwater in the Farm Ponds Area indicating that ROD performance standards may not be met. However, EPA noted recent unexplained declines in concentrations. In 2012 Wah Chang completed excavation and removal of the berm material that may have acted as a source of groundwater contamination, and collected confirmation samples of groundwater. EPA will evaluate the results of the completion report in 2013 to assess whether additional actions will be are required.

Wah Chang must conduct additional sampling and analysis of PCBs in sediments to ensure that the remedy for sediments is protective. EPA expects to evaluate additional data in 2013.

Wah Chang must submit a report to EPA documenting whether any of the wells being used for CERCLA Site investigations were installed by Schoen Electric and Pump. If improperly constructed wells are being used, Wah Chang must prepare a work plan for EPA approval and replace these wells with wells that are compliant with well construction regulations.

Wah Chang must verify the status of deed restrictions requiring that land use at the Site remain industrial, and whether deed restrictions for groundwater use and land use are in place for the properties Wah Chang recently purchased east of Old Salem Road. Wah Chang must also provide EPA with their site maintenance plan documenting information on areas of subsurface PCB and radionuclide contamination.

OU3 – SURFACE AND SUBSURFACE SOIL

A protectiveness determination of the remedy at OU3 cannot be made at this time until further information is obtained associated with exposure to radionuclides from resuspension due to tilling in the Soil Amendment Area. Further information will be obtained by taking the following actions. Under EPA oversight, Wah Chang must collect samples of SAA soil and test for radiological contamination by the end of calendar year 2013 so EPA can reevaluate in 2014 the risk to human health and the environment from the disturbance/resuspension of soil in order to evaluate whether human health is protected under the existing remedy.

Excavation of contaminated soil was completed and ICs are in place in the form of deed restrictions for the main plant that will prevent human exposure to remaining soils. Additionally, for the remedy to be protective in the long term, EPA and Wah Chang need to take the following actions to ensure protectiveness.

Prior to plant decommissioning, EPA and ODEQ will amend the SOW of the 1996 Consent Decree to incorporate applicable requirements of the 2001 Soil ESD for plant decommissioning.

Under EPA oversight, Wah Chang must retest for radon in the CoGen Building by the end of calendar year 2013 due to uncertainty in the location of the CoGen Building with respect to the overall soil radiation footprint remaining after remediation of the Sand Unloading Area.

Based on the results, EPA may require additional testing of radon in indoor air or radon mitigation.

SITEWIDE PROTECTIVENESS

EPA has determined that there is not enough information to evaluate protectiveness, primarily in the area of the site that has agricultural activities (SAA). Therefore, protectiveness is deferred until the following additional information is evaluated. Wah Chang must collect and analyze soil samples for radium so EPA can reevaluate the risk to human health and the environment from the disturbance/resuspension of soil. Given that the earlier testing did not demonstrate human health risk, the City may continue to use the property for agricultural activities including tilling the soil although it is suggested by EPA that ground disturbing activities that may resuspend soil should be limited. Following EPA's reassessment of the contaminated soils, should there be an indication of human health risk to those exposed to these soils under current agricultural practices, EPA will share those results with the City of Millersburg and discuss appropriate actions for future use of the property.

Progress to meet the groundwater RAOs is being made through an operating GETS enhanced with EISB. ICs are in place preventing exposure to contaminants of concern above cleanup goals through on-site and off-site deed restrictions on groundwater use, zoning, and access controls. In order to ensure long term protectiveness, Wah Chang must provide further information on pH conditions and groundwater COC concentrations following remedy enhancements so that EPA can evaluate the ability of the OU2 remedy to meet RAOs within the 15-year time frame specified in the ROD (2017). In addition, Wah Chang must confirm that all IC instruments required by EPA's decision documents are in place for all parcels of property that could be affected by contaminated groundwater. Wah Chang must verify the status of deed restrictions requiring that land use at the Site remain industrial, and whether deed restrictions for groundwater use and land use are in place for the properties Wah Chang recently purchased east of Old Salem Road. Wah Chang must also provide EPA with their site maintenance plan documenting areas of subsurface PCB and radionuclide contamination.

EPA required Institutional Controls are in place requiring that anyone constructing future buildings on the Teledyne Wah Chang Main Plant must conduct an assessment to determine whether radon levels could pose an unacceptable risk to building occupants and implement radon resistant construction and controls and radon testing if required. Since the CoGen building was not constructed using radon resistant construction methods and is located in an area where residual radioactive contamination may exist, Wah Chang must resample indoor air radon in this building to ensure long term protectiveness of human health, and depending on the results, EPA may require additional sampling and radon mitigation.

1 INTRODUCTION

The U.S. Environmental Protection Agency (EPA) Region 10 prepared this Five-Year Review (FYR) for remedial actions (RAs) at the Teledyne Wah Chang (Wah Chang) Superfund Site (the Site) in Millersburg, Linn County, Oregon. This is a statutory review and is the fourth FYR for the Site, covering the period of January 2008 through December 2012. EPA, as lead agency for the Site, conducted this review in coordination with the Oregon Department of Environmental Quality (ODEQ).

EPA conducted this FYR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) in Title 40 Code of Federal Regulations (CFR) Subsection 121(c) (§121(c)), as amended by §300.430(f)(4)(ii) of the National Oil and Hazardous Substances Contingency Plan (NCP).

CERCLA §121 states:

"If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the Site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such site in accordance with section [104] or [106] of the NCP, the President shall take or require such action. The President shall report to Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews."

The EPA further interpreted this requirement in NCP §300.430(f)(4)(ii), which states:

"If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the Site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action."

For the purpose of conducting RAs at the Teledyne Wah Chang Superfund Site, EPA organized three Operable Units (OUs) as follows:

- Operable Unit 1 (OU1); Sludge Ponds (EPA 1989)

  The OU1 remedy includes removal, solidification, and off-site disposal of sludge in the Lower River Solids Pond (LRSP) and Schmidt Lake. Wah Chang constructed a special monocell at the Finley Buttes Landfill in Boardman, Oregon, for the radioactive sludge removed from the LRSP and Schmidt Lake.

- Operable Unit 2 (OU2); Groundwater and Sediment (EPA 1994)

The OU2 remedy includes groundwater extraction and treatment in the Main Plant Area for areas with contaminants exceeding $1x10^{-4}$ risk; monitored natural attenuation in the Main Plant for the remaining areas not exceeding $1x10^{-4}$ risk (but exceeding $1x10^{-6}$); monitored natural attenuation for the Farm Ponds and Solids Areas formerly used to store waste sludges; environmental investigations of uninvestigated areas to ensure that CERCLA remedial action decisions remain effective; contaminated sediment removal from Truax Creek and bank stabilization of material left behind; and institutional controls for those areas where existing contamination does not allow unrestricted use. For remedial actions in the Feed Make-up Area, the remedy includes removal of contaminants in the subsurface source material via flushing of the source material with water. EPA has further augmented the groundwater remedy with the application of Enhanced In-situ bioaugmentation in the Fabrication Area.

- Operable Unit 3 (OU3); Surface and Subsurface Soil (EPA 1995)

  The OU3 remedy includes excavation of contaminated soil from the Sand Unloading Area, excavation from the front parking lot areas, and the implementation of institutional controls. The contaminated media was transported to an off-site facility for disposal.

The EPA initiation of on-site construction activities for OU1 triggered action for the FYR process in August 1991. Five-year reviews are required due to the presence of contaminants remaining above levels that allow for unlimited land use and unrestricted exposure at the Site. EPA conducted this fourth FYR pursuant to the Office of Solid Waste and Emergency Response Directive 9355.7-03B-P. The EPA Site manager conducted the review with the assistance of ODEQ between January and December 2012.

The purpose of this fourth FYR is to evaluate the implementation and performance of the selected remedies in order to determine if the remedies are or will be protective of human health and the environment.

2 SITE CHRONOLOGY

The following table summarizes the chronology of events at the Site.

Table 2-1. Chronology of Site Events

Event	Date
Production of zirconium begins	1957
Melting and fabrication facilities added	1959
Teledyne Industries, Inc. purchased Wah Chang	1967
Chlorinator residues disposed of at Teledyne Wah Chang (TWC)	1972-1978
Application of lime solids to Soil Amendment Area	1976
Confirmation of radioactive materials in unlined sludge ponds (OSHD)	1977
NORM license granted to TWC	3/1978
Use of V-2 Pond discontinued	1979
Farm Ponds constructed	1979
TWC facility proposed for inclusion on National Priorities List (NPL)	1982
TWC listed on NPL	10/1983
Magnesium Resource Recovery Pile (MRRP) project	1983-1988
All underground storage tanks removed	1987
V-2 pond emptied	1989
Record of Decision (ROD) for Sludge Ponds Unit is signed	12/28/1989
Schmidt Lake soil removal	6/19-11/6/1991
Removal action for Lower River Solids Pond (LRSP) and Schmidt Lake	1991-1993
TWC completed RI/FS	3/1993
Supplemental radioactive material removal action for Schmidt Lake	8/1992-1/1993
Polychlorinated biphenyl (PCB) soil removal in the Building 114 area	11/1992
Remedial Investigation and Feasibility Study (RI/FS)	3/1993
EPA issued certification of completion for the Sludge Ponds Unit	6/1993
Ownership of Soil Amendment Area transferred to the City of Millersburg	1994
Groundwater and Sediments ROD signed	6/10/1994
Surface and Subsurface Soil ROD signed	9/27/1995
Remedial actions for the OU2 and OU3 RODs implemented in accordance with Scope of Work (SOW)	9/19/1996
Groundwater Explanation of Significant Differences (ESD)	10/8/1996
Consent Decree lodged with U.S. District Court and State of Oregon	1/31/1997
Sediment cleanup of Truax Creek complete	1997
Sand Unloading Area removal	10/1997
First Five-Year Review	1997
Access Agreement signed for Sapp property	9/18/1998
TWC becomes Allegheny Technologies Inc. (ATI) Wah Chang	1999
Front Parking Lot Certificate of Completion	8/1999
Operation of South Extraction Area Groundwater Extraction and Treatment System (GETS) begins	10/2000
Soil and Subsurface Soil ESD	9/28/2001
Operation of Fabrication Area GETS begins	4/2001-8/2001
Operation of Feed Makeup Area GETS begins	4/2002

Event	Date
Second Five-Year Review	2003
Land Transfer of Solids Area to City of Albany	2004
Soil Amendment ICs implemented	2006
Proposed Consent Decree for the Soil Amendment ICs lodged with U.S. District Court: 3/27/06.	3/27/2006
Three-Year Groundwater Remedy Evaluation Reports for the Fabrication, Extraction, Solids and Farm Ponds Areas submitted.	2/2007 -9/2007
Discovery of DNAPL during drilling of FW-8 in the Acid Sump Area	9/2007
Third Five-Year Review	1/2008
In Situ Bioremediation Pilot project begins in the South Extraction Area	3/2008
In Situ Bioremediation begins in the Acid Sump Area	2009
In Situ Bioremediation begins in the Crucible Cleaning Area	2010

3 BACKGROUND

The following section presents an overview of the Site's location, physical characteristics, land and resource use, contamination history, initial agency response, and the basis for taking action.

3.1 SITE LOCATION AND DESCRIPTION

Wah Chang is an operating zirconium and other non-ferrous metals manufacturing plant located in Millersburg, approximately two miles north of downtown Albany and approximately 20 miles due south of Salem, Oregon (Figure 3-1).[1] The Wah Chang Site is located within an area in Millersburg that is zoned for heavy industry. Approximately 85 percent of the property is occupied by 180 buildings situated on 110 acres of land that are paved, gravel-covered, or vegetated.

The three main areas of the Site include the Main Plant Area, the Solids Area, and the Farm Ponds and Soil Amendment Areas. The Farm Ponds, historically used to hold wastewater treatment lime solids, are located approximately 0.75 mile north of the Main Plant.

The Site is within the Willamette River Valley along the east bank of the river. Portions of the property are located within the Willamette River's 100- and 500-year flood plains. Riparian areas along the Site's western boundary are densely vegetated. In addition, the Site is bounded to the east by Old Salem Road and Interstate 5 (I-5).

3.1.1 Main Plant Area

The Main Plant portion of the Site consists of the Extraction Area and Fabrication Area where the manufacturing process is centered. Site features are linked to the manufacturing process and support or have supported zirconium or non-ferrous metal production. The zirconium manufacturing process involves a number of physical, chemical and electrochemical steps t concentrate zircon, hafnium, vanadium, niobium, titanium, and radioactive byproducts such as uranium and thorium. Site areas are presented on Figure 3-2 and described below.

3.1.1.1 Extraction Area

The Extraction Area is a 40-acre triangular-shaped portion of the Site located south of Truax Creek. Zircon sand concentrate raw material is processed into hafnium and zirconium. The Extraction area includes the Feed Makeup Area (FMA) and the South Extraction Area (SEA).

3.1.1.2 Fabrication Area

The Fabrication Area is a 50-acre area located north of Truax Creek. Zirconium is consolidated into ingots and then welded together and melted into ingots. The ingots are then fabricated into numerous shapes and forms such as forgings, plate, sheet, foil, tubing, rod, and wire. The Fabrication Area includes the Acid Sump, Ammonium Sulfate Storage, Material Recycle, Dump Master, and former Crucible Cleaning Areas.

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[1] The Teledyne Wah Chang Albany plant name was changed in 1997 after a merger with Allegheny Technologies, and the abbreviation is Wah Chang.

3.1.2 Solids Area

The Solids Area is a 20-acre area located west of the Fabrication Area. Subareas include the following: LRSP, Schmidt Lake, Chlorinated Residue Pile (CRP), and the Magnesium Resource Recovery Pile (MRRP). This area received solids from Wah Chang's wastewater treatment system.

3.1.3 Farm Ponds Area

The Farm Ponds Area is an approximately 115-acre parcel located 0.75 mile north of the Main Plant. This area includes the former four 2.5-acre storage ponds that received the plant's wastewater treatment lime solids. The Farm Ponds Area is adjacent to the Soil Amendment Area.

3.1.4 Soil Amendment Area

The Soil Amendment Area is a 40-acre parcel currently owned by the City of Millersburg that is located north of the Farm Ponds. This area received a one-time application of lime solids from the LRSP in an ODEQ-permitted action. In accordance with the terms of the 2006 CERCLA Consent Decree, the City of Millersburg is required to comply with EPA Institutional Controls for radon mitigation applicable to construction of future buildings on the property.

3.2 PHYSICAL CHARACTERISTICS

The following section describes the Site's physical characteristics, including topography, surface water drainage, geology, and the hydrogeologic strata underlying the Site.

3.2.1 Physical Setting and Topography

Wah Chang is located within the broad and relatively flat Willamette Valley, which lies between the Coast Range Mountains to the west and the Cascade Mountains to the east. The ground surface in the vicinity of the Site slopes westward toward the Willamette River, with a gradient of approximately 11 feet per mile.

Elevations at the Main Plant range from approximately 212 feet above mean sea level (msl) to 180 feet msl, with higher elevations found along the eastern portion of the Site. Elevations at the Farm Ponds range from approximately 212 feet msl to 232 feet msl. The Fabrication Area of the Main Plant is relatively flat from Old Salem Road to the Burlington Northern Railroad where elevation varies less than approximately four feet. To the north of the Fabrication Area, steeper slopes are present within the channel of Murder Creek. To the south, steeper slopes are present in the channel of Truax Creek. The Extraction Area is south of Truax Creek and the facility's wastewater treatment plant and ponds sit at a lower elevation (approximately 200 to 202 feet msl) than the remaining Extraction Area (210 to 212 feet msl). The Extraction Area to the south of the wastewater treatment plant is at a slightly higher elevation. Elevations in the Solids Area range from approximately 208 feet msl along the western portion near the Burlington Northern Railroad line to 180 feet msl at the Willamette River. The Solids Area exhibits more pronounced changes in topography across the Site compared to the Main Plant Area.

3.2.2 Site Geology and Hydrogeology

Geologic deposits underlying Wah Chang are similar to those found in much of the central Willamette Valley (Beaulieu J.D., et al. 1974; CH2M Hill 1993; Ma et al. 2009). The geologic units influence the groundwater flow characteristics of the water-bearing zones at the Site.

Site stratigraphy of these units, from youngest to oldest, is as follows (additional details can be obtained from the remedial investigation/feasibility study [RI/FS] report for the Site [CH2M Hill, 1993] and the 2008 FYR Report [EPA 2008]):

Fill: A brown, poorly sorted subangular gravel with sand and silt. The fill may contain wood and metal debris in some areas. Fill is primarily encountered in the Fabrication Area, with irregular thickness between 1 and 23 feet, and along the banks of Truax and Murder Creeks. The unit is a poor water-bearing unit with limited saturated thickness.

- Recent Alluvium: Alluvial material is derived from present day streams and rivers, their floodplains, and abandoned channels. The alluvium at the Site consists of silts and sands with some possible reworked Linn Gravel. In areas of Truax and Murder Creeks the alluvium has been observed to be up to approximately 15 feet thick. In the Solids Area, alluvium ranges from 10 to 25 feet thick. The unit is generally a poor water-bearing zone composed of an upper silt unit and a lower silty clay-clay unit under unconfined conditions. Groundwater within this unit locally discharges to Truax Creek and the Willamette River.
- Willamette Silt: The Willamette Silt is a Pleistocene deposit associated with catastrophic Missoula Floods (Waitt 1985). The unit consists of stiff, fine-grained silt, with varying amounts of clay, and a gray clay is present at the base of the deposit. Thickness ranges from 4 to 30 feet. The Willamette Silt is generally found at the ground surface of the Site.
- Linn Gravel: The Linn Gravel is a Pleistocene outwash deposit from the Cascade Mountains that consists of well-sorted sub-rounded gravel with occasional layers of sand, silt, and clay. Unit thickness variations from 10 feet to over 40 feet appear to be related to an erosional surface of the Spencer Formation. The Linn Gravel is the predominant water-bearing zone at the Site and is under confined or semi-confined conditions. Groundwater within this unit locally discharges to Murder and Truax Creeks, Second Lake and the Willamette River.
- Blue Clay: The Blue Clay is a lakebed or river overbank deposit that filled depressions in the surfaces of the Spencer and Eugene Formations. The unit consists of a blue-gray to brown, stiff, silty clay with fine sand lenses. The thickness of the Blue Clay is variable, ranging from not encountered to over 145 feet thick. The unit serves as a confining layer that is not laterally continuous throughout the Site.
- Spencer Formation: The Spencer Formation consists of shallow marine indurated siltstone to fine grain sandstone with some layers of volcanic tuff or flows and is the shallowest bedrock formation in the Albany area. The Spencer Formation is estimated to be approximately 1,500 feet thick. The unit is a poor water-bearing, indurated siltstone. Yields may be dependent on fractures and jointing within the unit.

3.2.3 Groundwater Flow

Groundwater flow on a regional scale is toward the Willamette River (CH2M Hill 2005). Vertical groundwater flow is upward in the vicinity of the Willamette River. Localized downward flow is associated with infiltration of precipitation and retention pond seepage (CH2M Hill 1993). EPA determined the groundwater flow direction at the Site from groundwater elevation measurements in wells located throughout the Site. Figure 3-3 shows inferred groundwater elevation contours based on Wah Chang's May 2010 water level measurements, and Figure 3-4 shows inferred groundwater elevation contours based on Wah Chang's October 2012 water level measurements. The groundwater elevations are a typical representation of the groundwater surface at the Site, and while the elevations may change seasonally with precipitation, the general character of the groundwater surface and groundwater flow directions remain relatively unchanged. Wah Chang collected groundwater elevations for the Solids Area and Farm Ponds Area only for the October 2010 monitoring event.

Wah Chang installed a pump-and-treat remediation system at the facility in 2001. The groundwater extraction and treatment system (GETS) consists of seven extraction wells (identified FW-1 though FW-7) at the Fabrication Area, and six extraction wells (identified EW-l through EW-6) at the Extraction Area. Based on groundwater level measurements from the Fabrication Area, EPA identified an apparent groundwater divide that extends across the northwest portion of the Fabrication Area (Figure 3-3 and Figure 3-4). North of the divide, groundwater flows to Murder Creek, while south of the divide groundwater flows to Truax Creek. In the southeastern portion of the Fabrication Area, seepage from a Cooling Water Pond forms a localized groundwater mound that creates an east-to-southeast groundwater flow direction from the pond area through the Dump Master area and discharges to Truax Creek. Recharge from the Cooling Water Pond creates a groundwater flow divide between extraction wells FW-1, FW-4 and FW-7 in the Arc-Melting subarea, and extraction wells FW-2, FW-3 and FW-5 in the Acid Sump and Ammonia Sulfate Storage subareas. Extraction wells appear to locally influence the direction of groundwater flow.

Groundwater flows west-southwest across the Extraction Area to Second Lake or north to Truax Creek (Figure 3-3 and Figure 3-4). In the northern portion of the Extraction Area, seepage from Ponds 1B and 2 creates localized groundwater flow to the north and south of the ponds. Surface water seepage from retention ponds is a source of groundwater recharge to the Linn Gravels. Groundwater elevation data do not provide evidence that extraction wells EW-1 through EW-3 provide localized hydraulic capture in the FMA.

Groundwater flow in the Solids Area is generally to the southwest towards Truax Creek and the Willamette River (Figure 3-4). In the vicinity of Weyerhaeuser's primary settling ponds, there is a localized groundwater mound.

Groundwater flow in the Farm Ponds Area is generally to the west-southwest towards Third Lake and the Willamette River (Figure 3-5).

3.2.4 Surface Water

Surface water features at the Site include the Willamette River, Conser Slough, Truax and Murder Creeks, and Second, Third and Fourth Lakes. Figure 3-1 displays surface water features in and adjacent to Wah Chang. Also included are Wah Chang's four Site retention ponds: Cooling Water Pond, Pond 1B, Pond 2, and Schmidt Lake (Wah Chang has excavated and lined Schmidt Lake and has designated it Pond 3; for the purpose of this report it will be termed Schmidt Lake). The Weyerhaeuser settlement ponds and the Lower River Solids Pond (LRSP) are not used for Site water retention. The Weyerhaeuser ponds receive water from the

Weyerhaeuser facility. Wah Chang is not using the LRSP and it does not receive Site water. Surface water is an important feature at the Site because of its influence on groundwater flow, contaminant transport, and remedial actions.

The Willamette River borders the Site's western property boundary. Second, Third, and Fourth Lakes are remnant features from the ancestral Willamette River. Surface water flows into the Willamette River from Conser Slough, which in turn receives water from Second, Third, and Fourth Lakes. Third Lake receives discharge from Murder and Truax Creeks.

The Murder Creek drainage forms a topographic and hydrologic boundary between Wah Chang and the City of Millersburg public and semi-public lands to the north. Discharge in the creek is generally low during most of the year. Upstream of Wah Chang, the creek receives recharge from forested and agricultural lands that originates from Knox Butte. Immediately upstream of Wah Chang, the creek passes by a wood product and resin plant, and other light industrial facilities.

The Truax Creek drainage forms a topographic and hydrologic boundary between the Extraction and Fabrication Areas, flowing through the central portion of the Main Plant Area. The creek originates southeast of the facility in a basin of approximately 9 square miles consisting of residential, agricultural, and forested lands. During winter months (November–May), creek flows have been measured from 0.5 to 15 cubic feet per second in the reach that passes through the Wah Chang Site upstream of the Pond 2 weir. During the summer months (June–October), there is no measurable flow in Truax Creek upstream of the Wah Chang NPDES outfall. Sapp Ditch flows beneath Old Salem Road and into Truax Creek. In addition to natural surface water run-off, Truax Creek receives approximately 3 million gallons per day (mgd) of permitted discharge water from Pond 2, and approximately 150 gallons per minute (gpm) of water from the Cooling Water Pond.

Wah Chang's Cooling Water Pond is approximately 1 acre in size and 5 feet deep and is located in the southeast corner of the Fabrication Area (CH2M Hill 2005). Wah Chang pumps surface water from the Willamette River, treats the water, and stores it in the pond for industrial process use.

Wah Chang operates two wastewater ponds, Pond 1B and Pond 2, under an NPDES permit. The ponds are located south of Truax Creek at the north end of the Extraction Area. Water from Pond 1B, which originates from the wastewater treatment plant clarifier, is gravity-fed to Pond 2, and from there is pumped to Schmidt Lake (now called Cell 3) and ultimately pumped to an engineered wetlands along with treated effluent from the City of Albany prior to discharge to the Willamette River. The ponds are maintained at a constant surface elevation. By agreement with the City of Albany, additional water is pumped from the Willamette River to maintain summer flows in Truax Creek.

3.3 LAND AND RESOURCE USE

Wah Chang, Weyerhaeuser, and Simpson Timber own the majority of land within the Millersburg city limits. Wah Chang's Main Plant and surrounding properties are used primarily for industrial purposes and zoned for General Industrial use, with some recreational and residential use. The former residential area between I-5 and Old Salem Road is zoned for Limited Industrial Commercial use, and residential use is anticipated to be phased out with the use of this area becoming more industrial.

A conservation easement in place west of the Site is intended to retain this property as natural and scenic open space. Based on an interview with the mayor of Millersburg, the EPA does not anticipate re-zoning of surrounding properties which would require approval by the Millersburg City Council and Planning Commission.

Current groundwater use at Wah Chang includes base flow recharge to Murder and Truax Creeks, Second Lake and the Willamette River. Two supply wells—one owned by Wah Chang, the other owned by Georgia Pacific—are used for fire suppression (CH2M Hill 2005).

Groundwater at the Wah Chang Site is a potential source of drinking water based on the EPA classification scheme (EPA 1986). However, the EPA does not anticipate that domestic water wells will be installed in the future on the Wah Chang Site or adjacent properties, given the industrial zoning and the availability of potable water from the City of Albany. The City of Albany requires that all new developments connect to municipal water lines if service is available within 150 feet.

The Wah Chang Site and adjacent properties are subject to a declaration of restrictive covenants that specifically prohibit the construction of water supply wells (Wah Chang 2012c). Therefore, future use of potable groundwater under the Wah Chang facility is not anticipated and would be a violation of the Consent Decree without EPA approval. It is not known whether restrictive covenants addressing groundwater use are in place for the properties Wah Chang acquired in 2008 east of Old Salem Road.

3.4 HISTORY OF CONTAMINATION

Wah Chang began operating at the Site in 1956 when, under contract with the U.S. Atomic Energy Commission, Wah Chang Corporation reopened the U.S. Bureau of Mines Zirconium Metal Sponge Pilot Plant. Wah Chang began construction of new facilities at the location of the existing plant in 1957. Wah Chang established these facilities primarily for the production of zirconium and hafnium sponge; however, tantalum and niobium pilot facilities were also included. Wah Chang's melting and fabrication operations were added in 1959. Historical releases of hazardous chemicals to the environment at the Site were associated with the manufacturing process of converting zircon sand into metal products.

3.4.1 Main Plant

This section presents general information on historical contamination in areas of the Main Plant. Additional details can be found in the RI (CH2M Hill 1993).

3.4.1.1 Extraction Area

The Extraction Area of the facility is composed of the FMA and the SEA. The Extraction Area contains the physical and chemical processes that isolate and extract target metals (zirconium and hafnium) from the zircon sand concentrate.

- **Feed Makeup Area:** Wah Chang reported during the RI that zirconium tetrachloride was dissolved in water, resulting in a solution of very low pH that contained various other metals. The solution was ultimately transferred to the Separations Building via underground pipes. Leaks from the pipes and tanks containing the feed solution affected soil and groundwater in the vicinity. Based on the results of the RI, the source of the extremely low pH at well PW-28A was postulated to be buried pre-1978 feed solution that was previously used in Wah Chang's ongoing processes. At the time of remedy implementation, the groundwater pH was approximately 1 and contained inorganic chemicals, most notably zirconium, thorium, and radium.
- **South Extraction Area:** Wah Chang detected chlorinated solvents in groundwater during the RI that may have been released from the maintenance shop area. Wah Chang discontinued use of the cleaning solvents trichloroethene (TCE) and 1,1,1 trichloroethane (TCA) in 1982 and 1988, respectively. Spills of the solvents have not been documented in the area. However, a soil gas survey completed during the RI indicated the presence of

TCE and TCA in soil gas beneath the asphalt pavement. Groundwater samples from RI/FS wells documented the existence of a solvent plume composed of TCE and TCA. Soils in the chemical unloading areas were found to be contaminated with semi-volatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), and radionuclides.

3.4.1.2 Fabrication Area

The Fabrication Area contained the manufacturing facilities that processed the finished products, mainly the metal sponge produced during the extraction process. Contamination generally resulted from historical use of chemicals in five subareas: the Acid Sump Area (ASA), the Arc-Melting Building Area, Emergency Services Building, Truax Fill Area, and the Ammonium Sulfate Storage Area.

- **Acid Sump Area:** Solvents, caustics and acids were used for cleaning metals in the manufacturing process. Releases from the ASA have occurred from historical leaks and spills into soils and groundwater. Groundwater in the ASA contained the highest concentrations of chlorinated VOCs during the RI. Important constituents in groundwater include 1,1-dichloroethene (DCE), TCA, TCE and vinyl chloride (VC).
- **Arc-Melting Building Area:** Incidental releases during solvent handling (TCE and TCA) have been the source of contamination in soils and groundwater under and in the vicinity of the Arc-Melting Building Area.
- **Emergency Services Building:** A release of PCBs was encountered near the building during the RI. PCB-containing oil was found floating on the water table in 1991. The source of the PCB contamination was not discovered.
- **Truax Creek Fill:** Fill material along Truax Creek’s northern bank placed between 1958 and 1978 was found to be contaminated with radionuclides, PAHs, PCBs, and metals.
- **Ammonium Sulfate Storage Area:** In 1978, a 400,000-gallon tank containing ammonium sulfate in the Ammonium Sulfate Storage Area failed. This process liquid also contained methyl isobutyl ketone (MIBK), chloride, sulfate, iron, uranium, thiocyanate, and zirconium. In 1991 a spill of pickling acid (hydrofluoric and nitric acid) was the primary source of fluoride and nitrate in the ASA.

3.4.2 Solids Area

The Solids Area received process waste material from facility operations. Waste material primarily contained lime solid precipitate from industrial wastewater, magnesium chloride from non-ferrous metal operations, and carbon from sand chlorination. The Solids Area includes the Solids Ponds (LRSP and Schmidt Lake), the CRP, and the MRRP.

Wah Chang filled the Solids Ponds (LRSP and Schmidt Lake) with lime solids that resulted as a byproduct from the manufacturing process of zirconium from 1967 to 1979. Seepage from the ponds occurred from the carrier fluids to the shallow groundwater in the Solids Area. RI activities conducted between 1989 and 1992 indicated the presence of chlorinated volatile organic compounds (VOCs), SVOCs, trace metals, radium, ammonium, nitrate, chloride, fluoride, and magnesium (CH2M Hill 2003).

Wah Chang placed solid material from the sand chlorination processes in the CRP located north of Schmidt Lake between 1972 and 1977. The material contained 80 to 90 percent carbon, a small amount of zircon sand, and low levels of radionuclide constituents, including uranium, thorium, and their daughter products. Wah Chang removed approximately 5,000 cubic yards of material from the Solids Area in 1978.

Wah Chang made process modifications 1978 that allowed for the separation of radioactive compounds from wastewater treatment solids. The process modification directs the radioactive materials into a separate solid waste stream, referred to as chlorinator residue. The chlorinator residue is managed as low specific activity radioactive waste and is transported to Hanford, Washington, for disposal. Implementation of this process modification allows the remaining solids, referred to as lime solids, to be placed in the Farm Ponds Area.

Wah Chang stored approximately 44,000 cubic yards of magnesium chloride solids at the northeast corner of the LRSP. Rainwater seepage through the material may have mobilized water-soluble salts (Cl, Na, SO_4, Mg). Wah Chang placed solids material produced in the facility's non-ferrous metals operation in the MRRP until May 1983 and removed the material under EPA oversight in 1988.

3.4.3 Farm Ponds

Wah Chang started piping lime solid slurry to the south end of the Farm Ponds for additional settling and dewatering in October 1979. Solids-free return water was decanted from the north end of the ponds and sent to the wastewater treatment plant. Removal and disposal of the solids was regulated under an NPDES permit.

In 1994 Wah Chang stopped using the Farm Ponds and closed that portion of the Site. Closure was conducted by draining and returning the free water to the wastewater treatment system, excavating and drying the lime solids on an asphalt pad, and transporting the dried solids to a Waste Management, Inc. Subtitle D disposal facility in Arlington, Oregon. Wah Chang then re-graded the pond area to restore the natural topography. The closure work was performed between 1995 and 2000. Currently, Wah Chang manages lime solids as solid waste.

Although the material Wah Chang used to construct and dike the ponds was of relatively low permeability, dissolved phase chemicals in the carrier fluid seeped into the underlying soil and groundwater. Wah Chang conducted the RI investigation, that indicated the presence of VOCs, SVOCs, trace metals, radium, ammonium, nitrate, chloride, fluoride, and magnesium in groundwater in the vicinity of the Farm Ponds.

3.5 INITIAL RESPONSE

EPA and ODEQ were concerned that because the unlined sludge ponds in the Solids Area were located in the Willamette River floodplain, hazardous materials from the sludge ponds would migrate to soil, surface water, and groundwater. This led EPA to formally place Wah Chang on the National Priorities List (NPL) in October 1983.

3.6 BASIS FOR TAKING ACTION

In response to releases or a substantial threat of a release of a hazardous substance at or from the Site, Wah Chang commenced an RI/FS for the Site in 1987 under Consent Order (Docket No. 1086-02-19-106).

The sludge ponds in the Solids Area were separated from the rest of the Site in 1988 shortly after the commencement of the RI due to the likely source of groundwater contamination, the area being located in the Willamette River floodplain, radioactive materials contained in the sludge, and Wah Chang wanting to clean up the ponds before the full RI/FS was completed. The EPA designated the Sludge Ponds as Operable Unit 1 (OU1) in a Record of Decision (ROD) on December 28, 1989 (EPA 1989). The Farm Ponds were originally included in OU1 but were addressed under an investigation already underway for the rest of the Wah Chang Site under oversight with ODEQ.

On February 14, 1991, EPA issued a Unilateral Order to Wah Chang for design and implementation of the selected remedy for the Sludge Ponds Operable Unit (OU1). In June 1991, in association with the response action, Wah Chang completed construction of the off-site monocell at the Finley Buttes Landfill in Boardman, Oregon. Excavation and removal of the sludges began in July 1991 and were completed in November 1991. Approximately 100,000 cubic yards of solids (including cement) were transported to the monocell at Finley Buttes. Cover construction and grass seeding of the monocell were completed in April 1992. On June 30, 1993, EPA issued a Certification of Completion to Wah Chang for the OU1 remedial action.

After publication of the RI/FS (CH2M Hill 1993) and proposed plan, EPA selected the remedy for groundwater, sediments, and soils. EPA's decisions on remedial actions at Wah Chang are embodied in two final ROD documents on which the State of Oregon gave its concurrence:

- The Groundwater and Sediments Operable Unit 2 (OU2), executed on June 10, 1994 (EPA 1994).
- The Surface and Subsurface Soils Operable Unit 3 (OU3), executed on September 27, 1995 (EPA 1995).

The RODs included EPA's explanation for any significant differences between the final plans and the proposed plans, as well as responsiveness summaries to public comments.

3.7 CONTAMINANTS OF CONCERN

EPA determined that contaminants of concern (COCs) at the Wah Chang Site were selected based on the following criteria: (1) the concentration of the chemical exceeded naturally occurring levels; (2) there were EPA-derived slope factors or reference doses available for the respective chemical; or (3) the maximum detected concentration exceeded a conservative health-based screening concentration. Chemicals in groundwater and soil were eliminated from consideration if the maximum detected concentration was less than or equal to 10^{-6} excess lifetime cancer risk (ELCR) value, or less than or equal to 1 hazard index (HI) for non-cancer effects.

3.7.2 OU1 – Sludges

The ROD for OU1 identified the following COCs in the LRSP and Schmidt Lake sludge:

- Bis(2-ethylhexyl)phthalate
- Methylene Chloride
- 1,1-Dichloroethane (1,1-DCA)
- Hexachlorobenzene
- Tetrachloroethene (PCE)
- Trichloroethene (TCE)
- 1,1,1-trichloroethane (TCA)
- N-nitrosodi-N-propylamine
- Antimony
- Arsenic
- Barium
- Beryllium
- Cadmium
- Chromium VI
- Copper
- Cyanide
- Lead
- Mercury
- Nickel
- Radium-226
- Selenium
- Thorium
- Uranium
- Zinc
- Zirconium (metal)

3.7.3 OU2 – Groundwater and Sediment

The ROD for OU2 identified the following COCs for groundwater and sediments.

3.7.3.1 Groundwater

EPA identified the following COCs in groundwater:

Acetone	Antimony
Benzene	Arsenic
Chloroform	Barium
1,1-Dichloroethane (1,1-DCA)	Beryllium
1,2-Dichloroethane (1,2-DCA)	Cadmium
1,1-Dichloroethene (1,1-DCE)	Copper
1,2-Dichloroethene (1,2-DCE)	Magnesium
Methyl isobutyl ketone (MIBK)	Manganese
1,1,2,2-Tetrachloroethane	Mercury
Tetrachloroethene (PCE)	Nickel
1,1,1-Trichloroethane (1,1,1-TCA)	Thallium
1,1,2-Trichloroethane (1,1,2-TCA)	Thorium
Trichloroethene (TCE)	Uranium
Vinyl Chloride (VC)	Zinc
Hexachlorobenzene	Zirconium
Bis(2-ethylhexyl)phthalate	Ammonia
Polychlorinated biphenyls (PCBs)	Fluoride
Radium-226	Nitrate
Radium-228	

3.7.3.2 Sediments

EPA identified the following COCs in sediments:

Total PCBs,

hexachlorobenzene, and

radionuclides.

3.7.4 OU3 – Surface and Subsurface Soils

The EPA identified the following COCs in surface and subsurface soils:

Benzo(a)anthracene
Benzo(a)pyrene
Benzo(b)fluoranthene
Benzo(k)fluoranthene
Chrysene
Dibenz(a,k)anthracene
Hexachlorobenzene
Indeno(1,2,3-cd)pyrene
Total PCBs
Chromium
Thorium
Zirconium
Radium-226
Radium-228

4 REMEDIAL ACTIONS

This section describes the remedial action objectives, selected remedy, and highlights of remedy implementation for each of the three Operable Units of the Teledyne Wah Chang Site. Those Operable Units are OU1 Sludge Ponds, OU2 Groundwater and Sediments, and OU3 Surface and Subsurface Soils.

4.1 OU1 – SLUDGE PONDS

On December 28, 1989, EPA selected the Final Remedial Action for the Sludge Ponds Operable Unit 1 (OU1), which is described in the ROD (EPA 1989). This section discusses the RAOs and remedy selection, and remedy implementation for OU1.

4.1.1 Remedy Selection

The RAOs for OU1 were to effectively reduce risk to human health and the environment and to ensure that contaminants were not transported to groundwater, surface water, and/or air.

The remedy selected in the ROD for OU1 consisted of:

- Excavation and removal of approximately 110,000 cubic yards of solids from the ponds.
- Partial solidification of the sludge using Portland cement.
- Construction of a monocell at Finley Buttes Landfill, an off-site, permitted solid waste facility.
- Transportation of the solidified sludge to Finley Buttes Landfill and disposal in the monocell.
- Long-term operation and maintenance (O&M) of the off-site monocell.

4.1.2 Remedy Implementation

On February 14, 1991, EPA issued a Unilateral Order to Wah Chang for design and implementation of the selected remedy for the Sludge Ponds. Based on this order, excavated sludge was transported to the monocell at Finley Buttes Landfill in Boardman, Oregon. On June 30, 1993, EPA issued a Certification of Completion for the Sludge Ponds OU1 RA to Wah Chang (EPA 1993).

4.2 OU2 – GROUNDWATER AND SEDIMENTS

On June 10, 1994, EPA selected the Final Remedial Action for Groundwater and Sediments Operable Unit 2 (OU2), which is described in the ROD (EPA 1994). This section discusses the RAOs and remedy selection, and remedy implementation for OU2.

4.2.1 Remedy Selection

4.2.1.1 Remedial Action Objectives

Based on the results of the Risk Assessment and the findings of the RI/FS, the following RAOs were established for groundwater, surface water, and sediment in OU2.

Groundwater:

- Prevent people from drinking groundwater containing contaminant levels above federal or state drinking water standards.

- Prevent contaminated groundwater above federal or state drinking water standards from leaving the TWC property boundary.
- Reduce the concentrations of TWC-related organic, inorganic, or radionuclide compounds in groundwater to concentrations below federal or state drinking water standards or other risk based levels.
- Prevent groundwater containing TWC-related organic, inorganic, or radionuclide compounds above federal or state standards from discharging into nearby surface water.

Surface Water:

- Ensure that non-permitted discharges to surface water from the TWC facility do not exceed federal or state water quality standards.

Sediments:

- Reduce the concentrations of TWC-related organic, inorganic, or radionuclide compounds in groundwater to concentrations below federal or state drinking water standards or other risk based levels.
- Prevent sediments containing TWC-related contaminants from leaving the Site.
- Prevent aquatic organisms from coming into contact with contaminated sediments.
- Reduce concentrations of TWC-related compounds in sediments where necessary, to protect aquatic organisms.

4.2.1.2 Remedial Actions Identified in the ROD

The selected RAs for OU2 identified in the ROD consisted of groundwater extraction, pretreatment of discharged extracted groundwater, monitored natural attenuation (MNA), treatment or removal of subsurface source material near the Feed Makeup Area, slope erosion protection along the banks of Truax Creek, sediment removal, and Sitewide actions. The major components of the selected remedy are described below.

Groundwater Remedial Actions

- Remediation by groundwater extraction where contaminant concentrations exceed lifetime cancer risk levels of 10-4 and/or substantially exceed the non-cancer HI of 1 for worker exposure (hot-spot areas). Extraction shall continue until contaminant concentrations in groundwater throughout the Site are reduced to below Safe Drinking Water Act (SDWA) maximum contaminant levels (MCLs), non-zero maximum contaminant level goals (MCLGs), or cancer risk levels of 10-6 and non-cancer risk HI less than 1 for worker exposure, or until EPA in consultation with ODEQ determines that continued groundwater extraction would not be expected to result in additional cost-effective reduction in contaminant concentrations at the Site.
- Contaminated groundwater in exceedance of SDWA MCLs, non-zero MCLGs, or cancer risk levels of 10-6 and non-cancer risk HI greater than 1 for residential use shall be prevented from migrating off the Plant Site or beyond the current boundary of the groundwater contaminant plume at the Farm Ponds Area.
- Discharge of extracted groundwater into Wah Chang's wastewater treatment plant. Pretreatment of groundwater to comply with Clean Water Act (CWA) requirements prior to discharge to the wastewater treatment plant.
- Treatment or removal of subsurface source material near the Feed Makeup Building on the Main Plant.

Sediment Remedial Actions

- Slope erosion protection consisting of a geotextile covered by riprap placed along the banks of Truax Creek to prevent contaminated fill material from entering the creek.
- Removal of 3,600 cubic yards of contaminated sediments from surface water bodies adjacent to or flowing through the Site. Additional ecological characterization prior to removal to determine potential impacts of sediment removal to local ecosystems and to provide a mechanism to mitigate those potential impacts.

Sitewide Actions

- Deed restrictions and institutional controls on land and groundwater use for both the Main Plant and the Farm Ponds Area. The objective of this component of the remedy is to ensure that the property and groundwater are used for purposes appropriate to the cleanup levels achieved.
- Environmental evaluations of currently uncharacterized potentially contaminated source areas as needed to ensure achievement of groundwater remedial action objectives (RAOs). The objective of this component of the remedy is to ensure that contaminated source areas do not adversely impact the remedy.
- Long-term on- and off-site groundwater, surface water, and sediment monitoring, which shall include, at a minimum, the monitoring of on-site wells that are in exceedance of MCLs and non-zero MCLGs, cancer risk levels of 10-6, and non-cancer risk of HI greater than 1 for residential exposure.
- Review of selected remedy at least once every 5 years to ensure protection of human health and the environment.

4.2.1.3 ROD Amendments or Explanation of Significant Differences

During the preparation of the Scope of Work for implementation of the groundwater remedy, the following changes were made to the selected RA and outlined in EPA issued ESDs on October 8, 1996 (EPA 1996) and June 19, 2009 (EPA 2009).

Change 1 – Conditional Change to the Western and Northern Perimeter Containment Requirements: EPA dropped the requirement for groundwater extraction at and outside the plant boundaries on the northern and western perimeters. Dropping the perimeter requirements was contingent on certain conditions described in the ESD (EPA 1996) including placing deed restrictions on adjacent property on the western perimeter to preclude groundwater use for drinking water. The EPA considered that contaminants in groundwater would be reduced to below ROD cleanup levels at and outside compliance points, and the public would be protected through restrictions on groundwater use.

Change 2 – Clarification in Requirements for the Farm Ponds Area: The EPA made the remediation requirements for the Farm Ponds Area consistent with the rest of the Site. Within the Farm Ponds Area, remediation will take place through removal of hot spots of contaminated soil; however, the plume in the Farm Ponds must be kept from significantly expanding. Wah Chang's compliance with this requirement will be demonstrated by existing groundwater data; and by data collected pursuant to the RA indicating that contaminant levels (and total excess cancer risk and/or HI) in wells in the Farm Ponds Area are not increasing, or are declining; and/or other Site data or information indicating that natural attenuation is effectively reducing contaminant levels. For consistency with the rest of the Site, EPA changed the point of compliance to the property boundaries in the Farm Ponds Area through this ESD.

Change 3 – Correction in Sediment Area Exceeding the Action Level: EPA reviewed the RI/FS sediment data and identified that not all areas in the ROD exceeded action levels (1 ppm). Areas not exceeding the 1 ppm total PCBs action level will not be remediated. These include Conser Slough and Murder Creek. The areas that exceed sediment action levels, including the confluence of Murder and Truax Creeks, the confluence of Truax Creek and Second Lake overflow, and the reach of Truax Creek that passes along Truax Fill, were planned to be remediated.

Change 4 – Implementation of the Enhanced In Situ Bioaugmentation: Wah Chang installed GETS at the facility in 2001 that consists of seven extraction wells at the Fabrication Area, and six extraction wells at the Extraction Area. One well (FW-6) planned for the ASA was not implemented because the pump test revealed a sustainable yield of less than 0.1 gpm. Before the 2008 Five Year Review, EPA was concerned that RAOs may not be met within the ASA and required that an additional extraction well (FW-8) be installed. However, during drilling Wah Chang encountered a sheen/solvent odor and testing indicated TCA was detected at a concentration of 1,420 milligrams per liter (mg/L). The concentration of TCA was indicative of dense non-aqueous phase liquid (DNAPL). EPA determined that GETS alone would not achieve ROD performance standards. Therefore in addition to GETS, EPA selected a secondary treatment technology consisting of Enhanced In Situ Bioaugmentation (EISB) that was necessary to meet RAOs (EPA 2009).

4.2.2 Remedy Implementation

Implementation of the RAs for OU2 is described in the following sections.

4.2.2.1 Groundwater Extraction

Wah Chang implemented a GETS in the Extraction and Fabrication Areas as an element of the remedy to achieve groundwater RAOs and cleanup levels.

Extraction Area

The GETS in the Extraction Area consists of two groups of three extraction wells: EW-1, EW-2, and EW-3 in the FMA; and EW-4, EW-5, and EW-6 in the SEA (Figure 3-2). Startup of GETS operation in the SEA was completed in October 2000. Startup of GETS operation in the FMA was completed in April 2002.

Fabrication Area

The Fabrication Area well field consists of six extraction wells identified as FW-1, FW-2, FW-3, FW-4, FW-5, and FW-7 (Figure 3-2). Startup of the GETS operation was completed between April and August 2001. The Remedial Design of the Fabrication Area well field originally called for seven extraction wells. FW-6 was not implemented because of a low sustainable yield of less than 0.1 gpm. Operation at FW-7 was terminated in July 2009 per EPA approval due to low CVOC concentrations and the Wah Chang’s 2008 purchase of the residential property on the east side of Old Salem Road (Wah Chang 2009). Well FW-7 was installed in 2001 as a hydraulic barrier between the Wah Chang Site and the residential property.

4.2.2.2 Attainment of Groundwater Cleanup Levels

The purpose of groundwater extraction is to expedite the attainment of Sitewide groundwater ROD cleanup levels. Wah Chang will continue groundwater extraction until cleanup levels are achieved at the point of compliance. EPA established the point of compliance at the Main Plant property boundary and for the Farm Ponds Area, the edge of the Farm Ponds themselves. ROD cleanup levels for groundwater are presented in Table 4-1.

Table 4-1. COCs in Groundwater Cleanup Levels from Table 10-1 of the ROD

COCs[2]	Chemical Classification	Cleanup Level(µg/L)	Basis
Benzene	VOC	5	MCL
1,2-Dichloroethane (DCA)	VOC	5	MCL
1,1-Dichloroethene (DCE)	VOC	7	MCL
Methylisobutylketone (MIBK)	VOC	5,000	HI=1
1,1,2,2-Tetrachloroethane	VOC	0.175	10-6
Tetrachloroethene (PCE)	VOC	5	MCL
1,1,1-Trichloroethane (TCA)	VOC	200	MCL
1,1,2-Trichloroethane (1,1,2-TCA)	VOC	3	Non-zero MCLG
Trichloroethene (TCE)	VOC	5	MCL
Vinyl Chloride (VC)	VOC	2	MCL
Hexachlorobenzene	SVOC	1	MCL
Bis(2ethylhexyl)phthalate	SVOC	0.2	MCL
Total PCBs	SVOC	0.5	MCL
Beryllium	Metal	4	MCL
Copper	Metal	1,000	SMCL
Manganese	Metal	50	SMCL
Uranium	Metal	30	MCL
Radium-226	Radionuclide	5	MCL
Radium-228	Radionuclide	5	MCL
Ammonium	Inorganic	250,000	OAR 333-61-030
Fluoride	Inorganic	2,000	OAR 333-61-030
Nitrate	Inorganic	10,000	MCL

Notes:
COCs = Contaminants of Concern
MCL = Maximum Contaminant Limit
MCLG = Maximum Contaminant Limit Goal
HI = Hazard Index
OAR = Oregon Administrative Rule
SMCL = Secondary Maximum Contaminant Limit

The projected time frame for extraction is an estimated 15-year period beginning with the implementation of GETS in 2002. Under this performance standard, cleanup levels at the Site should be obtained in approximately 2017. To achieve this time frame, Wah Chang has completed several EPA approved modifications to GETS to enhance groundwater extraction and treatment. These include periodic well inspections, well rehabilitation to enhance efficiency and minimize downtime during pump failures, and keeping replacement pumps, flow meters, and other parts at the facility to expedite repairs. The GETS has also been augmented by EISB.

4.2.2.3 Groundwater Extraction System Monitoring

Wah Chang conducts GETS monitoring through periodic sampling and analysis of groundwater samples from extraction wells, selected monitoring wells, and treatment system influent and effluent to confirm that the system performance objectives are being achieved.

Wah Chang evaluates extraction well performance in bimonthly and annual progress reports, and fulfills requirements pursuant of Section 10 of Wah Chang's Consent Decree. Extracted groundwater is discharged to the facility's wastewater treatment plant. Treated wastewater discharges to the City of Albany's wetland treatment program.

4.2.2.4 Solids Area Groundwater Monitoring

Wah Chang stored lime solids in the LRSP and Schmidt Lake which leached dissolved organic and inorganic constituents into groundwater. Following the RA, Wah Chang implemented a groundwater monitoring program in 2000 to confirm the effectiveness of the sludge removal and to determine if groundwater quality cleanup levels could be achieved within the 15-year time frame specified in the Groundwater and Sediments ROD.

Wah Chang performed semiannual groundwater monitoring between March 2000 and September 2002. Beginning in fall 2003, sampling frequency was reduced to annual sampling for 2 years, and then after 2005, to biannual sampling. In general, the monitoring results showed that VOCs, trace metals, and radionuclides were below ROD cleanup standards in 2002.

4.2.2.5 Farm Ponds Groundwater Monitoring

The Farm Ponds Area formerly consisted of four 2.5-acre settling ponds. Wah Chang discharged approximately 2.5 million gallons per day of wastewater, containing 2 to 5 percent lime solids, between 1979 and 1993 from the facility's central wastewater treatment system. The solids were retained in the ponds and the water pumped back to the central wastewater treatment system. Wah Chang discontinued use of the Farm Ponds in 1993 when they were replaced by an advanced solids handling system located in the Main Plant.

Dissolved-phase chemicals present in the wastewater eventually seeped into the underlying groundwater. EPA evaluated groundwater data collected from the Farm Ponds area monitoring wells and determined that PCE, TCE, and VC were the primary VOCs in the groundwater at concentrations above the cleanup standards specified in the ROD. EPA believed the source of VOCs to be the former ponds' soil bentonite liner which Wah Chang eventually removed and disposed of at a solid waste landfill in 1999. Wah Chang leveled the pond dikes and regraded the area in 2001. Wah Chang conducts annual groundwater monitoring at selected Farm Ponds Area monitoring wells.

4.2.2.6 Long-Term Main Plant Groundwater and Surface Water Monitoring

Wah Chang conducts long-term monitoring consisting of sampling and analyzing groundwater from the Extraction Area, Fabrication Area, Solids Area, and Farm Ponds Area; and surface water from Truax and Murder Creeks. Procedures for groundwater and surface water monitoring are presented in the Field Sampling Plan (CH2M Hill 1997). Long-term monitoring was implemented as part of the RI and typically occurs in the spring and fall of each year. Monitoring must continue for a period of 5 years after cleanup levels are achieved.

4.2.2.7 Sediment Removal and Stabilization

In 1997, Wah Chang implemented sediment RAs that included removal of contaminated sediments in Truax Creek, and applying geotextile to the creek bank to stabilize remaining contaminated soil. Wah Chang removed approximately 3,600 cubic yards of contaminated sediments from the surface water areas adjacent to or flowing through the Site. In 2007 Wah Chang completed confirmation sediment sampling and testing to ensure that the sediment remediation and bank stabilization was effective. Analytical results did not indicate any PCB detections in Truax Creek sediment (CH2M Hill 2007a).

4.2.2.8 Environmental Evaluations of Uninvestigated Areas

Wah Chang conducts environmental evaluations of previously uninvestigated to ensure that remaining soil contamination is not affecting the groundwater remedy and that RAOs for groundwater are being achieved. Environmental evaluations of previously uninvestigated areas occur whenever Wah Chang discontinues the use of, paves, or otherwise disturbs any pond, plant area, or building on the Site (EPA 1994). Evaluations consist of analyses of surface soil samples for chemical or radiological contamination. If analytical results or other factors indicate potential elevated levels of contamination, additional soil and groundwater sampling would be required for uncharacterized portions of the Site. Environmental evaluation results are reported every 2 years until cleanup levels are achieved.

4.2.2.9 PCB Soil Removal in Fabrication Area to Protect Groundwater

Wah Chang encountered a floating non-aqueous oil layer containing 8 percent PCBs in December 1991 during the installation of a soil boring adjacent to the Emergency Services Building in the Fabrication Area of the Main Plant. Groundwater in the vicinity of this boring contained up to 22,500 ppb PCBs. The highest detected concentrations in soil consisted of 440,000 ppb at 12.5 feet bgs, located due east of the Emergency Services Building.

Wah Chang conducted remedial activities for the PCB-contaminated soil with EPA oversight on November 16–19, 1992 (CH2M Hill 2006). Remedial activities included the removal of approximately 200 cubic yards of contaminated soil. Soil was screened for disposal options using field test procedures. Of the 200 cubic yards of soil excavated, approximately 170 cubic yards were disposed of at Waste Management's Arlington Landfill, and 30 cubic yards were placed in the former V2 pond (CH2M Hill 2006). In November 1992 the excavation was backfilled with approximately 280 tons of crushed rock and then covered with asphalt.

4.3 OU3 – SURFACE AND SUBSURFACE SOILS

On September 27, 1995, EPA selected the Final Remedial Action for the Surface and Subsurface Soils Operable Unit 3 (OU3), which is described in the ROD (EPA 1995). This section discusses RAOs and remedy selection, and implementation of RAs for OU3.

4.3.1 Remedy Selection

4.3.1.1 Remedial Action Objectives

Original Site RAOs for soil in OU3 are as follows:

- Reduce the exposure to radon that would occur in future buildings constructed on the Main Plant and the Soil Amendment Area. Reduce surface gamma radiation exposure to acceptable levels (based on current risk assumptions, this level is 20 μrem/hour above background.)

- Ensure that areas, where surface and subsurface chemical risks are acceptable based on industrial or agricultural use, are not used for other purposes, and that proper handling and disposal of soil occurs when it is disturbed.
- Provide easily accessible information on the locations of the material for TWCA plant workers, future Site purchasers, or regulatory agencies, where there are areas with subsurface contamination. This includes the PCB contamination in the Fabrication Area, and the residual radionuclide contamination in the Fabrication Area and Extraction Area.

4.3.1.2 Remedial Actions Identified in the ROD

The EPA-selected remedy combined source removal with institutional controls to reduce risk to human health and the environment posed by contamination in surface and subsurface soils at the Site.

- Excavation of contaminated material exceeding the gamma radiation action level of 20 micro-roentgen (µrem/hour) above background levels. Transportation of the excavated material to an appropriate off-site facility for disposal.
- For areas of the Site where modeling indicates that radon concentrations in future buildings could exceed 4 pCi/liter, institutional controls requiring that future buildings be constructed using radon resistant construction methods.
- Requirement that information on areas of subsurface PCB and radionuclide contamination which do not pose a risk if they are not disturbed, be incorporated into the Wah Chang facilities maintenance plan and be made available to future Site purchasers or regulatory agencies.
- Because the determination that action is not required for certain areas of the Site is based on scenarios which do not allow unrestricted use, should excavation occur as part of future development of the Main Plant or the Soil Amendment Area, excavated material must be properly handled and disposed of in accordance with federal and state laws.
- Institutional controls requiring that land use remain consistent with current industrial zoning.

4.3.1.3 ROD Amendments or Explanation of Significant Differences

Following soil cleanup, EPA amended the soil remedy with a September 28, 2001, ESD (EPA 2001b), which includes:

- **Change 1:** Wah Chang will conduct Final Site closure for radionuclides pursuant to Wah Chang's Oregon Radioactive Materials License (Broad Scope Naturally Occurring Radioactive Material License) and the Energy Facility Siting Council (EFSC) Administrative Rules, Chapter 345, Division 50.

- **Change 2:** Wah Chang will control on-site surface gamma emissions through in-place management of contamination. Prior to Site decommissioning under Oregon Health Department (OHD) and EFSC, Wah Chang must keep surface gamma emissions below cleanup levels through in-place management under an EPA- and ODEQ-approved management plan, and additional excavation of contamination as part of on-going excavation occurring during on-site construction.
- **Change 3:** If the Site is not decommissioned under OHD and EFSC to EPA's cleanup requirements, radiation management shall be a condition of property transfer to ensure that these controls remain protective. Any partial or complete property transfer by Wah Chang shall be conditioned on implementation and maintenance of an appropriate EPA- and ODEQ-approved radiation management program.
- **Change 4:** Excavation and either engineered berms or off-site disposal are acceptable remedies for the Soil Amendment Area if institutional controls cannot be implemented.

4.3.2 Remedy Implementation

The selected remedy was implemented through the following RAs.

4.3.2.1 Schmidt Lake

EPA requested that Wah Chang conduct an electromagnetic survey of the Schmidt Lake area to identify possible buried drums. The survey discovered several corroded metal drums containing sands with elevated amounts of thorium and uranium, and an underground storage tank containing liquid petroleum product.

Wah Chang conducted the Schmidt Lake Excavation Project in December 1992 to remove 2,016 cubic yards of materials containing zircon sands with elevated levels of thorium and uranium from Schmidt Lake. Wah Chang transported the materials to the US Ecology low-level radioactive waste site in Washington for disposal.

Wah Chang excavated between 12 and 15 cubic yards of soil from Schmidt Lake in August 1998. Wah Chang excavated all areas exceeding the Site action level of 20 μrem/hour above background levels and transported the excavated material off-site for disposal at a permitted low-level radioactive waste facility. The area was left as it was pending potential re-use of the area. During the Site Inspection EPA observed that the area has returned to a functioning wetland habitat adjacent to the Willamette River.

4.3.2.2 Sand Unloading Area

The RI/FS identified an area where surface gamma radiation levels exceeded the cleanup standard of 20 μrem/hour above background. Excavation of the area was conducted in 1997, but was stopped when the northwestern edge of the material appeared to extend beneath a concrete slab in front of the mobile maintenance shop, and under the shop itself, and when the northernmost end of excavation would have interfered with on-site traffic with no evidence that the limit of contamination had been reached. Wah Chang encountered gamma-emitting material within 2 feet of the surface in the excavated areas. Wah Chang completed a confirmation surface gamma survey that showed levels were below the cleanup standard of 20 μrem/hour above background. The amount Wah Chang excavated was 1,890 cubic yards, twice the ROD estimate. Wah Chang disposed the material at a permitted low-level radioactive waste facility. Most of the Sand Unloading Area is now overlain by Wah Chang's Co-Generation (CoGen) Plant constructed in 2001, a natural gas–powered electricity-generating plant. The plant is built on a 14-inch-thick concrete slab, which acts as an effective gamma-blocking barrier.

4.3.2.3 Front Parking Lot Area

Wah Chang removed low-level, radioactive rutile sand from the Front Parking Lot Area. Samples of the sand indicated that radium-226 levels could cause radon concentrations in future buildings to exceed the action level of 4 pCi/L thus requiring future buildings to be constructed with radon-resistant construction methods.

4.3.2.4 Soil Amendment Area

Wah Chang obtained ODEQ solid waste permits in 1975 and 1976 for one-time applications of solids from the primary wastewater treatment plant. These were experimental soil amendments on the 40-acre Soil Amendment Area. The solids contained low levels of metals, radionuclides, and organic compounds. Radium-226 and radium-228 concentrations in surface soil averaged approximately 2.5 and 1.8 pCi/g, respectively. The RI/FS subsequently indicated that the radionuclide contamination in the Soil Amendment Area could result in an unacceptable risk from radon inhalation in any future buildings constructed on this area, and that organic compounds are above levels that would allow unrestricted use of the property. Between March 1989 and 1990, the Soil Amendment Area was transferred to the City of Millersburg through a deed agreement between the Teledyne Wah Chang Company and the City. The City acquired the 40-acre Soil Amendment Area, and Teledyne Wah Chang acquired property contiguous to its Farm Ponds Area. Presently, institutional controls for the Soil Amendment Area Operable Unit are enforced under a Consent Decree between the USA, State of Oregon, and the City of Millersburg (USA and Oregon 2006).

4.4 SITEWIDE ACTIONS

The following section summarizes the institutional controls and enforcement controls on the Site that serve to reduce the risk for exposure to Site contaminants and minimize additional releases.

4.4.1 Institutional Controls

The following institutional controls (ICs) are required at the Wah Chang Site:

4.4.1.1 Government Controls

- The City of Millersburg zoning restrictions to maintain industrial land use at the Site and adjacent properties (USA and State of Oregon 2006).
- The City of Millersburg Land Use Development Code Section 7.500 Radon Impacted Area Standards identifies the Soil Amendment Area as a Radon Impacted Area, prohibits residential development in that area, and requires radon resistant construction methods and testing.
- The City of Albany has Development Code Restrictions (Public Improvements 12.410) that require that all new development, including a single-family residence, must extend and connect to the public water system when service is available within 150 feet. This restriction prevents the use of groundwater for potable purposes. Note that the development code does allow new single-family homes to use wells for water supply, when service is not available, if approved by the City.

4.4.1.2 Proprietary Controls

- The EPA required deed restrictions or restrictive covenants that require Wah Chang and adjacent properties to restrict groundwater use as a drinking water supply. This includes land owned by Linn County in the vicinity of Old Salem Road, and on the Burlington

Northern Railroad right-of-way (Wah Chang 2001; Oremet-Wah Chang 1999a; Oremet-Wah Chang 1999b; Oremet Wah Chang 1999c; Stoel Rives 1999).

- Wah Chang has controls on the Main Plant and Farm Ponds Area to restrict access through the use of fencing, signage (postings), and daily security patrols and manned guard stations. The Farm Ponds Area has a fence only (Wah Chang 1997).
- Wah Chang donated 12 acres of the Solids Area in November 2004, which excluded the LRSP and Schmidt Lake, to the City of Albany. A fence was installed as part of an institutional control to prevent access to the Wah Chang Site. The conservation easement attached to the donation precludes future development of the donated parcel and requires that it be maintained as part of the Willamette Greenway.
- The EPA required a conservation easement to prevent land development, and to conserve and protect property and natural resources in the Solids Area.

4.4.1.3 Enforcement Controls

- The EPA required ICs on the Main Plant and Farm Ponds Area in the form of deed restrictions and access restrictions, which will be implemented as long as Wah Chang remains an active facility and/or until cleanup levels are achieved, as stipulated in the ROD for OU2 (EPA 1994).
- The EPA has provisions regarding transfer of property ownership (notice of obligations to successor in title) as stipulated in Consent Decree (USA and State of Oregon 1997).
- The EPA required ICs and deed restrictions on land and groundwater use for the Main Plant and Farm Ponds Area to ensure that the property and groundwater use are appropriate to cleanup levels achieved, as stipulated in the Consent Decree (USA and State of Oregon 1997; Wah Chang 1997).
- Wah Chang will provide access to the Site at all reasonable times to EPA and its Contractors, as stipulated in the Consent Decree (USA and State of Oregon 1997).
- Controls to ensure long-term protectiveness from materials contaminated with radionuclides are to be incorporated by Wah Chang in the Broad Scope Radioactive Materials License (#ORE-90001) for the facility. License conditions require that operations be conducted in accordance with the State of Oregon "Standards for Protection Against Radiation – OAR Division 333 Section 120 and Division 111" for the operating facility. Decommissioning requirements under this license establish protectiveness controls for any radioactive materials remaining in areas by requiring decontamination to release the Site for unrestricted use upon permanently discontinuing manufacturing activities.
- Environmental evaluations of currently uncharacterized potential contaminant source areas, as needed to ensure achievement of RAOs.
- Long-term maintenance in areas known or suspected to contain gamma-emitting materials (GEM) of pavement, capped material or structures, as stipulated in the ESD for OU3 (EPA 2001b).
- Long-term on-site and off-site groundwater, surface water, and sediment monitoring which shall include, at a minimum, monitoring on-site wells which exceed MCLs and non-zero MCLGs, cancer risk levels of 10^{-6}, and non-cancer risk HI greater than 1 for residential exposure (EPA 1994).
- Areas of the Site where modeling indicates that radon concentrations in buildings exceed 4 pCi/L require that buildings be constructed using radon-resistant construction methods,

as stipulated in the ESD for OU3 (EPA 2001b). Wah Chang has developed a Plant Standard regarding radon control actions for future building sites located on the Plant Site (Wah Chang 1997).

ICs for the Soil Amendment Area have been completed and are enforceable under the Consent Decree (USA and State of Oregon 2006). These ICs require that the City of Millersburg ensure that no buildings are erected in this area without testing indoor air for Radon and if sampling results indicate Radon at levels are above EPAs regulatory criteria then proper radon mitigation systems or remediation of the soil will be necessary.

4.4.1.4 Informational Devices

- Wah Chang has provided information to occupational workers regarding risks from contamination.
- Wah Chang has incorporated information on PCBs and radionuclide contamination, which do not pose a risk if they are not disturbed, into its maintenance plan and will make this information available to future Site owners or regulatory agencies.

5 PROGRESS SINCE THE LAST FIVE-YEAR REVIEW

This section cites the progress made since the last (third) FYR for the Wah Chang NPL Site, signed in January 2008. This section includes protectiveness statements for the three OUs (OU1 through OU3) cited in the 2008 FYR, and discusses the status of recommendations and follow-up actions cited in the 2008 FYR.

5.1 OU1 – SLUDGE PONDS

Protectiveness Statement from the Last Review

The EPA determined that the remedy for OU1 is protective of human health and the environment, and exposure pathways that could result in unacceptable risks are being controlled.

Status of Recommendations and Follow-up Actions Since the Last Review

No recommendations were made in the 2008 FYR.

Status of Any Other Prior Issues

The EPA did not identify other issues in the 2008 FYR.

5.2 OU2 – GROUNDWATER AND SEDIMENTS

Protectiveness Statement from the Last Review

In the Third Five Year Review, the EPA determined that progress to meet the groundwater RAOs was being made through GETS and institutional controls (ICs) were in place to restrict on-site and off-site beneficial use of groundwater. However, a protectiveness determination for the remedy at OU2 could not be made until further information was obtained.

At the time of the 2008 FYR, EPA anticipated that these actions would be completed in the end of fiscal year 2010 upon which a determination of protectiveness of OU2 could be made through an addendum to the 2008 FYR. However Wah Chang generated the necessary data that would have demonstrated progress with the remedy after 2010. In 2012, after review of these data, EPA signed an Addendum to the 2008 FYR (EPA 2012a) that continued to defer protectiveness for the Groundwater and Sediments OU2.

Status of Recommendations and Follow-Up Actions Since the Last Review

Table 5-1 provides a summary of issues and recommendations identified in the 2008 FYR Report (EPA 2008). The table includes updates on actions taken and outcomes. A description of each action taken and outcome, if any, are provided below the table.

Table 5-1. Third Five-Year Review Issues, Recommendations and Follow-Up Actions for OU2

Third Five-Year Review Issue	Follow-Up Action/ Recommendation	Action Taken and Outcome
GROUNDWATER		
Extraction Area		
• GETS will not likely reduce COCs concentrations in the FMA to below ROD cleanup levels within the 15-year time frame. COCs include fluoride, manganese, and radium, which are likely mobilized by acidic conditions. Acidic conditions are not effectively addressed by GETS.	• Evaluate the use of groundwater flushing as a new remedial action. Groundwater flushing would use a weak basic solution (lime) to raise groundwater pH and decrease the mobility of inorganic constituents. Evaluation would include bench scale testing and a pilot test under an approved Work Plan.	• Wah Chang has submitted a weak base groundwater flushing treatability study for EPA review and approval.
• GETS will not likely reduce VOCs concentrations in the SEA and Fabrication Area to below ROD cleanup levels within the 15-year time frame	• Evaluate the use of enhanced bioremediation as a new remedial action in the SEA. Evaluation would include a pilot test under an approved Work Plan.	• Wah Chang implemented an EISB pilot in the SEA that was effective at reducing concentrations of VOCs to below ROD cleanup levels. • The operation of GETS in the SEA has been suspended due to the implementation of bioaugmentation in this area. • Monitoring for rebound will continue for a 5-year evaluation period. • A larger scale EISB effort was implemented in the Fabrication Area following EPA signing a second ESD for the groundwater remedy.
Fabrication Area		
• Apparent limited hydraulic control of the hot-spot area in the vicinity of FW-3. • Extraction well FW-6 is not functioning as intended. • Increasing and/or persistent concentrations of VOCs exist in northern perimeter wells.	• Enhance GETS by installing new extraction well FW-8 in the ASA. • Optimize GETS by increasing groundwater pumping rates at FW-3 due to change in VOC treatment from GAC to cooling towers. • Continue semiannual groundwater sampling and analysis.	• Elevated VOCs discovered in groundwater and presence of DNAPL during drilling of well FW-8 made groundwater extraction not feasible for remediation • FW-3 has been shut down since July 2009 as part of the EISB at the ASA. • Semiannual groundwater sampling continues.

Table 5-1. Third Five-Year Review Issues, Recommendations and Follow-Up Actions for OU2 (continued)

Third Five-Year Review Issue	Follow-Up Action/ Recommendation	Action Taken and Outcome
• Discovery of NAPL and/or high concentration of VOCs in groundwater during drilling of proposed extraction well FW-8. Contamination may stem from a release from an unidentified source and may affect the groundwater remedy.	• Determine the nature and extent of VOCs in soil and groundwater using reconnaissance borings. • Assess source of contamination and release mechanism. • Prepare a feasibility study evaluating appropriate remedial options. Expedite a decision on implementing a remedial action if determined that a release has occurred. Revise installation location for FW-8. • 4. Should additional response action be needed regarding this issue, a decision document will be completed before end of fiscal year 2009.	• Following EPA's issuance of an ESD in 2008, Wah Chang implemented EISB in the ASA. Initial results indicate that reductive dechlorination is occurring and concentrations of VOCs are decreasing in the dissolved phase groundwater plume. • Wah Chang must continue monitoring groundwater concentrations in ASA wells to evaluate progress of the EISB remedy. • Wah Chang must evaluate source removal options.
• Apparent limited hydraulic control of the hot-spot area in the vicinity of FW-2 and FW-5.	Optimize GETS by conducting the following actions: • Increase pumping rates at FW-2 with a new electric submersible pump. • Change VOC treatment from GAC to cooling towers. • 3. Conduct maintenance and development on extraction well screens.	• System improvements and modifications have allowed for higher recovery rates at wells FW-1, FW-2, and FW-5.
• GETS may be limited in its ability to achieve RAOs and ROD cleanup levels in the projected 15-year time frame as indicated by persistent concentrations of DCE and TCE above ROD cleanup levels in groundwater.	• Continued groundwater monitoring on a semiannual basis.	• Semiannual groundwater monitoring has occurred since the 2008 FYR. • EISB enhancements are expected to assist the GETS system in achieving RAOs
• Conditions for natural attenuation may not be conducive for the full dechlorination of TCE and DCE, as observed by increasing concentration of VC and cis 1,2-DCE in groundwater from perimeter and non-hot-spot wells, and in surface water. The data set used to evaluate MNA is limited.	• Continue groundwater monitoring semiannually. Sample and analyze for applicable and relevant water quality indicators to evaluate MNA.	• Wah Chang encountered additional source materials in the ASA that eliminate the applicability of MNA in the Fabrication Area.

Table 5-1. Third Five-Year Review Issues, Recommendations and Follow-Up Actions for OU2 (continued)

Third Five-Year Review Issue	Follow-Up Action/ Recommendation	Action Taken and Outcome
• Chemical-specific applicable or relevant and appropriate requirements (ARARs) for Oregon's Ambient Water Quality Criteria (AWQCs) for protection of human health water and fish ingestion have been updated from Oregon Administrative Rules (OAR) 340-41-445 to 340-041-0033 (adopted by the Environmental Quality Commission on May 20, 2004 to become effective February 15, 2005) (Section 10.2). Updated AWQCs have not been recognized by EPA; however, appear to be consistent with 2006 CWA AWQCs for human health, consumption of water, and organisms.	• Compare criteria between OAR 340-41-445 and 340-041-0033. Use criteria which are most stringent to evaluate COCs in groundwater and surface water.	• EPA approved Oregon's proposed water quality standards for toxic pollutants on October 17, 2011. EPA is comparing surface to the new water quality standards.
• Wah Chang is further investigating the CCA SWMU in order to further define the nature and extent of TCA contamination in soils and groundwater.	• Work with ODEQ Resource corrective action program to ensure that SWMU closures are consistent with the groundwater remedy.	• Since the 2008 FYR, Wah Chang implemented EISB in the CCA. Further evaluation is necessary to determine if the remedy will prove to be effective. • Wah Chang must continue monitoring groundwater concentrations in CCA wells so EPA can evaluate progress of the EISB remedy.
• Ensure that contaminated groundwater does not pose a risk to building occupants through vapor intrusion.	• Continue to evaluate groundwater VOC concentrations in areas where potential exposures could occur. Should groundwater VOC concentrations increase in these areas, vapor intrusion pathway will be assessed. Advise building occupants of the results. Take necessary actions to address unacceptable exposure impacts.	• VOC concentrations in groundwater for the indoor air evaluation wells (PW-12, PW-42A, PW-71A, and PW-86A) have been decreasing. No additional action has been necessary to address vapor intrusion to indoor air. If concentrations of VOC in these wells increase, indoor air sampling and evaluation will occur.

Table 5-1. Third Five-Year Review Issues, Recommendations and Follow-Up Actions for OU2 (continued)

Third Five-Year Review Issue	Follow-Up Action/ Recommendation	Action Taken and Outcome
Solids Area		
• Natural attenuation processes may be limited in their ability to achieve RAOs and ROD cleanup levels as indicated by persistent concentrations of manganese and fluoride above the ROD cleanup levels in groundwater from noted monitoring.	• Continued groundwater monitoring on a semiannual basis.	• Wah Chang conducts semiannual groundwater monitoring that has occurred since the 2008 FYR. Results have been decreasing as seen from the results of the latest sampling effort.
Farm Ponds Area		
• Natural attenuation processes may be limited in their ability to achieve RAOs and ROD cleanup levels as indicated by persistent concentrations of PCE, TCE and VC above the ROD cleanup levels in groundwater from noted monitoring.	• Continued groundwater monitoring on an annual basis through 2010. • EPA will require that Wah Chang analyze groundwater for chloride and specific conductance from identified wells (WS, PW-43S/43A, PW-44S/44A) in future sampling events. EPA believes these results may help better understand advective movement of groundwater and the role of natural attenuation for VOCs.	• Wah Chang conducts annual groundwater monitoring that has occurred since the 2008 FYR. • Chloride and specific conductance have been included in groundwater analysis. • Concentrations of VOCs in groundwater have been below ROD performance standards since September 2009. However no explanation has been provided and EPA is concerned that the GW plume may have migrated. • In 2012, Wah Chang removed the contaminated berm that may have been a source to GW. EPA will evaluate the results of confirmation sampling when they are available.
SURFACE WATER		
• Surface water in Truax Creek has exceeded ROD cleanup levels for TCE and VC.	• Conduct supplemental surface water sampling at Truax Creek and groundwater sampling from applicable western perimeter wells in March of 2008. Evaluate risks of exposure to human health and the environment via the surface water pathway.	• Surface water sampling in Truax Creek has not detected TCE or VC above ROD cleanup levels since 2008.
• Potential threat to human health and the environment from consumption of fish or organisms in Second Lake.	• Evaluate if exposure pathway is complete by end of calendar year 2008.	• A public health assessment (Oregon Department of Human Services 2009) indicated no apparent public health hazard from surface water exposure and indeterminate public health hazard from consumption of fish. Also, tests for GW pH have not indicated that acidic conditions have migrated from the FMA to Second Lake.

Table 5-1. Third Five-Year Review Issues, Recommendations and Follow-Up Actions for OU2 (continued)

Third Five-Year Review Issue	Follow-Up Action/ Recommendation	Action Taken and Outcome
SEDIMENT		
• Determine if the remedial action for sediment is functioning as intended.	• Conduct sediment sampling and analysis in a manner consistent with approved work plan. Results of sampling demonstrate that the sediment remedy is protective.	• Wah Chang is planning to sample Truax Creek sediment and EPA is currently reviewing their work plan.
• Historic impacts to soil from PCBs in the vicinity of the Emergency Services Building may affect the protectiveness to the groundwater remedy.	• Work with Wah Chang to further assess potential PCB impacts to groundwater. Sample and analyze groundwater from monitoring wells PW-30A and PW-46A for Total PCBs by the applicable EPA method. Should PCBs be detected in groundwater from these wells, Wah Chang may have to take further remedial actions or conduct modifications to GETS to meet RAOs and ensure the protectiveness of the groundwater remedy.	• Groundwater samples collected in June 2009 from wells PW-30A still exceeded ROD cleanup levels whereas PW-46A did not exceed. • Groundwater monitoring for total PCBs will continue.

5.3 OU3 – SURFACE AND SUBSURFACE SOIL

Protectiveness Statement from the Last Review

The remedy for OU3 is protective of human health and the environment, and exposure pathways that could result in unacceptable risks are being controlled.

Status of Recommendations and Follow-Up Actions Since the Last Review

Table 5-2 provides a summary of issues and recommendations identified in the 2008 FYR Report (EPA 2008). The table includes updates on actions taken and outcomes. A description of each action taken and outcome, if any, are provided below the table.

Table 5-2. Third Five-Year Review Issues, Recommendations and Follow-Up Actions for OU3

Third Five-Year Review Issue	Follow-Up Action/ Recommendation	Action Taken and Outcome
• The SOW and Consent Decree do not incorporate requirements of the 2001 Soil ESD regarding overall cleanup during decommissioning and other factors.	• Prior to plant decommissioning, amend the SOW to incorporate applicable requirements of the Soil ESD for plant decommissioning by calendar year 2009.	• The SOW has not been updated.
• Construction of the CoGen Building may not comply with institutional controls that require that future buildings be constructed using radon-resistant construction methods. It is uncertain however, whether the CoGen building is directly on the soil hotspot.	• Radon testing will be conducted in the CoGen Building by end of calendar year 2008. All other buildings constructed on areas of the Main Plant where residual radiological contamination would lead to an increased risk of radon exposure will require testing. Radon testing will be conducted to evaluate risk to human health and if mitigation is necessary.	• Wah Chang conducted radon sampling in 2008 of indoor air in two buildings (CoGen and Mobile Shop). The highest concentration of radon detected during the sampling was 0.5 pCi/L, well below the 4.0 pCi/L OU3 ROD cleanup level. • Wah Chang must retest for radon in 2013 and depending on the results, EPA may require further monitoring or actions.

5.4 SITEWIDE

Table 5-3 provides a summary of issues and recommendations identified in the 2008 FYR Report (EPA 2008).

Table 5-3. Third Five-Year Review Sitewide Issues, Recommendations and Follow-Up Actions

Third Five-Year Review Issue	Follow-Up Action/ Recommendation	Action Taken and Outcome
• Verify that all institutional controls (ICs) are in place	• Complete Title Search for all parcels for entire Site by end of calendar year 2008.	• Wah Chang completed a title study in 2012 and the results are presented in this Fourth FYR Report. EPA is requiring Wah Chang to provide some additional information missing from the title search on deed restrictions and documentation on informational devices. Information needed by EPA include the following 1) title search information on properties purchased by Wah Chang in 2008 on the east side of Old Salem Road where groundwater contamination is present, 2) information showing that restrictive covenants prohibiting residential and agricultural use are in place for the entire facility not just the portion of Parcel 1 (Solids Area), 3) restrictive covenants that prohibit construction, installation, maintenance or use of any wells on the Soil Amendment Area for the purposes of extracting water for human drinking purposes or for the irrigation of food or feed crops, 4) plant standards for radon control actions for future buildings located on the Main Plant, and 5) informational devices warning workers of occupational risks from residual contamination on the Main Plant.

6 FIVE-YEAR REVIEW PROCESS

6.1 ADMINISTRATIVE COMPONENTS

This fourth FYR followed EPA's Comprehensive Five-Year Guidance (EPA 2001a). EPA Region 10 Remedial Project Manager, Mr. Ravi Sanga led the FYR effort. Mr. Sanga was assisted by Ms. Debra Sherbina, the EPA Community Involvement Coordinator (CIC); Ms. Joan Shirley, EPA Assistant Regional Counsel; Mr. Timothy Brincefield, EPA Policy Advisor; Mr. Curt Black, EPA Risk Evaluation Unit Hydrogeologist; Mr. Geoff Brown, ODEQ Project Manager; and Mr. Mike Marshall and Ms Lisa Gilbert, Parametrix Project Manager/Hydrogeologists. The FYR was conducted from January 18, 2012, to December 30, 2012.

6.2 COMMUNITY INVOLVEMENT

A newspaper notice was placed in the Albany Herald on June 21, 2012, to announce the start of the FYR (Appendix A). No public comments were received. Another newspaper notice will be placed in the Albany Herald upon completion and availability of this review.

6.3 APPROPRIATE, RELEVANT, AND APPLICABLE REQUIREMENTS REVIEW

The remedies selected in the OU1, OU2, and OU3 RODs are intended to be protective of human health and the environment and to comply with ARARs. The ARARs have been reviewed to identify any new or updated state or federal regulatory standards that might affect the protectiveness of the remedy if the RODs were written today.

6.3.1 OU1

ARARs for off-site disposal include Oregon Solid Waste Disposal Regulations. The Finley Buttes landfill has state permits under these regulations. EPA determined that no additional ARARs are considered under this OU.

6.3.2 OU2

EPA identified the following ARARs during the ROD. This section presents the ARARs and provides any updates or changes to the standard that may impact protectiveness.

6.3.2.1 Chemical-Specific ARARs

Safe Water Drinking Act (SWDA) MCLs and non-zero MCLGs, 40 CFR Part 141

- The SWDA has not been updated since the 2008 FYR.

Standards for degree of cleanup required, ORS 465.315; Cleanup rules, standards, OAR 340-122-040

- ODEQ adopted EPA's slope factors for TCE and PCE in 2012, resulting in RBCs that are more consistent with EPA's Regional Screening Levels.

Oregon Water Quality Criteria for the Willamette Basin, OAR 340-41-445

- OAR 340-041-0033 Ambient water quality criteria (AWQC) Effective October 17, 2011, ODEQ made changes to the AWQC and the concentrations of pollutants listed in Table 40 were derived to protect humans from potential adverse health impacts associated with long-term exposure to toxic substances associated with consumption of fish, shellfish, and water. The "organism only" criteria are established to protect fish and shellfish consumption and apply to waters of the state designated for fishing. The "water + organism" criteria are established to protect the consumption of drinking water, fish, and shellfish, and apply where both fishing and domestic water supply (public and private) are designated uses.

- Human health criteria for arsenic (water+organism) were revised to 2.1 ug/L (ODEQ 2011; EPA 2011).
- The Environmental Quality Commission (EQC) adopted revisions to Oregon's water quality criteria for manganese by withdrawing the "water and fish ingestion" and "fish consumption only" criteria as they apply to freshwaters (ODEQ 2010). EPA approved these revisions on June 9, 2011.

Oregon Groundwater Quality Statute, ORS 468B.150 to 185

Risk-based numerical values, under the Oregon Environmental Cleanup Rules, have been revised on several occasions, since the ROD for OU2 was issued, to incorporate changes in toxicity studies.

6.3.2.2 Location-Specific ARARs

Executive Order 11988, statement of procedures on floodplain management and wetlands protection Appendix A to 40 CFR Part 6

Oregon Statewide Planning Goals

- Goal 5 – Open spaces, scenic and historic areas and natural resources
- Goal 6 – Air, water, and land resource quality
- Goal 7 – Areas subject to natural disaster and hazards
- Goal 15 – Willamette River greenway

These goals have not been updated since the 2008 FYR.

Oregon removal-fill law, ORS 196.800-196.990

- Modifications to this rule do not appear to significantly impact protectiveness

CWA Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material, 40 CFR Part 230; Section 404(c) Procedures 40 CFR Part 231

Fish and Wildlife Coordination Act (16 USC Part 661 et seq.) 40 CFR Part 6.302 and 50 CFR Part 83

- These have not been updated since the 2008 FYR.

6.3.2.3 Action-Specific ARARs

Toxic Substance Control Act (TSCA) PCB Disposal regulations, 40 CFR 761.60; Oregon Hazardous Waste Management Rules for PCBs, OAR 340-110

- These have not been updated since the 2008 FYR.

RCRA Land Disposal Treatment Standards, 40 CFR Part 268, Subpart D; RCRA Transportation Regulations 40 CFR Part 263

- 40 CFR Part 263 was updated in 2010 since the 2008 FYR. Should future soil removal actions occur at the Site, the new RCRA standards will be applicable.

Oregon Waste Management Rules, OAR 340-100; Oregon Standards Applicable to Generators of Hazardous Waste, Identification and Listing of Hazardous Wastes, OAR 340-10, OAR 340-102;

- These have not been updated since the 2008 FYR.

Oregon Standards for Owners and Operators of Hazardous Waste Treatment and Storage and Disposal Facilities; OAR 340-104

- These have not been updated since the 2008 FYR.

CWA NPDES industrial and/or Stormwater Discharge Permits regulations, 40 CFR 122; Ambient Water Quality Criteria, 40 CFR Part 131; Oregon Regulations Pertaining to NPDES Permits, OAR 340-45

- These have not been updated since the 2008 FYR.

CAA National Primary and Secondary Ambient Air Quality Standards, 40 CFR Part 50; CAA National Emissions Standards for Hazardous Air Pollutants, 40 CFR Part 60; CAA New Source Performance Standards, 40 CFR Part 61; RCRA Air Emission Standards for Process Vents, 40 CFR Part 264, Subpart AA

- These have not been updated since the 2008 FYR.

OSHA, 29 USC 651; Oregon OSHA OAR Chapter 437

- These have not been updated since the 2008 FYR.

Amendment to NCP, Planning and Implementing Off-site Response Actions, 40 CFR 300-400

- These have not been updated since the 2008 FYR.

RCRA Closure and Post-Closure Regulations, 40 CFR Part 264

- This has not been updated since the 2008 FYR.

6.3.3 OU3

The following regulations are applicable for Site soils: ORS 465; OAR 340-122, Sections 10 through 110. They require cleanup to background or the lowest feasible level.

- These have not been updated since the 2008 FYR.

The following rules govern disposal of radioactive material in Oregon and are applicable to the Site: Energy Conservation, ORS 469.375, 469.525, 469.556, 469.559; Radioactive Waste Materials, OAR 345-050, Section 006 through 130.

- These have not been updated since the 2008 FYR.

6.4 INTERVIEWS

EPA conducted interviews with a few key individuals to gain a greater understanding of the Site background, state and local considerations for the project, and remediation activities. Interviews were conducted with representatives of Wah Chang, ODEQ, the Oregon Health Department, the Mayor of the City of Millersburg, and an expert in bioremediation technology. Summaries of those interviews are provided in Appendix B.

6.5 INSTITUTIONAL CONTROLS

EPA reviewed the status of institutional controls at the Site, including proprietary controls, government controls, and informational devices.

6.5.1 Proprietary Controls

Wah Chang provided a title search in 2012 (Wah Chang 2012c) to document the current status of proprietary controls at the Site. Based on a review of the title search, EPA found the following deed restrictions to be in place:

6.5.1.1 Teledyne Wah Chang

Main Plant and Solids Area:

- Restrictive Covenants (April 18, 1991): "There shall be no construction, installation, maintenance or use of any wells on the above-described site for the purposes of extracting water for human drinking purposes or for the irrigation of food or feed crops."

Solids Area (partial)

- Restrictive Covenant (April 18, 1991): "Residential and agricultural uses are prohibited"

Burlington Northern Santa Fe Railway Company (November 25, 1998), Union Pacific Railroad Company (March 29, 2001), Linn County (April 10, 2001):

- Equitable Servitude and Easement Agreements: "Grantor agrees it will not install, construct, or use any groundwater supply wells (which does not include groundwater monitoring wells) on the Property so long as this Equitable Servitude and Easement is in effect."

6.5.1.2 Simpson Timber Company

- Equitable Servitude and Easement Agreement (April 9, 1999): "Grantor agrees it will not install, construct, or use any groundwater supply wells (which does not include groundwater monitoring wells) on the Property so long as this Equitable Servitude and Easement is in effect."

6.5.1.3 City of Millersburg:

- Environmental Protection Easement and Equitable Servitude Agreement (re-recorded December 14, 2007).

  1) Use Restriction. No portion of the property shall be used for residential purposes,

  2) Building Construction, including initial construction, testing after building is constructed, radon monitoring, maintenance, notice to occupants.

  3) Soil Management and Excavation Requirements,

  4) Record Keeping and Reporting, and

  5) Environmental Protection Easement.

- Deed Restriction (May 8, 1990): "The rights of the public in and to that portion of the herein described property lying within the limits of public roads, streets, or highways, and portion of the property is designated as an EPA hazardous waste site."

- Restrictive Covenant (April 18, 1991): "There shall be no construction, installation, maintenance or use of any wells for the purposes of extracting water for human drinking purposes or for the irrigation of food or feed crops

Observations during the Site Inspection confirmed the Site is adequately fenced including security cameras. The Farm Ponds Area was also observed to be fenced.

6.5.2 Government Controls

Interviews with ODEQ and Oregon Department of Health (Appendix B) indicated that the ICs are functioning as intended and there have been no changes in land use or zoning.

EPA verified with the City of Millersburg that Wah Chang's Main Plant and surrounding properties are still zoned for General Industrial use and the former residential area between I-5 and Old Salem Road is zoned for Limited Industrial Commercial use. Based on an interview with the mayor of Millersburg (Appendix B), the EPA does not anticipate rezoning of surrounding properties which would require approval by the Millersburg City Council and Planning Commission.

EPA verified with the City of Millersburg that the City of Millersburg Land Development Code Section 7.500 is in place that identifies the Soil Amendment Area as a Radon Impacted Area and provides restrictions on land use and requires radon resistant construction methods and testing.

EPA verified that the City of Albany Development Code restrictions (Public Improvements 12.410) that require that all new developments, including a single-family residence, must extend and connect to the public water system when service is available within 150 feet are still in place.

6.5.3 Informational Devices

Wah Chang provided EPA with Plant Standards regarding radon control actions for future building sites located on the Plant Site (Wah Chang 1997).

6.6 SITE INSPECTION/TECHNOLOGY REVIEW

EPA inspected the Wah Chang Site on June 6 through June 8, 2012. An environmental scientist (hydrogeologist) from Region 10, Office of Environmental Assessment conducted the inspection. Twenty-one inspection targets were identified prior to the Site visit for review and assessment. Inspection activities focused on the active ground-water remedy for the Site. Each source area and plume was evaluated as to adequacy of perimeter control. Each plume was evaluated for trend data and potential to reach the 15 year time frame for cleanup established in the ROD. Areas of past cleanup activities were evaluated as to the on-going protectiveness of the remedy and adequacy of ground-water monitoring. 65 wells, representing more than half of the wells in the monitoring well system, were visited and evaluated. Noel Mak, NPL Program Coordinator was interviewed during the inspection. Mike Cochran, an employee in charge of extraction well maintenance and system operation was questioned about system maintenance. Randy Coots, a long-time security officer for the facility was questioned as an assessment of Site security and access control. Geoff Brown, Oregon Department of Environmental Quality participated in part of the inspection. Lisa Gilbert, an employee of Parametrix participated as a contractor to the EPA assisting with the Five Year Review. The inspection report is included as Appendix C.

6.6.1 Management System Review

As part of the FYR for the Wah Chang Site, a Management System Review (MSR) has been performed. This review identifies any issues that might affect the protectiveness of the remedy. These issues are covered extensively in Section 7 of this document.

6.6.2 Technical Compliance Evaluation

The technical compliance evaluation is included to evaluate whether each element of the remedy is being maintained and operated in accordance with its intended function.

Evaluation of Intended Function:

- The exposure pathways and land use assumptions that were stated in the ROD are still valid.
- No zoning or land use changes have been made since the ROD.
- Major removal actions of solid source materials have greatly reduced observed residual ground-water contamination in areas such as the LRSP and Farm Ponds Areas.
- Site access is controlled by security constantly. The entire Site is fenced and security cameras cover much of facility.
- Areas of residual ground-water contamination are undergoing monitoring. The SEA and CCA EISB remedies appear technically appropriate to deal with the dissolved chlorinated solvent concentrations present. The plume in the northern portion of the Fabrication Area requires additional assessment. The source area in the acid sump area will require a different technical approach to deal with DNAPL solvent.
- Feed Makeup Area remedy modifications including the addition of buffered or acid-neutralizing solutions are expected to address low-pH and metals mobility in this area as this remedy modification is adopted.

Specific evaluations of each remedy component are addressed in detail in Section 7.

6.6.3 Source Control

Significant cleanup actions have been completed at the Wah Chang Site. Hundreds of thousands of yards of material have been removed from the Site to address source control. Completed projects include the Lower River Solids Ponds, Magnesium Resource Recovery Pile, the Farm Ponds Area and others. Areas of ongoing issues with source control include the Feed Makeup Area with the low pH ground water and the potential for mobilization of constituents of concern from the feed material as well as the metals mobilized by the low pH. The Acid Sump Area has been identified as an area of high concentrations of chlorinated solvents that indicate the presence of DNAPL. The technology (EISB with sugars and edible emulsified oils) is not likely to adequately address a DNAPL source. Wah Chang must develop plans for additional excavation or an alternative treatment for this area. The associated dissolved plume that is discharging to the north from the Acid Sump Area appears to be potentially discharging at the northern plant boundary. As of this writing, the plume has not yet dropped to concentrations that are near the ROD cleanup levels despite the EISB that has changed ground-water chemistry to conditions to those suitable for solvent destruction.

6.6.4 Groundwater Remediation

Groundwater Remediation continues in several parts of the plant. These include:

- The EISB projects in the South Extraction Area;
- The EISB project in the Fabrication Area – Acid Sump;
- The EISB project in the Fabrication Area – Crucible Cleaning Area;
- Ground-Water Extraction and Treatment in the Feed Makeup Area;
- Ground-Water Extraction and Treatment in the Fabrication Area protecting Truax Creek.

Detailed reviews of each of these systems and assessment of their operations and issues requiring remedy modification are included in Section 7.

6.7 DATA REVIEW FOR OU1

EPA issued a Certification of Completion for OU1 RA to Wah Chang on June 30, 1993 (EPA 1993). The RA for OU1 is considered complete. SCS Engineers conducts semiannual groundwater monitoring at the Finley Buttes Landfill monocell in Boardman, Oregon. Wells MW-4 and MW-5 are used to monitoring upgradient and downgradient groundwater conditions, respectively. The 2010 groundwater monitoring results (SCS Engineers 2011) confirmed that trace metal results were not detected above the method reporting limits with the exception of antimony, arsenic, and barium in MW-4 and barium and zinc in MW-5. Manganese was detected one time over the past 5 years in MW-5 at 0.014 mg/L. All metals detected were below the MCL and SMCL, and VOCs were not detected in groundwater samples

6.8 DATA REVIEW FOR OU2

EPA obtained data through 2011 from Wah Chang and conducted an independent review of the data as part of this FYR, including preparing summary tables, potentiometric surface maps, time-series plots, and isoconcentration maps. EPA reviewed data beginning in October 2002 to evaluate groundwater concentration trends over time and to provide overlap with the 2008 FYR report.

This section presents a summary of EPA's findings for OU2. Remedial sectors include the Main Plant Area, including Extraction and Fabrication Areas, the Solids Area, and the Farm Ponds Area. Information obtained during the Site Inspection is described in this section.

6.8.1 Main Plant: Groundwater Extraction and Treatment System (GETS)

The remedy for groundwater in the Main Plant Area is GETS though granular activated carbon (GAC) in the FMA and SEA and phase separation though air stripping in the cooling towers in the Fabrication Area.

6.8.1.1 Operation and Maintenance

Wah Chang is responsible for the operation and maintenance of the groundwater extraction system. System operation includes recording system pumping rates, influent concentrations, extraction well downtime, and routine and non-routine maintenance activities.

Wah Chang employs one full-time staff personnel to satisfy operation requirements in accordance with the operation and maintenance plan. This person conducts weekly inspections of the conditions at each extraction well, identifies potential issues, maintains parts on hand, and repairs equipment as needed. Several other personnel assist with maintenance and sampling. Wah Chang has responded to unscheduled, non-routine maintenance activities in a timely manner. Wah Chang stores groundwater extraction pumps on-site and replaces pumps in the FMA approximately every 3 months due to the low pH corrosion of the equipment.

During the Site Inspection, extraction wells were observed operating as expected. Treatment systems appeared well maintained and spare parts were observed. Totalizers were functioning and metered treatment equipment was observed treating water prior to pumping for additional treatment. Inspection logs were observed. Site access control was observed. Maintenance issues were noted with several of the flush-completed wells in the monitoring well system, specifically, the sealing of flush-completed wells in areas of high traffic. Wells were observed where, due to heavy traffic, threads on vaults or the bolts to seal the vaults were stripped, vaults were cracked, gaskets were missing, locks were found to be inoperable due to corrosion and the seals on wells were compromised due to wear on seals. At least one well was observed that should be reconstructed with a new vault. Overall, a new approach to sealing wells should be established in high traffic areas to protect the integrity of the monitoring well program. Nearly all wells with above ground completions were found to be labeled, locked, capped and protected with yellow-painted barrier posts. Inside the protective casing nearly all wells were found to have marked measurement points. See Appendix C for specific observations.

Wah Chang submitted a Work Plan (Wah Chang 2012d) to conduct a pumping test at extraction well FW-4 and monitoring well PW-30A to assess the capability of well FW-4 to hydraulically capture groundwater in the portion of the Site previously captured by extraction well FW-7 where pumping was discontinued in 2009, and to evaluate possible capture zone improvements gained by augmenting well FW-4 pumping. EPA expects to review the pump test work plan by 2013.

6.8.1.2 Extraction Area

Extraction well and monitoring well locations for the Extraction Area are presented on Figure 6-1. Groundwater contamination in the FMA is characterized by the presence of metals, radionuclides, and low (acidic) pH levels. Groundwater contamination in the SEA is characterized by the presence of chlorinated solvents. The groundwater monitoring network in the Extraction Area is composed of 18 monitoring wells.

Feed Makeup Area

Mass Removal

Wah Chang reported that 3.92 pounds of fluoride, 149.02 pounds of ammonia, 1.32×10^{-10} pounds of radium-226, and 1.32×10^{-8} pounds of radium-228 were removed by GETS in the FMA during 2009 (Wah Chang 2010c). Wah Chang reported that 6.9 pounds of fluoride, 112.43 pounds of ammonia, 8.9×10^{-9} pounds of radium-226, and 1.24×10^{-6} pounds of radium-228 were removed by GETS in the FMA Area during 2010 (Wah Chang 2011e). Wah Chang reported that 6.33 pounds of fluoride, 82.12 pounds of ammonia, 3.2×10^{-10} pounds of radium-226, and 2.56×10^{-6} pounds of radium-228 were removed by GETS in the FMA Area during 2011 (Wah Chang 2012f). The mass recovery volumes reported above are derived from Wah Chang’s annual reports. EPA compared the reported mass removal to analytical data and extraction rates obtained from Wah Chang. The results of this comparison indicated that the values were similar and were within approximately 25% of Wah Chang reported values and EPA calculated values. This difference in values is likely due to assumptions made during calculations; however, the values agree in general.

Mass Removal (pounds) in the FMA Reported by Wah Chang

	2008	2009	2010	2011
Fluoride	NA	3.92	6.9	6.33
Ammonia	NA	149.02	112.43	82.12
Radium 226	NA	1.3×10^{-10}	8.9×10^{-9}	3.2×10^{-10}
Radium 228	NA	1.32×10^{-8}	1.24×10^{-6}	2.56×10^{-6}
TDS	20509	15663	13989	10295

Groundwater Monitoring

Nine monitoring wells are located in the FMA (Figure 6-1). Additional information about the wells follows:

- Five wells were installed in the area where groundwater concentrations were above the 10-4 risk and are considered hot-spot wells: PW-28A, PW-28B, PW-50A, PW-51A, and PW-52A.
- One well was installed in the area where groundwater concentrations were below the 10-4 risk and is considered a non-hot-spot well: PW-27A.
- Four wells were installed adjacent to Second Lake and are considered perimeter wells: PW-21A, PW-22A, PW-23A, and PW-24A.

Table 6-1 presents a summary of arsenic, radium-228, radium-226, fluoride, ammonium, cadmium, and nickel concentrations in groundwater beginning in October 2002. pH levels are summarized in Table 6-2. Data for FMA extraction wells is presented in Table 6-3. During the December 2011 groundwater monitoring event (approximately 9 years after the GETS startup):

- Two perimeter wells exceeded the ROD cleanup level of 2 mg/L for fluoride (PW-22A at 2.4 mg/L and PW-23A at 11 mg/L).
- One hot-spot well exceeded the ROD cleanup level of 0.05 mg/L for arsenic (PW-28A at 0.09 mg/L).
- No radium was detected above ROD cleanup levels during either 2001 monitoring event.
- Groundwater pH ranged from 2.5 to 6.7 (Table 6-2). With the exception of perimeter well PW-22A(6.67), all wells in the FMA did not meet the pH level required by the ROD.

Figure 6-2 presents pH trends in FMA wells beginning in October 2002. Although in the majority of wells, pH has slightly increased since the 2008 FYR by approximately 1 pH unit, pH remains below the ROD cleanup-up range. The lowest pH values were observed in wells PW-28A, PW-52A, and PW-50A.

The number of detections and concentrations of metals and radionuclides in the FMA have decreased. However, monitoring data in the FMA currently show that concentrations of COCs are above ROD cleanup levels and the concentrations over time have been highly variable (Figure 6-3 through Figure 6-5).

Second Lake pH sampling EPA requested that Wah Chang perform an additional Site characterization in 2011 (Wah Chang 2011f)to select a location for a new downgradient monitoring well in the FMA to evaluate migration of a low pH groundwater plume extending from the FMA to Second Lake. The Site characterization included a groundwater sampling transect downgradient of the FMA and oriented perpendicular to the direction of groundwater flow.

Wah Chang measured groundwater discharge into Second Lake and indicated that the pH of groundwater entering Second Lake ranged between 5.52 and 7.47. Based on the results of the investigation, EPA determined that the low pH groundwater plume did not appear to discharge into Second Lake.

South Extraction Area (SEA)

The 2008 FYR report concluded that based on water quality data, GETS was not effective in reducing DCE and TCE concentrations and would not likely achieve ROD performance standards within the time frame. Wah Chang completed an EISB pilot test in June 2008 in the SEA to reduce the concentration of VOCs in the area (Wah Chang 2011b). Wah Chang installed two new monitoring wells to support the evaluation of VOC concentrations in groundwater. A drilling contractor completed temporary injection wells for Wah Chang to inject amendment water, substrate, and the SiREM KB-1 Plus microbe culture. Temporary injection points were distributed around the SEA where there were elevated VOC concentrations. A groundwater amendment included the injection of deoxygenated water used to alter the groundwater environment to be suitable for bacterial growth. Wah Chang added approximately 125 ppm of food-grade 60 percent sodium lactate and Newman Zone vegetable oil to stimulate biotic and oxygen-consuming activity. Wah Chang monitored chemical parameters consisting of dissolved oxygen (DO), pH, and oxidation-reduction potential (ORP) to determine if additional lactate and amendment water were required to complete the deoxygenating process.

Nine monitoring wells are in the SEA (Figure 6-1). Additional information about the wells follows:

- Three wells were installed in the area where groundwater concentrations were below the 10-4 risk and are considered non-hot-spot wells: PW-47A, PW-48A, and PW-96A.
- Six wells were installed adjacent to Second Lake and are considered perimeter wells: PW-25A, PW-26A, PW-29A, PW-49A, PW-57A, and PW-97A.

Table 6-4 presents a summary of VOC concentrations in groundwater in the SEA. As a result of EISB treatment, with the exceptions of PW-96A, VOCs in the SEA have not been detected above their respective method reporting limit since the April 2010 monitoring event. Figure 6-6 presents concentrations of DCE and Figure 6-7 presents concentrations of TCE in groundwater wells in the SEA. No VOCs were detected during the April and December 2011 groundwater monitoring events. EPA has determined that groundwater field parameter data indicated current conditions were conducive to survival and function of dechlorination microbes, which are necessary to break down VOCs. These parameters include anoxic and negative oxidation potentials of less than -70 mV.

Based on analytical data that indicated that no VOCs were detected in the SEA above the method reporting limits, EPA approved suspending operation of extraction wells EW-1, -2, and -3. However, given the lack of identification of the source area of the VOC concentrations, Wah Chang will monitor wells biannually in the SEA for VOCs for a period of at least 5 years from the shutdown of extraction wells (operation was suspended in April 2011) to determine if rebound occurs. If rebound occurs and additional action is necessary, Wah Chang and EPA will consider remedial action options to reduce VOCs in the SEA.

6.8.1.3 Fabrication Area

Groundwater contamination in the Fabrication Area is characterized by the presence of chlorinated solvents, primarily DCE, TCA, TCE, PCE, and VC. The Fabrication Area GETS includes extraction wells FW-1 through FW-5 and FW-7. Well FW-7 was taken out of operation in 2009. Extraction and monitoring well locations are presented on Figure 6-8. The main objectives of GETS in the Fabrication Area are to remove VOC mass and reduce VOCs concentrations to below ROD cleanup levels.

Wah Chang performed additional response actions in the Fabrication Area to reduce concentrations of COCs in groundwater in two areas, the ASA and the CCA. Specific response actions included EISB that the EPA had not considered at the time of the ROD. The EPA signed an ESD in June 2009 to use EISB as a new RA in the Fabrication Area.

Mass Removal

In 2008, Wah Chang extracted approximately 20 million gallons of water from the Fabrication Area and removed 130 pounds of VOCs (Wah Chang 2009b). In 2009, Wah Chang extracted approximately 19.5 million gallons of water and removed 94 pounds of VOCs (Wah Chang 2010b). In 2010, Wah Chang extracted approximately 16.1 million gallons of water and removed 101.8 pounds of VOCs (Wah Chang 2011d). In 2011, Wah Chang extracted approximately 13.2 million gallons of water and removed 35.1 pounds of VOCs (Wah Chang 2012i).

Mass Removal in the Fabrication Area

	2008	2009	2010	2011
Water Extracted (million gallons)	20	19.5	16.1	13.2
VOCs removed (pounds)	130	94	101.8	35.1

Acid Sump Area

In September 2009, Wah Chang completed EISB in the ASA. Approximately 12 months following EISB, monitoring results from Wah Chang’s sampling indicated groundwater field parameter conditions conducive to dechlorination microbes, which are necessary to reduce VOCs, had improved from the baseline conditions prior to injection (Wah Chang 2011c). As noted above, EPA determined that COC concentrations in some wells still remain above ROD cleanup levels (Table 6-15). However, groundwater analytical data for VOCs indicate that the proportions of TCA and TCE concentrations have been reduced, and in general daughter compounds increased as a result of EISB (Figure 6-31a and Figure 6-31b). Reductive dechlorination of chlorinated ethenes appears to be more pronounced in TMW-5 and PW-98A. A DNAPL source is indicated by the initial concentrations of several chlorinated solvents in the ASA. This source will require additional assessment and an additional remediation technology to address the indicated DNAPL.

Crucible Cleaning Area

In September 2010, Wah Chang completed EISB in the CCA, and installed two additional monitoring wells to support performance monitoring. Wah Chang's initial groundwater analytical results show that VOC concentrations have been reduced (Wah Chang 2011d). Additional performance monitoring results are anticipated from Wah Chang in 2012. The EISB Technology applied here appears capable of addressing the dissolved chlorinated solvents present.

Groundwater Monitoring

The groundwater monitoring network in the Fabrication Area is composed of 51 monitoring wells and 7 extraction wells (Figure 6-8).

Hot-Spot Area Wells

Of the wells in the Fabrication area, 24 are installed in an area where groundwater concentrations were above the 10^{-4} risk and are considered hot-spot wells. These include the following monitoring wells:

- PW-11, PW-12, PW-13, and PW-99A located near the ASA.
- PW-01A, PW-03A, and PW-83A located near the Ammonium Sulfate Storage Building.
- PW-42, PW-85A, and PW-86A located near the Material Recycle Building.
- PW-45A, PW-68A, PW-69A, PW-71A, PW-93A, PW-94A, PW-95A, PW-100A, MW-01A, MW-02A, MW-03A, and MW-04A located near the former CCA.
- PW-30A and PW-73B located near the Dump Master Building.

Table 6-5 through Table 6-11 present a summary of VOC concentrations in groundwater from hot-spot wells in the Fabrication Area. The tables indicate that DCE, TCA, TCE, PCE and VC exceeded their respective ROD cleanup levels in two or more hot-spot wells since the spring 2008 groundwater monitoring event.

Figure 6-9 through Figure 6-13 display DCE, TCA, TCE, PCE and VC concentrations in groundwater, respectively, over time for hot-spot wells that exceeded ROD cleanup levels for one or more of these compounds in the past 5 years. In general, the figures indicate that contaminant concentrations have decreased in a majority of hot-spot wells since the implementation of GETS. In November 2011, TCA, DCE, and VC concentrations remained above their respective ROD cleanup levels in 14 hot-spot wells. Most noteworthy are the following hot-spot wells:

- PW-12, PW-13, and PW-99A (ASA).
- PW-42A and PW-85A (Material Recycle).
- PW-69A, PW-93A, PW-94A, PW-95A, PW-100A, MW-02A, and MW-04A (CCA).
- PW-30A and PW-73B (Dump Master).

Table 6-12 and Table 6-13 present a summary of fluoride and nitrate in hot-spot wells. No hot-spot wells exceeded the ROD cleanup level for ammonium in the last 5 years. Table 6-12 indicates that four wells (PW-11, PW-12, PW-13, and PW-99A) exceeded ROD performance levels for fluoride and nitrate in the last 5 years. Only two hot-spot wells (PW-13 and PW-

99A) exceeded the ROD cleanup level for fluoride and one well (PW-13) for nitrate in November 2011.

Non-Hot-Spot Area Wells

There are 22 wells installed in areas where groundwater concentrations were below the 10^{-4} risk and are considered non-hot-spot wells:

- PW-10, PW-14, PW-16A, PW-19A, PW-80A, PW-81A, PW-82A, and PW-98A located near the ASA.
- PW-20A, PW-89A, and PW-92A, located near the Ammonia Sulfate Storage Building.
- PW-84A, PW-87A, and PW-88A, located near the Material Recycle Building.
- PW-70A, PW-72A, and PW-101A located near the CCA.
- PW-46A, PW-74B, and PW-75A and PW-91A near the Dump Master area.
- PW-31A, located in the northeast corner of the Site (hydraulically upgradient).

Table 6-5 through Table 6-11 present a summary of VOC concentrations in non-hot-spot wells. The table indicates that DCE, TCA, and TCE exceeded their respective ROD cleanup levels in one or more non-hot-spot wells since the spring 2008 groundwater monitoring event.

Figure 6-14 through Figure 6-17 display DCE, TCA, PCE, TCE, and VC concentrations over time for non-hot-spot wells that exceeded ROD cleanup levels for one or more of these compounds in the past 5 years. In general, the figures indicate that contaminant concentrations have decreased in non-hot-spot wells since the implementation of GETS. In November 2011, TCE, DCE, and VC concentrations above their respective ROD cleanup levels persisted in 2 non-hot-spot wells:

- PW-98A (ASA)
- PW-101A (CCA) (below ROD cleanup level for TCE)

Table 6-12 and Table 6-13 present a summary of fluoride and nitrate in non-hot-spot wells. Three wells (PW-10, PW-89A, and PW-98A) exceeded the ROD cleanup level for fluoride and one well (PW-89A) exceeded the ROD cleanup level for nitrate in the last 5 years, although concentration of fluoride and nitrate have decreased in these wells over the past 5 years. No non-hot-spot wells exceeded the ROD cleanup level for ammonium in the last 5 years.

Northern Perimeter Wells - Murder Creek

Five wells are installed in the area adjacent to Murder Creek and are considered perimeter wells:

- PW-15AR (inactive), PW-76A, PW-77A, PW-78A, and PW-79 (ASA)

Table 6-5 through Table 6-11 present a summary of VOC concentrations in northern perimeter wells. DCE concentrations exceeded the ROD cleanup level in three of the five northern perimeter wells since the spring 2008 groundwater monitoring event. No other VOCs were detected above ROD cleanup levels in northern perimeter wells.

Figure 6-18 displays DCE concentrations over time for the three northern perimeter wells that exceeded ROD cleanup levels for DCE in the past 5 years. While DCE concentrations still exceed ROD cleanup levels, DCE concentrations have decreased or remained consistent in northern perimeter wells since the implementation of GETS.

Table 6-12 and Table 6-13 present a summary of fluoride and nitrate in northern perimeter wells. Fluoride concentrations in one well (PW-79A) exceeded the ROD cleanup level in the last 5 years. Fluoride concentrations in well PW-79A have not exceeded the ROD cleanup level of 2 mg/L since June 2009. No concentrations of ammonium or nitrate exceeded the ROD cleanup level in northern perimeter wells in the last 5 years.

Isoconcentrations

EPA prepared isoconcentration maps (Figures 6-19 through 6-26) of persistent VOCs (DCE, TCE, TCA, and VC) in the Fabrication Area to evaluate changes in spatial distribution in COCs during the fall sampling events of 2009 and 2011. These isoconcentrations include data from wells installed in the ASA (TMW-1, TMW-3, TMW-4, and TMW-5, shown in Table 6-15) as a result of the discovery of DNAPL in this area. Three areas of elevated concentrations of VOCs are present in the Fabrication Area. A comparison of groundwater DCE concentrations above the ROD cleanup level in 2009 to those in 2011 (Figure 6-27) indicates that the areal extent of DCE in groundwater has not been significantly reduced over this 2-year period. However, TCE (Figure 6-28) does appear to have reduced in areal extent. VC (Figure 6-29) appears only to have slightly been reduced in one area as a result of the concentration of VC in PW-42A). TCA (Figure 6-30) appears to have been significantly reduced in areal extent.

Surface Water Monitoring

Wah Chang collects surface water samples in Murder and Truax Creeks to monitor discharge of contaminated groundwater from the Fabrication Area to the creeks. Samples are collected upstream and downstream of the facility (Figure 6-8). Table 6-14 displays a summary of COC concentrations in surface water samples collected adjacent to perimeter wells along Murder Creek (MC) and Truax Creek (TC) during the past 5 years. In addition, the table displays ROD cleanup criteria based on AWQCs for human health, water and fish consumption that ODEQ finalized in October 2011.

Murder Creek

Wah Chang collected surface water samples from upstream (MC-U) and downstream (MC-D) of the facility in Murder Creek from locations adjacent to the northern perimeter wells PW-79A, PW-78A, PW-77A, and PW-76A.

Following the 2008 FYR report and as presented in Table 6-14, VOCs were not detected in downstream surface water above the AWQC. However, the method reporting limit is higher than the AWQC for PCE and VC.

Truax Creek

Wah Chang collected surface water samples from upstream (TC-U) and downstream (TC-D) of the facility in Truax Creek from locations adjacent to western perimeter wells PW-89A, PW-88A, and PW-75A.

Following the 2008 FYR report and as presented in Table 6-14, VOCs were not detected in downstream surface water above the AWQC. However, the method reporting limit is higher than the AWQC for PCE and VC.

6.8.2 Monitored Natural Attenuation

Monitored natural attenuation (MNA) is a technique used to monitor or test the progress of natural processes that can degrade contaminants in soil and groundwater. The data interpretation focuses on detection of spatial and temporal changes and assessment of their impacts on the achievement of Site-specific goals. The following section summarizes the MNA progress in the Solids and Farm Ponds Areas.

6.8.2.1 Solids Area

The primary groundwater contaminant source in the Solids Area was lime solids stored in the LRSP and Schmidt Lake. In September 2010, Wah Chang used high density polyethylene (HDPE) material to line the pond formerly known as Schmidt Lake and now designated Pond 3. This was completed as part of a joint project with the Cities of Albany and Millersburg to divert Wah Chang's wastewater discharge from Truax Creek to the City of Albany's new wetland treatment system. When the new system is operational, water will be pumped from Pond 2 to Pond 3 for additional cooling and discharged to the wetland treatment system and no longer discharged to Truax Creek. Additional water will be pumped from the Willamette River to the Cooling Pond for release to Truax Creek to maintain flows through the summer months.

Groundwater flow in the Solids Area is from the east to the west as indicated on Figure 3-5.The groundwater monitoring network in the Solids Area is composed of 17 monitoring wells (see Figure 3-5).

- Eight wells are screened in Willamette Silt (WS): PW-07A, PW-09A, PWA-1, PWB-1, PWC-1, PWF-1, PW-17B, and PW-18B.
- Four wells are screened in the Linn Gravels (LS): PWA-2, PWB-2, PWD-1, and PWE-1.
- Five wells are screened in the Blue Clay (BC): PWB-3, PWC-2, PWD-2, PWE-2, and PWF-2.

Based on analytical results, the only COC detected above ROD cleanup levels since June 2007 was fluoride (Table 6-16). Out of the 17 wells, concentrations of fluoride in six wells were above the ROD cleanup level of 2 mg/L. During the fall of 2011, the concentration of fluoride in only one out of the 17 wells was above the ROD cleanup level. The November 2011 concentration of fluoride was 2.1 µg/L in PWE-1, and fluoride was detected in PWB-1 at a concentration of 2 µg/L and PWB-3 at a concentration of 1.7 µg/L.

6.8.2.2 Farm Ponds

The groundwater monitoring network in the Farm Ponds Area is composed of 19 monitoring wells (see Figure 3-5). Of these 19, three wells screened in Willamette Silt are sampled regularly: PW-40S, SS, and PW-65S. Groundwater flow in the Farm Ponds Area is from the east-northeast to the west-southwest as indicated on Figure 3-5.

Table 6-17 displays a summary of VOC concentrations in groundwater from monitoring wells in the Farm Ponds Area. Groundwater monitoring data from PW-40S indicates that removal of lime solids from the Farm Ponds Area in 1999 reduced groundwater VOC concentrations (Figure 6-32). However, increasing concentrations of PCE and TCE were observed in well SS following the regrading of the Farm Pond dikes and were a concern to EPA as potential indicators that source material may still be present (EPA 2012b). As shown on Figure 6-33, PCE and TCE in well SS steadily increased from 2002 to peak in September

2008. Following the fall 2008 event, PCE and TCE concentrations decreased abruptly to below the ROD cleanup levels.

Analytical results from 2009, 2010, and 2011 indicate that TCE was detected in well SS below the method reporting limit in 2009 and 2010, but was not detected in 2011. PCE was detected at concentrations of 2.52 µg/L, 2.13 µg/L, and 1.45 µg/L in 2009, 2010, and 2011, respectively. No other VOCs were detected above ROD cleanup levels in the Farm Ponds monitoring wells in 2011.

The increasing concentrations of PCE and TCE in well SS from 2002 to 2008 prompted Wah Chang to consider removing the remaining dike material surrounding the well. Wah Chang completed this work under an approved EPA work plan (Wah Chang 2012e; EPA 2012b) in the summer of 2012. The work included decommissioning well SS with excavation and disposal of the remaining dike followed by confirmation soil sampling. Wah Chang collected groundwater samples and EPA will assess the results to determine whether additional actions will be required. Wah Chang discovered during decommissioning that well SS, installed by Schoen Electric and Pump, had not been constructed in accordance with the regulations, and the depths and construction were not as shown on the well construction log. ODEQ checked Oregon's database for registered wells and found that Schoen Electric and Pump installed at least 14 other wells for Wah Chang between 1978 and 1982. Wah Chang must submit a report to EPA documenting whether any of the wells being used for CERCLA Site investigations were installed by Schoen Electric and Pump. If improperly constructed wells are being used, Wah Chang must prepare a work plan for EPA approval and replace these wells with wells that are compliant with well construction regulations.

6.8.2.3 Environmental Evaluations of Uninvestigated Areas

The ROD requires evaluation of areas not investigated during the RI/FS to ensure RAOs for groundwater at the Site are being achieved. Wah Chang field-screened excavated soil for potential contamination, and samples with positive detections were analyzed for toxicity characteristic leaching potential (TCLP) metals, VOCs, and SVOCs.

The 2008 to 2009 Biennial Environmental Evaluation Report (Wah Chang 2010a) disclosed that 167 excavations were conducted in previously uninvestigated areas from January 2008 to December 2009. The 2008 to 2009 biennial report indicated the following:

- Samples from 21 excavations where field pH or soil conductivity exceeded screening levels were analyzed for TCLP metals. Results indicated metals were not detected above Site background levels.
- One excavation was analyzed for VOCs and detected TCA at a concentration of 0.167 mg/kg which was below the risk-based screening level of 2 mg/kg.
- In all excavations surface gamma radiation was less than the 30.5 µrem/hr screening level.
- Contaminated soil was not in contact with the water table.

The 2010 to 2011 Biennial Report (Wah Chang 2012h) disclosed that 155 excavations were conducted in previously uninvestigated areas between January 2010 and December 2011. Of these, 68 excavations contained soils requiring environmental evaluation and 155.25 cu yards of soils were removed. The report indicated the following:

- Samples from seven excavations where field pH or soil conductivity exceeded screening levels were analyzed for TCLP metals. Results indicated metals were not detected above Site background levels.

- Eleven excavations were analyzed for VOCs and none of the soils exceeded screening levels.
- All excavation base samples had surface gamma radiation less than the 30.5 µrem/hr screening level. Surface gamma radiation was above than the 30.5 µrem/hr screening level in the disposal piles at four locations in areas already known to have soils containing radium.
- Contaminated soil was not in contact with the water table.

6.8.2.4 PCBs

The 2008-2009 Biennial Evaluation Report (Wah Chang 2010a) indicated that PCB concentrations in excavated soil exceeded the 50 mg/kg TSCA disposal requirement in five excavations and in the bottom of two of these excavations.

PCBs detected in soil (85.9 mg/kg) and left in place (28.3 mg/kg) in the vicinity of the Emergency Services Building Area were consistent with historical observations in this area. Groundwater samples collected from PW-30A downgradient of the excavation confirmed PCB levels had not increased since the RI/FS.

Wah Chang completed excavations near Building 1, Building 53, and Building 54. Previous excavations in this area indicated elevated PCB levels in shallow soil. PCBs were left in place at concentrations of 35.7 mg/kg and 2.78 mg/kg in two of the excavations at approximately 4 feet bgs. Wah Chang completed one excavation near the mobile shop, Building 73, where excavated soil exceeded 50 mg/kg. Confirmation sampling at the bottom of the excavation indicated that PCBs was not detected at 4 feet bgs.

The 2010 to 2011 biennial report (Wah Chang 2012h) indicated that samples from one excavation west of Building 1 encountered PCBs left in place at a concentration of 212 mg/kg at a depth of 2 ft below ground surface exceeding the 50 mg/kg TSCA requirement. Mobilization of PCBs to groundwater at this location is believed to be unlikely because the sample was collected inside a covered building under a 12-inch thick concrete slab.

6.9 DATA REVIEW FOR OU3

Wah Chang constructed the CoGen Building on top of the former Sand Unloading Area with no excavating or sampling prior to construction. The unoccupied CoGen Building is capable of producing the electricity needed to operate the plant. Wah Chang performed gamma surveys to meet the ROD gamma radiation cleanup criteria; however, the ROD also required demonstration that construction over residual contamination will not result in radon concentrations in indoor air above 4 pCi/L. Wah Chang conducted radon sampling of indoor air in two buildings (CoGen and Mobile Shop) from June 3, 2008 to December 3, 2008 (Wah Chang 2008). The highest concentration of radon detected during the sampling was 0.5 pCi/L, well below the 4.0 pCi/L OU3 ROD performance standard. Wah Chang submitted a work plan (Wah Chang 2012a) for additional radon sampling in these buildings, which EPA is currently reviewing. Results from this analysis are expected in 2013.

EPA interviewed the Mayor of Millersburg regarding the status of the SAA. Based on this interview, the Mayor indicated tilling agricultural activity was taking place on the SAA. The EPA determined that there is presently no current radiological data for the soil on the SAA. The EPA is requiring that Wah Chang sample soil in the SAA to determine the current status of Site soils and crop residues grown in this area to determine whether a risk to human health exists.

6.10 RCRA INVESTIGATIONS

6.10.1 Drain SWMUs

In a 1997 RCRA Facility Assessment (RFA) of the Site (PRC Environmental Management 1997), SWMUs were identified as “Any discernible unit at which solid wastes have been placed at any time, irrespective of whether the unit was intended for the management of solid or hazardous waste. Such units include any area at a facility at which solid wastes have been routinely and systematically released.” On this basis all catch basins, sumps, and drain systems at the Site were identified as SWMUs.

The RFA identified three categories of SWMUs:

- **Low Release Potential SWMUs** are those that have little or no potential of releasing hazardous constituents to the environment. The RFA stipulates that no further action is required on low priority SWMUs.
- **Moderate Release Potential SWMUs** are those that have some potential to release hazardous wastes or constituents to the environment, based on the materials it contains, its proximity to risk-contoured areas, and its integrity. Further investigation was required for all Moderate Release Potential SWMUs. All catch basins and pumped sumps in the south drainage systems were included in this category.
- **High Release Potential SWMUs** are those that meet the criteria of the Moderate Release Potential SWMUs and have either a documented release or a very likely release. Among the South Drain System, the connecting drain systems are included in this category. High Release Potential SWMUs required further investigation.

For Moderate and High Release Potential SWMUs the RFA required the additional investigation including:

- Verification of drainage system features such as piping, sumps, catch basins, etc.
- Evaluating the materials that are or have been conveyed in the drainage systems.
- Evaluate the integrity of the drainage system
- Characterization of releases to soil and groundwater

The RFA identified all SWMUs as Moderate or High release potential SWMUs.

In 2007, Wah Chang submitted a report evaluating all of the drainage related SWMUs south of Truax creek (CH2M Hill 2007b). These SWMUs consisted of 202 catch basins, 21 sumps, and four drain systems totaling 19,142 feet of drain piping.

Most of these SWMUs did not have documented releases to soil or groundwater. Rather they were identified as potential locations where a release could occur based on the presence of underground or above ground plumbing that conveyed wastewater that may have contained hazardous waste.

The report detailed engineering inspections and reports for each catch basin and sump, camera inspections of all underground lines, relining of underground lines in poor conditions, and results of limited soil and groundwater sampling.

Based on a review of the document, ODEQ concluded that all catch basins and sumps except 10 met the requirements of low release potential SWMUs. The remaining SWMUs require additional evaluation in order to reclassify. ODEQ also reclassified two of the drain systems as low release potential.

6.10.2 Non-Drain SWMUs

During the 2008-2012 period, ODEQ assisted EPA in evaluating the Former Crucible Cleaning Area, which was identified as a potential source for groundwater contamination in an earlier ODEQ evaluation of non-drain SWMUs.

ODEQ is also working with EPA to evaluate potential petroleum impact to groundwater and possibly surface water near the former Deep Hole Boring Machine SWMU. Wah Chang recently completed an evaluation of the area downgradient of an underground storage tank in the area but has not yet submitted the results.

7 TECHNICAL ASSESSMENT

7.1 TECHNICAL ASSESSMENT OF OU1

The following section presents the technical assessment of OU1.

7.1.1 Question A: Is the remedy functioning as intended by the decision documents?

The review of documents and the results of the Site Inspection indicate that the remedy is functioning as intended by the ROD. EPA issued a Certification of Completion for the OU1 RA cleanup of contaminated material in the LRSP and Schmidt Lake on June 30, 1993.

Wah Chang lined Schmidt Lake (Pond 3). The Wah Chang facility wastewater will be pumped from Pond 2 to Pond 3 for additional cooling and discharged to the wetland treatment system and no longer discharged to Truax Creek.

Institutional Controls in the form of a conservation easement preclude further development on 12 acres of the Solids Area that is part of the LRSP.

7.1.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?

There are no changes in the exposure assumptions or RAOs used in making the remedy decisions in OU1.

7.1.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

No information calling into question the protectiveness of the remedy was identified during this FYR.

7.1.4 Technical Assessment Summary

The remedy for OU1 is functioning as intended and there are no changes that would affect protectiveness of human health and the environment.

7.2 TECHNICAL ASSESSMENT OF OU2

The following section presents the technical assessment of OU2.

7.2.1 Question A: Is the remedy functioning as intended by the decision documents?

EPA has determined that the remedy in OU2 is not functioning as intended by the decision documents in that the cleanup levels may not be met in the time frame of 15 years from the time of completion of GETS as specified in the Groundwater and Sediments ROD.

7.2.1.1 Groundwater

Extraction Area

The number of detections and concentrations of metals and radionuclides in the FMA have decreased, according to data reports Wah Chang submitted to EPA. However, annual monitoring data in the FMA currently show that COC concentrations are above ROD cleanup levels and the concentrations over time have been highly variable (Figure 6-3 through Figure 6-5). EPA has concluded that this could be due to acidic conditions in groundwater that mobilize metals from soil into the groundwater aquifer. The GETS system was not designed to address the acidic groundwater condition in the FMA that is potentially mobilizing COCs into groundwater. Therefore, in accordance with the ROD, implementation of in situ soil flushing is necessary. Since the 2008 FYR, discussions between EPA and Wah Chang resulted in the EPA's decision not to implement the original in situ soil flushing with solely water as specified in the ROD. The large amounts of water that are needed would overwhelm the utility trenches at the Site. Wah Chang submitted to EPA a focused feasibility study and treatability study work plan (Wah Chang 2012b) to evaluate the option of neutralizing the chemistry of the FMA acid plume by direct injection of base or buffer solutions instead of unbuffered water. EPA and Wah Chang are currently discussing the appropriate buffer technology. EPA expects to issue an ESD to the 1994 ROD by the end of 2013 in order to implement the unanticipated change of soil flushing with a buffer solution to raise pH in groundwater so RAOs can be met.

Since the 2008 FYR, Wah Chang performed source characterization to define the extent of soil flushing needed in the FMA. Wah Chang's source characterization included sampling a groundwater transect in September 2011 to determine if low pH groundwater was reaching Second Lake. Based on the results of the study, EPA determined that low pH groundwater was not detected in groundwater entering Second Lake (Wah Chang 2011a).

EPA determined from low extraction volumes in the extraction wells in the SEA and elevated concentrations of VOCs in groundwater that GETS was ineffective in this area. EPA further concluded that groundwater VOC concentrations in the SEA were not declining at a rate that would achieve RAOs within the timeframe called for in the ROD. Response actions that Wah Chang took to address this issue included EISB that EPA did not consider at the time of the ROD. Wah Chang and EPA evaluated the use of EISB as a new RA in the SEA through a March 2008 pilot test under an approved EPA work plan. Approximately 30 months (Fall 2010) following the implementation of EISB through the SEA pilot, EPA concurred with Wah Chang that all wells in the SEA met cleanup standards set forth in the ROD for OU2. Concentrations of VOC daughter products indicated that breakdown of parent compounds was occurring suggesting that reductive dechlorination was active and progressing. Groundwater field parameter data indicated geochemical conditions in the SEA were conducive to survival and function of dechlorination microbes, which are necessary to reduce VOCs (Wah Chang 2011b). Based on the low concentrations in the SEA, EPA approved Wah Chang's proposal for suspending operation of area extraction wells. .Given the lack of source area identification for the VOC concentrations, Wah Chang must monitor wells biannually in the SEA for VOCs for a period of at least 5 years from the shutdown of extraction wells (operation was suspended in April 2011) so EPA can determine if rebound is occurring. EPA will evaluate whether rebound occurs after the area returns to an oxygenated chemistry. If rebound occurs and additional action is necessary, Wah Chang and EPA will consider RA options to reduce VOCs in the SEA.

Fabrication Area

Following issuance of the second ESD for the groundwater ROD in 2009, Wah Chang performed EISB in the Fabrication Area to reduce COC concentrations in groundwater in two areas, the ASA and the CCA. In September 2009, Wah Chang, under EPA oversight, completed EISB in the ASA. Approximately 12 months following EISB, Wah Chang sampled groundwater and monitoring results indicated groundwater field parameter conditions conducive to dechlorination microbes, which are necessary to reduce COCs, had improved from the baseline conditions prior to injection (Wah Chang 2011c). Based on review of the ASA data summary, EPA determined that some wells still remain above action levels. However, Wah Chang's groundwater analytical data for VOCs indicate that TCA and TCE concentrations have been reduced and daughter compounds increased as a result of EISB. Wah Chang must continue monitoring to assess the continued effectiveness of parent compound dechlorination and to monitor changes in concentrations indicative of rebound conditions. The results of 18- and 24-month long-term monitoring following EISB implementation are expected in 2012 and should reveal to EPA how the remedy is progressing and if follow-up actions are needed.

After review of annual monitoring reports and ASA data summaries, EPA noted the presence of DNAPL solvent as a source. EPA is requiring Wah Chang to perform additional source characterization and removal or treatment in the ASA due to EPA's determination following review of ASA data summaries that the EISB has limited effect in the treatment of DNAPL sources.

In September 2010, Wah Chang completed EISB in the CCA and two additional monitoring wells were installed to support performance monitoring. Wah Chang's initial groundwater analytical results show that VOC concentrations have been reduced (Wah Chang 2011d). Additional performance monitoring results are anticipated from Wah Chang in 2012.

Farm Ponds

Analytical data from groundwater in the Farm Ponds Area indicated that concentrations of VOCs abruptly and unexpectedly decreased to below ROD cleanup levels after the 2008 monitoring event in the most contaminated well. However, since Wah Chang could not explain the decrease in VOC concentrations, the presence of chlorinated source material remains, and the possibility of rebound is likely. Wah Chang conducted additional actions in 2012 at the Farm Ponds to eliminate the suspected source of contaminants (Wah Chang 2012e) including removing the source material and excavating beyond the contaminated depth of the remaining pond's berms, with confirmation sampling. Wah Chang sampled groundwater downgradient of the former berms and EPA expects to evaluate the data in 2013 to assess the extent of dissolved solvents.

7.2.1.2 Surface Water

Wah Chang conducted supplemental surface water sampling on a biannual basis at Truax Creek and groundwater sampling from applicable western perimeter wells so the EPA could evaluate the potential for exposure to human health and the environment via the surface water pathway. Based on the results from surface water sampling, EPA has determined that VOCs have not been detected in surface water since the fall of 2008. However, EPA observed increased concentrations of VOCs in well PW-78A (close to Murder Creek) (Wah Chang 2011d) since the 2008 FYR until following the fall 2009 monitoring event when concentrations began to decrease in this well. The concentration of DCE in PW-78A again increased in November 2011. Isoconcentration maps also indicate the proximity of the DCE plume to Murder Creek. Wah Chang must collect additional surface water samples in the vicinity of this well to evaluate the potential for release of contaminated groundwater to the creek.

In order to evaluate risk to human health and the environment from the consumption of fish and/or organisms at Second Lake, Wah Chang recently sampled (August 2011) a transect that was discussed in the FMA section above. Since low pH groundwater was not detected in groundwater entering Second Lake, EPA concluded that constituents that would have been mobilized by the extremely acidic conditions would not be present in the lake as well. EPA also determined that contaminants are not reaching surface water and therefore not adversely impacting potential risk to human health from the consumption of fish and/or organisms. The implementation of the FMA acidic groundwater treatability study will likely increase the pH in groundwater and reduce the potential for COCs to be released from the underlying soils, transported by groundwater and reach surface water. Wah Chang will continue to monitor perimeter wells and EPA will evaluate the results.

7.2.1.3 PCBs

Wah Chang conducted a soil excavation in the early 1990s to remove PCBs in soil in the vicinity of the Emergency Services Building. Groundwater is being monitored in PW-30 and PW-46 to assess future impacts to groundwater that might come from sources in the soil of PCB contamination. In general, available information shows that PCB contamination does not pose a concern to human health and the environment because direct exposure to contaminated soil is limited by a protective cap (concrete or asphalt). Based on Wah Chang's data for ongoing environmental evaluations of uninvestigated areas, the groundwater remedy is not likely to be adversely affected by PCB contamination because PCB concentrations greater than 50 mg/kg have not been found to be in contact with groundwater.

7.2.1.4 Institutional Controls

ICs are required to prevent on- and off-site use of contaminated groundwater and to ensure that Site use remains industrial. ICs have been implemented on the Site in the form of restrictions on land use, groundwater use for drinking water, access, and construction; and Equitable Servitude and Easement Agreements on adjacent properties preventing use of groundwater for drinking water. The City of Albany requirements provide additional control that all new developments connect to municipal water lines if service is available within 150 feet.

Interviews with ODEQ and Oregon Department of Health (Appendix B) indicated that the ICs are functioning as intended and there have been no changes in land use or zoning.

Observations during the Site Inspection confirmed the Site is adequately fenced including security cameras. The Farm Ponds Area was observed to be fenced.

The Consent Decree requires deed restrictions on the Main Plant and Farm Ponds Areas to ensure groundwater will not be used for human consumption until remediation is complete, and to ensure that Site use remains industrial. Based on Wah Chang's title search (Wah Chang 1212c), EPA verified that deed restrictions on groundwater use are in place for the Main Plant and Farm Ponds Area. EPA verified that the Site is zoned for General Industrial use by the City of Millersburg, and ODEQ and Oregon Department of Health (Appendix B) do not anticipate future changes in zoning. Deed restrictions prohibiting residential use are in place for the Solids and Soil Amendment Areas, but not for the Main Plant and Farm Ponds Areas (Wah Chang 1212c).

The 1996 ESD requires "deed restrictions or other institutional controls acceptable to EPA and ODEQ for all off-site properties where groundwater containing contaminants above cleanup levels is present. These deed restrictions or other institutional controls shall notify future potential buyers of Site conditions, prevent the installation of water supply wells (and/or require proper abandonment of existing wells), and shall run with the land until groundwater contaminated above cleanup levels does not leave the Site boundary, and off-site cleanup levels are achieved." Based on Wah Chang's title search (Wah Chang 1212c), EPA confirmed that Equitable Servitude and Easement Agreements restricting groundwater use are in place on adjacent properties. However, EPA could not determine whether any deed restrictions are in place for the properties Wah Chang purchased in 2008 on the east side of

Old Salem Road where groundwater contamination has been confirmed, although EPA verified with the City of Millersburg that these properties are zoned for Limited Industrial Commercial use. EPA will further work with Wah Chang to verify that deed restrictions for properties on the east side of Old Salem Road are still indeed in place.

The ROD for OU2 required that "information on areas of subsurface PCB and radionuclide contamination which do not pose a risk if they are not disturbed be incorporated into the TWCA facilities maintenance plan, and be made available to future Site purchasers or regulatory agencies." EPA is requiring that Wah Chang provide a copy of this section of their site maintenance plan.

7.2.1.5 Sediment

Wah Chang implemented bank stabilization in 2000 that is currently functioning as intended. EPA does not plan additional RA for sediments. Wah Chang is planning to conduct an additional round of sediment sampling and analysis for PCBs in Truax Creek to assess the protectiveness of the remedy (Wah Chang 2012g). Results of this analysis are expected in 2013.

7.2.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?

The State of Oregon has revised the Risk Based concentrations for some COCs. The exposure concentrations for PCE, TCE, and VC under Oregon's Risk Based Concentrations have been increased and are now consistent with EPA's RBCs. There have been no changes to toxicity factors to these chemicals in IRIS.

Chemical-specific ARARs for Oregon's AWQCs protection of human health water and fish ingestion have been updated from OAR 340-41-445 to 340-041-0033 (adopted by the Environmental Quality Commission and became effective February 15, 2005). EPA recognized the updated AWQCs in October 2011. EPA is unable to determine the impact from the updated AWQC values because method reporting limits of the surface water samples are higher than the AWQC values. The manganese human health water quality criterion has been removed, and the arsenic human health water quality criterion has been revised to 2.1 ug/L.

The Environmental Health Assessment Program (EHAP), part of Oregon Public Health Division (OPHD), developed a Public Health Assessment (OPHD 2009) to evaluate the public health risk of exposure to contaminants in and around the Site. EHAP evaluated the public health impact of exposure to surface water in Second Lake and the consumption of fish caught from Second Lake, and determined that exposure to surface water from Second Lake poses no apparent public health hazard to adults or children who use the lake recreationally or as transients. To protect public health, EHAP recommended that Wah Chang continue to maintain perimeter fencing and security measures that prevent public access to areas within the Wah Chang plant, and notify EHAP if Wah Chang operations are altered such that parts of the plant, Truax Creek, or Murder Creek become accessible to the general public. EHAP also recommended that people not drink the water from Second Lake, because the water is not treated and may contain non-Site related bacteria or algae that could cause disease.

7.2.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

In 2007, as a result of implementing an EPA-required additional extraction well, Wah Chang released a source of TCA in the subsurface of the ASA. Following Wah Chang's groundwater investigation under EPA oversight, EPA concluded that a TCA concentration of 1,420,000 µg/L existed that was above the 10 percent solubility limit of the compound suggesting that DNAPL product is present in this area (CH2M Hill 2008). Due to the potential presence of DNAPL and/or the high concentrations of dissolved phase chlorinated organics in groundwater, EPA determined that modification to the groundwater remedy in the Fabrication Area was necessary to achieve RAOs in the estimated 15-year time frame for cleanup. In 2009, EPA issued the second groundwater ESD so Wah Chang could implement EISB under EPA oversight as a cleanup enhancement. Pending Wah Chang's submission of the results of additional groundwater monitoring data in 2013, additional remedial action in this area is required to address the source material that is unlikely to be successfully treated by EISB.

Wah Chang discovered during decommissioning that well SS, installed by Schoen Electric and Pump, had not been constructed in accordance with the regulations, and the depths and construction were not as shown on the well construction log. ODEQ checked Oregon's database for registered wells and found that Schoen Electric and Pump installed at least 14 other wells for Wah Chang between 1978 and 1982. Wah Chang must determine whether any of these wells are part of the routine monitoring program, and replace them if they are being used.

7.2.4 Technical Assessment Summary

EPA is evaluating the effectiveness of GETS and EISB and its ability to achieve cleanup goals in a reasonable time frame through review of ongoing groundwater monitoring data. Concentrations of COCs in groundwater remain above cleanup levels in the Fabrication Area and a DNAPL source discovered in the ASA will likely require additional treatment efforts.

In the FMA of the Extraction Area of the Main Plant, low groundwater pH is persistent. Although decreases in concentrations of some COCs have been observed since the 2008 FYR, modifications to the remedy in the FMA are required to achieve RAOs and the estimated 15-year time frame for cleanup. Wah Chang and EPA are evaluating the feasibility of groundwater infiltration using a basic solution to neutralize acidic groundwater and precipitate metals. EPA will evaluate Wah Chang's groundwater data collected following the 2012 source material removal at the Farm Ponds Area to confirm that concentrations of COCs are below cleanup levels.

The Site is zoned for General Industrial use and changes in zoning are not expected. Fencing is in place at the Main Plant and Farm Ponds Areas. Deed restrictions or Equitable Servitude and Easement Agreements restricting groundwater use are in place for the Main Plant, Farm Ponds Area, and adjacent properties. Wah Chang must verify the status of deed restrictions requiring that land use at the Site remain industrial, and determine whether deed restrictions for groundwater use and land use are in place for the properties Wah Chang recently purchased east of Old Salem Road.

7.3 TECHNICAL ASSESSMENT OF OU3

The following section presents the technical assessment of OU3.

7.3.1 Question A: Is the remedy functioning as intended by the decision documents?

The remedy is functioning as intended by the decision documents. Final Site closure for radionuclides will be conducted pursuant to Wah Chang's Oregon Radioactive Materials License and the Energy Facility Siting Council Administrative Rules. This work will be conducted under the oversight of the OHD and in consultation with ODEQ and EPA. Currently, Site safety is in place through Wah Chang's radiation management programs.

The Sitewide controls required in the September 2001 Soil ESD need to be incorporated into the Scope of Work for long-term protectiveness. At the time of decommissioning, Site controls will be added to the Consent Degree and SOW. Short-term protectiveness is in place through the Broad Scope Materials Radioactive License and is being implemented as part of the Wah Chang ongoing safety program.

The Soil Amendment Area is currently being used for agriculture and institutional controls are in place for radon mitigation with future buildings constructed on the property. Since it has been 17 years since the data were collected, EPA is requiring additional evaluation for radionuclides to ensure that tilling of soils or consumption of crops does not present risk to human health or the environment. There is uncertainty as to whether the current use of tilling the soil for agricultural purposes and the resulting soil resuspension were evaluated in the 1995 Radiological Survey Addendum. Wah Chang will be collecting soil samples and reevaluating the exposure and risk under EPA oversight.

Where radon concentrations in buildings could exceed 4 pico Curies per liter (pCi/L), the Consent Decree required institutional controls such that future buildings will be constructed using radon-resistant construction methods. These institutional controls include plant institutional controls, plant building codes, deed restrictions, or deed notices placed on the identified Main Plant Areas. Wah Chang has developed a Plant Standard providing requirements for radon control actions (Wah Chang 1997).

The Consent Decree and ROD also require institutional controls requiring that land use remain consistent with current industrial zoning. The Site is currently zoned for General Industrial use and zoning changes are not anticipated. Deed restrictions prohibiting residential use are in place for the Solids and Soil Amendment Areas, but not for the Main Plant and Farm Ponds Areas (Wah Chang 2012c).

7.3.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?

There have been no changes to the exposure assumptions, toxicity data, cleanup levels, and RAOs that would affect the remedy for the soils OU.

The Environmental Health Assessment Program (EHAP), part of Oregon Public Health Division (OPHD), developed a Public Health Assessment (OPHD 2009) to evaluate the public health risk of exposure to contaminants in and around the Site. EHAP evaluated the risk of the Soil Amendment Area, and determined that touching or swallowing soil from the Soil Amendment Area north of the Wah Chang plant is not expected to harm people's health, and recommended that the City of Millersburg ensure that no buildings are erected in this area without proper radon mitigation systems or remediation of the soil. EPA still has concerns regarding the agricultural process of tilling the soil and will be evaluating the current risks from farm worker exposure to resuspended soils.

7.3.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

Wah Chang has constructed the CoGen facility on an area of the Site where residual radioactive contamination potentially remains in place. This building was not constructed using radon resistant construction methods and does not include radon controls. Under EPA oversight, Wah Chang sampled indoor air in 2008 for radon and Wah Chang's results showed no radon detected above the action level and therefore no risks were present at the time of sampling.

Wah Chang's compliance with the ROD requirements for future operations will continue to be monitored and enforced. Site contamination not previously addressed is subject to investigation and corrective action under RCRA and may be addressed under either RCRA or CERCLA.

7.3.4 Technical Assessment Summary

EPA has determined that the remedy is functioning as intended by the ROD and as modified by the 2001 ESD based on review of Wah Chang's data. Although Wah Chang has completed the soil remediation in accordance with the 2001 ESD, Wah Chang is required to cleanup additional soils under the Wah Chang NORM License in order to comply with EPA's decommissioning rules at plant closure.

Anyone constructing future buildings on the Teledyne Wah Chang Main Plant must comply with EPA's decisions set forth in the ROD and ESD, and must conduct an assessment to determine whether radon levels could pose an unacceptable risk to building occupants and implement radon resistant construction and controls and radon testing if required. Since the CoGen building was not constructed using radon resistant construction methods and is located in an area where residual radioactive contamination may exist, Wah Chang must resample indoor air radon in this building to ensure protection of human health, and depending on the results, EPA may require additional sampling and radon mitigation.

EPA required institutional controls for radon mitigation in future buildings for the Soil Amendment Area and the City of Millersburg has such ICs in place. Since the City is conducting agricultural activities and tilling on the SAA, the existing soil radionuclide data were collected 17 years ago, EPA is requiring Wah Chang to collect and analyze soil samples in the SAA to reassess remaining levels of radionuclides and determine the risk to human health and the environment from the disturbance of soil.

8 ISSUES

This section discusses issues identified during the technical assessment and FYR activities, and provides a determination of whether each issue affects current or future protectiveness.

8.1 OU1 – SLUDGE PONDS

There are no issues regarding OU1.

8.2 OU2 – GROUNDWATER AND SEDIMENT

Table 8-1. Issues for OU2

Issue	Affects Protectiveness Current/Future
GROUNDWATER	
• Groundwater monitoring constituents have been reduced since the RI/FS. Contamination may have migrated over this period and monitoring points must be reassessed.	NO/YES
• During decommissioning of well SS in the Farm Ponds Area, Wah Chang discovered that Well SS was not properly constructed, and the contractor that installed well SS, Schoen Pump and Electric, also installed other wells at the Site.	NO/YES
• EPA has determined that Wah Chang needs to provide additional information on the status of the Institutional Control Instruments to verify that all institutional controls required by EPA's decision documents are in place.	NO/YES
Extraction Area	
• From Wah Chang's annual progress summaries and an independent review of Wah Chang's data, EPA determined that although GETS has reduced the concentrations of radium and other COCs in groundwater, low pH conditions persist that are contributing to COCs above ROD cleanup levels. Therefore it is unlikely that ROD cleanup levels will be achieved in the 15-year time frame without using a different treatment technology.	NO/YES
• Wah Chang implemented EISB as a pilot project under EPA oversight and VOCs were not detected in the SEA in 2011. Following EPA approval, Wah Chang shut down extraction wells in April 2011, although a source was never determined. The groundwater data needs to be assessed for potential reestablishment of a dissolved plume.	NO/YES
Fabrication Area	
• EISB has been implemented in the CCA and EPA is currently evaluating its effectiveness.	NO/YES
• Wah Chang completed EISB in the ASA in 2009 and EPA is currently evaluating its effectiveness. However, Wah Chang's release of DNAPL and/or high chemical concentrations in the ASA is an additional source area not encountered during the RI/FS, and it is unlikely that ROD cleanup levels will be achieved in 15-year time frame without additional remedial actions.	NO/YES
Farm Ponds Area	
• Based on Wah Chang's annual progress summaries and an independent review of Wah Chang's data, EPA noted that VOCs significantly and unexpectedly decreased to below ROD cleanup levels and was concerned about possible plume migration. In 2012, Wah Chang excavated potential source material, with EPA oversight, since the drop in concentrations was unexplained.	NO/YES
SURFACE WATER	
• Wah Chang's method reporting limits for some VOCs (PCE and VC) in surface water samples exceed the AWQC.	NO/YES
• EPA noted from Wah Chang's annual progress summaries and an independent review of Wah Chang's data that VOCs have been detected in surface water at the Site sporadically in past years. However, EPA believes that since the 2008 FYR, elevated concentration of VOCs observed in PW-78A may indicate migration of contaminated groundwater to Murder Creek.	NO/YES
SEDIMENT	
• Additional information on PCB concentrations in sediment is needed from Wah Chang so EPA can determine if the RA for sediment is functioning as intended.	NO/YES

8.2.1 Additional Issues

The FYR Site Inspection has identified maintenance issues in some of the flush completed monitoring wells and extraction wells.

8.3 OU3 – SURFACE AND SUBSURFACE SOIL

Table 8-2. Issues for OU3

Issue	Affects Protectiveness Current/Future
• The SOW and Consent Decree do not incorporate requirements of the 2001 Soil ESD regarding overall cleanup during decommissioning and other factors (see recommendations in Table 9.3).	NO/YES
• The Mayor of Millersburg indicated that tilling for agricultural purposes was being conducted on the SAA. Although the RI/FS determined that agricultural practices did not pose a risk to human health or the environment, EPA is revisiting the issue since it has been 17 years since the soil radionuclide data were collected and the original evaluation did not assess risks to agricultural workers from soil resuspension due to tilling. (see recommendations in Table 9.3).	YES/YES
• There is uncertainty in the location of the CoGen Building with respect to the overall soil radiation footprint left behind after Wah Chang's remedial actions in the Sand Unloading Area. EPA Institutional Controls require that anyone constructing future buildings use radon-resistant construction methods if those buildings are located on top of radioactive contamination (see recommendations in Table 9.3).	NO/YES

9 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

This section discusses required and/or suggested improvements to current Site operations, remedies, or conditions.

9.1 OU1 – SLUDGE PONDS

There are no issues regarding OU1.

9.2 OU2 – GROUNDWATER AND SEDIMENT

Table 9-1. Issues, Follow-Up Actions, and Recommendations for OU2

Issue	Follow-Up Action/ Recommendation	Affects Protectiveness Current/Future	Responsible Party	Milestone Date
GROUNDWATER				
Groundwater monitoring constituents have been reduced since the RI/FS. Contamination may have migrated over this period and monitoring points should be reassessed.	Wah Chang must submit a work plan to EPA and conduct a round of Sitewide monitoring for wells and parameters included in the original RI/FS using current analytical methodology.	NO/YES	Wah Chang with EPA oversight	12/31/2014
During decommissioning of well SS in the Farm Ponds Area, Wah Chang discovered that well SS was not properly constructed, and the contractor that installed well SS, Schoen Pump and Electric, also installed other wells at the site.	Wah Chang must submit a report to EPA documenting whether any of the wells being used for CERCLA Site investigations were installed by Schoen Electric and Pump. If improperly constructed wells are being used, Wah Chang must prepare a work plan for EPA approval and replace these wells with wells that are compliant with well construction regulations.	NO/YES	Wah Chang with EPA oversight	12/31/2013
EPA has determined that Wah Chang needs to provide additional information on the status of Institutional Control instruments to verify that all institutional controls required by EPA's decision documents are in place.	Wah Chang must verify the status of deed restrictions requiring that land use at the Site remain industrial, and whether deed restrictions for groundwater use and land use are in place for the properties Wah Chang recently purchased east of Old Salem Road. Wah Chang must also provide EPA with their site maintenance plan documenting areas of subsurface PCB and radionuclide contamination.	NO/YES	Wah Chang with EPA oversight	12/31/2013
Extraction Area				
From Wah Chang's annual progress summaries and an independent review of Wah Chang's data, EPA determined that although GETS has reduced the concentrations of radium and other COCs in groundwater, low pH conditions persist that are contributing to COCs above ROD cleanup levels. Therefore it is unlikely	Evaluate the use of basic solution (lime) groundwater flushing as a new RA to raise groundwater pH and decrease the mobility of inorganic constituents. Wah Chang has submitted a treatability study and if EPA determines that this technology is feasible, EPA expects to issue an ESD before the end of 2013 to implement the remedy.	NO/YES	Wah Chang with EPA oversight	12/31/2015

Table 9-1. Issues, Follow-Up Actions, and Recommendations for OU2 (continued)

Issue	Follow-Up Action/ Recommendation	Affects Protectiveness Current/Future	Responsible Party	Milestone Date
that ROD cleanup levels will be achieved in the 15-year time frame without using a different treatment technology.				
Wah Chang implemented EISB as a pilot project under EPA oversight and VOCs were not detected in the SEA in 2011. Following EPA approval, Wah Chang shut down extraction wells in April 2011, although a source was never determined. The groundwater data needs to be assessed for potential reestablishment of dissolved plume.	Wah Chang must continue to monitor groundwater conditions biannually under EPA oversight for 5 years following shutdown of extraction wells to assess whether the dissolved plume is reestablishing itself.	NO/YES	Wah Chang with EPA oversight	12/31/2016
Fabrication Area				
EISB has been implemented in the CCA and EPA is currently evaluating its effectiveness.	Wah Chang must continue additional performance monitoring to determine if ROD cleanup levels will be achieved by 2017 which is the time frame specified in the ROD.	NO/YES	Wah Chang with EPA oversight	12/31/2017
Wah Chang completed EISB in the ASA in 2009 and EPA is currently evaluating its effectiveness. However, a release of DNAPL and/or high chemical concentrations in the ASA indicate an additional source area not encountered during the RI/FS, and it is unlikely that ROD cleanup levels will be achieved in the15-year time frame without additional remedial actions.	Wah Chang must continue additional performance monitoring to determine if ROD cleanup levels will be achieved. Treatment of the plume is successfully reducing dissolved phase chlorinated solvents, however geochemical evidence in the form of high dissolved concentrations in the source area indicate a DNAPL source remains that will require more aggressive remediation.	NO/YES	Wah Chang with EPA oversight	12/31/2015
Farm Ponds Area				
Based on Wah Chang's annual progress summaries and an independent review of Wah Chang's data, EPA noted that VOCs unexpectedly decreased to below ROD cleanup levels and was concerned about potential plume migration. In 2012, Wah Chang excavated potential source material since the drop in concentrations was unexplained.	Wah Chang excavated the potentially contaminated pond's berms, and collected groundwater samples to confirm groundwater conditions. EPA will evaluate the data to determine whether the extent of the dissolved solvent plume requires additional assessment.	NO/YES	Wah Chang with EPA oversight	12/31/2014

Table 9-1. Issues, Follow-Up Actions, and Recommendations for OU2 (continued)

Issue	Follow-Up Action/ Recommendation	Affects Protectiveness Current/Future	Responsible Party	Milestone Date
SURFACE WATER				
Wah Chang's method reporting limits for some VOCs (PCE and VC) in surface water samples exceed the AWQC.	Wah Chang must reduce the method reporting limits for PCE and VC in surface water samples to enable identification of COCs in surface water.	NO/YES	Wah Chang with EPA oversight	12/31/2014
EPA noted from Wah Chang's annual progress summaries and an independent review of Wah Chang's data that VOCs have been detected in surface water at the Site sporadically in past years. However, EPA believes that since the 2008 FYR, elevated concentration of VOCs observed in PW-78A may indicate migration of contaminated groundwater to Murder Creek.	Wah Chang must add surface water sample locations in the vicinity of PW-78A in Murder Creek to evaluate potential for contaminated groundwater to be released to surface water.	NO/YES	Wah Chang with EPA oversight	12/31/2014
SEDIMENT				
Additional information on PCB concentrations in sediment is needed from Wah Chang so that EPA can determine if the RA for sediment is functioning as intended.	Wah Chang must submit an appropriate work plan to EPA for approval and conduct sediment sampling and analysis in a manner consistent with the approved Work Plan.	NO/YES	Wah Chang with EPA oversight	12/31/2014

9.2.1 Additional Recommendations and Follow-Up Actions

The FYR Site Inspection has identified maintenance issues in some of the flush completed monitoring wells and extraction wells. Wah Chang will conduct minor maintenance on some of those monitoring wells and contract with a driller to conduct rehabilitation of some of those extraction wells.

9.3 OU3 – SURFACE AND SUBSURFACE SOIL

Table 9-2. Issues, Follow-Up Actions, and Recommendations for OU3

Issue	Follow-Up Action	Affects Protectiveness Current/Future	Responsible Party	Milestone Date
The SOW and Consent Decree do not incorporate requirements of the 2001 Soil ESD regarding overall cleanup during decommissioning and other factors.	Prior to plant decommissioning, EPA and ODEQ will amend the SOW of the 1996 Consent Decree to incorporate applicable requirements of the 2001 Soil ESD for plant decommissioning.	NO/YES	Wah Chang and USA and State of Oregon	01/07/2018
The Mayor of Millersburg indicated that tilling for agricultural purposes was being conducted on the SAA. Although the RI/FS determined that agricultural practices did not pose a risk to human health or the environment, EPA is revisiting the issue since it has been 17 years since the soil radionuclide data were collected and the original evaluation did not assess exposures to agricultural workers from soil resuspension due to tilling.	Wah Chang must collect and analyze soil samples for radium so EPA can reevaluate the risk to human health and the environment from the disturbance/resuspension of soil and remaining levels of radionuclides in soil. Given that the earlier testing did not demonstrate human health risk, the City may continue to use the property for agricultural activities including tilling the soil although it is suggested by EPA that ground disturbing activities that may resuspend soil should be limited. Following EPA's reassessment of the contaminated soils, should there be an indication of human health risk to those exposed to these soils under current agricultural practices, EPA will share those results with the City of Millersburg and discuss appropriate actions for future use of the property.	YES/YES	EPA and the City of Millersburg	12/31/2014

Table 9-2. Issues, Follow-Up Actions, and Recommendations for OU3 (continued)

Issue	Follow-Up Action	Affects Protectiveness Current/Future	Responsible Party	Milestone Date
There is uncertainty in the location of the CoGen Building with respect to the overall soil radiation footprint left behind after Wah Chang's remedial actions in the Sand Unloading Area. EPA Institutional Controls require that anyone constructing future buildings use radon-resistant construction methods if those buildings are located on top of radioactive contamination.	Wah Chang, under EPA oversight, must retest indoor air for radon in the CoGen Building by end of calendar year 2013, and based on the results of radon concentrations, EPA may require further testing or actions.	NO/YES	Wah Chang with EPA oversight	12/31/2014

10 PROTECTIVENESS STATEMENTS

This section presents protectiveness statements for OU1 through OU3.

10.1 OU1 – SLUDGE PONDS

The remedy for OU1 is protective of human health and the environment, and exposure pathways that could result in unacceptable risks are being controlled.

10.2 OU2 – GROUNDWATER AND SEDIMENT

The remedy at OU2 is currently protective of human health and the environment in the short term. Progress to meet the groundwater RAOs is being made through an operating GETS enhanced with EISB. ICs are in place preventing exposure to contaminants of concern above cleanup goals through on-site and off-site deed restrictions on groundwater use, zoning, and access controls. In order for the remedy to be considered protective in the long term, Wah Chang must obtain and provide to EPA further information on pH conditions and COC concentrations and verify that all IC instruments required by EPA's decision documents are in place. Long term protectiveness will be obtained when Wah Chang and EPA take the actions described below:

Wah Chang must implement buffer solution treatment under EPA oversight to the groundwater source area contamination in the FMA stemming from acidic pH conditions and resulting in concentrations of COCs that remain above ROD cleanup levels. Groundwater quality conditions in the FMA are unlikely to achieve RAOs within the estimated 15-year time frame specified in the ROD. EPA will evaluate the effectiveness of additional remedial actions in the FMA as data become available. EPA expects this action to be completed and data available to assess effectiveness in 2016.

Since Wah Chang's annual progress summaries indicate that no VOCs have been detected in groundwater in the SEA, and that ROD cleanup levels have been met, EPA considers the SEA protective in the short term. EPA-required ICs are in place at the Site that prevent human use of groundwater, and the Site is still zoned for General Industrial use by the City of Millersburg. Long term protectiveness will require Wah Chang under EPA oversight to assess the mobilization of solvents from the source area after oxygen has stopped the reductive dechlorination of dissolved chlorinated solvents. This assessment will consist of long-term ground-water monitoring. EPA will reassess the effectiveness of EISB in the SEA based on Wah Chang's groundwater monitoring data that will be submitted annually through 2016.

EPA has determined that due to elevated concentrations of VOCs in the ASA and CCA, Wah Chang must continue to monitor geochemical conditions to evaluate the effectiveness of EISB and reductive dechlorination. In 2014, EPA will reassess the effectiveness of the EISB based on the groundwater data collected by Wah Chang and will make a decision whether the remedy will meet ROD cleanup levels in the 15-year time frame specified in the ROD or whether additional treatment will be required. However, Wah Chang's release of DNAPL and/or high concentrations of VOCs in the ASA is an additional source area not encountered during the RI/FS that will likely require more aggressive remediation. Wah Chang must assess the source of DNAPL in the ASA and provide data to EPA by 2014.

EPA has observed increased concentrations of VOCs in well PW-78A (close to Murder Creek). The current downstream surface water sampling is located 200 feet from the anticipated discharge point of groundwater in the vicinity of this well. Under EPA oversight, Wah Chang must collect additional seepage and surface water samples in the vicinity of well

PW-78A so EPA can evaluate the potential for release of contaminated groundwater to the creek. EPA expects to evaluate additional data by 2013.

Since the 2008 FYR, Wah Chang's annual progress summaries and EPA's independent review of Wah Chang's data showed increasing CVOC concentrations in groundwater in the Farm Ponds Area indicating that ROD performance standards may not be met. However, EPA noted recent unexplained declines in concentrations. In 2012 Wah Chang completed excavation of the berm material that may have acted as a source of groundwater contamination, and collected confirmation samples of groundwater. EPA will evaluate the results of the completion report in 2013 to assess whether additional actions will be are required.

Wah Chang must conduct additional sampling and analysis of PCBs in sediments to ensure that the remedy for sediments is protective. EPA expects to evaluate additional data in 2013.

Wah Chang must submit a report to EPA documenting whether any of the wells being used for CERCLA Site investigations were installed by Schoen Electric and Pump. If improperly constructed wells are being used, Wah Chang must prepare a work plan for EPA approval and replace these wells with wells that are compliant with well construction regulations.

Wah Chang must verify the status of deed restrictions requiring that land use at the Site remain industrial, and whether deed restrictions for groundwater use and land use are in place for the properties Wah Chang recently purchased east of Old Salem Road. Wah Chang must also provide EPA with their site maintenance plan documenting areas of subsurface PCB and radionuclide contamination.

10.3 OU3 – SURFACE AND SUBSURFACE SOIL

A protectiveness determination of the remedy at OU3 cannot be made at this time until further information is obtained associated with exposure to radionuclides from resuspension due to tilling in the Soil Amendment Area. Further information will be obtained by taking the following actions. Under EPA oversight, Wah Chang must collect samples of SAA soil and test for radiological contamination by the end of calendar year 2013 so EPA can reevaluate in 2014 the risk to human health and the environment from the disturbance/resuspension of soil to evaluate whether human health and the environment are protected under the existing remedy.

Excavation of contaminated soil at the main facility was completed and ICs, in the form of deed restrictions, are in place for remaining contaminated soil so human exposure will not occur. Additionally, for the remedy to be protective in the long term, EPA and Wah Chang need to take the following actions to ensure protectiveness:

Prior to plant decommissioning, EPA and ODEQ will amend the SOW of the 1996 Consent Decree to incorporate applicable requirements of the 2001 Soil ESD for plant decommissioning.

Under EPA oversight, Wah Chang must retest for radon in the CoGen Building by the end of calendar year 2013 due to uncertainty in the location of the CoGen Building with respect to the overall soil radiation footprint remaining after remediation of the Sand Unloading Area. Based on the results, EPA may require additional testing of radon in indoor air or radon mitigation.

10.4 SITEWIDE PROTECTIVENESS

EPA has determined that there is not enough information to evaluate protectiveness, primarily in the area of the Site that has agricultural activities (SAA). Therefore, the Sitewide protectiveness is deferred until the following additional information is evaluated. Wah Chang must collect and analyze soil samples for radium so EPA can reevaluate the risk to human health and the environment from the disturbance/resuspension of soil. Given that the earlier testing did not demonstrate human health risk, the City may continue to use the property for agricultural activities including tilling the soil although it is suggested by EPA that ground disturbing activities that may resuspend soil should be limited. Following EPA's reassessment of the contaminated soils, should there be an indication of human health risk to those exposed to these soils under current agricultural practices, EPA will share those results with the City of Millersburg and discuss appropriate actions for future use of the property.

Progress to meet the groundwater RAOs is being made through an operating GETS enhanced with EISB. ICs are in place preventing exposure to contaminants of concern above cleanup goals through on-site and off-site deed restrictions on groundwater use, zoning, and access controls. In order to ensure long term protectiveness, Wah Chang must provide further information on pH conditions and groundwater COC concentrations following remedy enhancements so that EPA can evaluate the ability of the OU2 remedy to meet RAOs within the 15-year time frame specified in the ROD (2017). In addition, Wah Chang must confirm that all IC instruments required by EPA's decision documents are in place for all parcels of property that could be affected by contaminated groundwater. Wah Chang must verify the status of deed restrictions requiring that land use at the Site remain industrial, and whether deed restrictions for groundwater use and land use are in place for the properties Wah Chang recently purchased east of Old Salem Road. Wah Chang must also provide EPA with their site maintenance plan documenting areas of subsurface PCB and radionuclide contamination.

EPA required Institutional Controls are in place requiring that anyone constructing future buildings on the Teledyne Wah Chang Main Plant must conduct an assessment to determine whether radon levels could pose an unacceptable risk to building occupants and implement radon resistant construction and controls and radon testing if required. Since the CoGen building was not constructed using radon resistant construction methods and is located in an area where residual radioactive contamination may exist, Wah Chang must resample indoor air radon in this building to ensure long term protectiveness of human health, and depending on the results, EPA may require additional sampling and radon mitigation.

11 NEXT REVIEW

The next statutory review will be in 2018, 5 years after the signature date of this review. Based on the ROD performance standards, concentrations of Site contaminants must be below cleanup levels by the time of the next FYR. However, if hazardous substances remain above levels that allow for unlimited use and unrestricted exposure at the Site, five-year reviews will continue and the remedy may need to be revisited.

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APPENDIX A

Public Notice

United States Environmental Protection Agency

Teledyne Wah Chang Superfund Site Cleanup 5-Year Review

Public Comments Invited Through July 31, 2012

The U.S. Environmental Protection Agency (EPA) is preparing the fourth 5-Year Review of the Teledyne Wah Chang Superfund Site in Millersburg, Oregon. EPA is required to review the cleanup decision for Superfund sites every five years. The review evaluates whether the cleanup continues to protect people and the environment. Cleanup at Teledyne Wah Chang combined soil excavation with a system to extract and treat contaminated groundwater; it also included land use restrictions.

Teledyne Wah Chang continues to monitor chemical concentrations in the groundwater. EPA regularly reviews the data to ensure that the cleanup is progressing as planned. EPA welcomes the public's participation in this review. Anyone who has information that may help the review, or concerns about the site should contact EPA Project Manager Ravi Sanga at 206-553-4092, or toll free at 1-800-424-4372, extension 4092. You can send email to: sanga.ravi@epa.gov. *TDD users may call the Federal Relay Service at 1-800-877-8339 and give the operator Ravi Sanga's phone number.*

The Teledyne Wah Chang site is on EPA's National Priorities List of the nation's most contaminated hazardous waste sites. The site was contaminated by wastes from a metals production plant. Pollutants include radionuclides and volatile organic compounds, which impacted site groundwater, sediments, and soils. Cleanups took place during the mid- and late-1990s and in early 2000.

To learn more, visit www.epa.gov/r10earth/, click on *Index A-Z*, then click on *T* and select *Teledyne Wah Chang*.

APPENDIX B

Interviews

INTERVIEW RECORD

Site Name: Wah Chang	**EPA ID No.:** ORD050955848	
Subject: Five Year Review Report Interview	**Time:** 1300	**Date:** 3-12-12
Type: ☐ Telephone ☐ Visit ☐ Other **Location of Visit:**	☐ Incoming ☐ Outgoing	

Contact Made By:

Name: Ravi Sanga	**Title:** TOPO	**Organization:** EPA
Name: Mike Marshall	**Title:** Geologist	**Organization:** Parametrix

Individual Contacted:

Name: Clayton Wood	**Title:** Mayor	**Organization:** City of Millersberg
Telephone No: 541-928-4523 **E-Mail Address:** bcastillo@cityofmillersburg.org	**Street Address:** 422 NE Old Salem Road **City, State, Zip:** Albany, Or 97321	

Summary Of Conversation

1. How long have you been mayor?
   a. Since January 2, 1976

2. Are you aware of the soil amendment area (SAA)? What is your knowledge about the parcel of property that was received from Teledyne ?
   a. The status of the property has not change from farmland. The property is used for the production of grass seed. The City of Millersburg is aware of the radionuclide contamination on the property.

3. Do you recall the transfer of the soil amendment area? Do you recall the circumstances that lead to the transfer off the SAA to the City of Millersburg ?
   a. The transfer was a part of a land swap deal between Wah Chang and the City of Millersburg. The land was traded for land closer to Wah Chang the City owned for the SAA that was connected to land on owned by the City on each side of the SAA

4. Has anything to your knowledge changed in the area? What is the current use of the property ? Has anything changed regarding the land use of the property in the past 5 years ? 10 years ?
   a. No land use has changed within the last 10 or 5 years

   b. Current use includes agricultural activities which till and farm for the production of grass seed. The land is plowed and the grass seed added. The recent use of direct seed planting occurred last year. This process does not use tilling. The grass seed is planted by drilling a small hole and the seed placed inside. The tilling process usually impacts the top 7 or 6 inches of soil.

5. Are land use and zoning laws unchanged in this area?
   a. Zoning laws are unchanged

6. Do you have the deed and title documents for this property?
    a. These documents should have land use restrictions in them.
7. Have there been any complaints on the site or trespassing?
    a. No complains or trespassing activity has been reported
    b. No buildings have been constructed on the property
    c. There has been no interest in building on the property. Development in the area has been very dead in the last 5 years.

8. Can EPA have a copy of the deed to ensure the appropriate restrictions are placed on the property?
    a. yes we can have copy
    b. Barbara Castillo will provide a copy

9. Do you feel informed about the Teledyne site's activities and progress? By activities we mean progress with the GW cleanup, monitoring for Radon in buildings etc.
    a. There is not much contact with the site related to cleanup or contamination
    b. The only communication is when there is a link with the city and Jim Dennum with Wah Chang is requesting building permits

10. Do you have any additional questions or comments regarding the 5 year review process or the Teledyne Wah Chang Superfund site and the SAA ?
    c. No additional questions

INTERVIEW RECORD

Site Name: Wah Chang	**EPA ID No.:** ORD050955848	
Subject: Five Year Review Report Interview	**Time:** 1530	**Date:** 8-09-12
Type: ☒ Telephone ☐ Visit ☐ Other **Location of Visit:**	☐ Incoming ☒ Outgoing	

Contact Made By:

Name: Ravi Sanga	**Title:** TOPO	**Organization:** EPA
Name: Lisa Gilbert	**Title:** Hydrogeologist	**Organization:** Parametrix

Individual Contacted:

Name: David Farrer	**Title:** Public Health Toxicologist, Environmental Health Assessment Program	**Organization:** Oregon Health Authority Public Health

Telephone No: 971-673-0971 **E-Mail Address:** david.g.farrer@state.or.us	**Street Address:** Research and Education Services 800 NE Oregon Street, Suite 640 **City, State, Zip**: Portland, OR 97232

Summary Of Conversation

1. What is your overall impression of the Teledyne Wah Chang Superfund Site? Are there any human health or Ecological concerns that you may have resulting from the contamination? Do you think the health of the surrounding communities are being affected by the site?

Their agency deals with public health, not worker health. The remaining risks are contained on the site property and barriers including ICs bar access to the general public. There are no residual risks for the general public. Second Lake (recreation and fishing) and the Soils Amendment Area were found to have a low risk to the general public. There may be risks in the future to the public if the site were to shut down and become accessible to the public.

2. Have there been routine communications or activities (site visits, inspections, reporting activities, etc.) conducted by your office with Teledyne Wah Chang regarding any human health or ecological issues that you have been concerned about ? If so, please give purpose and results.

Prepared the Public Health Assessment in May 2008 and released it in December 2009. David hasn't been to the site since then. The conclusion of the Public Health Assessment was no substantial health risk, even in Second Lake, although the water should not be a drinking source because it is generally untreated. Wah Chang is maintaining ICs and physical barriers.

3. Have there been any concerns from your constituents, violations, or other incidents related to the contamination at Teledyne Wah Chang that require a response by your office? If so, please give details of the events and results of the responses.

No there has been little contact from the general public.

4. Do you feel well informed about the cleanup at the site?

Yes but haven't kept up on all the information.

5. Do you have any comments, suggestions, or recommendations regarding the contamination still present at Teledyne Wah Chang? Are there any concerns you have regarding the current manufacturing/production operation of Teledyne that you believe is still resulting in contamination to the environment?

No.

6. Are there any changes in State laws or regulations that may impact protectiveness?

No.

7. Has the site been in compliance with permitting or reporting requirements from the programs you enforce or manage? If not what has been going on and what are your concerns?

This question is Not Applicable since Public Health does not have authority.

8. Do you have any additional questions or comments regarding the 5 year review process or the Teledyne Wah Chang Superfund site and the SAA ?

No.

INTERVIEW RECORD

Site Name: Wah Chang	**EPA ID No.:** ORD050955848	
Subject: Five Year Review Report Interview	**Time:** 1430	**Date:** 8-09-12
Type: ☒ Telephone ☐ Visit ☐ Other **Location of Visit:**	☐ Incoming ☒ Outgoing	

Contact Made By:

Name: Ravi Sanga	**Title:** TOPO	**Organization:** EPA
Name: Lisa Gilbert	**Title**: Hydrogeologist	**Organization:** Parametrix

Individual Contacted:

Name: Geoff Brown	**Title:** Hydrogeologist	**Organization:** Oregon Department of Environmental Quality
Telephone No: 541-686-7819 **E-Mail Address:** brown.geoff@deq.state.or.us	**Street Address:** 165 East 7th Avenue, Suite 100 **City, State, Zip:** Eugene, OR 97401	

Summary Of Conversation

1. What is your overall impression of the Teledyne Wah Chang Superfund Site?

Wah Chang is working hard and spending a lot of money to remedy past practices.

Are there any human health or Ecological concerns that you may have resulting from the contamination?

No concerns that are not being addressed by the remedy.

Do you think the health of the surrounding communities are being affected by the site?

No. Soil and groundwater are in control, we have a good sense of the beneficial uses, and we know where the soil amendment was spread.

2. Have there been routine communications or activities (site visits, inspections, reporting activities, etc.) conducted by your office with Teledyne Wah Chang regarding any human health or ecological issues that you have been concerned about ? If so, please give purpose and results.

None related to the Superfund cleanup, but DEQs Hazardous Waste Department has had interactions with the operation side. There was an issue not too long ago with an unrelated facility.

3. Have there been any concerns from your constituents, violations, or other incidents related to the contamination at Teledyne Wah Chang that require a response by your office? If so, please give details of the events and results of the responses.

No violations or incidents have occurred during the last 5 years, but it DEQ may have responded to some spill incidents. Geoff will search Spills Program database. There have been sporadic inquiries about the Soil Amendment Area for potential development. Also there was an inquiry about the Main Plant regarding influence on a nearby organic farm, but this site was upgradient, and a question about a site as to whether soil amendment had been applied (negative).

4. Do you feel well informed about the cleanup at the site?

Yes and No. Overall Yes. But there are nagging issues regarding documents not being received by DEQ, and DEQ would like to receive communication in a more consistent fashion.

5. Do you have any comments, suggestions, or recommendations regarding the contamination still present at Teledyne Wah Chang? Are there any concerns you have regarding the current manufacturing/production operation of Teledyne that you believe is still resulting in contamination to the environment?

Nothing concrete. No concerns regarding the complex manufacturing process. However, there are a lot of pipes at the site and DEQ has had past concerns regarding the soil screening criteria. It is possible that contaminants were missed because of field-based tests. Additional testing is not required but would present an opportunity to identify source soils.

6. Are there any changes in State laws or regulations that may impact protectiveness?

No the site is governed by EPA. However, DEQ just revised its TEQs for TCE and PCE to be less stringent by a factor of 20, and the resulting drinking water RBCs went way up.

7. Has the site been in compliance with permitting or reporting requirements from the programs you enforce or manage? If not what has been going on and what are your concerns?

Yes Wah Chang rarely pushes back.

8. Do you have any additional questions or comments regarding the 5 year review process or the Teledyne Wah Chang Superfund site and the SAA ?

The SWMU evaluation of the south drainage system (south of Truax Creek, including catch basins, sumps, and pipes) was completed in 2008 and looked at SWMUs identified in the 1997 RCRA Facility Investigation with low, moderate or high release potential. Some pipe systems where potential leaks were identified were sealed with epoxy, but the majority of the SWMUs were recharacterized as low potential risk. DEQ is currently tallying the remaining issues. The only discovery was near the CCA SWMU and this is being addressed by EISB.

The Deep Hole Boring UST is on a path toward closure. There are no seeps to the creek but some possible contamination in groundwater. DEQ has recently sent modifications to the Work Plan to Wah Chang, and the investigation is moving forward.

INTERVIEW RECORD

Site Name: Wah Chang	**EPA ID No.:** ORD050955848	
Subject: Five Year Review Report Interview	**Time:** 1100	**Date:** 3-12-12
Type: ☒ Telephone ☐ Visit ☐ Other **Location of Visit:**	☐ Incoming ☒ Outgoing	

Contact Made By:

Name: Ravi Sanga	**Title:** TOPO	**Organization:** EPA
Name: Mike Marshall	**Title:** Geologist	**Organization:** Parametrix

Individual Contacted:

Name: Jeff Roberts	**Title:** Laboratory Manager	**Organization:** SiREM Labs
Telephone No: 1-866-251-1747ext.228 **E-Mail Address:** jroberts@siremlab.com	**Street Address:** 130 Research Lane Suite 2 **City, State, Zip:** Guelph, Ontario, Canada, N1G5G3	

Summary Of Conversation

1. What is your technical background and role with SiREM?

Bachelor of Science Degree from Waterloo University for environmental science. Graduated in 2003, and was hired by SiREM. Attended the master degree program at the University of Waterloo, Ontario, Canada for Earth Science. Currently the Lab manager, after working through the ranks. Mr. Roberts oversees the bioremediation activities at hundreds of sites across the country. Oversees a lot of culture growth and maintenance in the lab as well as treatability studies.

2. How long have you been with the company?
   a. Since about 2002 as a co-op student.
3. What is your experience with the Wah Chang site?
   a. First exposed with GIS in about 2007 for the first pilot test
      i. GSI provided site data and Mr. Roberts worked with that to recommended appropriate volume of kb-1 and KB-1 plus
   b. Data needed for recommendations, contaminated concentrations, redox, pH, DO Sulfate and nitrate, other electron acceptors, proposed number of injection points, electron donor, and size of treatment area.
   c. Standard dosing based on volume of groundwater trying to treat and can be adjusted form other factors, like high concentrations may require increased volume of KB-1.
   d. What is your opinion of progress?
      i. Great success data received showed TCA and TCE concentration decreased to ROD limits within several months.
      ii. The site is well suited to this treatment and the way implemented was done well.
      iii. Adding the electron donor, ensuring the groundwater was reduced, culture was added under the appropriate conditions was key.
      iv. And the process was conducted effectively.
      v. SiREM provided insight and data review for GSI.
4. Have you had much coordination with Wah Chang following the implementation of the remedy?
   a. Coordinate with GSI for size, volumes, geochemistry
5. Can you briefly describe the dechlorination process?
   a. Ethenes (PCE) parent compounds is dechlorinated by removal of a chlorine atom and is replacement by hydrogen. And it becomes a less chlorinated compound. The dehalococcoides is respiring the compound using is it as an electron acceptor and hydrogen as an electron donor.
6. How do you think the progress is going across the site in the other areas (ASA and CCA)

a. Believe that based on conversations with GSI the results are positive.

7. At what point would you recommend amendment to the treatment in progress?
    a. Most cases KB1 does not need to be reapplied
        i. Once established the bacteria are hardy. But Adding deoxygenated water with some lactate could be enough to reinvigorate bugs
    b. Certain criteria to suggest need for additional treatment see a dechlorination trend stall, electron donor level depletion
    c. Rule of thumb to reamendment is necessary when 100 mg/L of TOC present
    d. ORP in negative range -70 to -100 mV is ideal
8. What other compounds in groundwater could limit the effectiveness of treatment?
    a. Iron and mag compete for electron donor so if present they need to be reduced first before the chlorinated compound will be reduced.
    b. Chloroform and 1,1,1 -TCA can inhibit ethene pathway so the KB-1 was used due to halobacter bacteria.
9. Do you have any other recommendations to enhance treatment effectiveness?
    a. Monitor and keep an eye on indicators; dechlorination, low ORP and enough electron donor presents. And if something begins to change additional electron donor could be added.
10. Are you aware of the effect of oil substrate on water level measurements?
    a. Oil present in the water can coat ORP membrane and distort ORP measurements. This needs to be regularly cleaned off.
    b. Some sites bio fowling may occur at some sites from lactate additives. Screen intervals could be influencing water levels in the wells.
11. Will the bacteria consume NAPL?
    a. The bacteria will only consume VOCs in the dissolved phase, they won't degrade pure NAPL. The bacteria can only access what is in aqueous phase. However, they enhance the dissolution of the DNAPL as the concentration becomes low at the product water interface, the bacteria can increase the dissolution rate from the pure phase to the dissolved phase. The dehalococcoides will die off when chlorinated compounds are gone.

INTERVIEW RECORD

Site Name: Wah Chang	**EPA ID No.:** ORD050955848
Subject: Five Year Review Report Interview	**Time:** 1500 **Date: 2-16-12**
Type: ☐ Telephone ☒ Visit ☐ Other **Location of Visit:**	☐ Incoming ☐ Outgoing

Contact Made By:

Name: Mike Marshall	**Title:** Geologist	**Organization:** Parametrix

Individual Contacted:

Name: Noel Mak	**Title:** Resource Conservation Specialist	**Organization:** Wah Chang
Telephone No: **E-Mail Address:**	**Street Address:** **City, State, Zip:**	

Summary Of Conversation

The EPA interviewed Ms. Noel Mak of Wah Chang on February 16, 2012. Ms. Mak is Wah Chang's Resource Conservation Specialist.

Her overall impression of the clean-up activities at the site were things were going well and that she expected ROD standards to be achieved within the required time frame. Ms. Mak indicated that monitoring data collected at the site currently showed that progress was being achieved in all areas, and contaminant concentrations were decreasing. Ms. Mak indicated that the clean-up activities for OU1 were complete, cleanup for OU2 was ongoing, and the cleanup for OU3 was ongoing until OU2 cleanup was completed. She indicated that gamma radiation left in place at the Sand Unloading Area and the front parking lot will remain until appropriately transferred under the facilities naturally occurring radioactive materials (NORM) license.

She mentioned that the facility had a full-time employee that was responsible for operation and maintenance of the GETS. Mr. Mike Cochran is the facilities dump master and repairs, monitors, and directs replacement of the treatment system components as necessary. If repairs are beyond his abilities, he pursues assistance from pump specialists, electricians, and outside contractors as necessary to maintain operation of the groundwater treatment system. To maintain operation, Wah Chang replaces pumps in the FMA extraction wells approximately every 3 months due to the corrosive nature of groundwater in the area. Several parts and replacement pumps are stored at the Wah Chang facility to minimize downtime associated with malfunctioning equipment. Broken parts can be quickly replaced with parts on hand at the site. Ms. Mak stated that the Operation and Maintenance Plans associated with the GETS were up to date and reviewed annually.

Ms. Mak mentioned that the facility no longer discharges site wastewater to Truax Creek. The facility's wastewater is piped to a recently completed joint project with the City of Albany. The project constructed a wetland wastewater treatment facility south of the Wah Chang facility, and site wastewater was redirected to the wetland treatment system in October 2011. She stated that the facility was compliant with all of the required permits (NPDES, POTW, Title 5, NORM, DOT, RCRA, and Department of Homeland Security). The facility has not received complaints from the public regarding foul odors or releases to the Willamette River to the best of her knowledge.

APPENDIX C

Five-Year Review Site Inspection Checklist

Appendix C

Wah Chang, Albany, Oregon

4th Five Year Review Inspection Report

Inspection Dates: June 6 – 8, 2012

Inspector: Curt Black, Environmental Scientist (Hydrogeologist), EPA, Region 10, Seattle, 206 553-1262 Geoff Brown, Oregon Department of Environmental Quality participated in part of the inspection. Lisa Gilbert, an employee of Parametrix participated as a contractor to the EPA assisting with the Five Year Review.

Remedy Includes: Access controls, Institutional controls, Groundwater pump and treat system, Groundwater containment, Ground-water monitoring in areas of past removal actions

Interviews: Noel Mak, NPL Program Coordinator was interviewed during the inspection. Mike Cochran, an employee in charge of extraction well maintenance and system operation was questioned about system maintenance. Randy Coots, a long-time security officer for the facility was questioned as an assessment of site security and access control.

Brief Site Overview: Operations since 1957, 1982 NPL Listing, ROD OU1 1989, RIFS, 1993, First 5-year review 1997, Ground-water treatment and extraction system October 2000, Soil and Subsurface Soil ESD September 2001.

Site Inspection Targets / Areas of Interest:

- Emergency Services Area – well PW-46A – PCB source issue;
- Fabrication Area – Plume Containment near PW-78 – DCE trends and fate;
- Temporary Monitoring wells in Acid Sump – TMW-4 388,000ug/l TCA – Source Control Options;
- Source Area Review for each source including: Plume maps, well pattern, transport and adequacy of monitoring, location selection criteria, address preferential pathways and bypassing of monitoring;
- Review all trend data for 15 year ROD target for cleanup;
- Monitoring program instrumentation issues with OPR and DO data;
- MEMTEK Facility – solids deposition and liquids handling;
- Past Cleanup Areas – LRSP/Schmidt Lake – wastes handled vs current analyte list;
- Farm Ponds – Examine Well-SS and review excavation process, confirmation sampling and future groundwater assessment of CVOC fate;
- Soil Amendment Area – Current activity, assessment of current levels and fate of radionuclides in soil and plant/crop residues;
- Ammonium Sulfate Storage Area – 1978 400,000 gallon process liquid loss, NH4-SO4, MIKB, Cl-, U, thiocyanate, zirconium – fate, progress and adequacy of monitoring;
- Dump-Master Area – Ground-water monitoring and waste handling evaluation
- Truax Creek - Remedy modification – assessment of preferential pathways and current monitoring program. Need for and options for additional assessment;
- Arc-Melting Sub Area (Crucible Cleaning Area) EISB remedy evaluation
- Acid Sump Area – EISB remedy evaluation;
- Extraction Area EW-1 – 6 inspect wells, labeling, locks, condition;

- South Extraction Area – EISB remedy evaluation;
- Fabrication Area – Evaluation of FW-1 – FW-7
- Cooling Water Pond – Historic use, liner, effect on hydrology
- Deep Hole Boring Machine UST – SWMU – steps for closeout
- Murder Creek – sampling locations vs. plume discharge location

Sixty-five of the wells in the monitoring program were evaluated for condition, security, integrity of each location (prevention of tampering and ingress of water and protection from damage). Specifically, inspector examined the presence and condition of labels, locks, protection including barrier posts and covers, seals for the well, marked measurement points and signs of ongoing maintenance. Various plumes were evaluated for establishment of containment, locations of wells with respect to plume extent, potential for offsite transport of COCs and trend data for achievement of ROD 15 year timeframe to cleanup. Groundwater treatment and extraction system was evaluated for condition of pipes, valves, pumps, totalizers, treatment steps, electrical conditions, safety, security and the availability of spare parts for operation. Tanks were evaluated for the presence of secondary containment, signage on contents and appropriate response in event of release. Discharge structures were examined – the weir to Truax creek has been replaced with a pump system which discharges to Schmidt Lake (now Cell 3) for cooling and polishing followed by discharge to a new constructed wetland where the water is commingled with City of Albany water prior to return to the Willamette River.

Overall assessment:

Plant is a large, complex chemical and fabrication facility with many waste generating processes and past practice issues. Many of the earlier sources have been removed. Issues are noted on the following:

- Incomplete perimeter containment of CVOC plume on the north boundary,
- Source control issue in Acid Sump for NAPL solvent in absence of remedy suitable for NAPL
- Current fate of dissolved CVOCs from Well-SS remains unassessed
- Time to cleanup in Feed Make-up Area will require remedy modification
- Soil Amendment Area requires assessment of current radionuclide concentrations and the fate of radionuclides in plant/crop materials derived from site.
- Many wells were noted to be damaged by heavy traffic and high traffic. Flush well completions were frequently found to be in a condition which precluded securing the vault from inflow of water from the pavement. Many vaults were found to be filed or partially filled with water. Locks were frequently inoperable due to corrosion, well seals were in several cases in a condition which could allow intrusion of water from the vault to the well. Most above ground well completions were found to be locked, with barrier posts in place and the well inside the protective casing was found sealed with the exception of several wells with cracked caps from the continued presence of bailers suspended from the caps. Nearly all wells were visibly labeled with the well ID and had a visible measurement point. See site visit chronology for specific findings.

Opportunities for Optimization:

As the several EISB remedies continue, there should be the opportunity the reduce the number of wells in the CVOC plume areas. Once the dissolved constituents are lowered below action levels, the active pumping system could be expected to be removed from service. At the present time, no wells are suggested for removal from the monitoring program due to their use in monitoring the progress of cleanup. Additional well coverage at the north boundary of the site in the area of PW-78 is recommended to assess CVOCs potentially discharging to Murder Creek. Once the CVOC plume concentrations are lowered below action levels, it should be possible to reduce monitoring in the surface waters of Truax and Murder Creeks. Given the questions about plume trajectory on the north boundary, an additional surface water monitoring point in Murder Creek is recommended.

Site Inspection Chronology:

June 6, 2012 – Arrived at 1150. Checked in and showed ID, watched a mandatory safety video, met Noel Mak and set out inspection targets for the next 3 days. Discussed inspection process and started.

Conditions: Clear, Sunny, 70 Degrees F, Wind SW 5 mph.

1245 – Started in the South Extraction Area – viewed Plant Well, PW-96A. This well had just been sampled. Lock was open and corroded. New lock was reported to be on order.

1305 - PHOTO – 293 –South Extraction Area Treatment System control panel inside locked treatment shed

PHOTO – 294 –Treatment pressure monitoring system

PHOTO – 295 –Treatment system totalizers

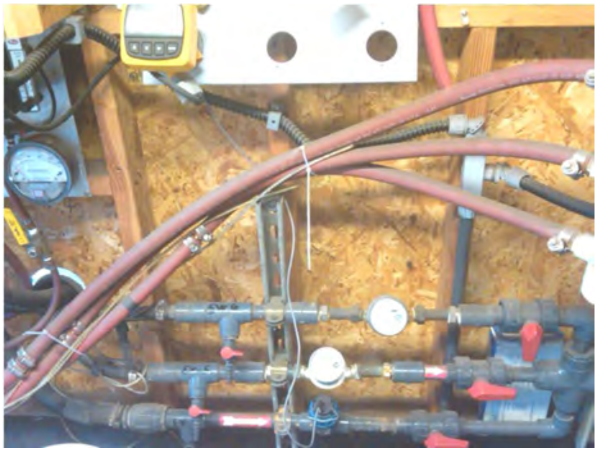


PHOTO – 296 –Treatment system carbon canisters – 2 parallel systems

1310 – View Well 57A and PW-26A – sampled previous week – well protected yellow barrier posts, steel casing, lock, cap and measurement point all present

1314 PHOTO – 297 –View north from EW-4 across PW-26A to PW96A

1317 PHOTO – 298 –View of Well 49A – Well locked, still with old bailer inside from old sampling program. Label found welded onto casing, barrier posts present, yellow paint, measurement point present

1328 PHOTO – 299 –View of well PW-47A – Well found locked, but with welded ring loose (requires maintenance), steel casing intact, cap present, measurement point visible, barrier posts present.

1340 – PHOTO – 300 – View of PW-24A – West toward railroad tracks and Second Lake – good steel casing present, locked well, measurement point present

1344 – PHOTO – 301 – View of PW-27A – example of a problematic flush completion where damage has occurred to the vault so the cover does not seal. The well is labeled however the cap is cracked and water could easily enter to the risk of the integrity of the monitoring program.

1347 – Visit well PW-23A – well found locked, barrier posts present, cap in place and intact, measurement point present

1352 – PHOTO – 302 – View of Solvent storage tank with environmental codes and disposal information – secondary containment present as well as fire control system

1402 – PHOTO – 303 – View from EW-3 toward EW-2 and EW-1 – Extraction Area Separations Feed Makeup Area

1411 – Viewed PW28B and discussed release in FMA – 40K gallons of feed lost 1970s – during investigation, found piping that was compromised and abandoned.

1415 – PHOTO – 304 – EW-1,2 & 3, Extraction System control panel – Maintenance log viewed in shed. Equipment in shed for the continuous logging of pH and totalizers – containment system present with alarms

1418 – PHOTO 305 - View North across feed deck from control shed

1424 – PHOTO 306 - View North across Pond 2 to new 3-pump system to covey water to Cell 3 (Formerly Schmidt Lake)

1428 – PHOTO 307 – View north across the former (1979-1989) V-2 solids settling pond location – 3 tanks are the treatment that replaces the V-2 pond. V-2 waste stream is pickling solution including hydrofluoric acid – now solids are filter pressed with liquids to acid sludge treatment – this area is now contractor parking.

Photo embargoed by Wah Chang – due to process info inadvertantly captured – replacement photo not yet received from Wah Chang

1436 – Visit PW-22A – Observed barrier posts present and locked well. Found cracked (16th inch) cap and measurement point visible

1444 – Visit PW-21A – Observed barrier posts and lock present, found piping in the well for the 1-month duration radium sampling which is ongoing.

1448 – PHOTO 308 – View south from ½ distance from PW-21A to PW-20A. Across V-2 Tanks to separations stacks in background

1452 – Visit PW-20A – Well found locked, label present, with barrier posts present – well cap cracked

1455 – Visit PW-19A – Well found locked, label present, barrier posts present, cap intact

1459 – PHOTO 309 – View to the SW on the W side of the railroad tracks. View is of the Truax Creek sample point showing the volume of water flowing.

1520 – PHOTO 310 – View of PW-84A – 2-inch well, barrier posts present and well locked. Intact cap, monitor point present.

1524 – PHOTO 311 – View west at ammonium storage – 2 400K gallon wood stave tanks (48% ammonium)

1526 Viewed PW-85A – 2-inch well, locked, barrier posts present, cap present and measurement point present

1536 – Viewed PW-01A –barrier posts present, steel casing, locked and labeled, cap and measurement point present

1532 – PHOTO 312 – View South across PW-01A to Pond 2 west end and 3 new wetland pumps

1536 – Visit PW-83A – Found flush-mounted and not able to open with tools available

1540 – Visit PW-82A – 2-inch flush mounted, locked with sealing cap – not opened

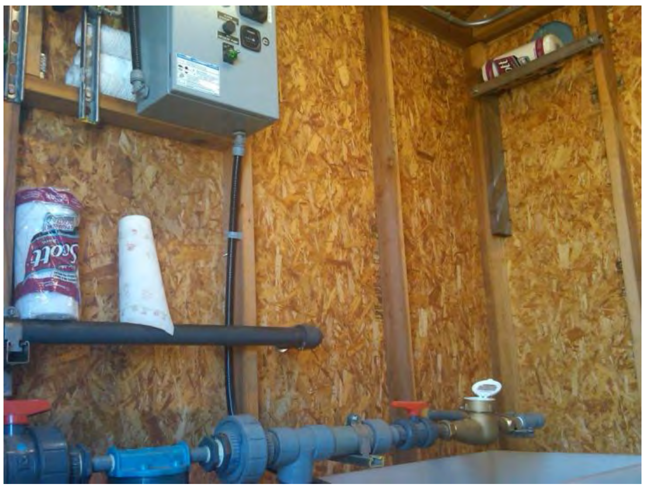
1545 – Visit PZ-1 –Barrier posts found, well locked, steel casing, vent hole in cap (old practice) with bailer still present in well. Recommended removing bailers since they are no longer used and the weight and eye-hook hole in caps appears to be leading to damage by cracking.

1543 – PHOTO 313 – View of calcium chloride tank showing secondary containment

Visit PW-3A –Barrier posts present, well locked, steel casing, labeled, sealing cap, measurement point present

1550 – PHOTO 314 –View East From PW-3A to Truax Creek and Pond 2

1555 – PHOTO 315 – View of treatment shed (locked) at FW-5 – totalizer and secondary containment present. Discharges into ammonium recovery system.

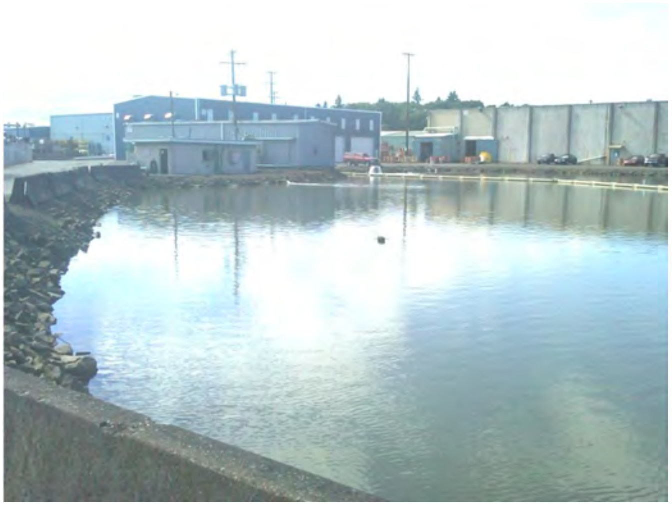


1610 – Conversation with Mike Cochran – talked about the historic LRSP Cleanup and Cleanup of Magnesium Recovery Pile, Schmidt Lake Cleanup and well maintenance procedures and observations.

1624 – Visit well PW-89A – found barrier posts present, steel casing, label, well not locked, cap good – well needs new lock due to corrosion.

1626 – PHOTO 316 – View across PW-89A to South East across Truax Creek to the now unused weir on Pond 2

1635 – PHOTO 317 – Cooling water pond – receives Willamette River water from pump station on river for use throughout the plant. About to increase the pumping by ½ to allow replacing Pond 2 outfall flow into Truax Creek that it is diverted to Cell 3. Discharge is arranged with City of Albany to maintain summer flow in Truax. This pond is unlined and significantly alters the ground-water contours in this area.

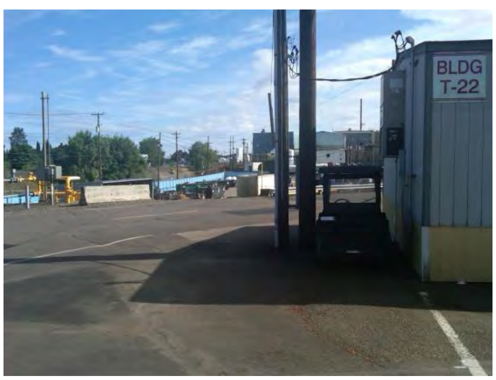


1637 – Visit PW-74A and PW-74B – wells with flush completions – unable to open with tools available.

1640 – Visit PW-46A – Flush completion – bolts stripped, lock inoperable, sealed cap in place in casing

1648 – Visit PW-73A and PW-73B– wells with flush completions – unable to open with tools available.

1650 PHOTO 318 – View south east into Dump Master Area from Emergency Services Building where PCB spill occurred – Well PW-46A is highest in system for PCBs



1710 – Interview with Randy Coots – Security Officer for Wah Chang. Examined logs (electronic) of entry control system. Viewed extensive security system with demonstrations of camera system and intruder alert features.

1718 Offsite to hotel – Holiday Inn Express, Albany

Thursday, June 7, 2012 – 0700 Records review and target selection - Onsite 0755 – 50 degrees F, steady rain, wind 10mph Southwest.

0815 - Meet Noel Mak, Continue site visit

0820 – Visit Murder Creek up-stream surface-water sample site at north property line

0830 PHOTO 319 – View north at up-stream sample location – stream is nearly obscured by blackberry and reed-canary grass (Phalaris)

0832 Visit PW-34A – Adjacent to small parts disposal on flake-board property. Piles of small parts like these have previously been associated with solvent disposal to the surface – this is not on Wah Chang property

0835 – Visit PW-15AR (replacement) – well found locked, with barrier posts in good condition, with label and visible measurement point

0836 – PHOTO 320 – View across PW-15AR toward Creek

0837 – PHOTO 321 – View north of Murder Creek in Reed-canary grass and blackberries from PW-15AR

0841 – Visit PW-76A –Barrier posts found, steel casing, well found locked.

0846 Visit PW-77A – Flush mount completion, no bolts present, opened lid and found lock in place, sealing cap in place, measurement point visible

0849 PHOTO 322 – View of Deep Hole Boring Machine UST area – located under pad on N. end of Building 71. View south at pad location

0850 PHOTO 323 – View North toward murder creek from DHBM UST former location. Zirconium stock to be fabricated into tubing on pallets

0853 – Visit Outfall 2 discharge into Murder Creek north of PW-78A

0855 – PHOTO 324 – View north through outfall control equipment to Murder Creek – outfall flowing due to ongoing rainfall event. Blackberries were later removed by a contractor for our investigation in the creek

0902 – Visit PW-78A –Used tools to open this flush completion well. All bolts present, Location is just west of building 100

0908 – PHOTO – 325 – Pw-78A – View downward showing measurement point, showing label on bottom of protective cover. Compromised gasket allows parking lot water to accumulate – cup it to bail water down below top of casing prior to cap removal

0912 – Visit FW-6 – Well under manhole – not removed. This well is not used as extraction. Used for chemistry to monitor EISB progress.

0914 – Photo 326 - PW-10 – View downward showing bent protective casing, no pad on well, no barrier posts, label present inside, well found locked, good cover. Need rehabilitation – new well pad, barrier posts, recommend redrilling due to bent casing. Also, well is partially completing (old well).

0922 – Visit PW-79A – Flush completion. Found good bolts, good gasket, no water, locked well, labeled with visible measurement point.

0926 – Visit PW-16A – Found Barrier posts present, casing present, locked, labeled and measurement point visible. Old style vent hole in cap, well needs new pad – surface completion.

0935 PHOTO 327 – View to South East across LRSP – all solids removed in closure process – water present year round, found good habitat feature. Still groundwater contamination and still monitoring ongoing. Manganese exceedances – area will be included in August sampling

0936 PHOTO 328 – View south across Truax Creek to end of Second Lake from south-west corner of old dike protecting LRSP from 500 year events.

0943 – PHOTO 329 – View west from same dike as photo 328 viewing confluence of Truax Creek and discharge from Second Lake just above confluence with Murder Creek

0945 – Visit PW-09 – Well entombed beneath "drivable" cover and could not be opened for inspection.

0950 – Searched for PW-E and PW-B unsuccessfully in heavy undergrowth

0955 – Return to visitor center to pick up Lisa Gilbert

10:22 – Visit PWA-1 and PWA-2 in single protective steel casing – multiple completion

10:23 – PHOTO 330 – View downward at casing including the nested PWA-1 and PWA-2 in single protective pipe. Well found locked, labeled – next to be sampled in August with expanded 5-year review analyte list

1040 – Searched unsuccessfully for well 17B

1044 – PHOTO 331 – View to southeast toward the plant from PWC-1 and PWC-2 – Schmidt Lake Excavation Project Pad and current soil staging area from all excavations while testing is completed. Also cooling area for slag and cement in drums before shipment to Columbia Ridge LF.

1048 - Visit PW-C – well found locked with steel casing and cap. Barrier posts not painted and found damaged

1051 – Visit PW-07 – Unorthodox design of well completion found – sanitary seal being used for well cap – no locks present, well labeled. Well should be recompleted – no barrier posts, no pad, no measurement point

1057 – Visit to 90 day accumulation area. Contractor actively inspecting and testing wastes as they arrived. Random sample of labels on drums found all within 90 days - oldest observed was March 19, 2012.

1100 – PHOTO – 332 and 333 – Views of 90 day accumulation area showing acceptance process for flammable drums – photos embargoed by Wah Chang.

1103 – PHOTO 334 View southwest across new Cell 3 – previously Schmidt Lake – completed 1 year ago to allow additional cooling and polishing prior to discharge to new constructed wetland to the south with City of Albany.

1110 – PHOTO 335 – View northeast across former Magnesium Resource Recovery Pile toward well PW-07. Photo embargoed by Wah Chang.

1130 - Mobe to Soil Amendment Area – North on Old Salem Highway then east on Conser Road, 0.25 miles.

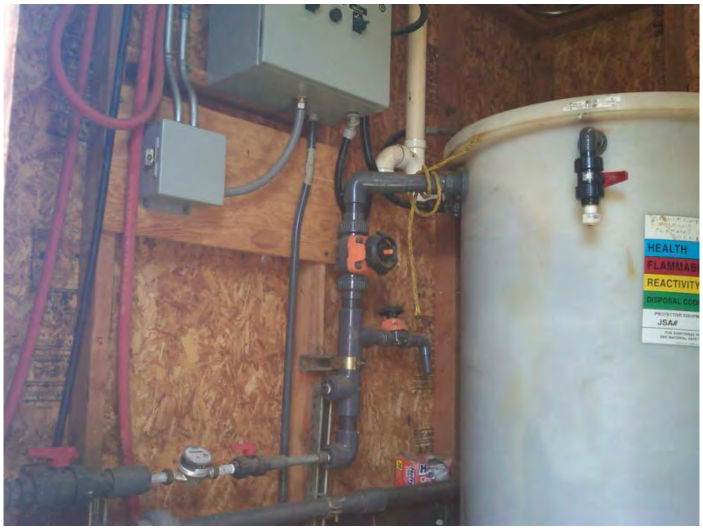
1134 – PHOTO 336 – View southeast across the soil amendment area

1140 – Break for lunch

1238 PHOTO – 337 – View north across constructed wetlands which receives effluent from Wah Chang Cell 3 and City of Albany for polishing prior to discharge to the Willamette River –wetlands are wildlife filled public attraction named "Talking Water Gardens"

1251 – Mobe to area between I-5 and Old Salem Road - Visit MW-01A – found yellow barrier posts, steel casing, well was locked, straight well with slight twist to the north, water visible in bottom.

1255 PHOTO 338 – Well FW-7 Extraction treatment shed showing GAC control panel – not currently in use – was to protect specific neighbor prior to property acquisition from plant groundwater. Treatment was GAC through 2005, then discharge was plumbed directly across Old Salem Highway into main plant for treatment. Shed and GAC have secondary containment and leak detection equipment still visible.



1300 PHOTO – 339 – View west from FW-7 to plant showing treatment shed and security fencing.

1305 – Visit MW-10A – Found yellow barrier posts, well locked, steel casing cap, visible measurement point

1306 – Visit MW-05A – Yellow barrier posts present, locked well, steel protective casing, sealing well cap in place, cement pad present

1320 – Mobe back into main plant site – Visit PW-35A – Flush completion – found no bolts, compromised cover, no lock and no marking

1323 – Visit FW-4 – well has sealing cap installed – Treatment building found to have control equipment and observed equalization tanks.

1324 – Visit PW-30A – found yellow barrier posts, above grade completion, well found locked, 4-inch PVC – marked measurement point.

1326 – PHOTO 340 – Interior of treatment building for FW-4 with metering injection equipment and equalization tanks visible

1327 – PHOTO – 341 – Treatment building for FW-4 – view to south across PW-30A to treatment building and dump master area

1332 – PHOTO – 342 – View of PW-91A – Flush completion – labeled on inside lid, found holding water, found locked cap inside, but improvements to sealing should be made to preclude ingress of water.

1340 – Visit PW-75 – No label visible at first – found label on cap after removing mud – flooded flush completion found, , without bolts, sealing cap found locked on casing – however lock not usable – corroded – cap slips off for access. Well requires repair to protect integrity of monitoring program

1345 – PHOTO 343 – View to south of Truax Creek in Dump Master Area flowing west – showing confluence from multiple conduits under Old Salem Road

1347 – PHOTO 344 – View northwest across emergency services parking lot across PW-73A and PW-73B toward process water Cooling pond – Building 122 – cobalt 60 source storage building in background. This parking lot was the site of PCB removal

1352 – PHOTO – 345 - View across FW-1 to well shed for FW-1. Observed totalizer, equalizations tanks, filtration. Discharge is routed to cooling tower, spare filters are stored. Shed is equipped with secondary containment.

1358 – PHOTO 346 – Current Crucible Cleaning Area – view to southwest showing crucible storage from PW-95A

1401 – Visit to PW-95A – well labeled with spray paint on the pavement- flush completion found water present in vault just below the level of the sealing cap – cap present and locked. Lock is rusted but still usable. Water ingress is a concern.

1405 – Visit PW-69A – Man hole covered – not removed for inspection – Noel reported a 5 gallon bucket us used to remove standing water prior to unsealing the well for sampling.

1415 – stopped to pick up Geoff Brown, ODEQ from visitor center.

1428 – Visit PW-101A – Newest well in system – installed for EISB monitoring – bolts found to be in good condition, flush completion, white cover present, well opened, lock open on bottom and corroded. Sealing cp present on 2-inch PVC casing. No label seen – gasket good and apparently functioning.

1436 – Visit PW93A – In-house manufactured cover to attempt to find a design which can withstand heavy equipment traffic. Good strong design, but not water proof. Vault found full of water, locked sealing cap in place and functioning. PW-100 in vicinity also visited, but under pallets and not opened.

1437 – PHOTO 347 – View to southwest from PW-93A and in direction of calculated groundwater flow with presumed Crucible Cleaning Area Source to the right and injection points array for the EISB project east and west of this

1440 – PHOTO 348 – View across Crucible Cleaning Plaza to east along 2nd line of injection point and across well PW-93A

1500 – mobe to north end of plant for assessment of former Deep Hole Boring Machine UST site with ODEQ

1530 PHOTO 350 – Testing for nature of stream bed prior to deciding if mini-wells or other techniques would be suitable for assessing discharge of the northern Fabrication Area plume into Murder Creek. Also part of the Deep Hole Boring Machine assessment for close-out of that SWMU with ODEQ. Streambed found to be largely very soft materials recently deposited at the waning stages of the severe flooding which occurred last winter.

1549 – mobe to Farm Ponds Area – north on Old Salem Road, west on Arnold Lane

1606 – Visit well SS and discuss remediation of this solvent source area, approaches to confirmation sampling, discrepancies in the analytical data including an unexplained drop in concentrations the last several rounds and approaches for assessing impacts to groundwater from the ongoing source. Well found with no barrier posts, well in steel casing, found locked, active paper wasp nest inside cover.

1620 – PHOTO – 351 – Farm Ponds Area – view to north across remediated pond system showing non-hazardous soil and waste storage pad.

1621 – PHOTO 352 – View west from southeast corner of former Farm Ponds Area toward berm remnant. Photo is facing wells PW-40A and PW-40S with yellow barrier posts visible

1625 – Demobe to Main Plant

1630 – Visit Acid Sump Area with Geoff Brown, ODEQ to discuss remediation issues such as NAPL recalcitrance to EISB remediation. Visit PW-13 – well requires recompletion. No bolts are present, threads stripped, unsealed vault, well cap fits into casing exactly – no vault space – suggest rehabilitation with appropriate sized vault to provide protection from ingress of surface water.

1639 – PHOTO 353 – View of Acid Sump courtyard across TMW-1 toward acid tanks and I1 and toward PW-11

1641 – PHOTO 354 View from PW-13 to the northeast to the northeast corner of the Acid Sump Courtyard

1645 – PHOTO 356 (Photo 355 deleted on site to better capture intended well pattern in courtyard) View southeast from area of PW-13 to show injection well in foreground toward the more distant TMW-4 and I-1 – the center of the apparent NAPL solvent source material which will require excavation or another remedial approach to achieve a protective remedy in this area

1652 PHOTO #57 – View to the northeast from the southeast corner of the Acid Sump Courtyard with acid tanks and piping and loading facilities visible – underground piping is also present in this area

1700 – Deadline to be out of operating plant site achieved. Returned to Administration Building – off site 1730, June 7, 2012

End of Site Inspection Chronology

June 8, 2012 – On site at Wah Chang

0730 – Meet Noel Mak for review of outstanding issues and questions, review of records and discussion of observations

Outstanding Issues and Resolution

- V-2 Pond – Ground-water monitoring wells – PW-21A and PW-22A appear well located to monitor perimeter concentrations - concentrations appear to be decreasing with time. No recent exceedances
- MEMTEK Process – Question on disposition of waste streams – awaiting diagram of process from facility. Examined the diagram on site.
- Well SS – Monitoring results discrepancy – possible analytical or sampling change to explain significant drop in observed VOC concentrations – no explanation. Well is about to be removed along with the source material. The area will undergo confirmation sampling followed by an assessment of any potential dissolved plume which may remain.
- LRSP/Schmidt Lake – Question on the adequacy of analyte list and well pattern. Suggest revisiting the RIFS analyte list for one round for this 5-year review to address potential for unmonitored COCs to have migrated into or across the area.
- Records of Soils Excavation tracking system and evidence of ongoing testing. Examined records which appear to be congruent with the wording of the remedy.
- Progress on ICs – Deferred until conversation with Ravi, Wah Chang PM.
- Functionality of the Groundwater Extraction and Treatment System (GETS) – on hold awaiting the outcome of the EISB remedial action. Results for all plumes are on track to achieve remedial goals with the exception of Acid Sump Area plume discharging to the north across the Fabrication Area.
- FMA Remedy – Remedy modification in this area appears to be an adequate approach for reaching the pH targets and reduced mobility of metals called for in the ROD.

- Acid Sump Remedy – evaluation of the well pattern, trend data and data from wells in the source area indicate that this remedy component is unlikely to achieve cleanup goals in the ROD timeframe. Additional actions are expected to be necessary in the Acid Sump Area source to remove the NAPL source as well as additional action to address solvent discharge across the northern boundary into Murder Creek. Recommend adding an additional monitoring point along the northern boundary between PW-77A and PW-78A to assess concentrations at mid plume.
- PCB source at the Emergency Services Building and distributed PCBs across site: Ongoing testing as each excavation is advanced appears to be functioning as defined by the ROD
- EISB in Crucible Cleaning Area – EISB appears to be removing dissolved CVOCs at a rate which would achieve cleanup in the timeframe developed in the ROD.
- Requested O&M costs for remediation and ground-water treatment for the period of the 5-year review. Costs not yet received. However, this item is usually included in the review to provide an early notice of issues with the remedy. We have already determined that the ROD timeframe is unlikely to be met without the specific modifications noted for the Feed Makeup Area and Acid Sump Area. This data-gap is therefore not considered significant.

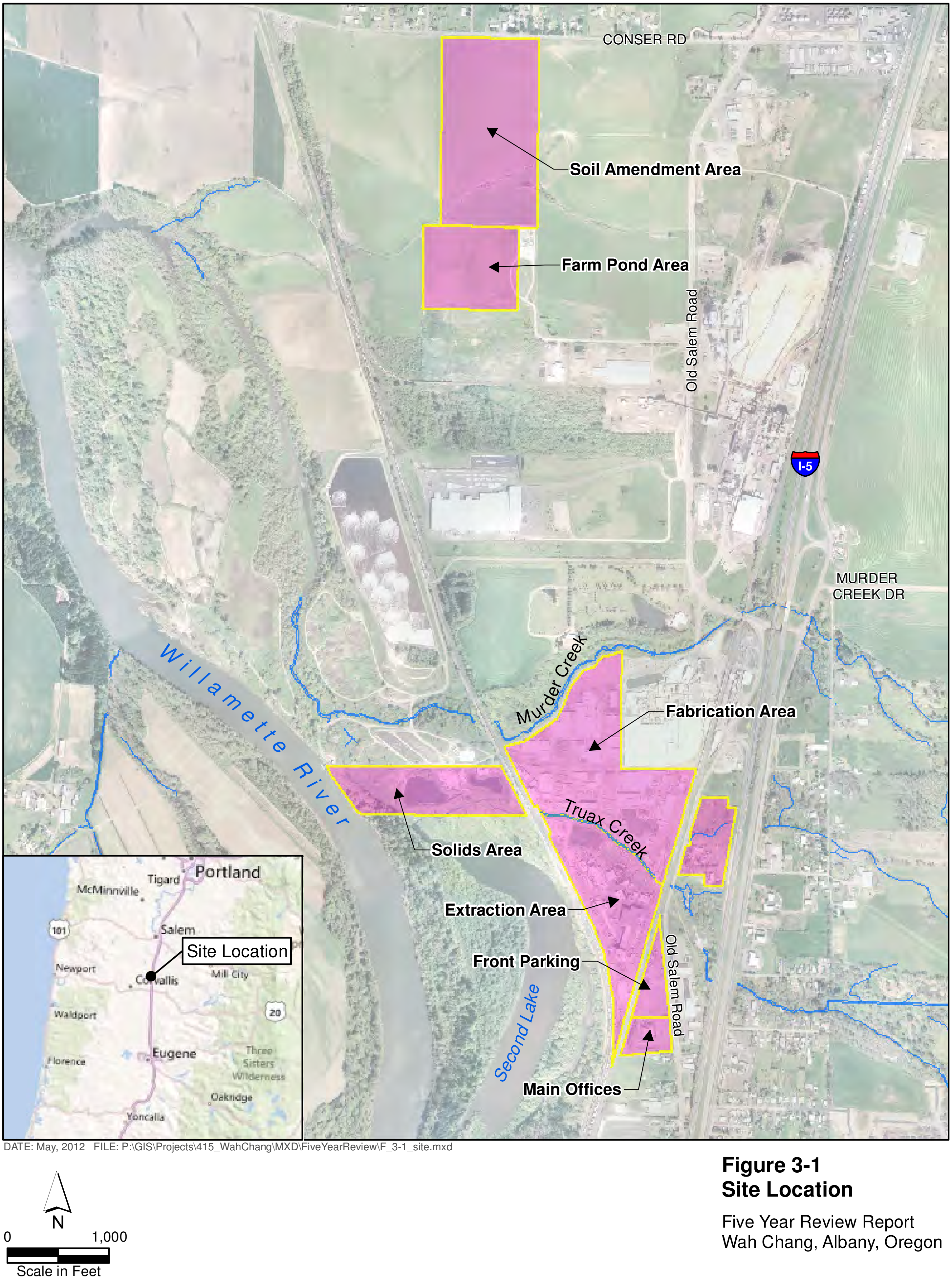
Exit Interview

Discussed with Noel Mak the perimeter control to Murder Creek and potential new well in this area to address uncertainty with discharge. Discussed maintenance issues with monitoring wells (particularly the challenges with flush completions in areas of high traffic), specifically the integrity of covers, seals labels and locks and the importance of these items to the representativeness of the samples obtained in the groundwater monitoring program.

End of Report – Curt Black

June 21, 2012

FIGURES



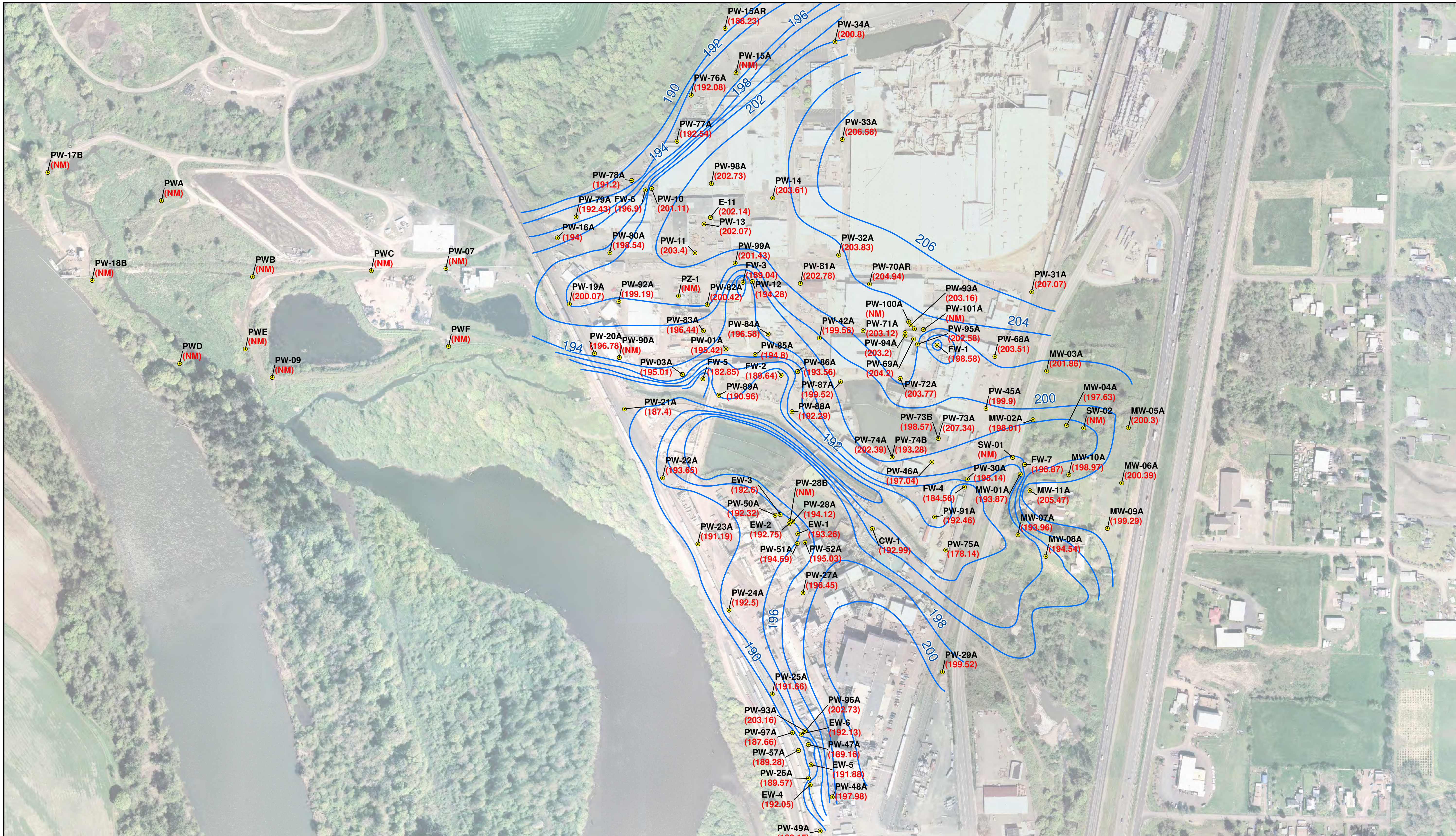
DATE: May, 2012 FILE: P:\GIS\Projects\415_WahChang\MXD\FiveYearReview\F_3-1_site.mxd

Figure 3-1
Site Location

Five Year Review Report
Wah Chang, Albany, Oregon

Figure 3-2
Main Plant Site Areas

Wah Chang Five Year Review
Albany, Oregon



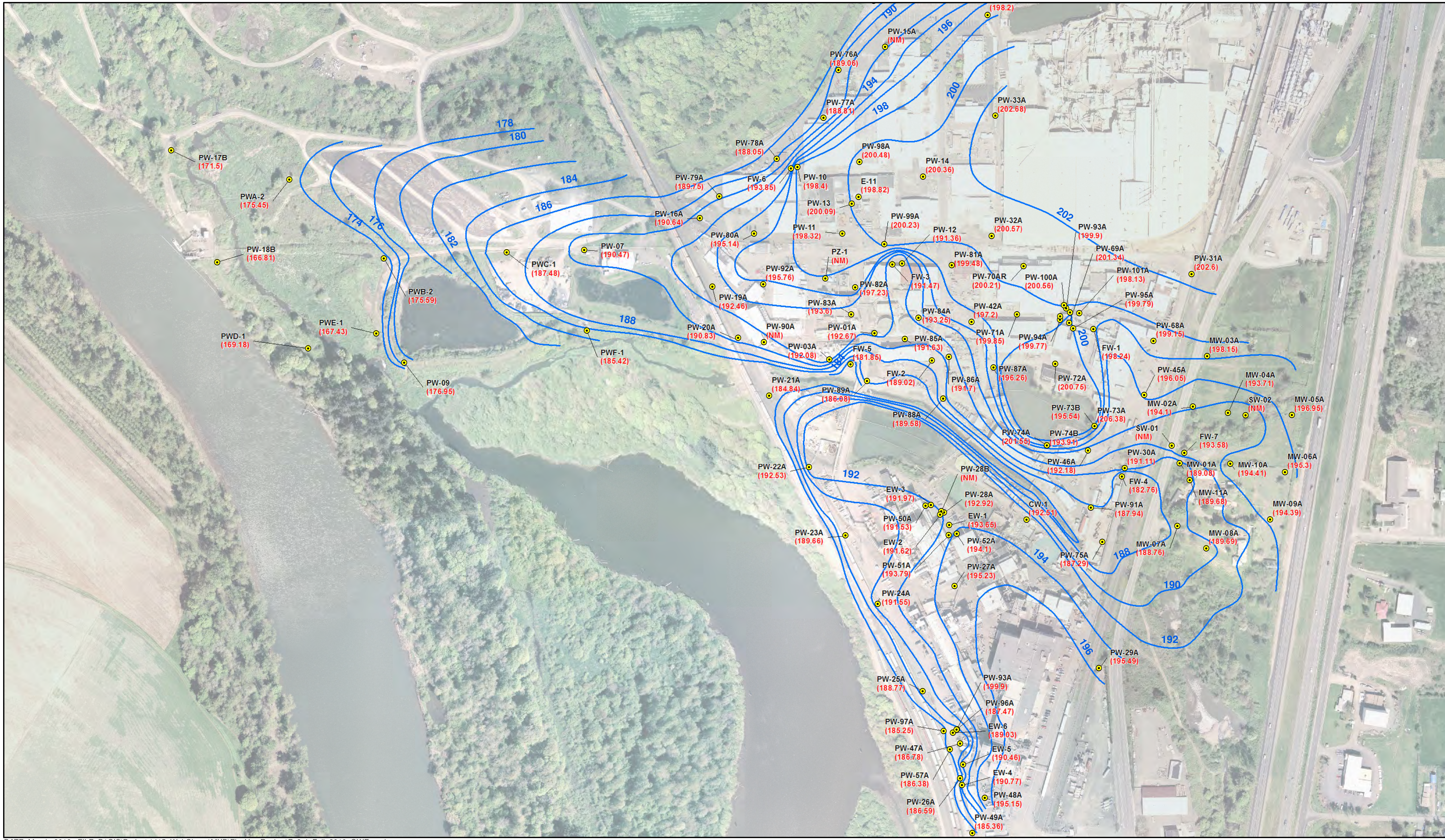
DATE: March, 2012 FILE: P:\GIS\Projects\415_WahChang\MXD\FiveYearReview\F_3-3_Spring_2010_GWE.mxd

Monitoring Wells and Spring 2010 Groundwater Elevation (feet msl)

Spring 2010 Groundwater Elevation Contour (feet msl)

Figure 3-3
Spring 2010 Groundwater Elevation
Main Plant

Wah Chang
Albany, Oregon



DATE: March, 2012 FILE: P:\GIS\Projects\415_WahChang\MXD\FiveYearReview\F_3-4_Fall_2010_GWE.mxd

N

0 500

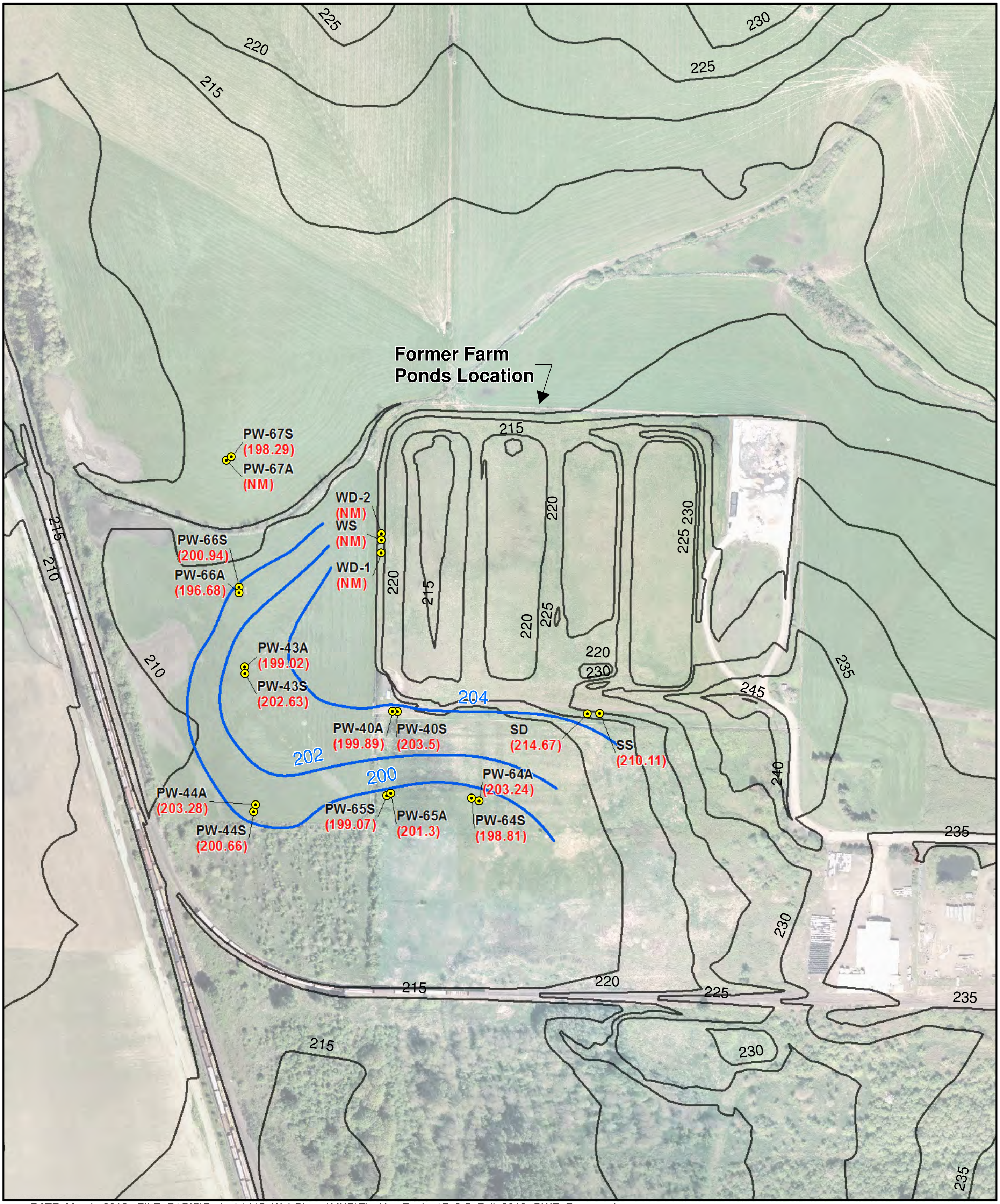
Scale in Feet

Monitoring Well with groundwater elevation in feet msl

Fall 2010 Groundwater Elevation (feet msl)

Figure 3-4
Fall 2010 Groundwater Elevation
Main Plant

Wah Chang
Albany, Oregon



DATE: March, 2012 FILE: P:\GIS\Projects\415_WahChang\MXD\FiveYearReview\F_3-5_Fall_2010_GWE_Farm.mxd

N

0 500
Scale in Feet

- Monitoring Well with groundwater elevation (feet msl)
- Groundwater Elevation (feet msl)
- Ground Elevation Contour (5 feet contour)

Figure 3-5
Fall 2010 Groundwater Elevation Farm Ponds

Wah Chang
Albany, Oregon

Date: March, 2012 P:\GIS\Projects\415_WahChang\MXD\FiveYearReview\F_7-1_ExtArea.mxd

N

0 250
Scale in Feet

Extraction Well
Monitoring Well

Figure 6-1
Extraction Area

Wah Chang Five Year Review
Albany, Oregon

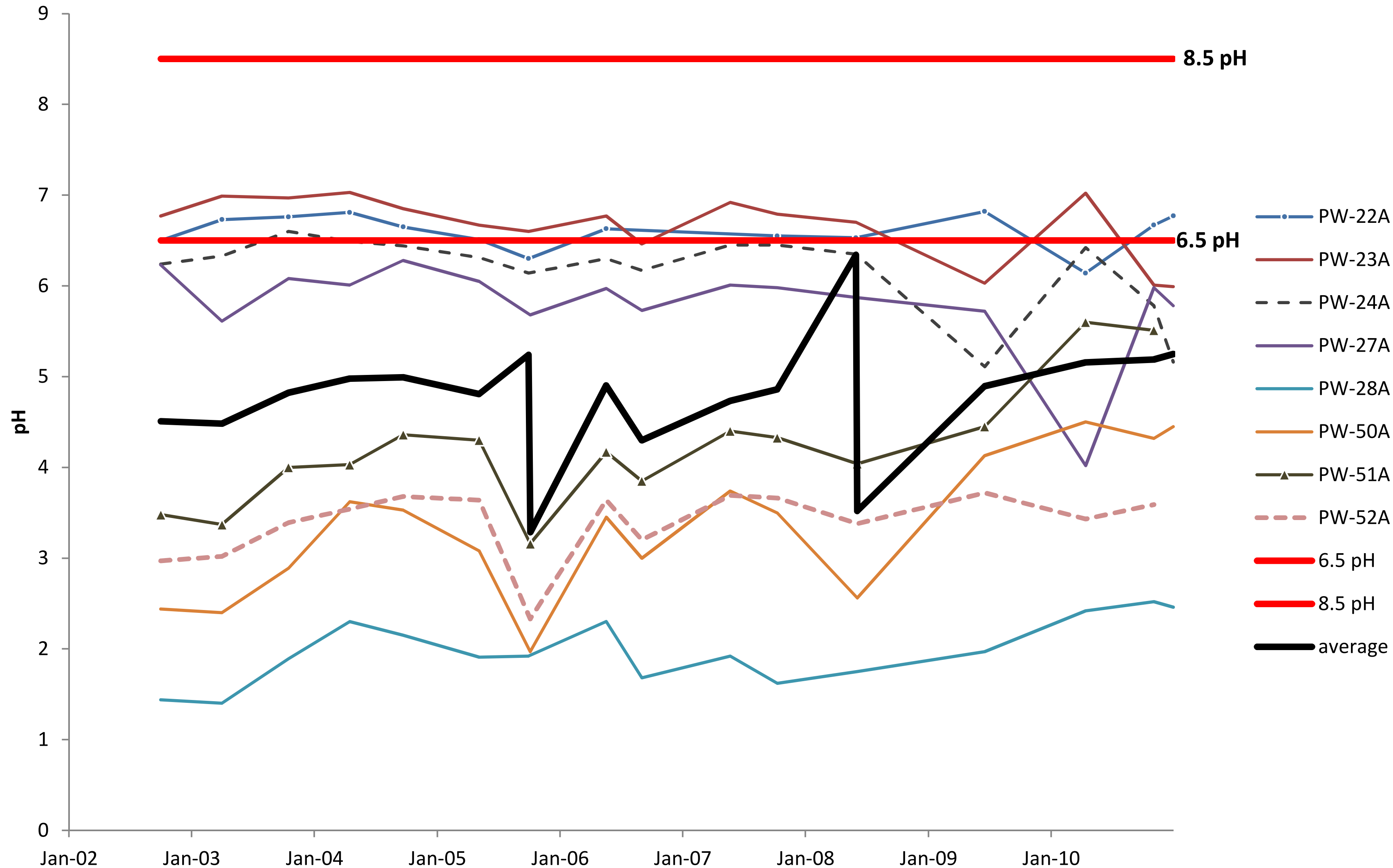


Figure 6-2. FMA pH Level in Groundwater

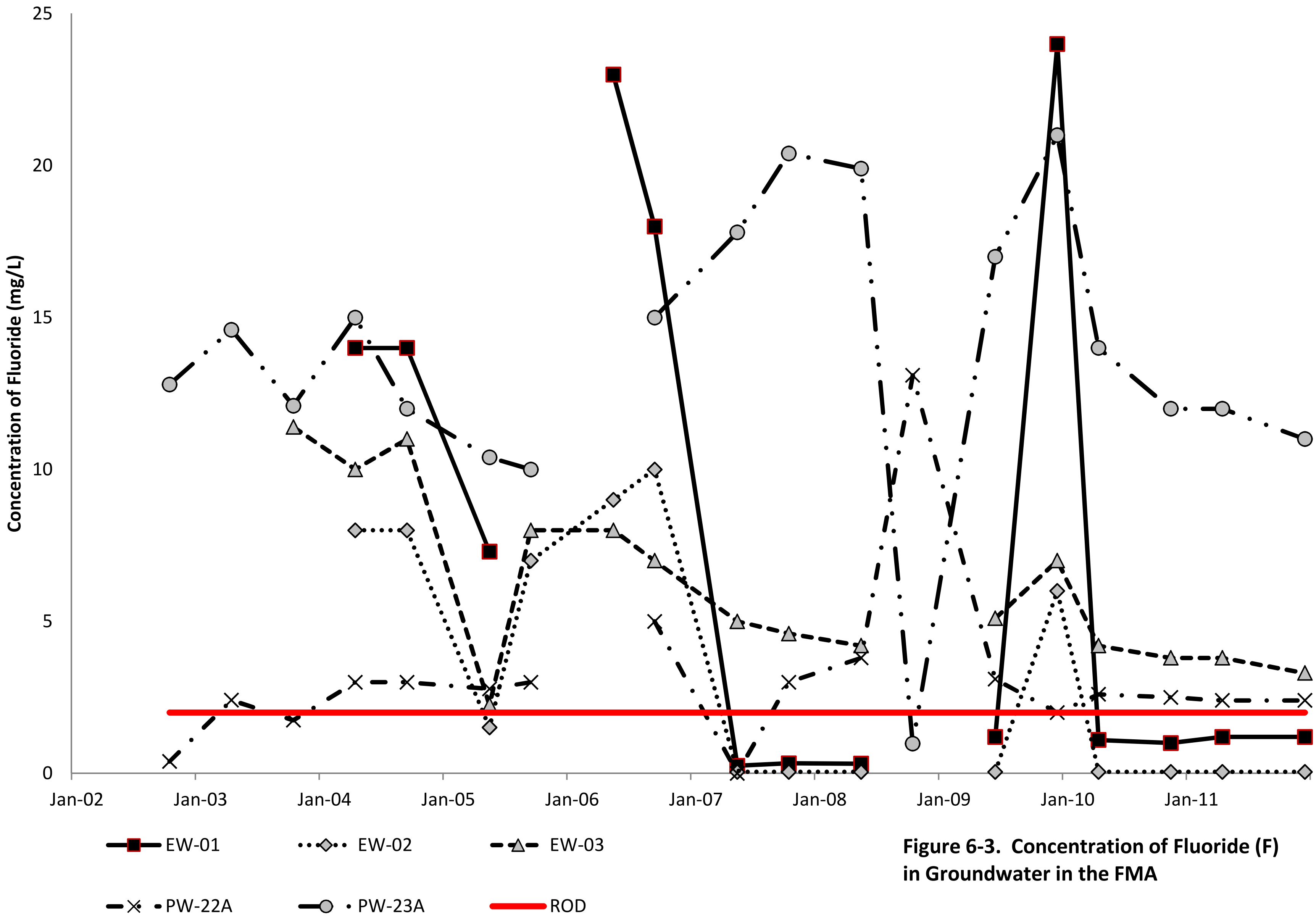


Figure 6-3. Concentration of Fluoride (F) in Groundwater in the FMA

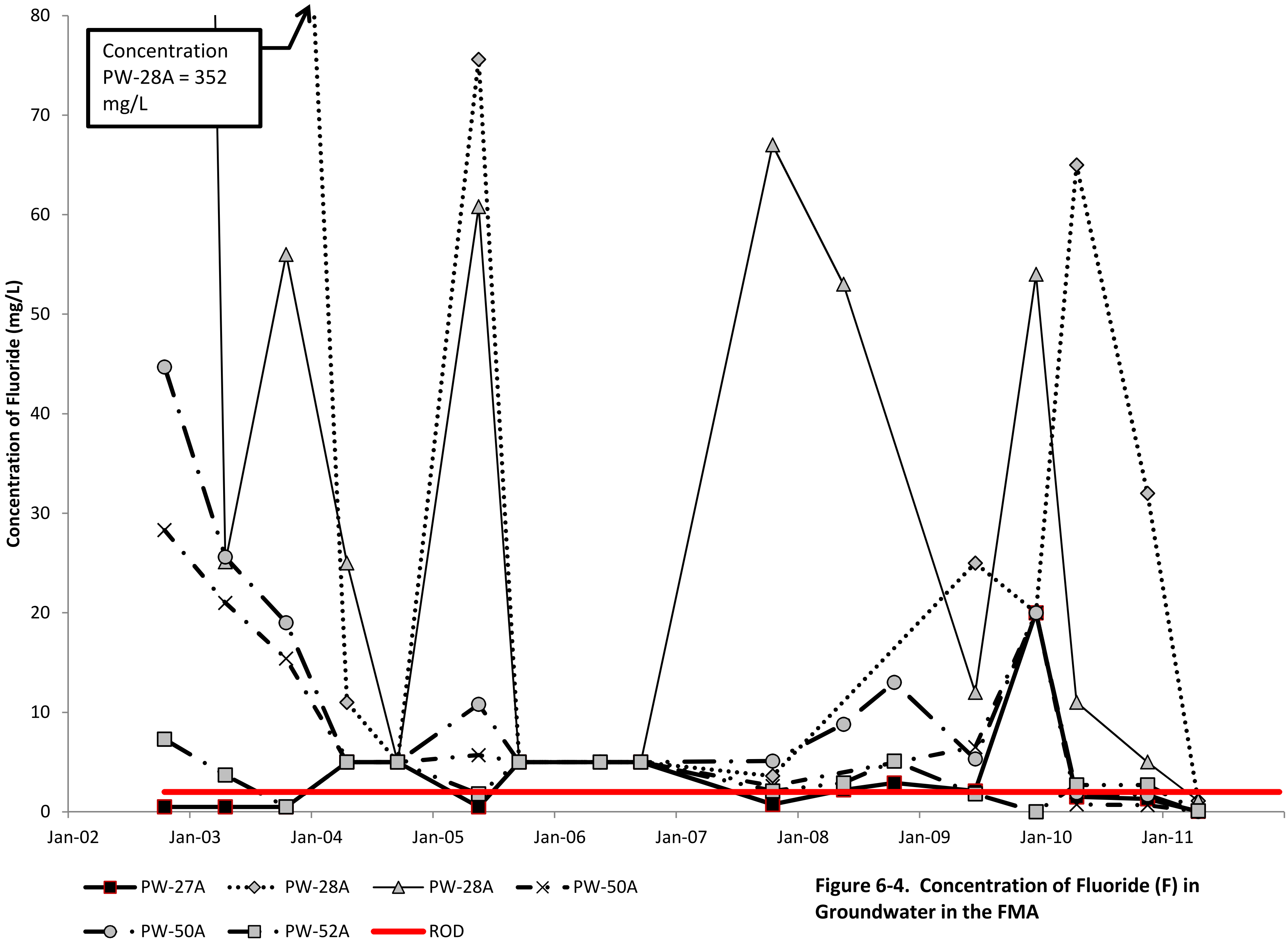


Figure 6-4. Concentration of Fluoride (F) in Groundwater in the FMA

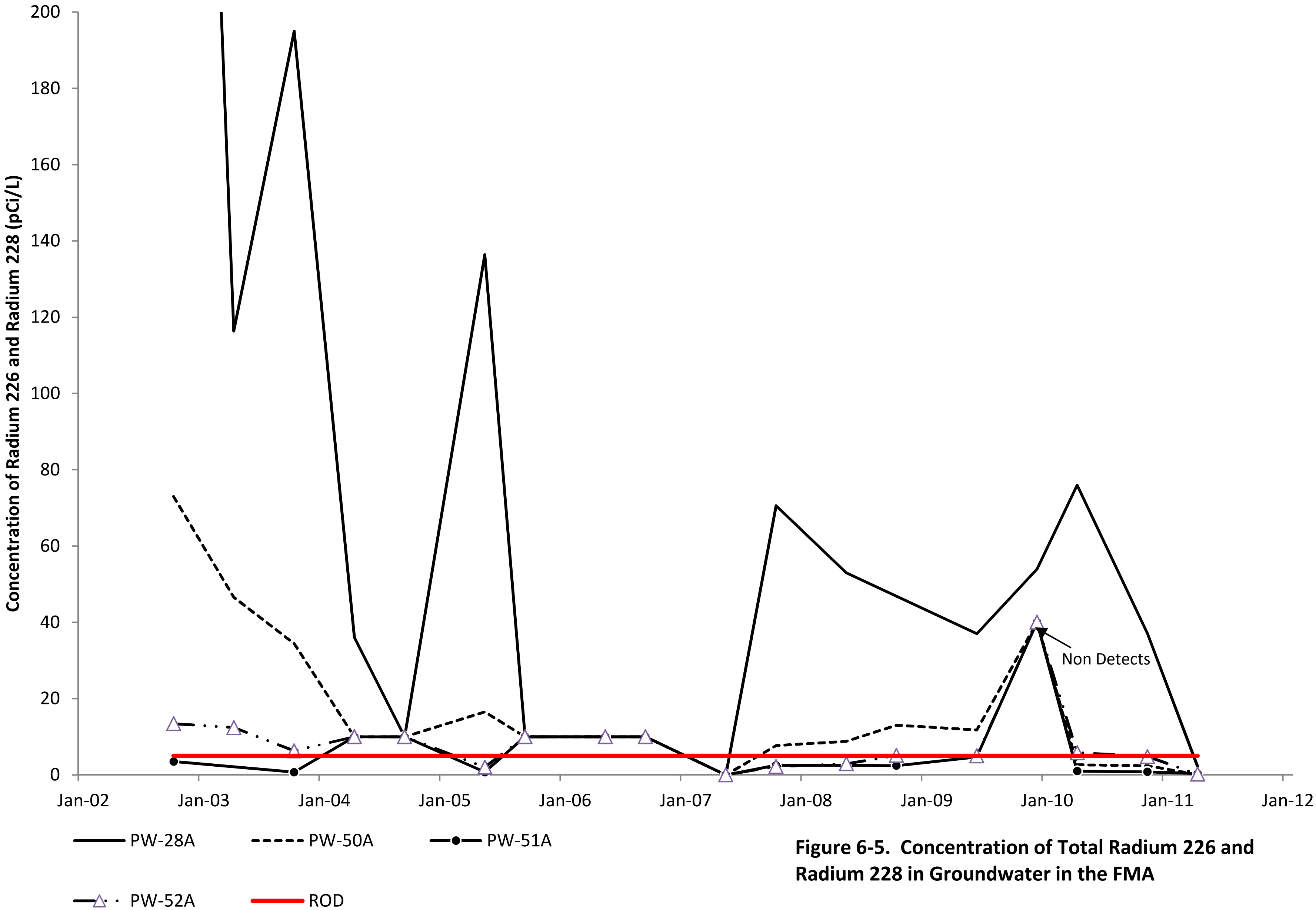


Figure 6-5. Concentration of Total Radium 226 and Radium 228 in Groundwater in the FMA

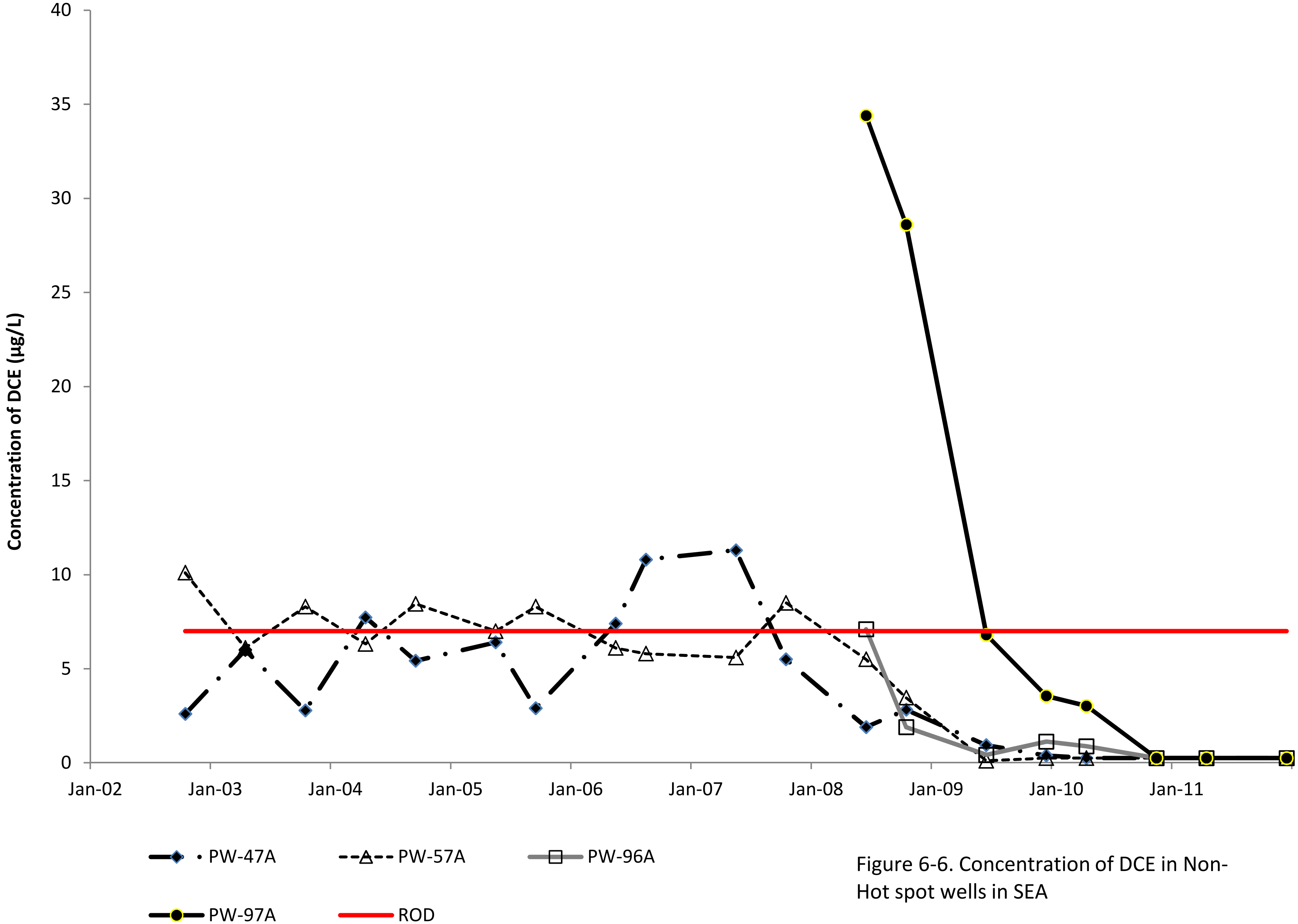


Figure 6-6. Concentration of DCE in Non-Hot spot wells in SEA

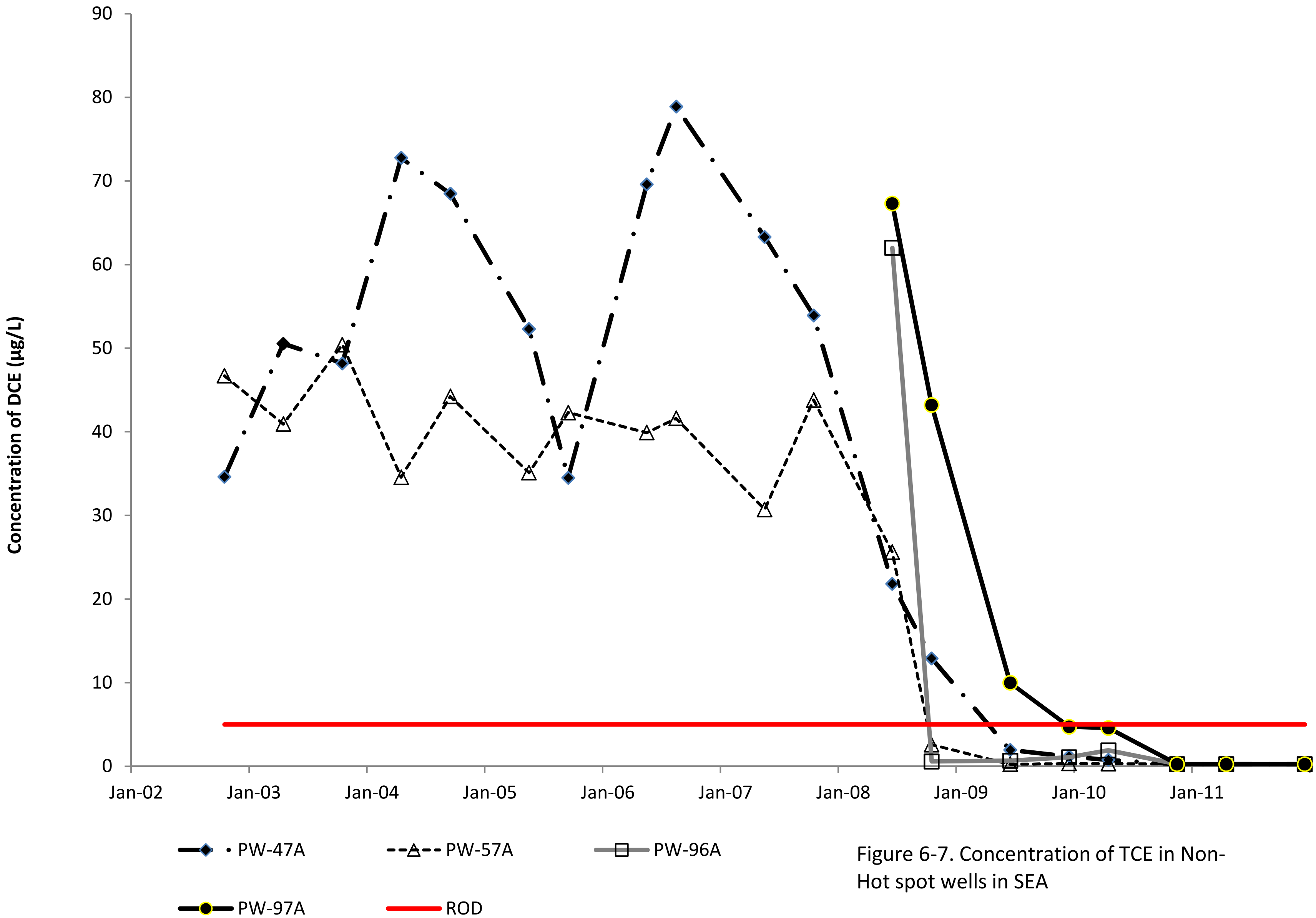
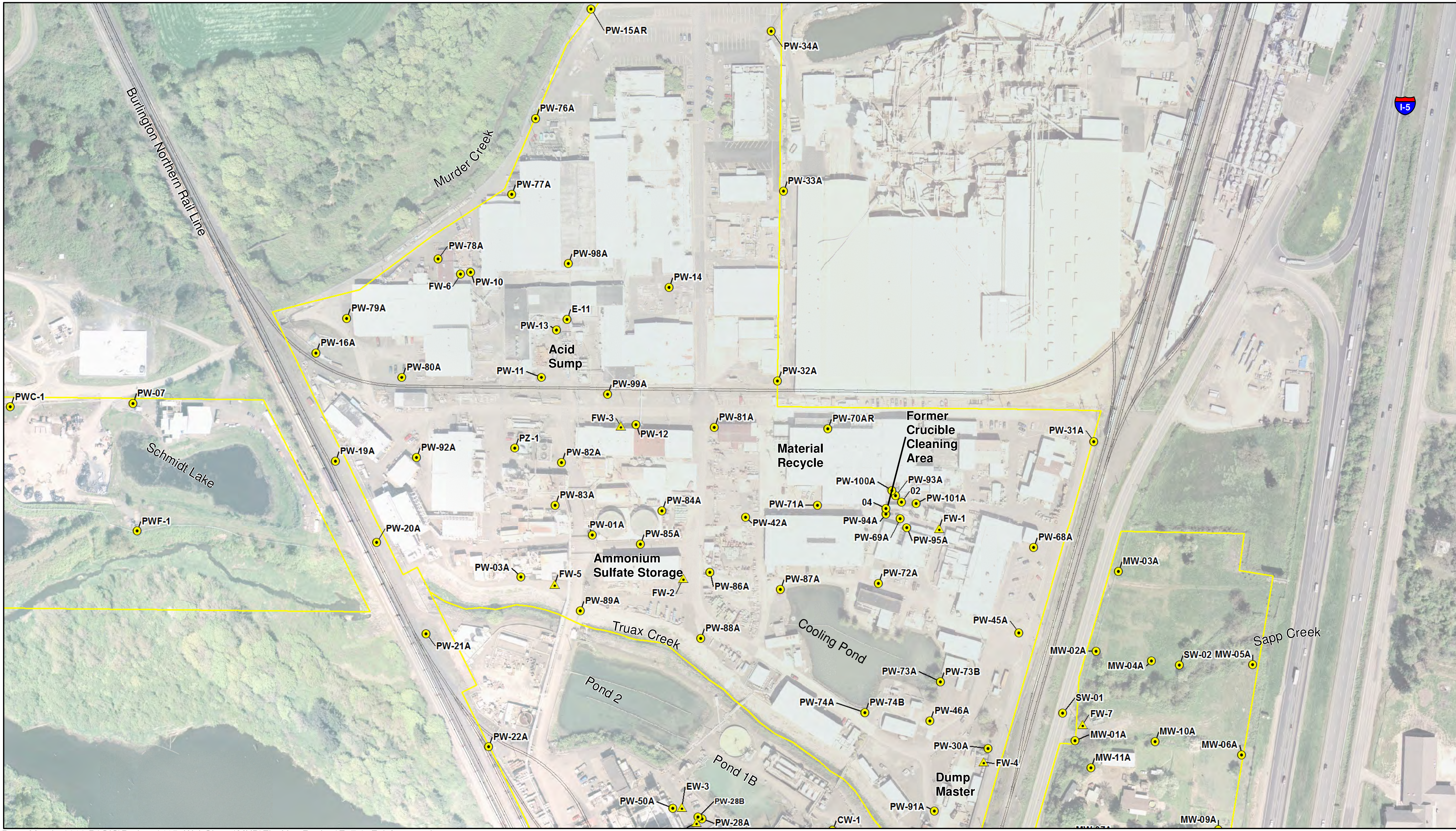


Figure 6-7. Concentration of TCE in Non-Hot spot wells in SEA



Date: March, 2012 P:\GIS\Projects\415_WahChang\MXD\FiveYearReview\F_7-8_FabArea.mxd

N

0 250

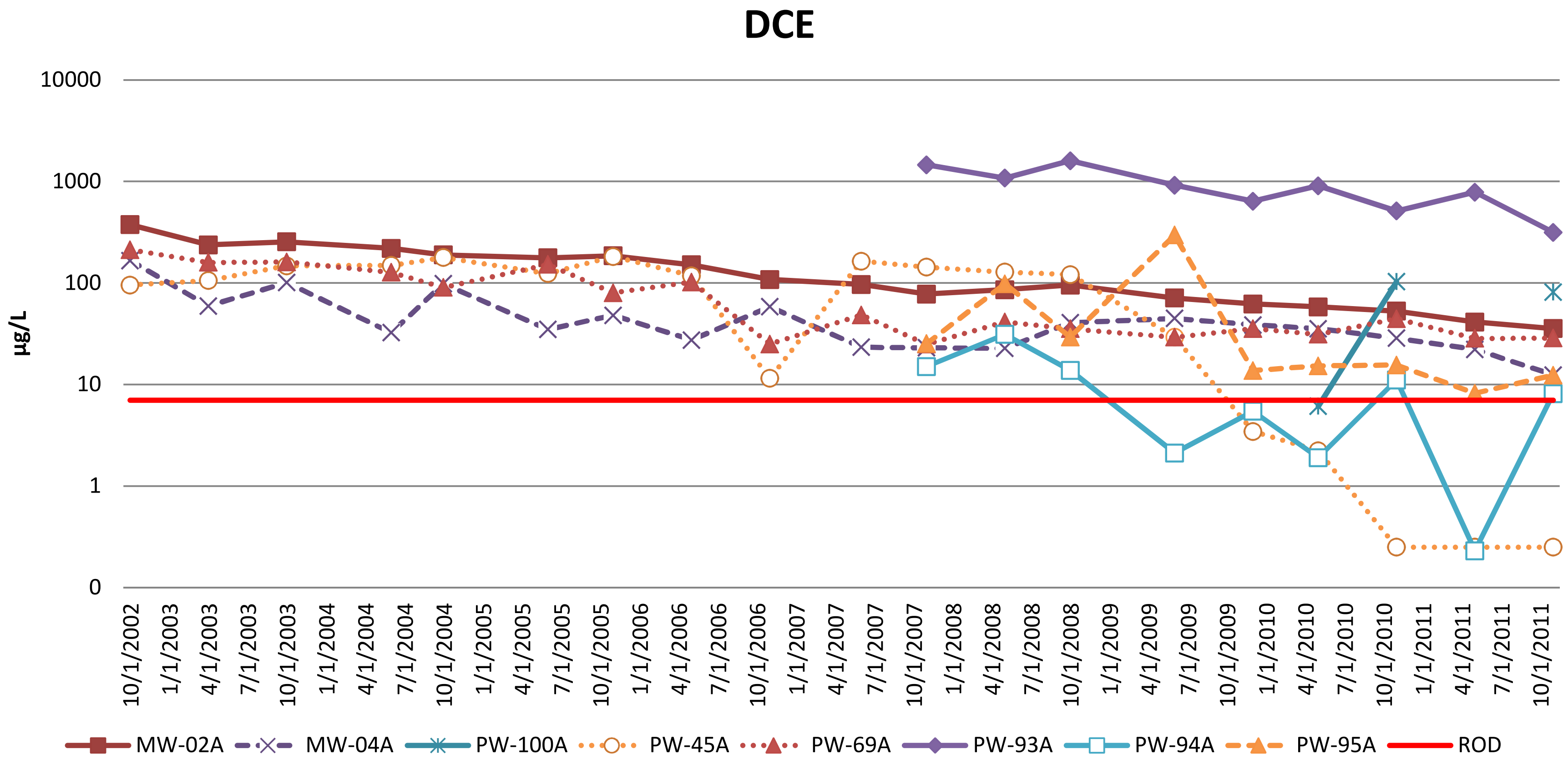
Scale in Feet

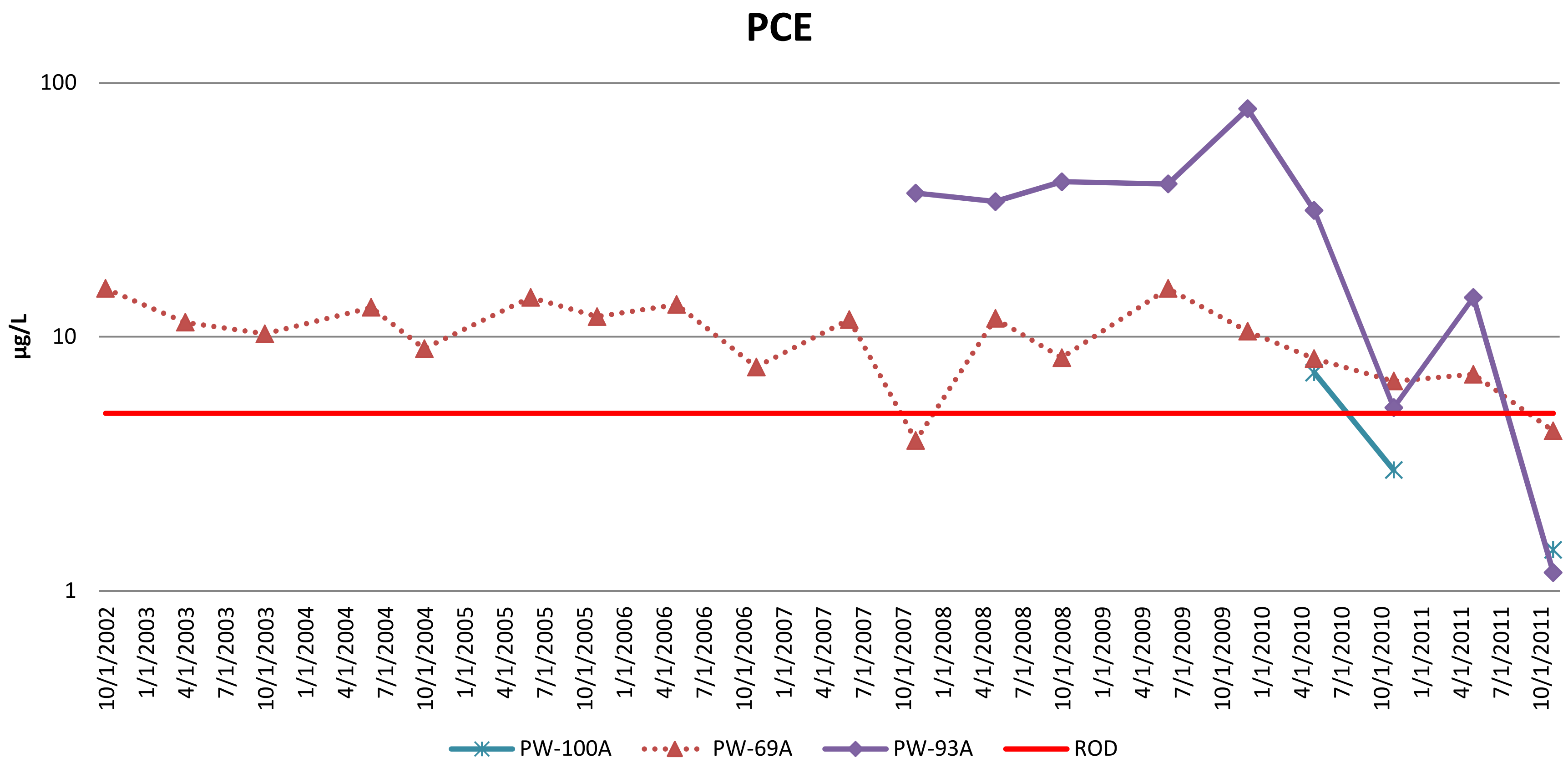
Extraction Well

Monitoring Well

Figure 6-8
Fabrication Area

Wah Chang Five Year Review
Albany, Oregon





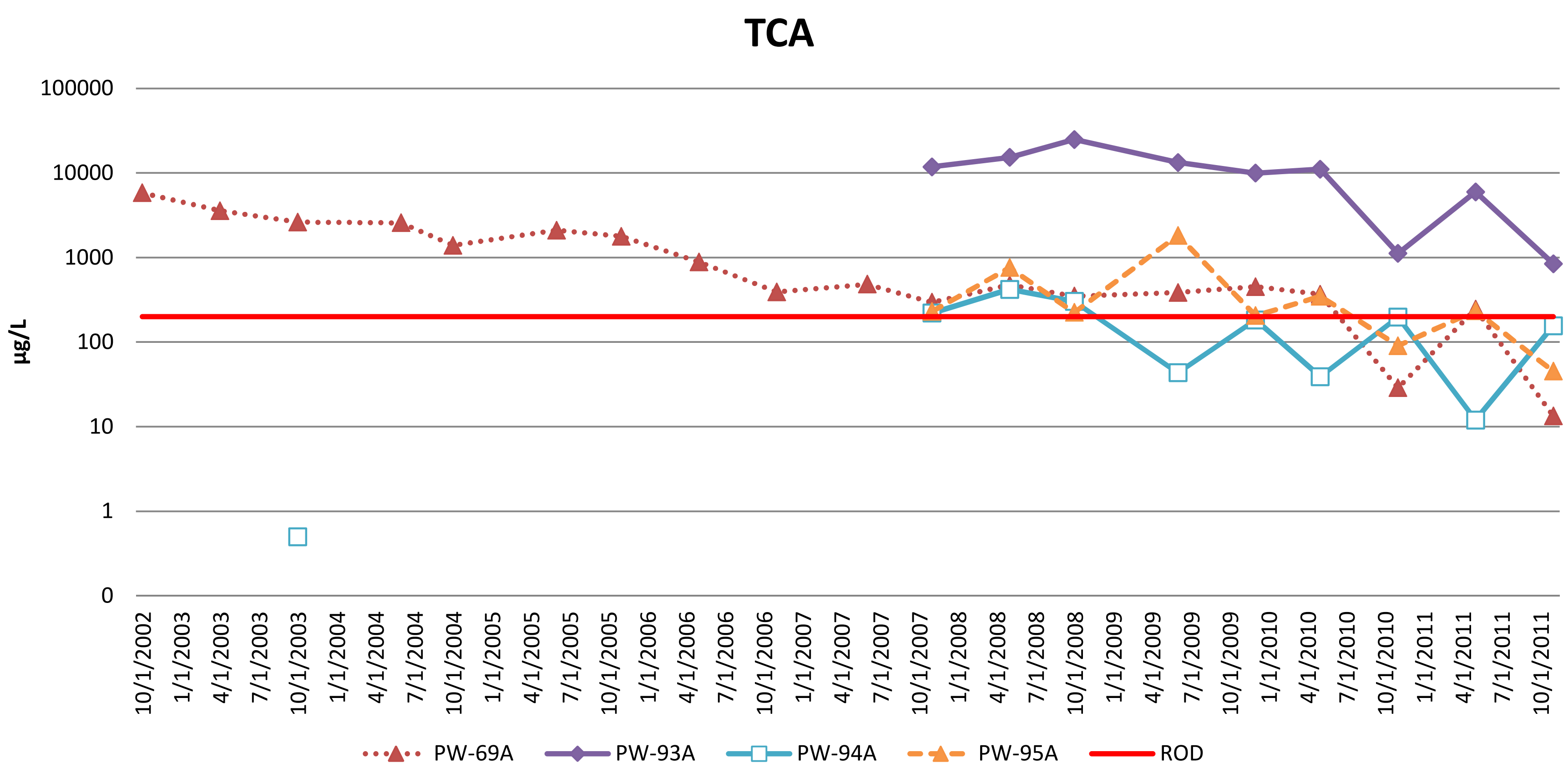
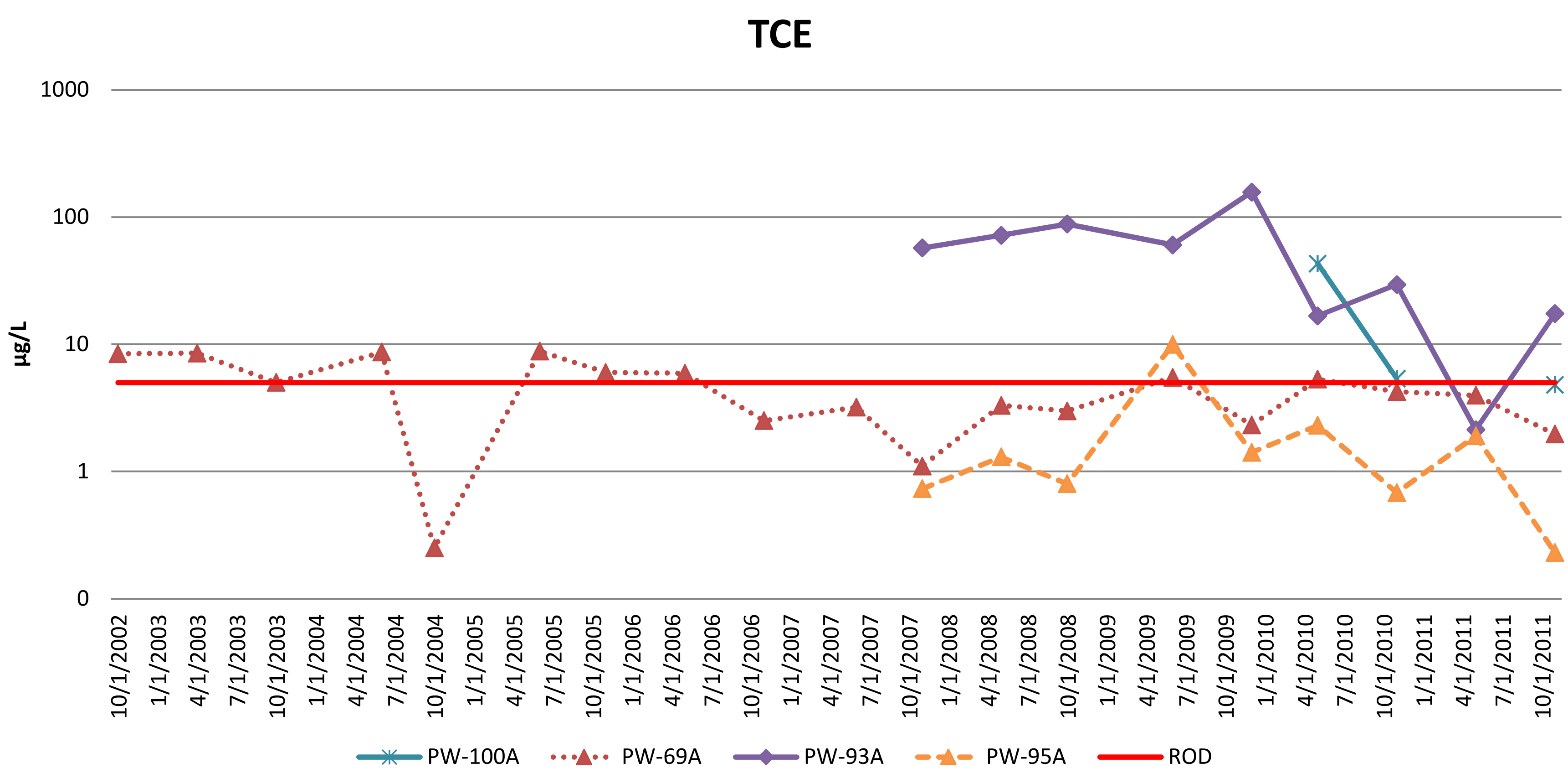


Figure 6-9. VOC Concentrations for Former Crucible Cleaning Area Hot Spot Wells in the Fabrication Area



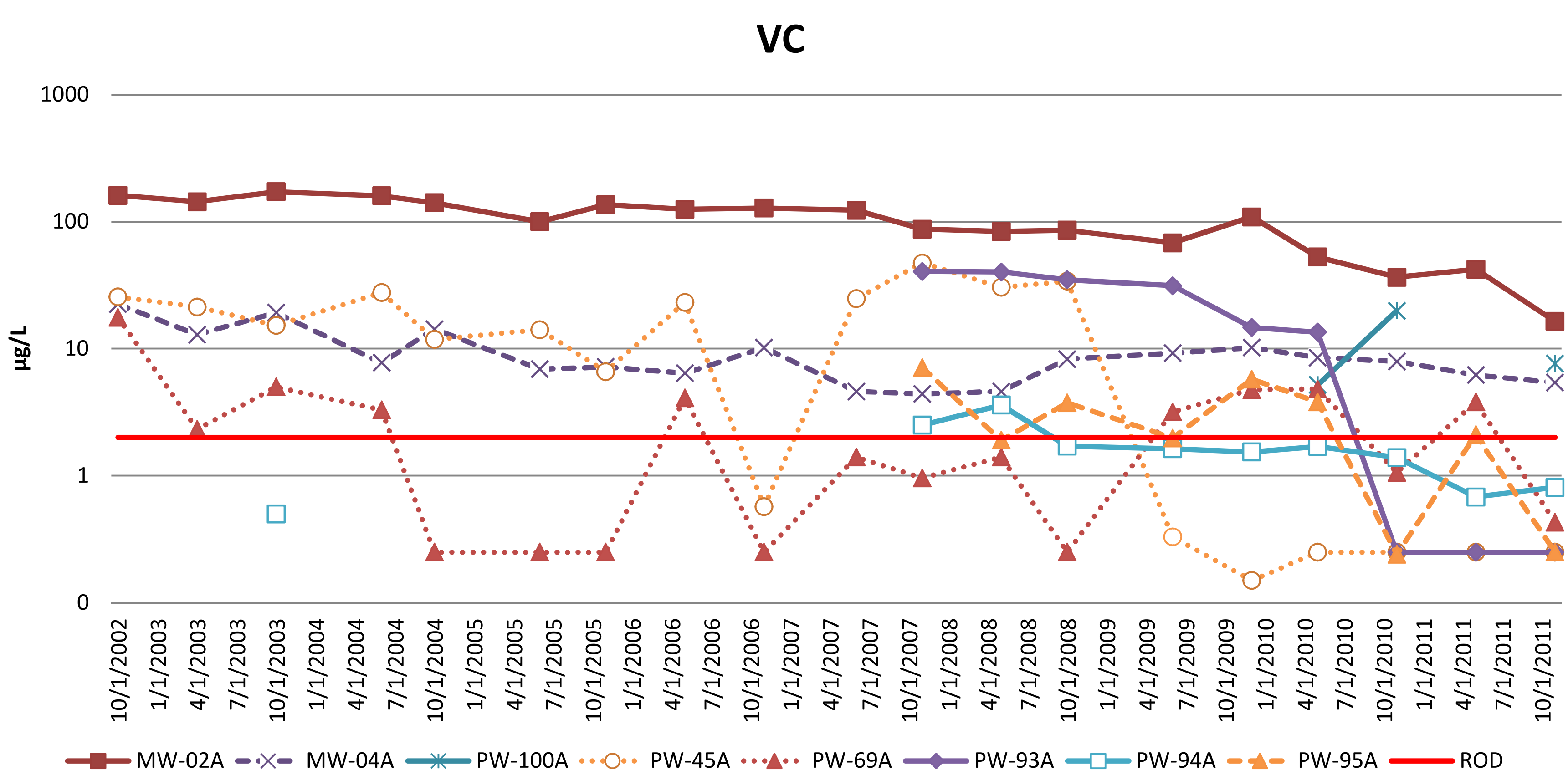
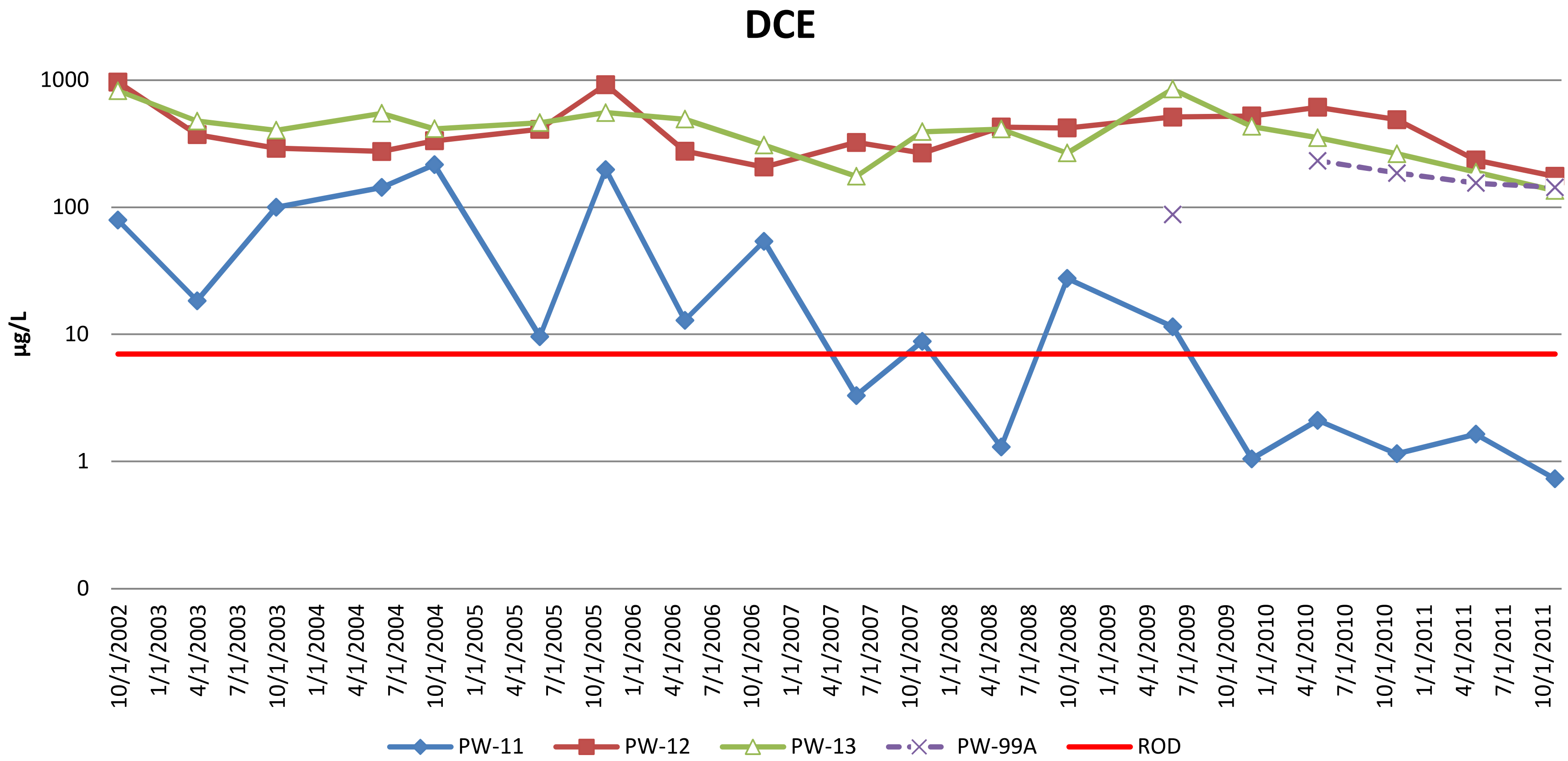
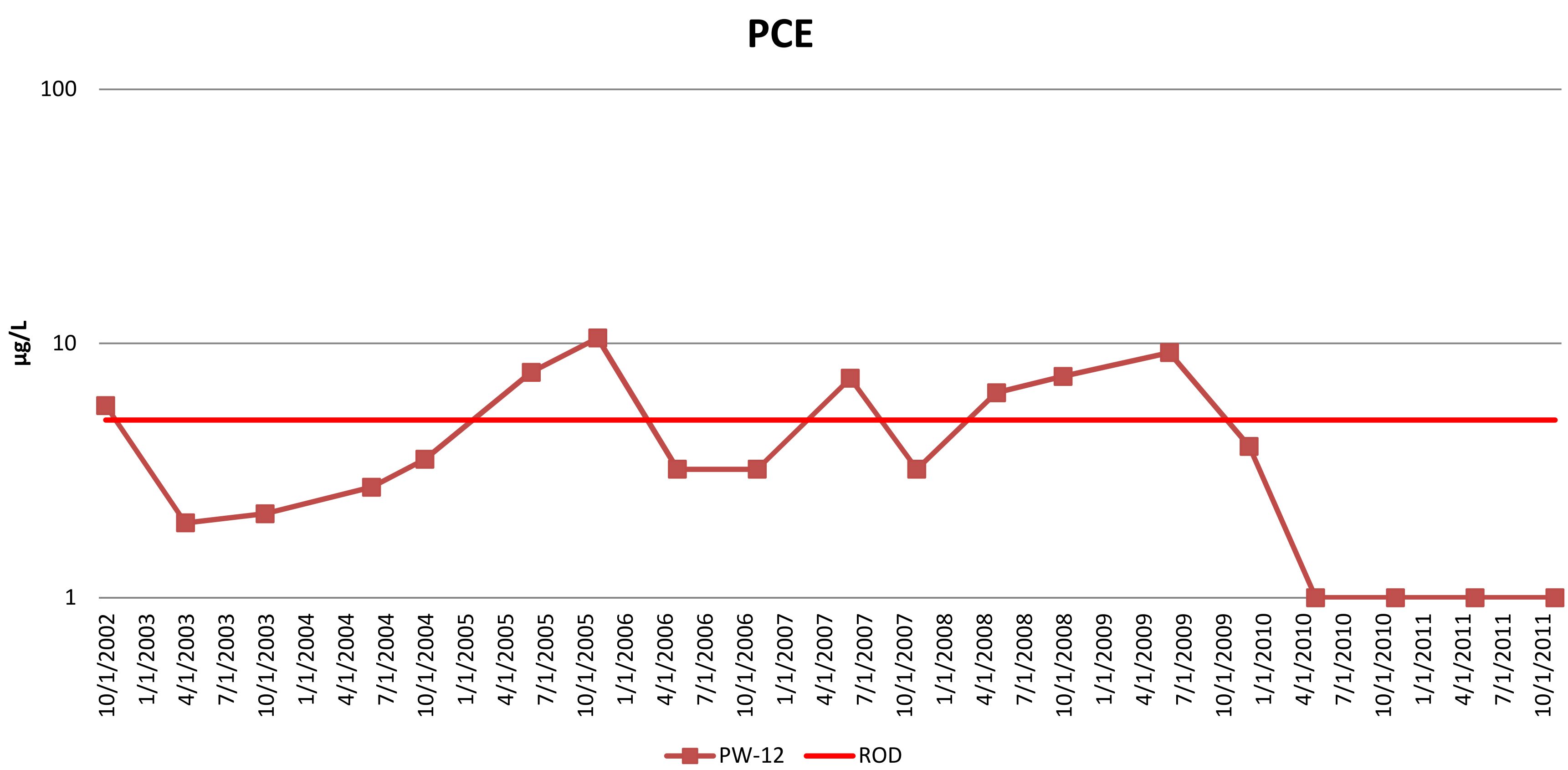


Figure 6-9. VOC Concentrations for Former Crucible Cleaning Area Hot Spot Wells in the Fabrication Area





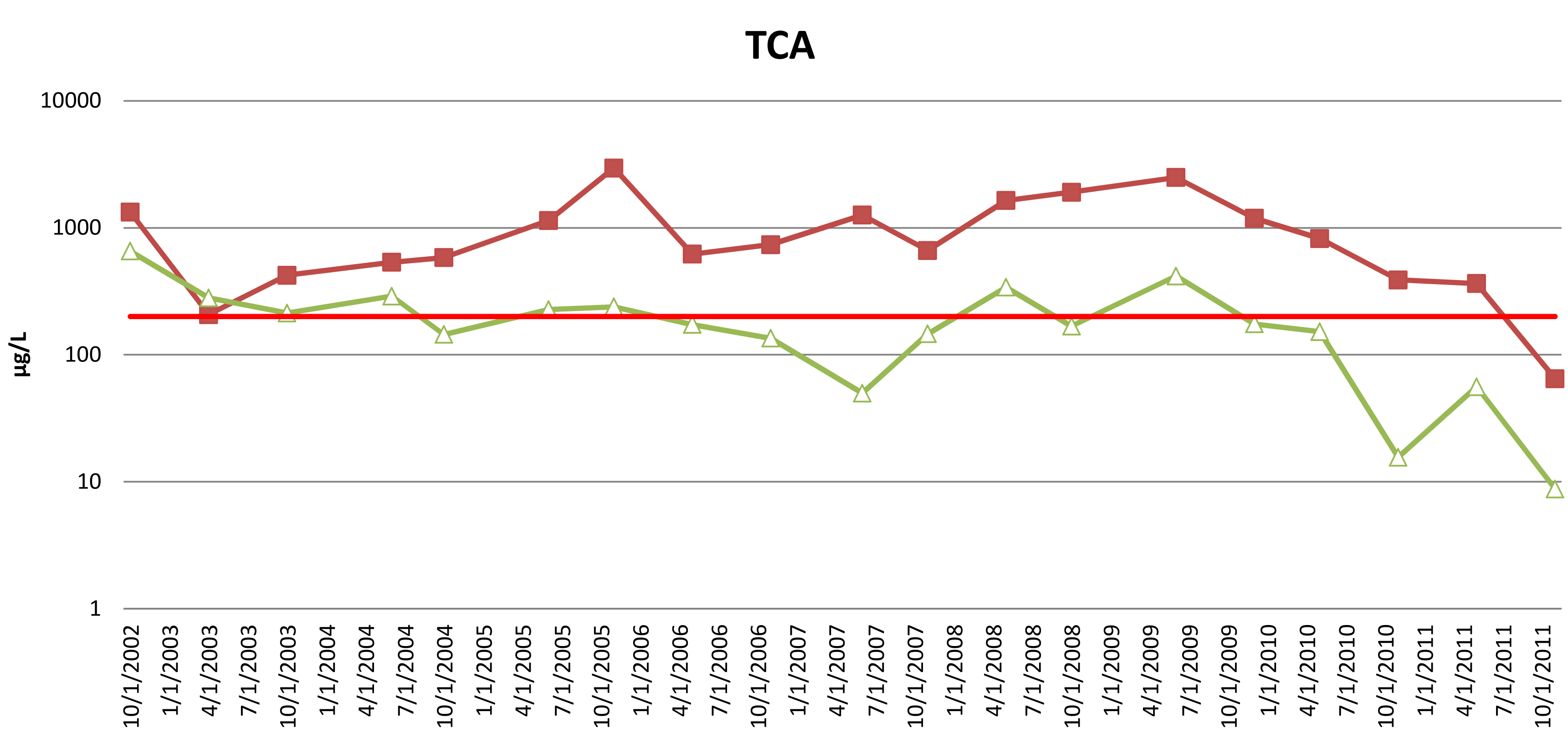
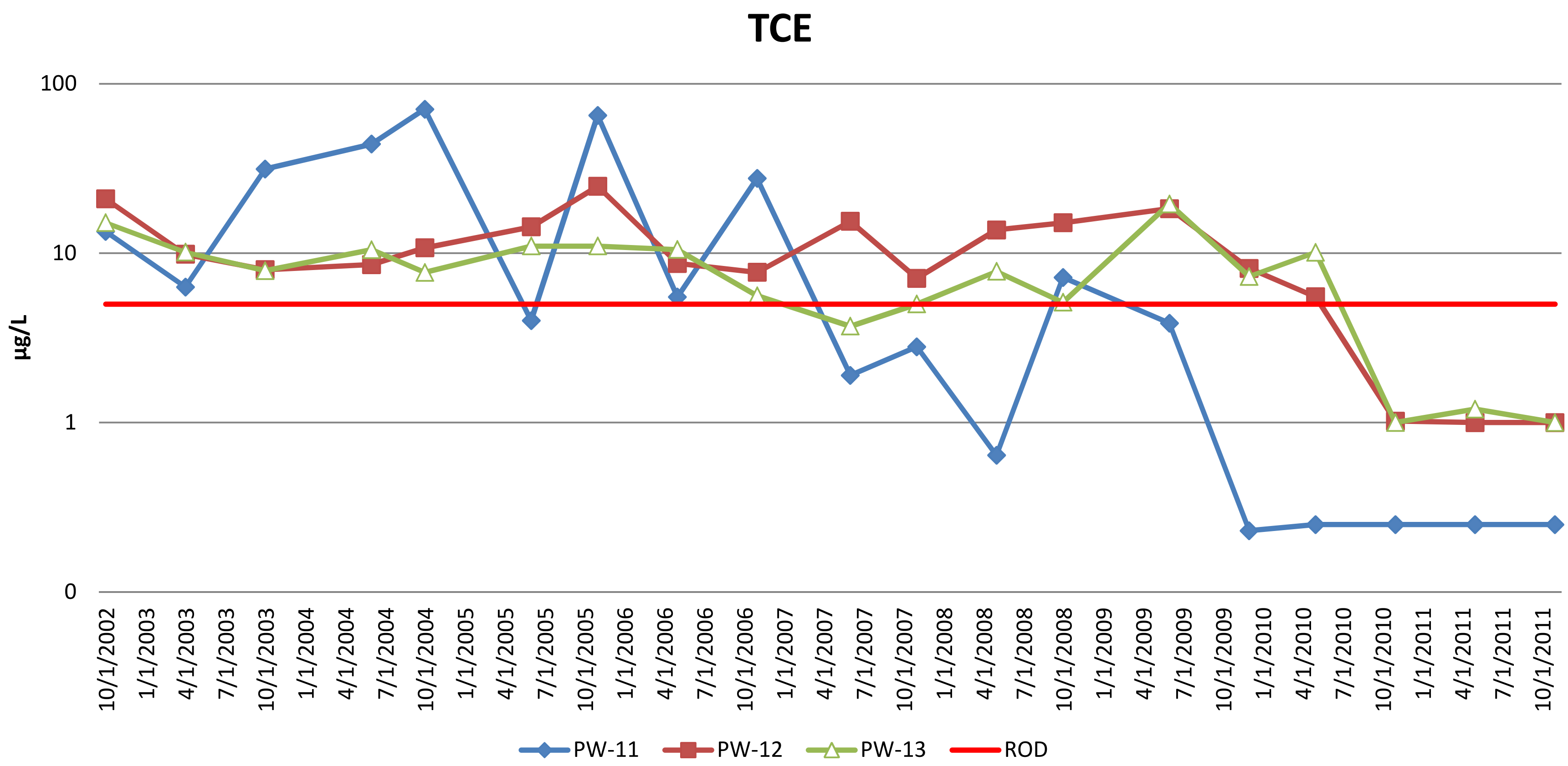


Figure 6-10. VOC Concentrations for Acid Sump Area Hot Spot Wells in the Fabrication Area



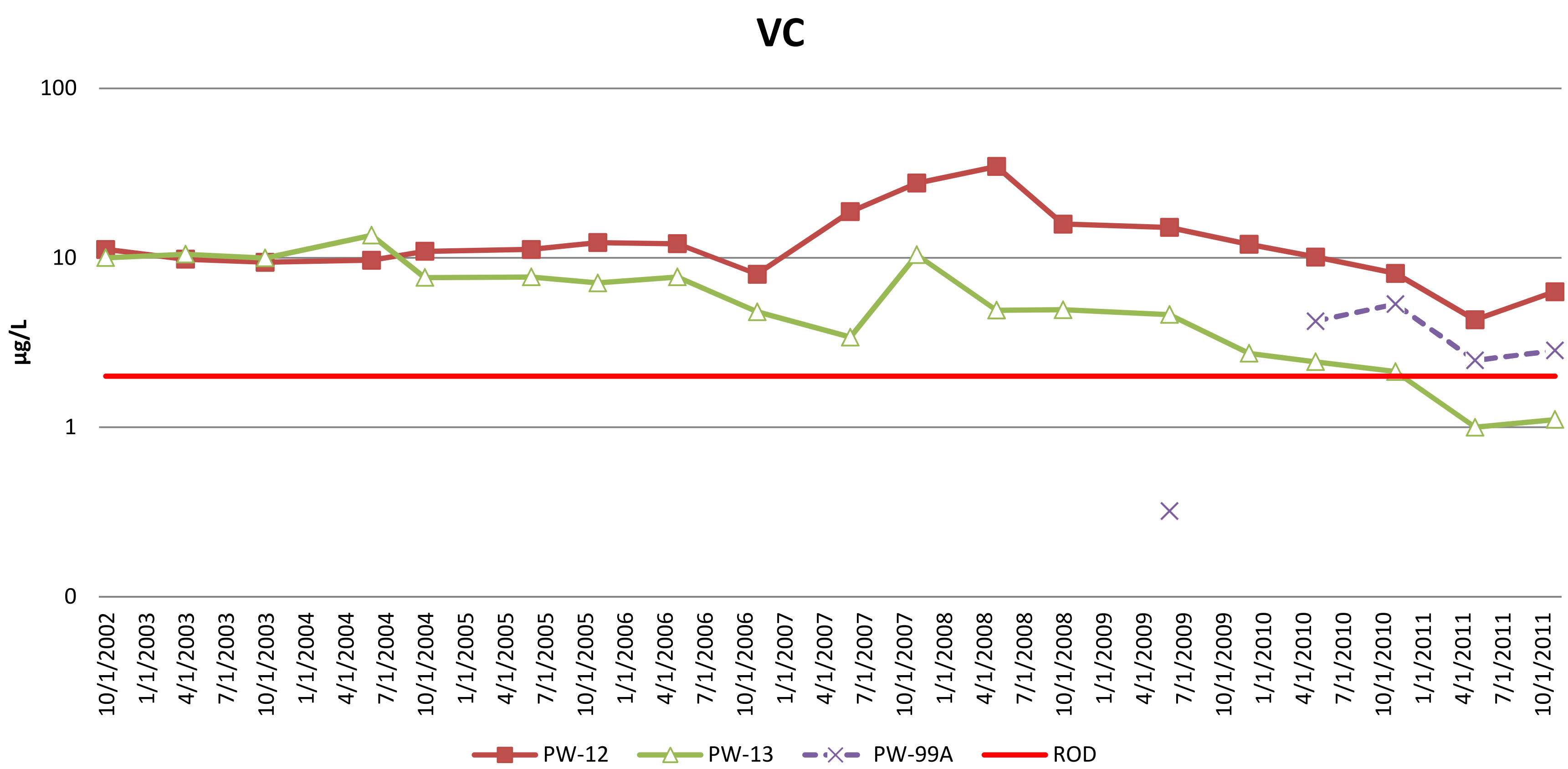
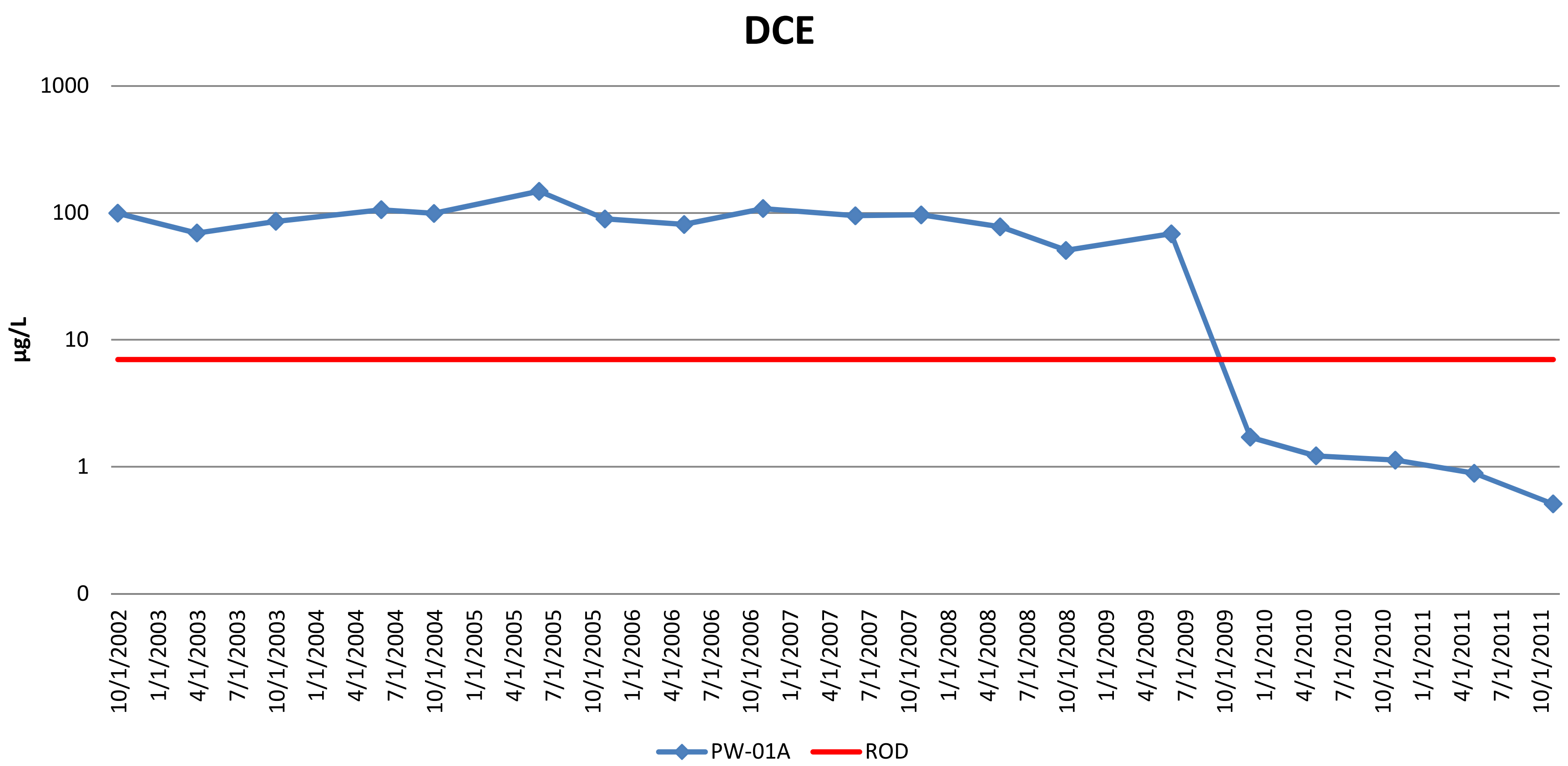
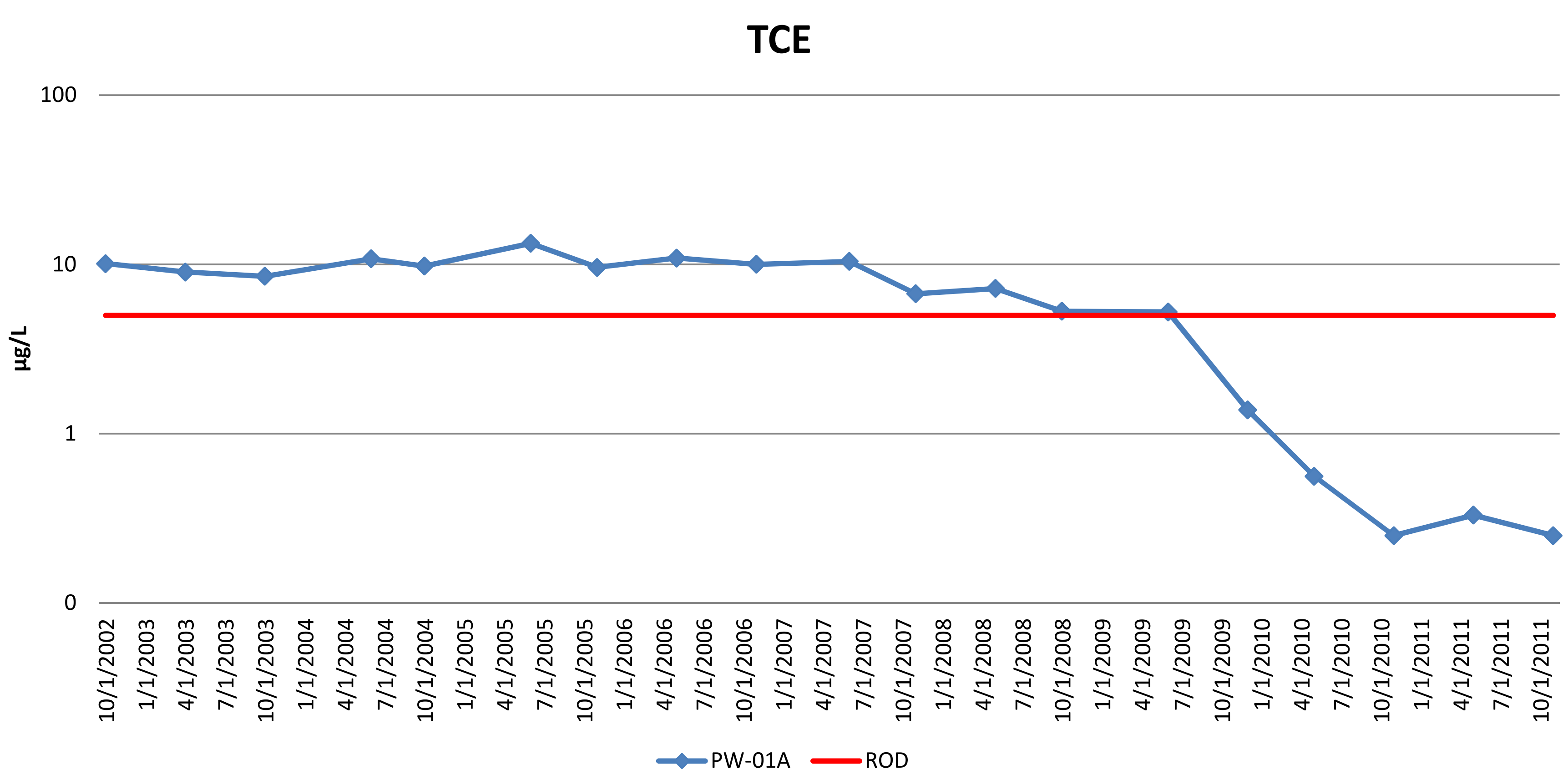


Figure 6-10. VOC Concentrations for Acid Sump Area Hot Spot Wells in the Fabrication Area





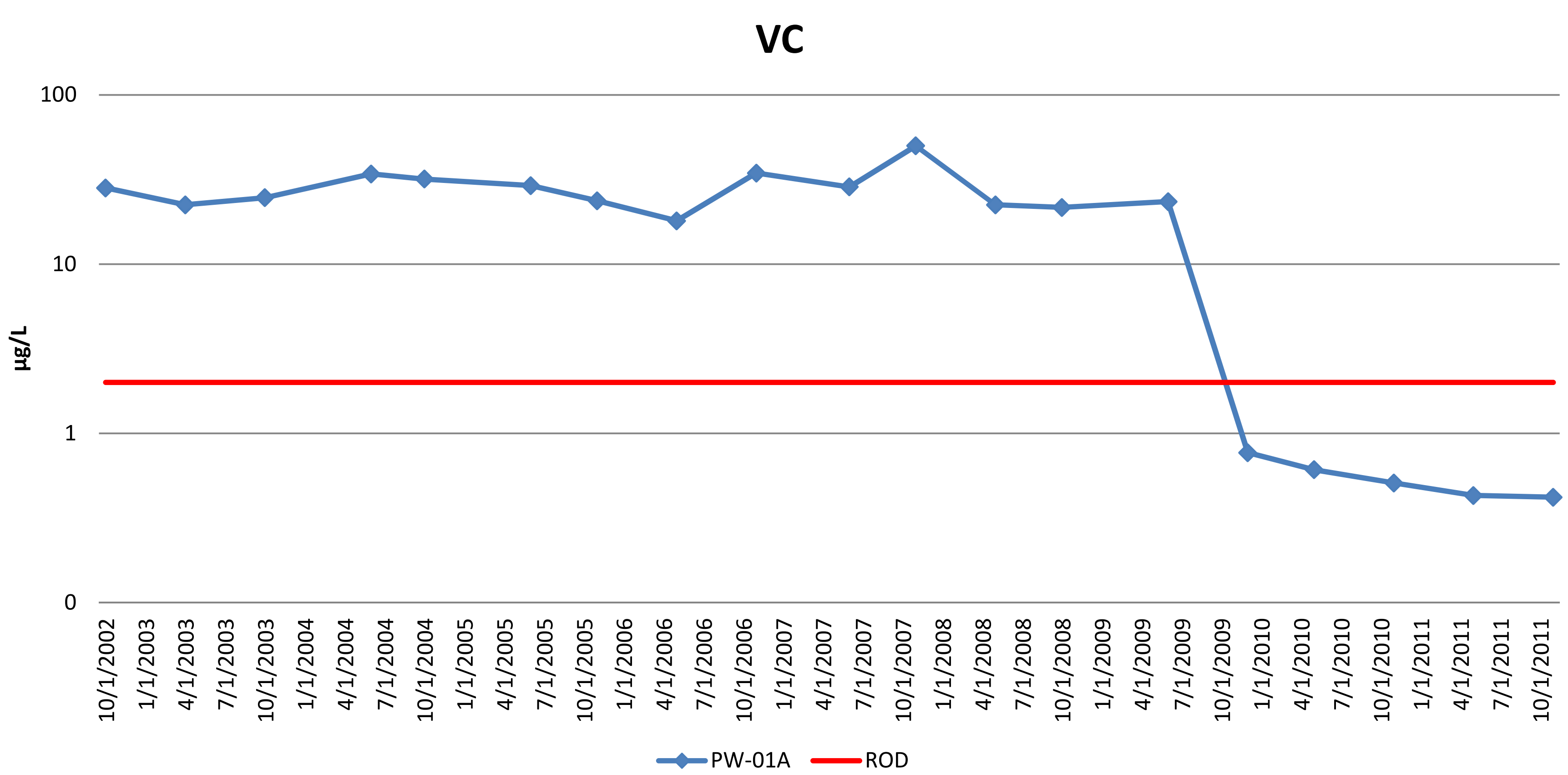
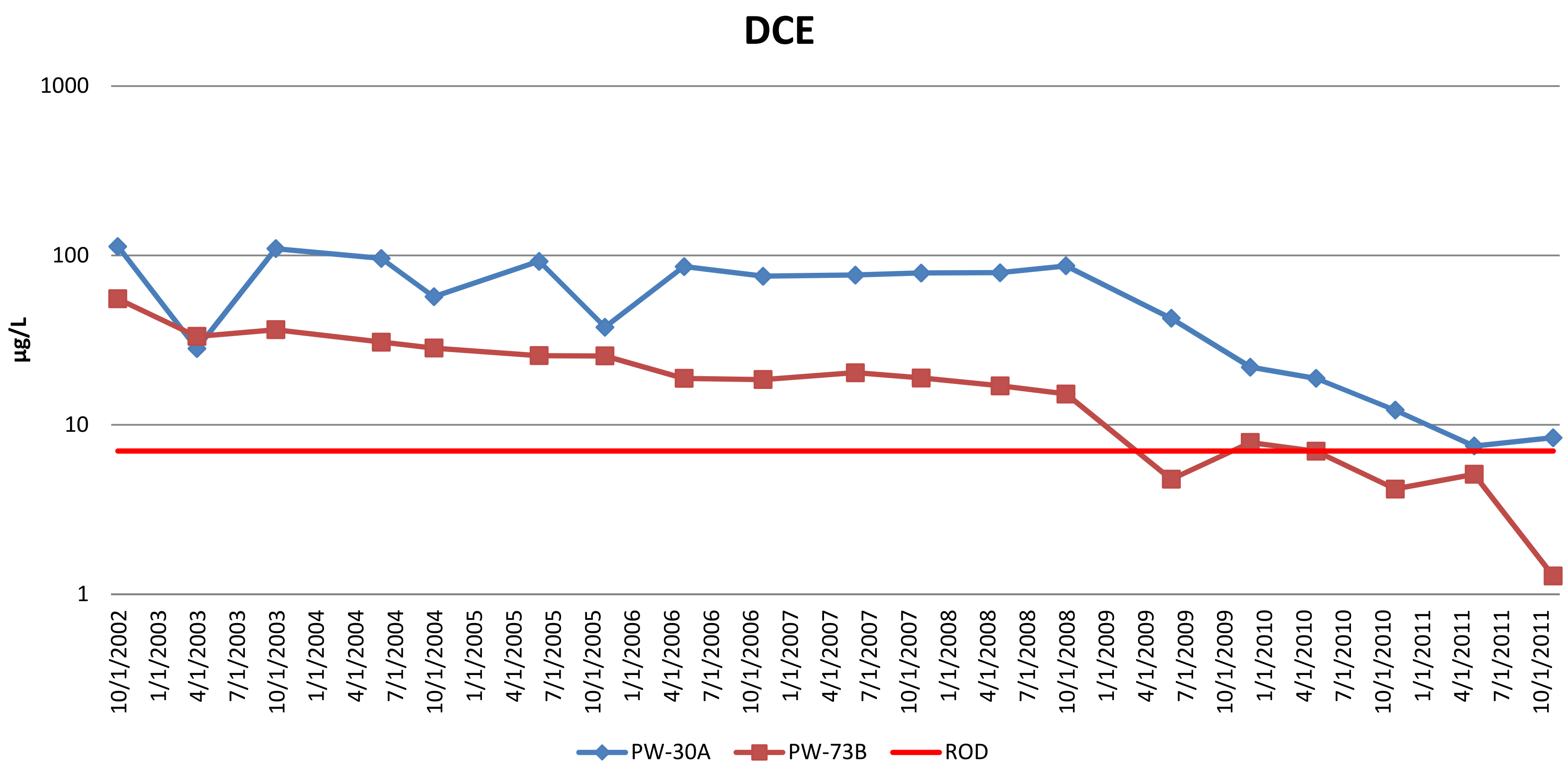
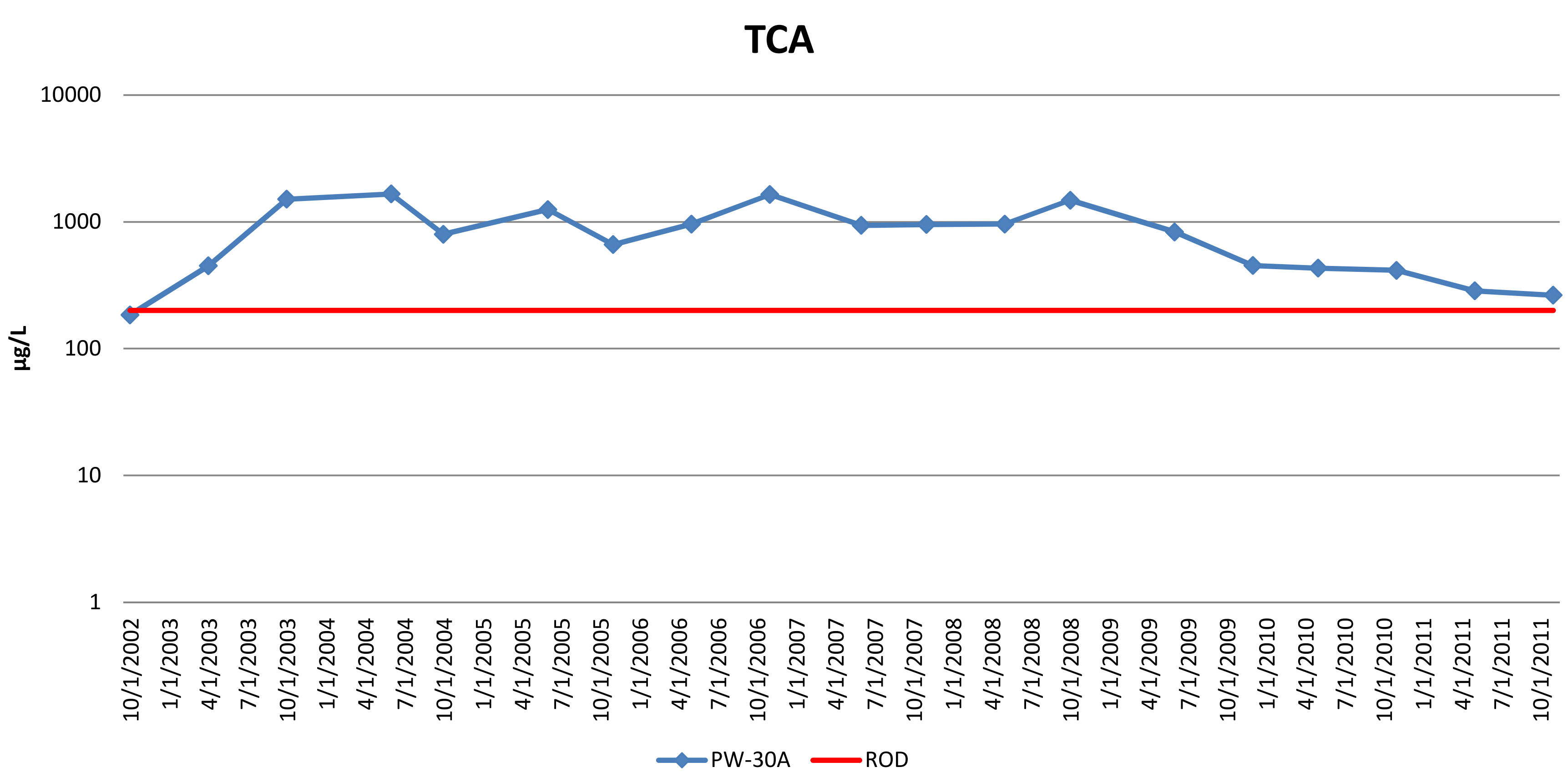


Figure 6-11. VOC Concentrations for Ammonium Sulfate Area Hot Spot Wells in the Fabrication Area





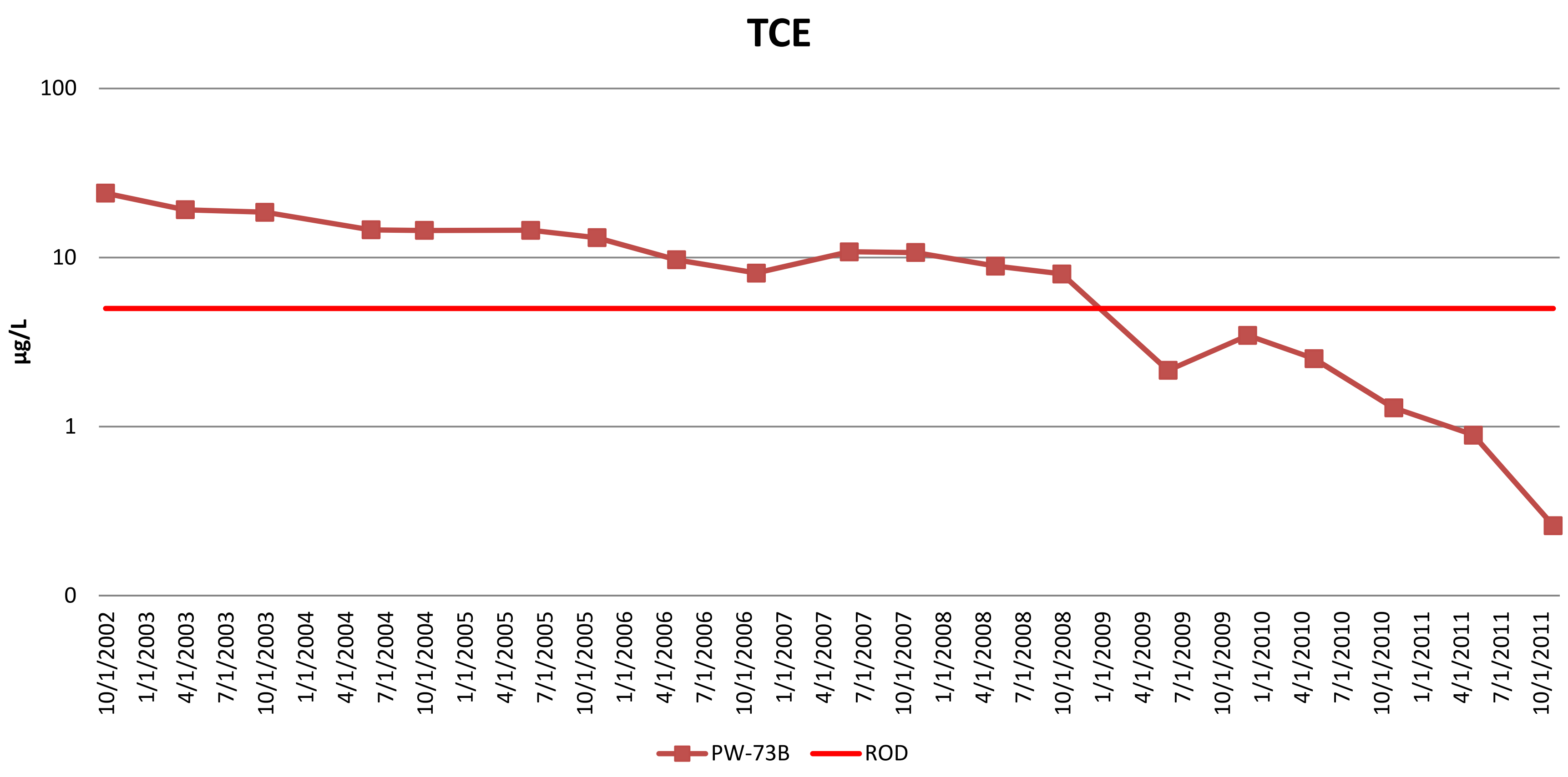


Figure 6-12. VOC Concentrations for Dump Master Area Hot Spot Wells in the Fabrication Area

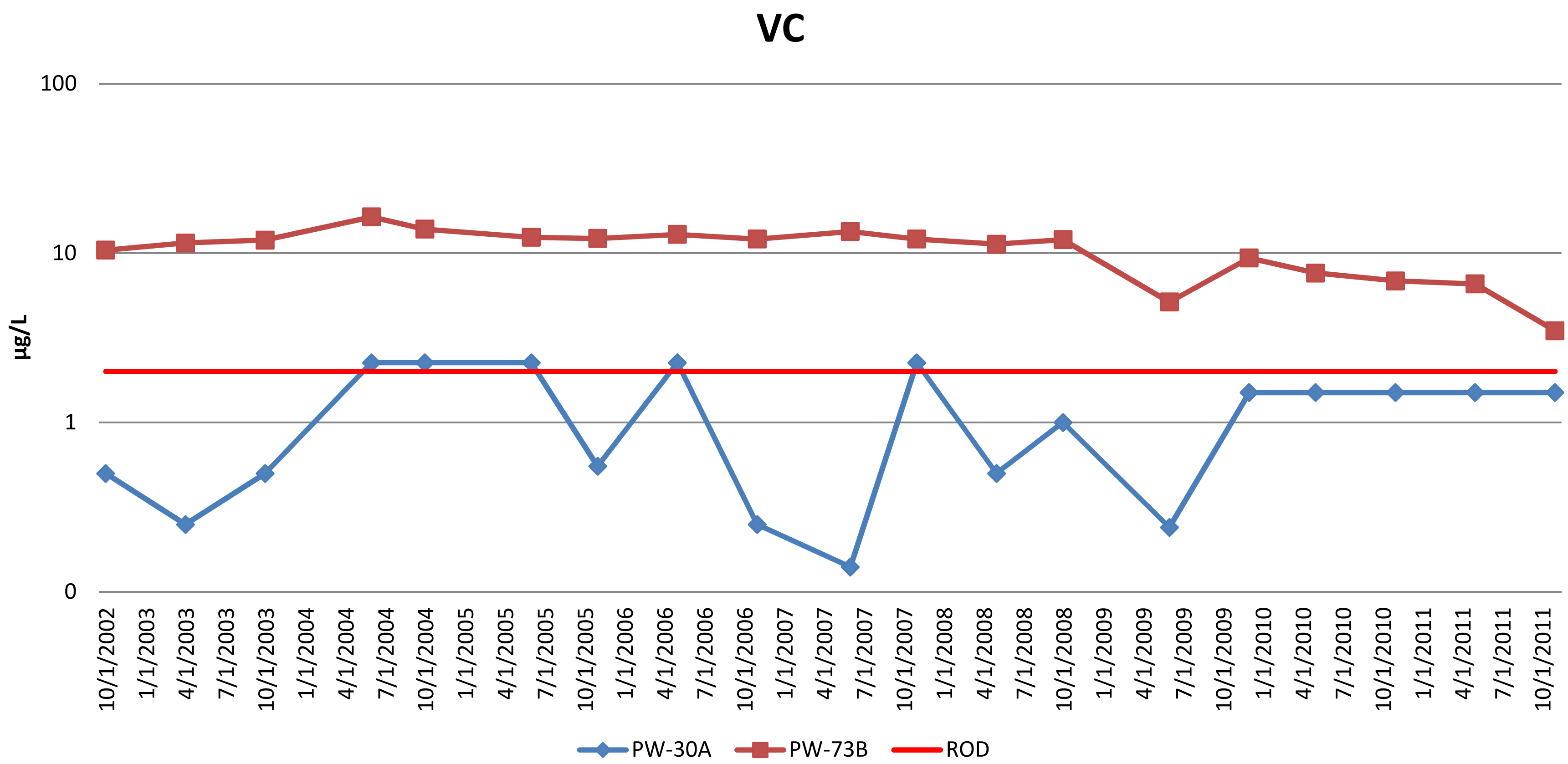
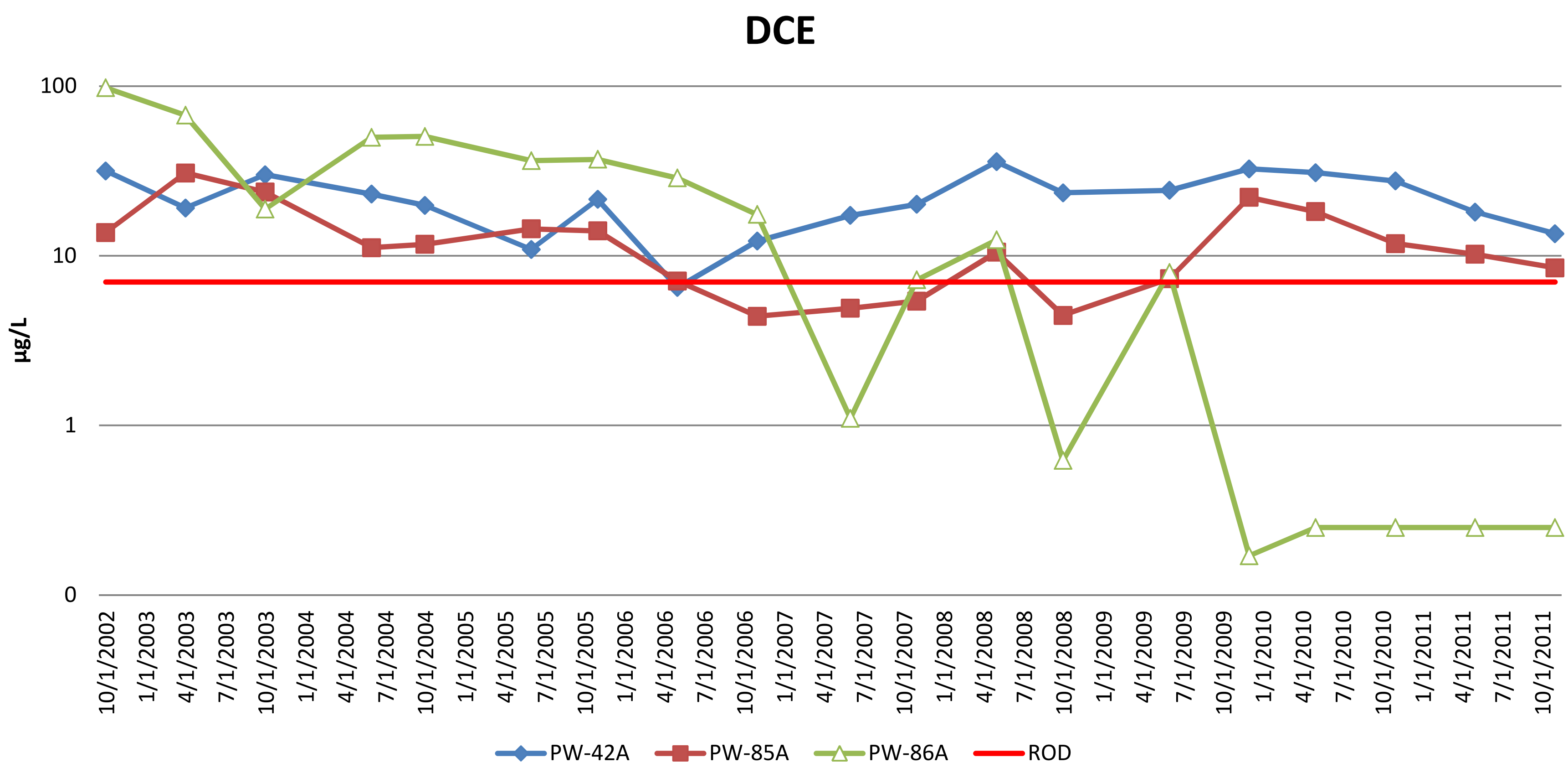
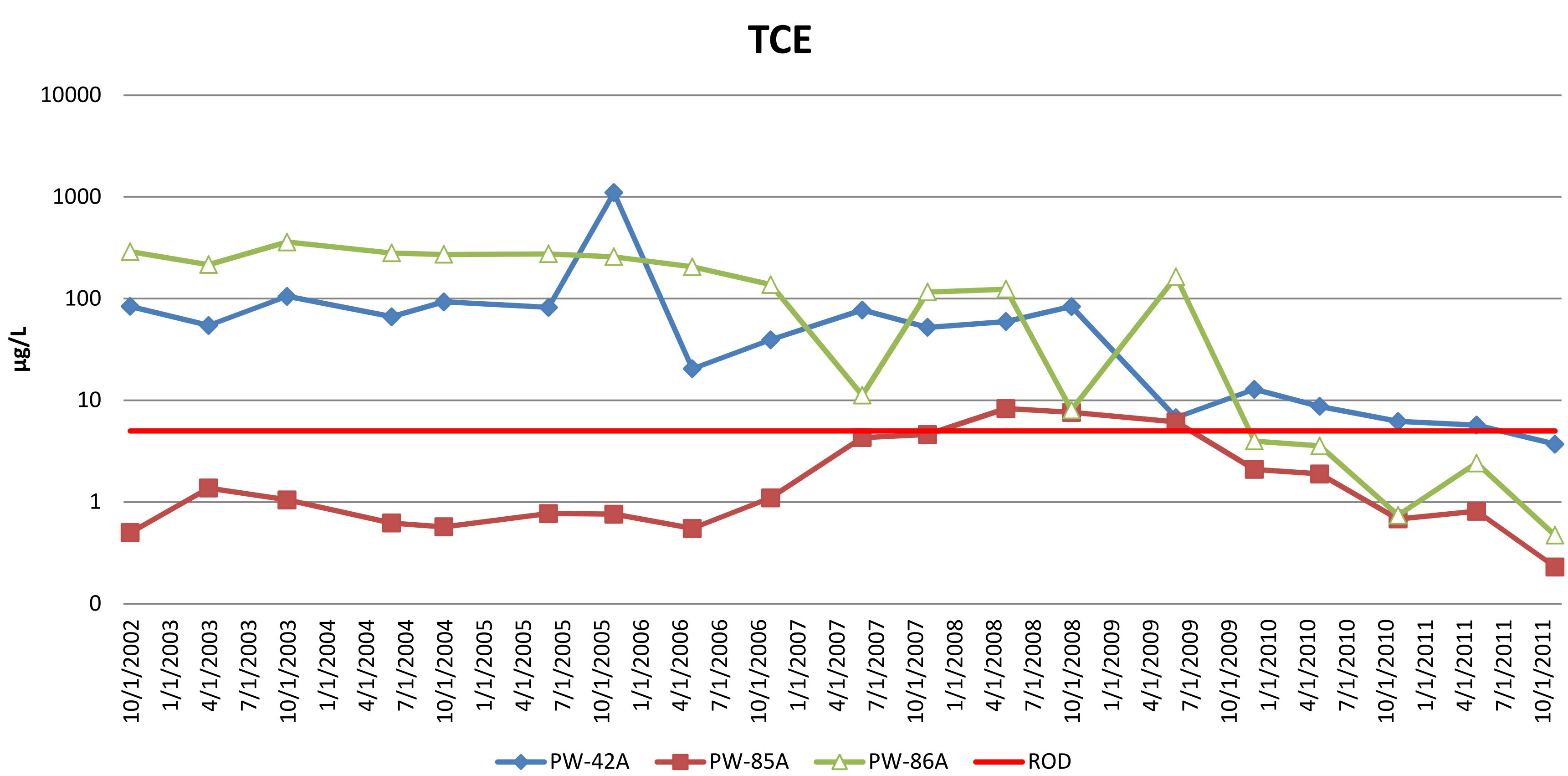


Figure 6-12. VOC Concentrations for Dump Master Area Hot Spot Wells in the Fabrication Area





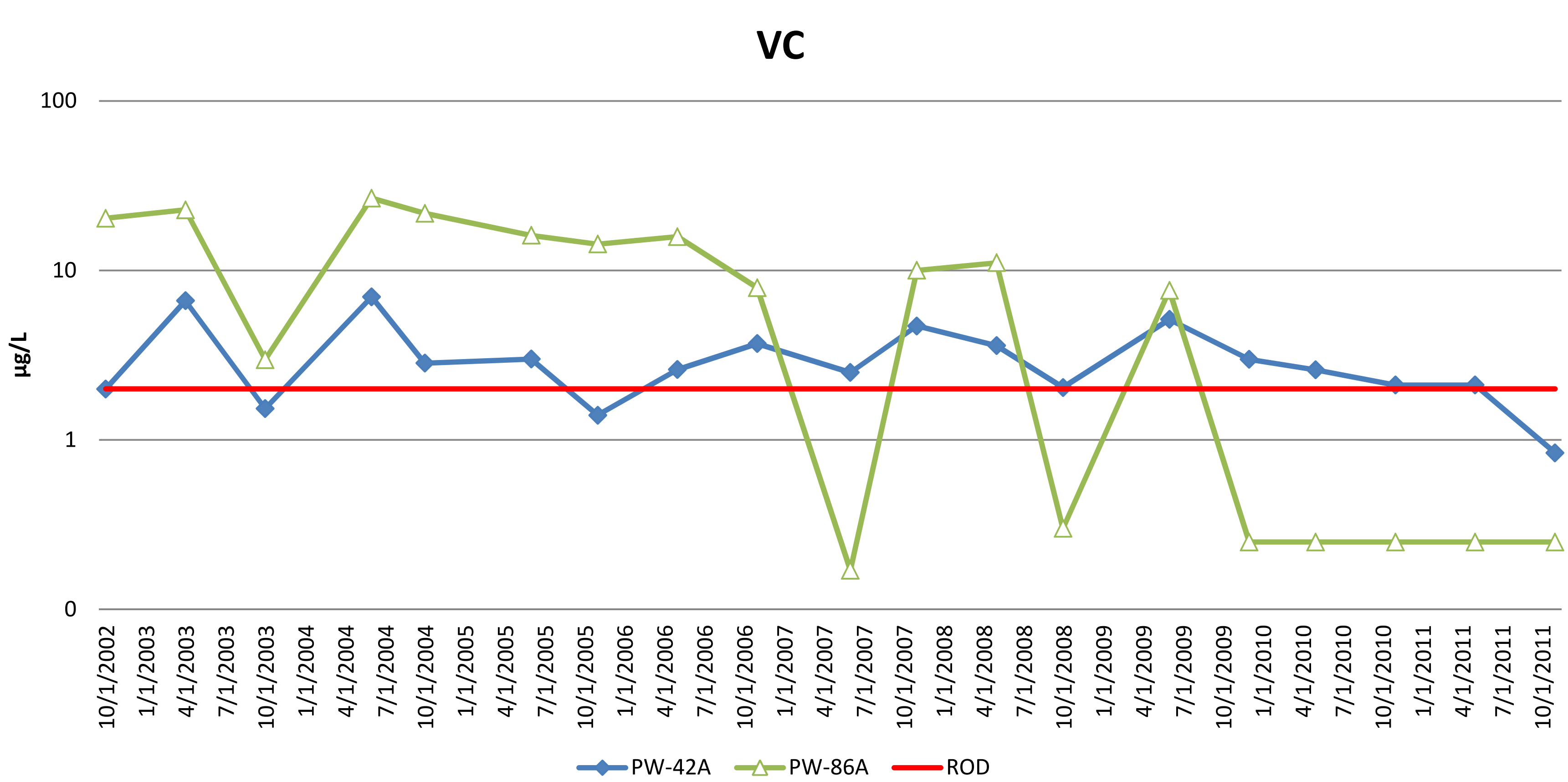
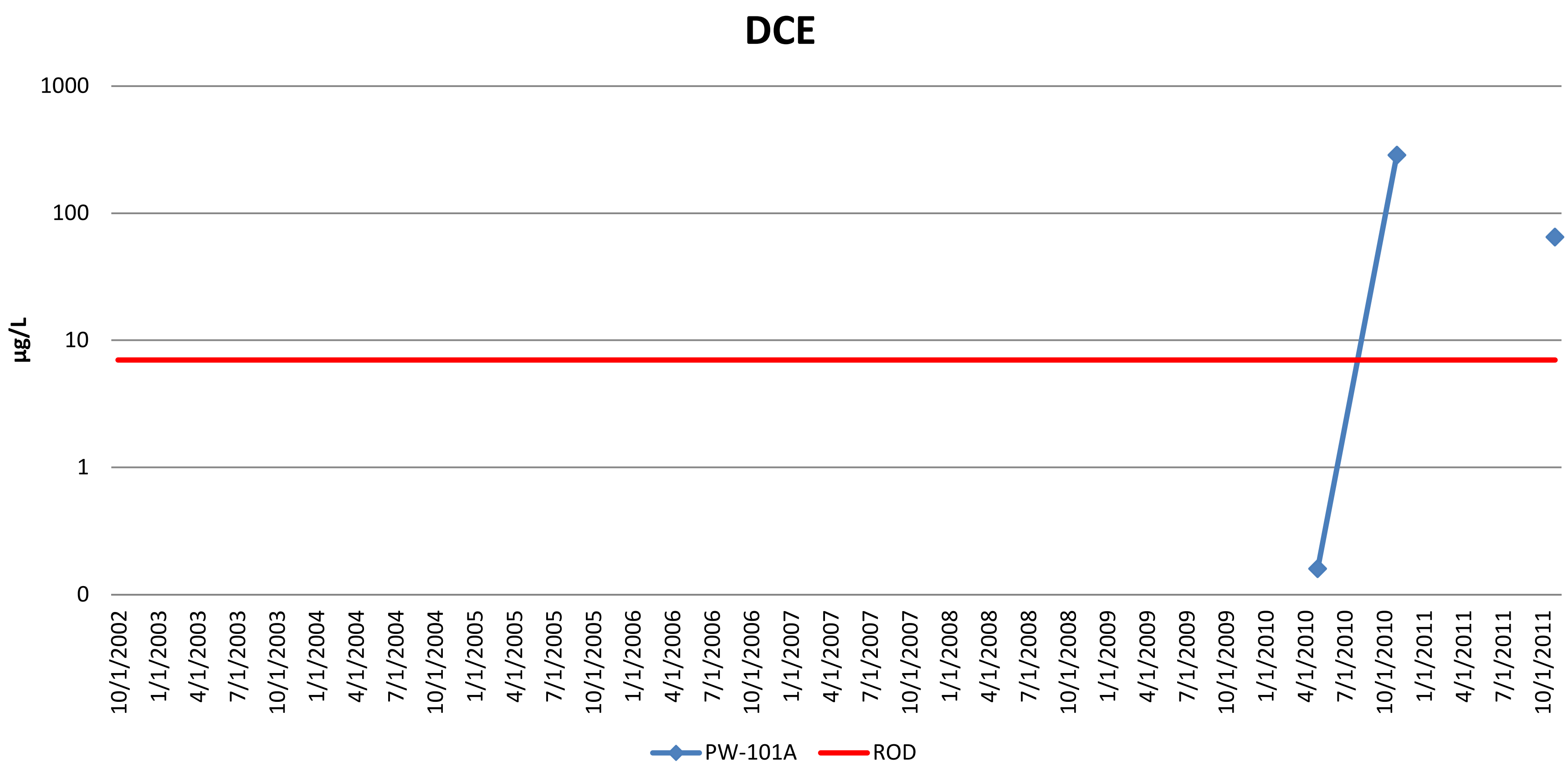
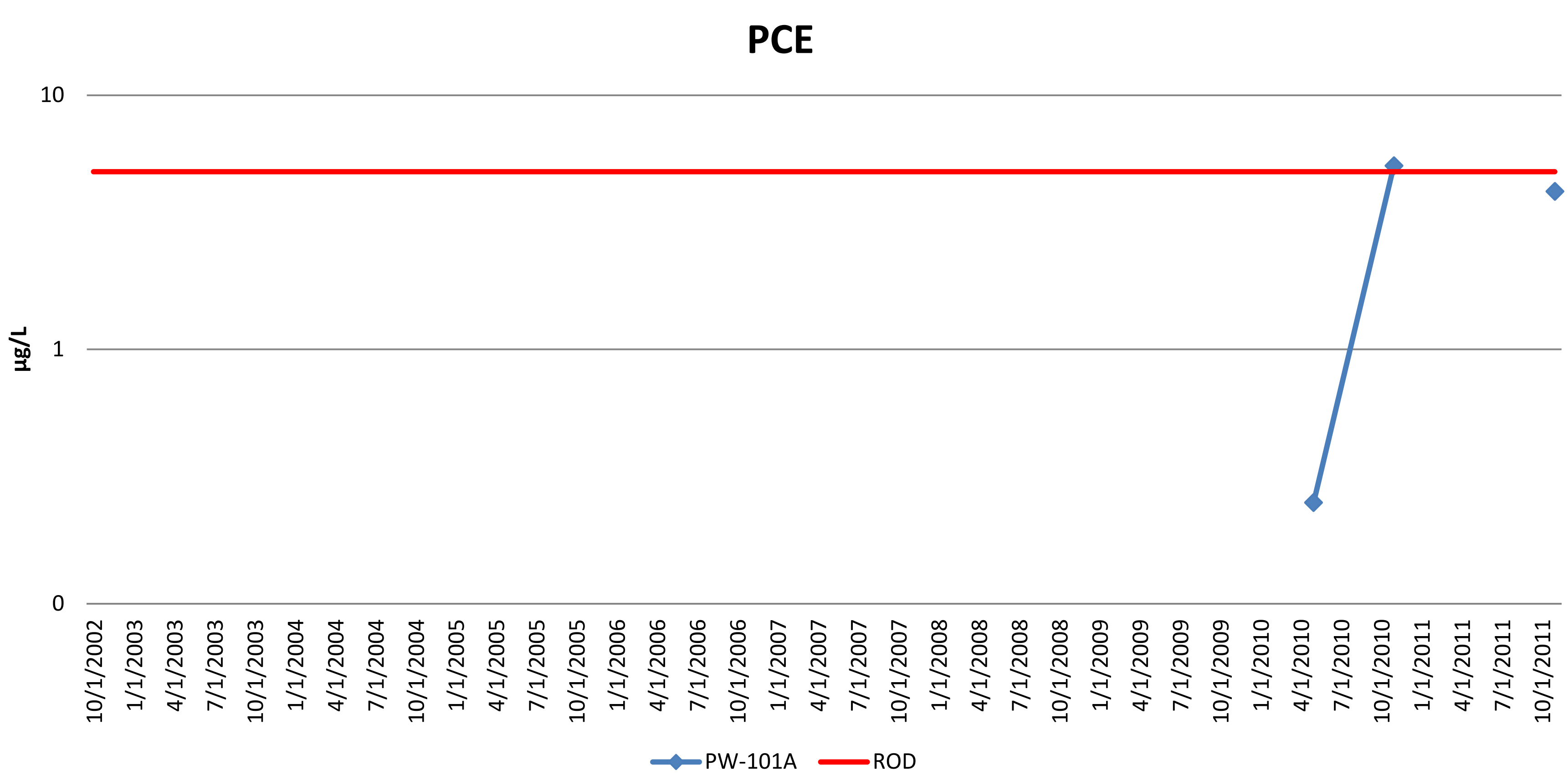


Figure 6-13. VOC Concentrations for Material Recycle Area Hot Spot Wells in the Fabrication Area





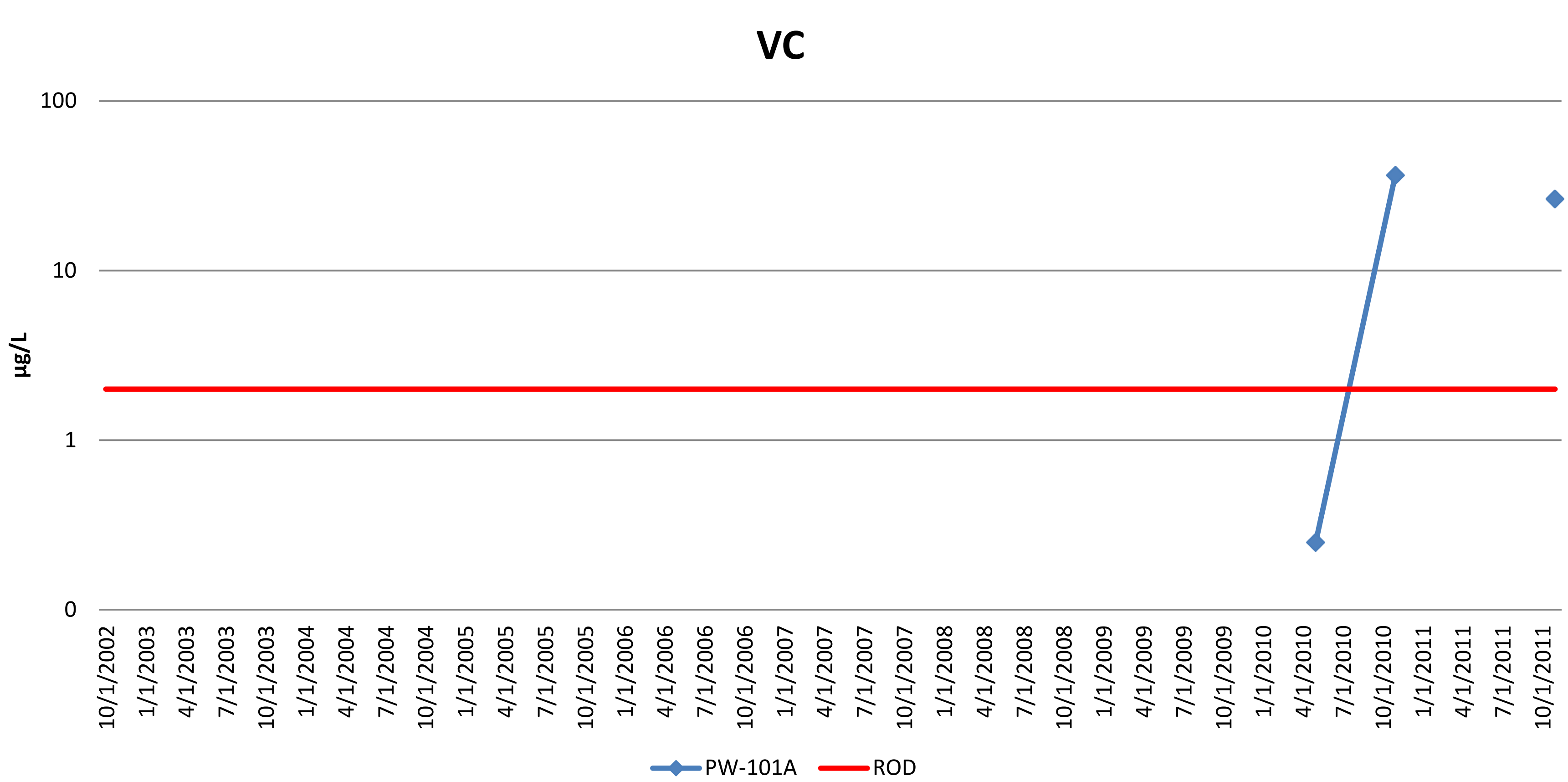
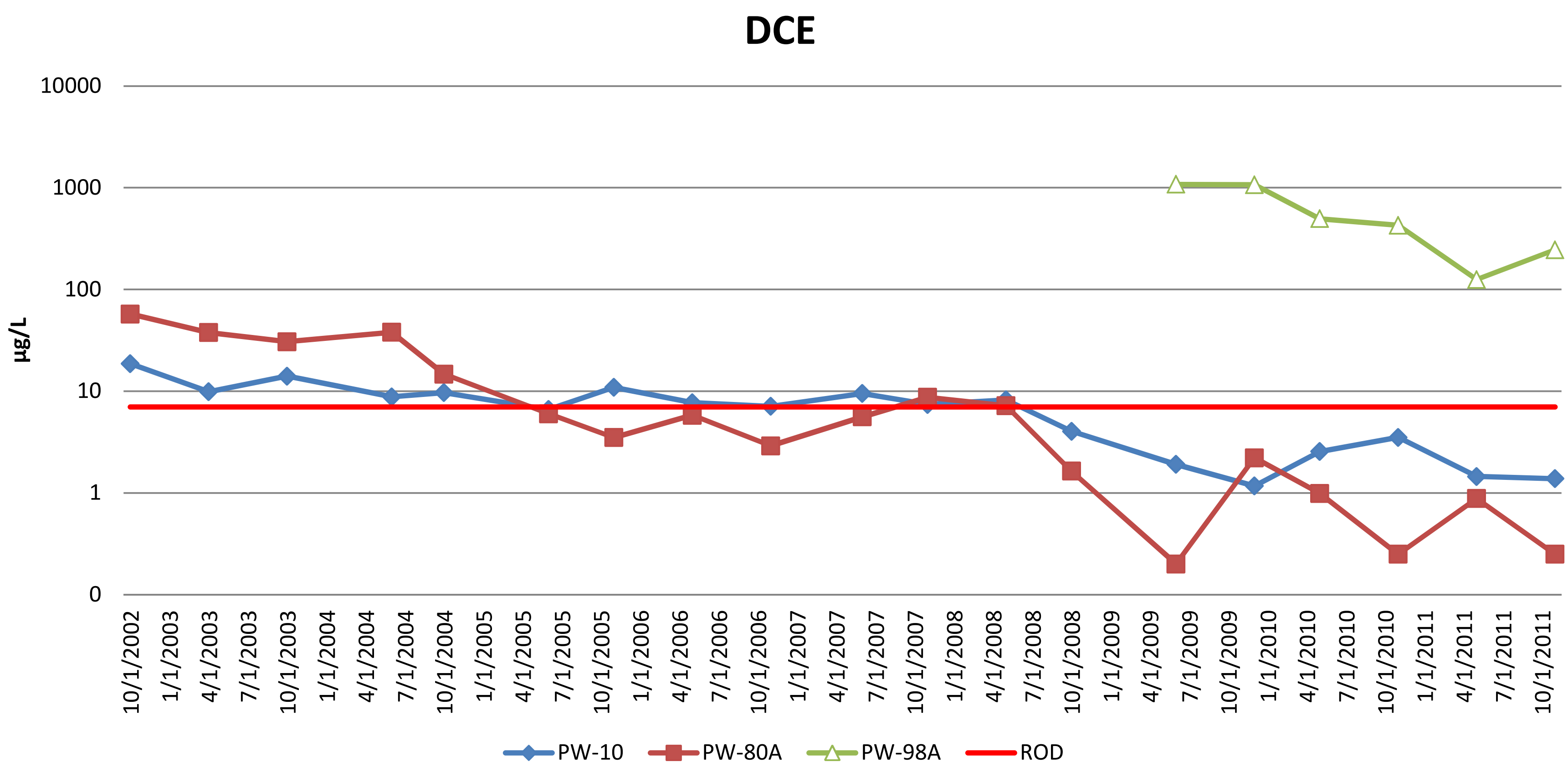
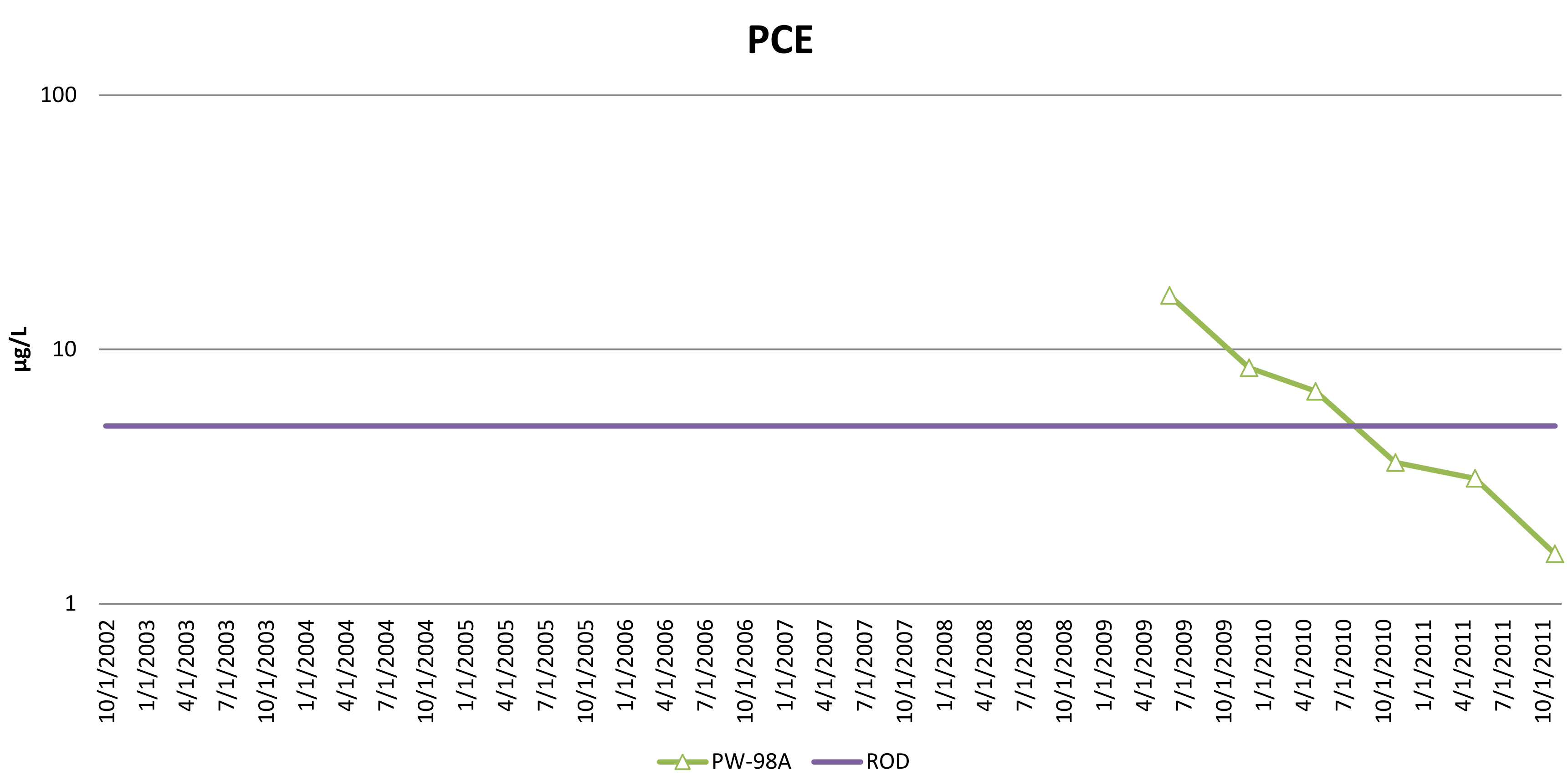


Figure 6-14. VOC Concentrations for Former Crucible Cleaning Area Non-Hot Spot Wells in the Fabrication Area





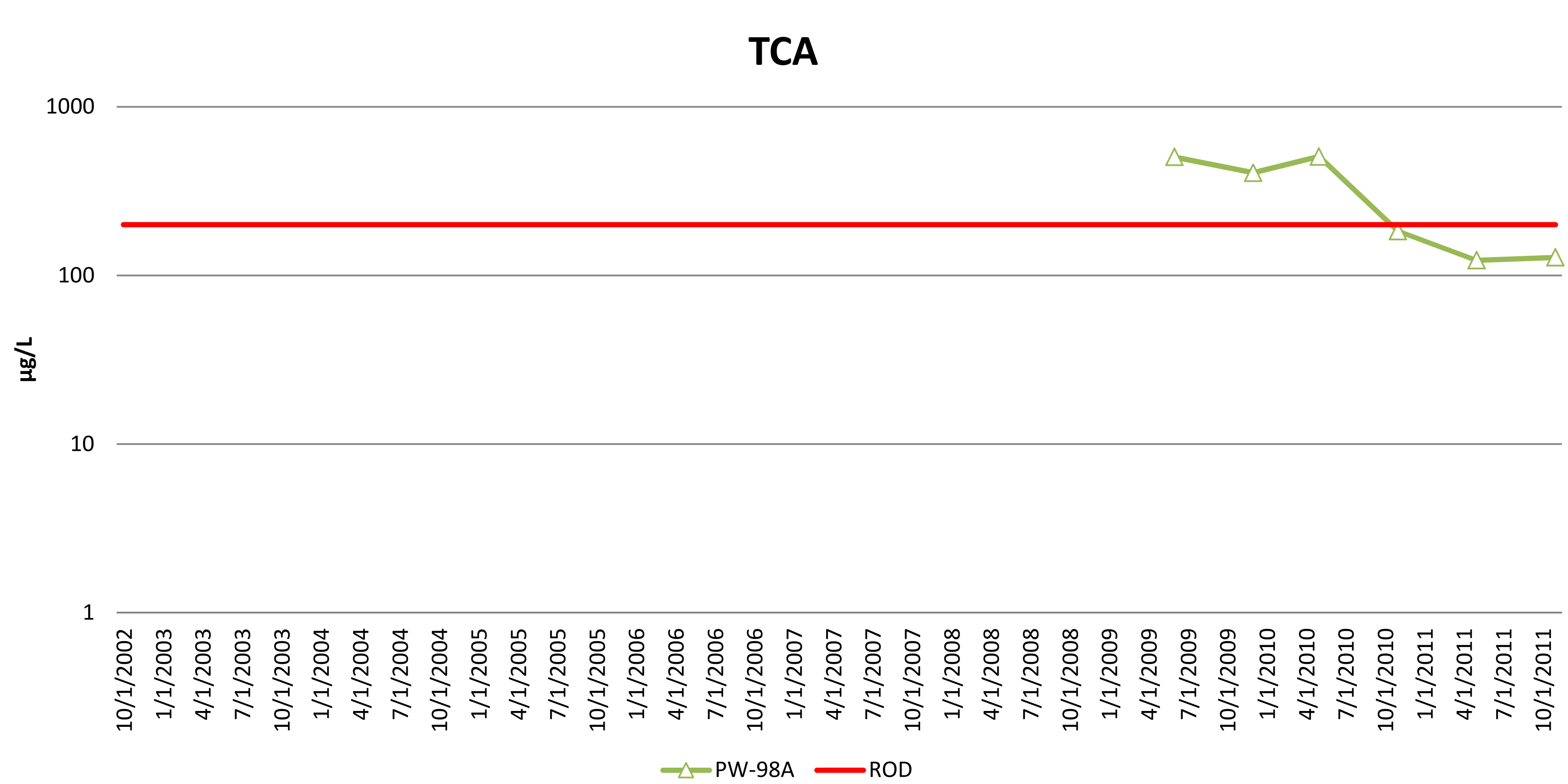
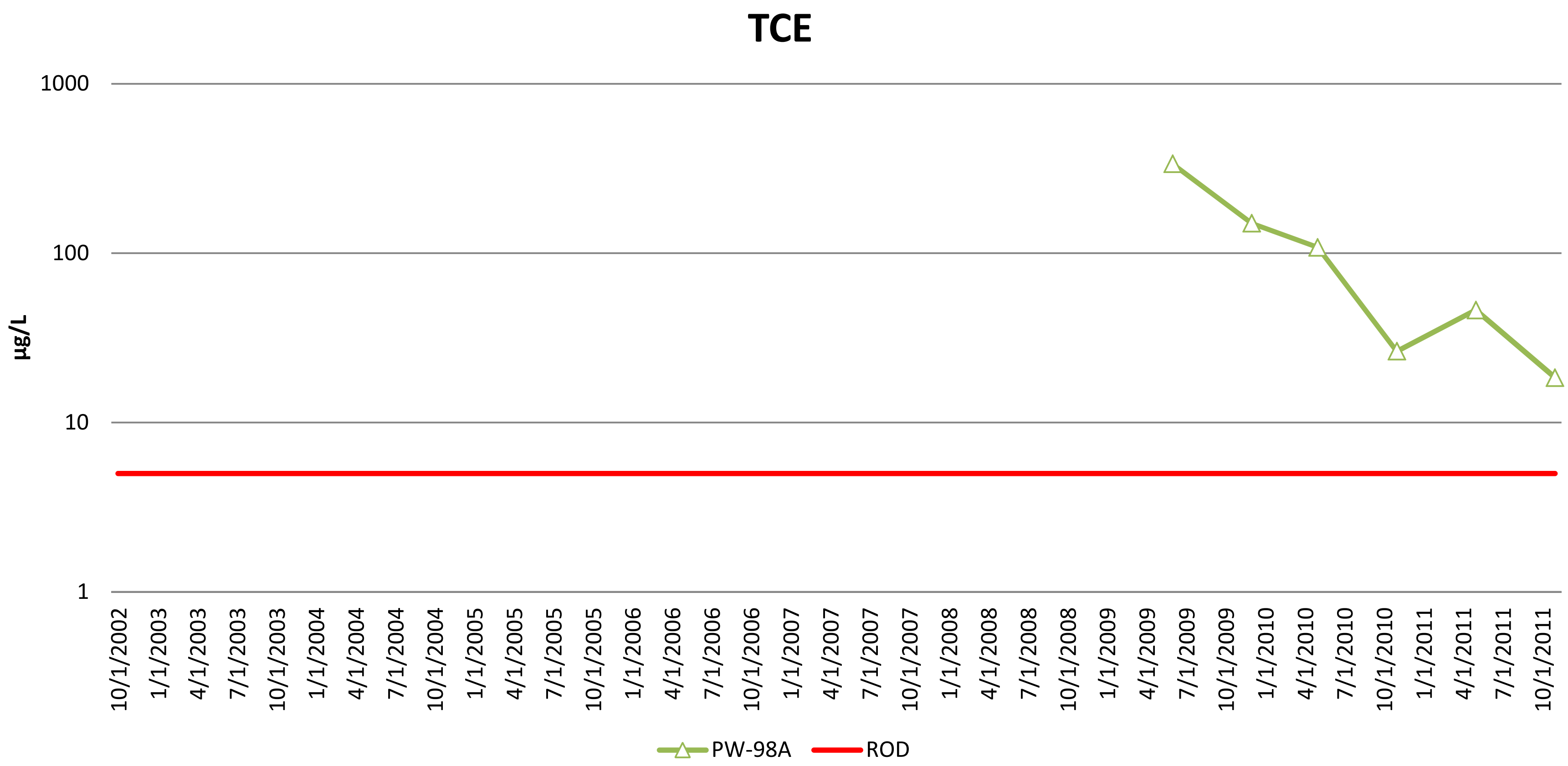


Figure 6-15. VOC Concentrations for Acid Sump Area Non-Hot Spot Wells in the Fabrication Area



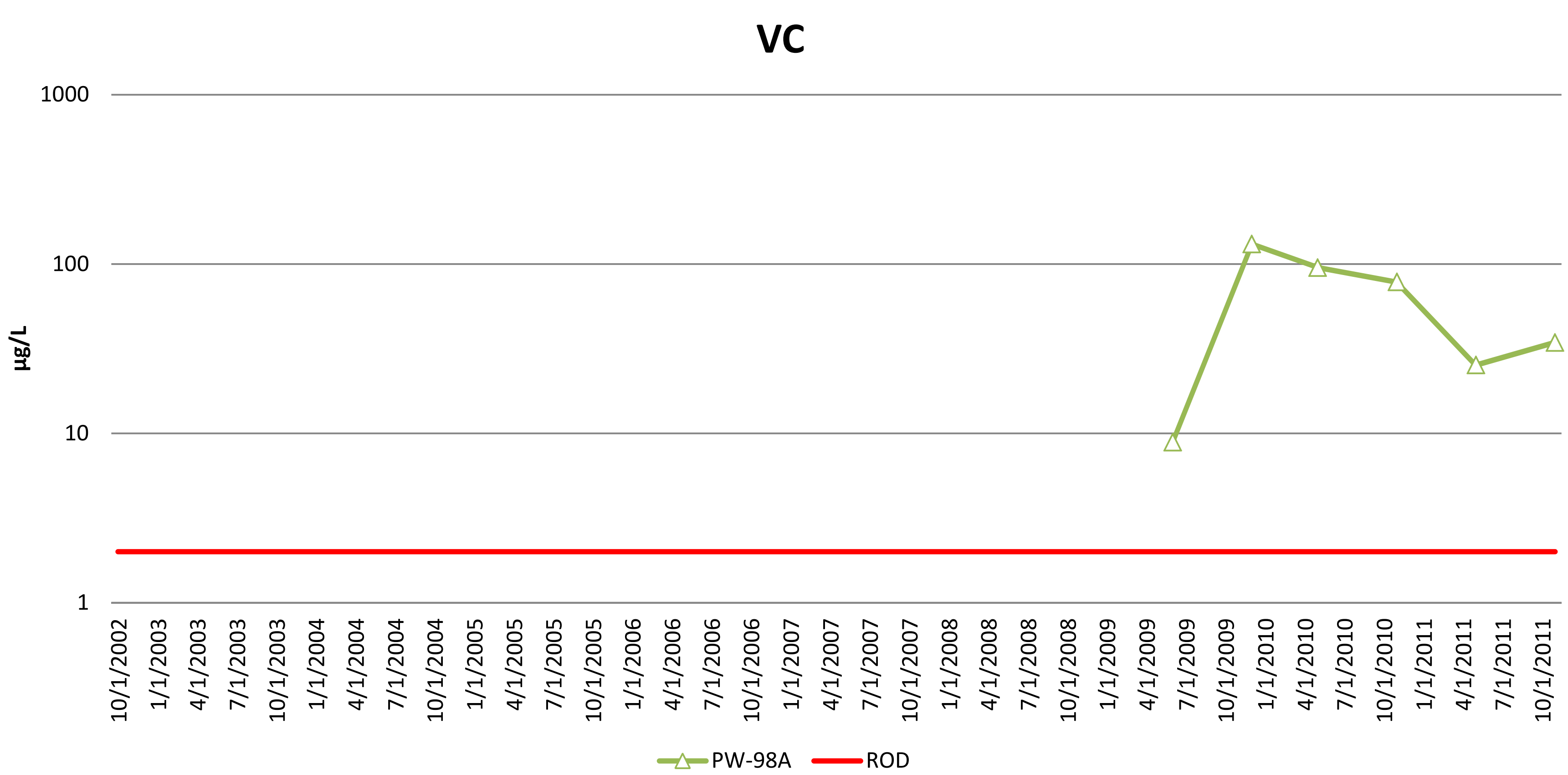
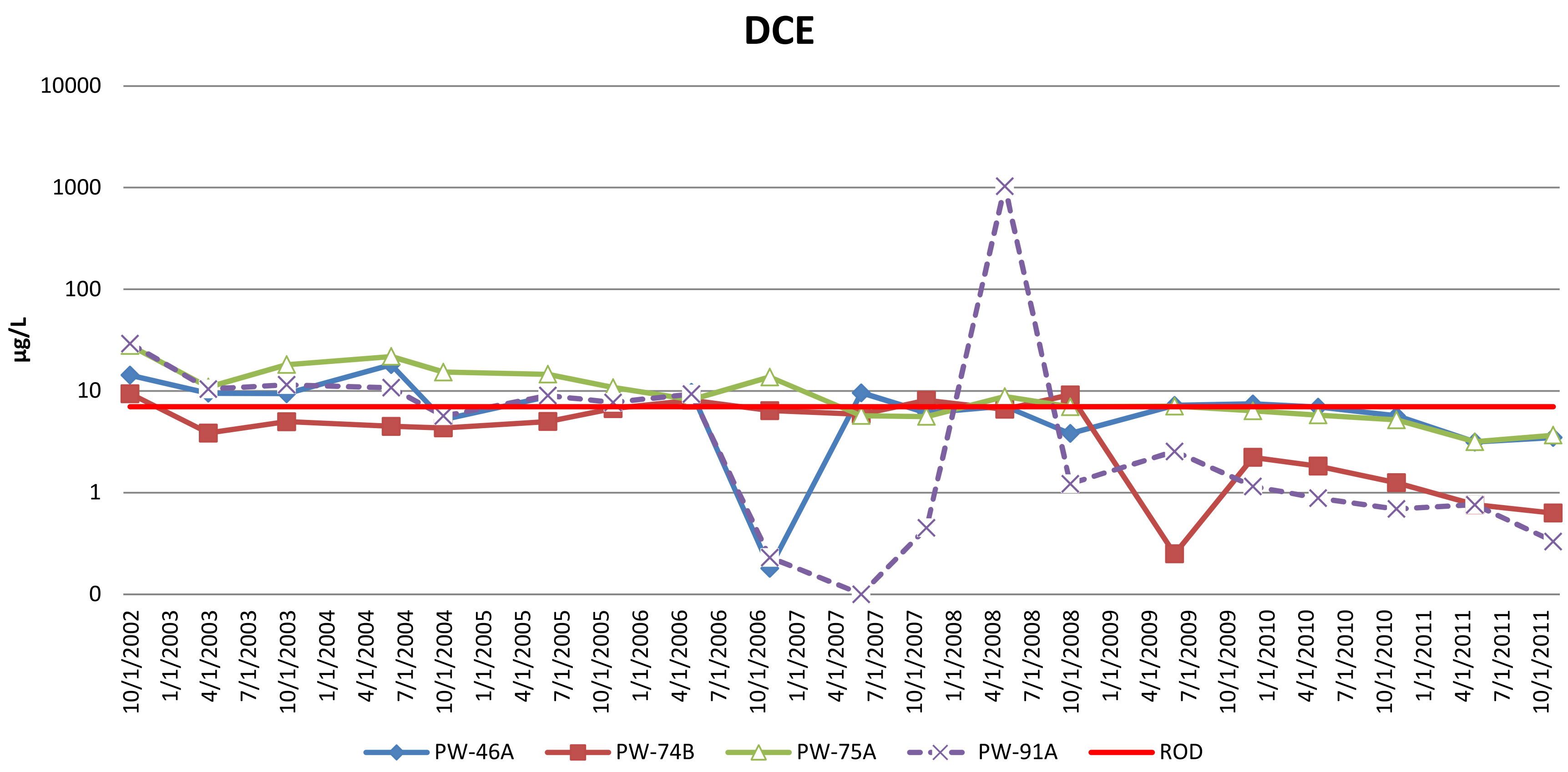
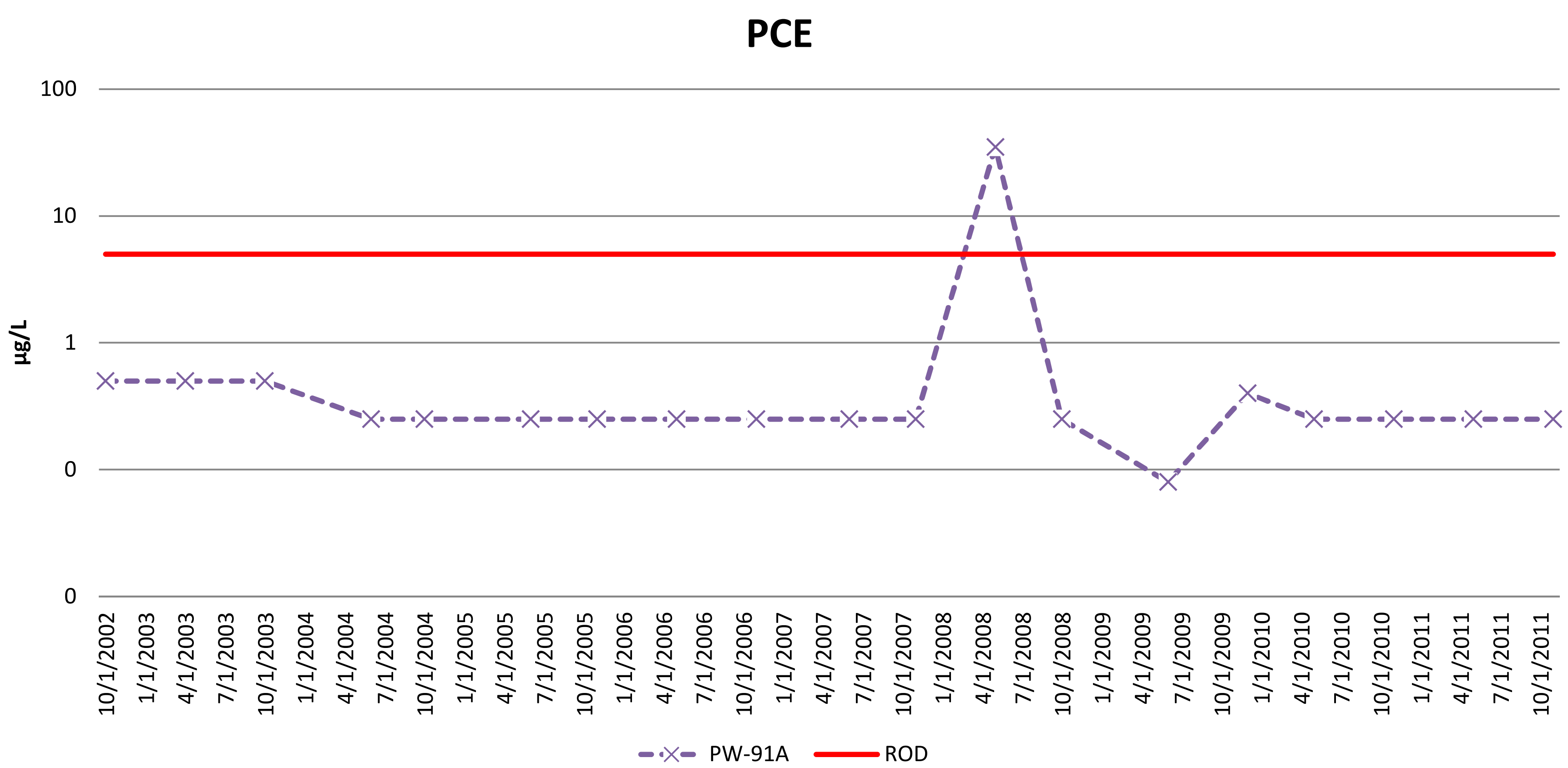


Figure 6-15. VOC Concentrations for Acid Sump Area Non-Hot Spot Wells in the Fabrication Area





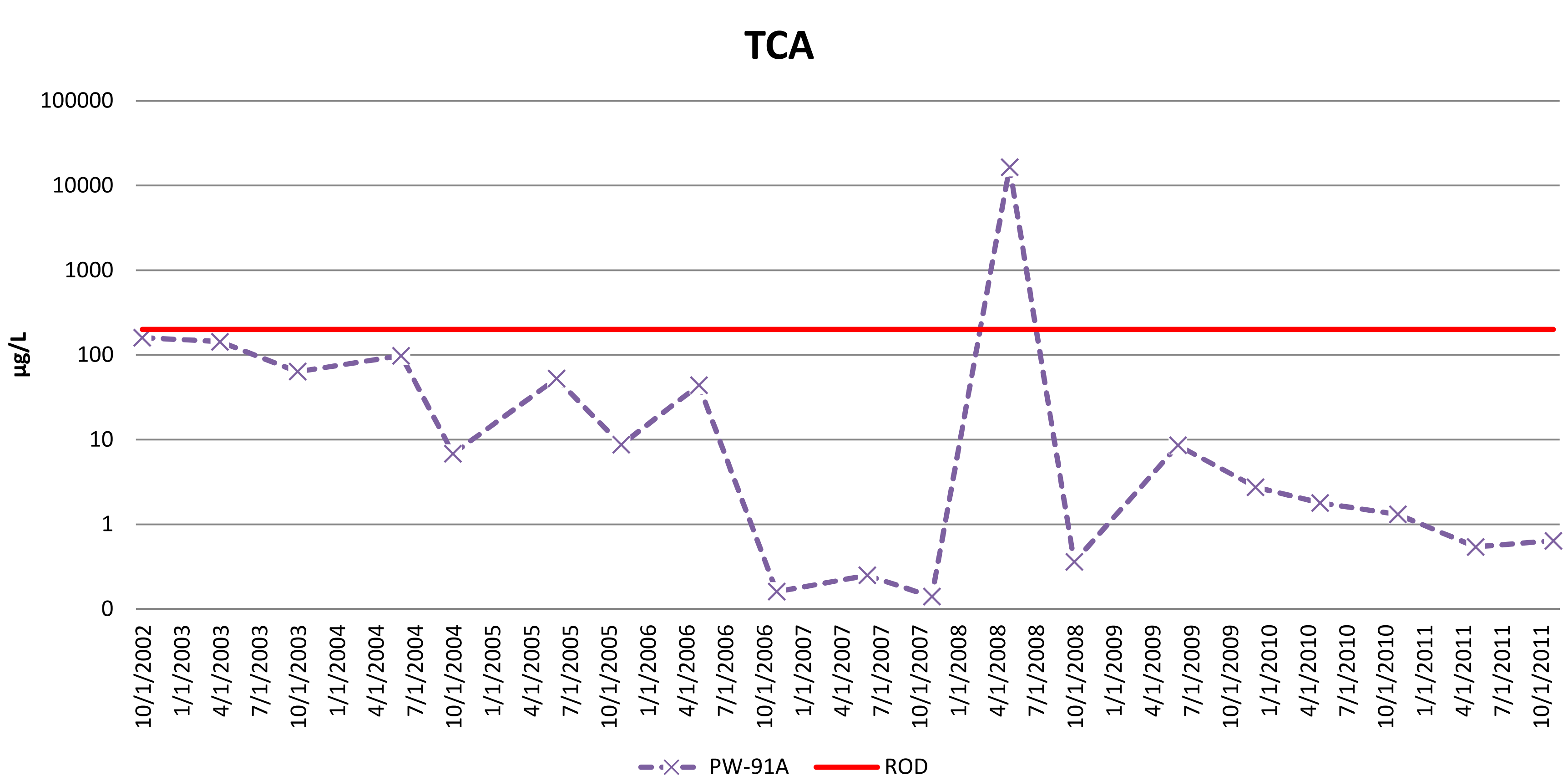
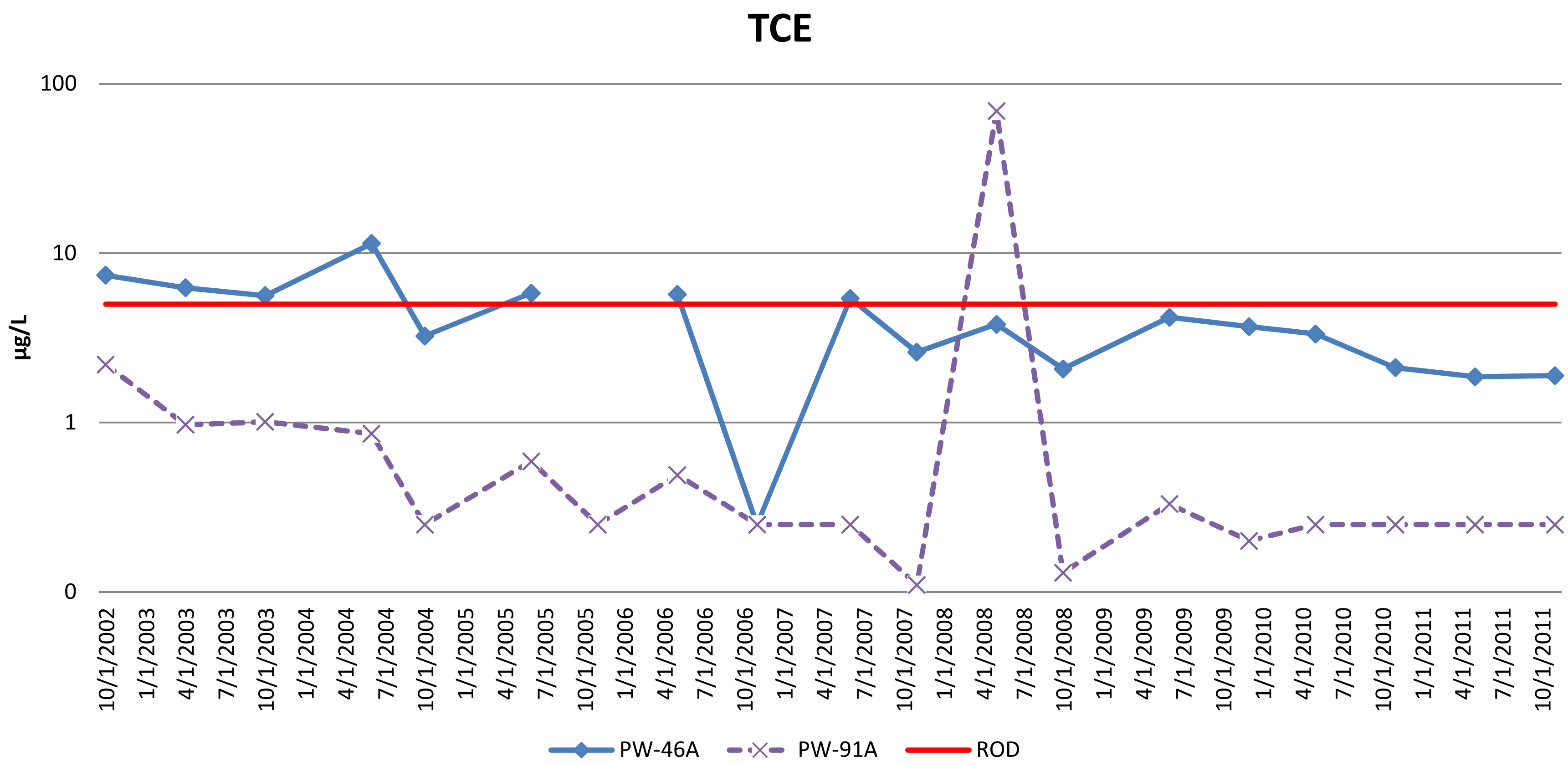


Figure 6-16. VOC Concentrations for Dump Master Area Non-Hot Spot Wells in the Fabrication Area



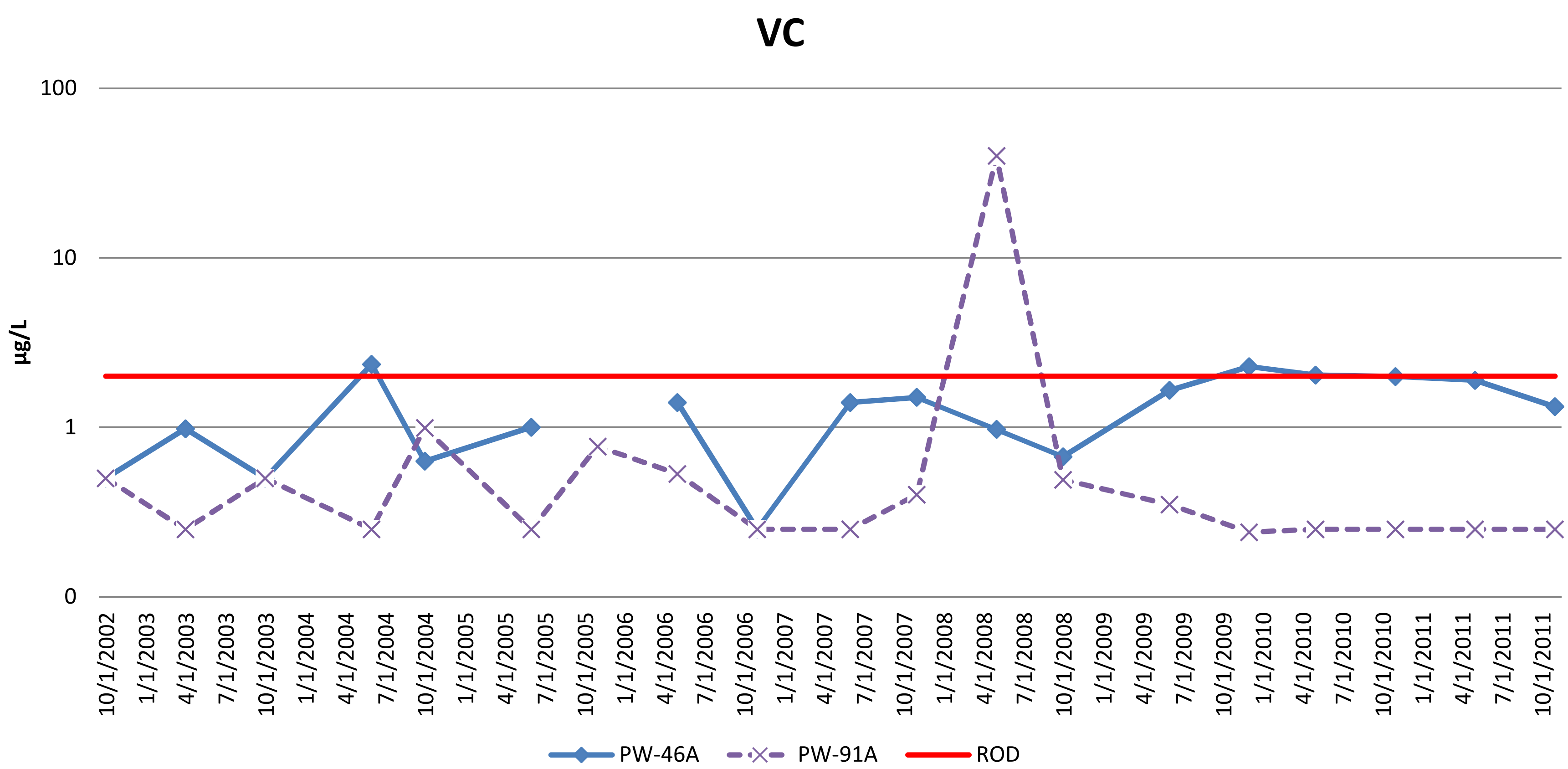
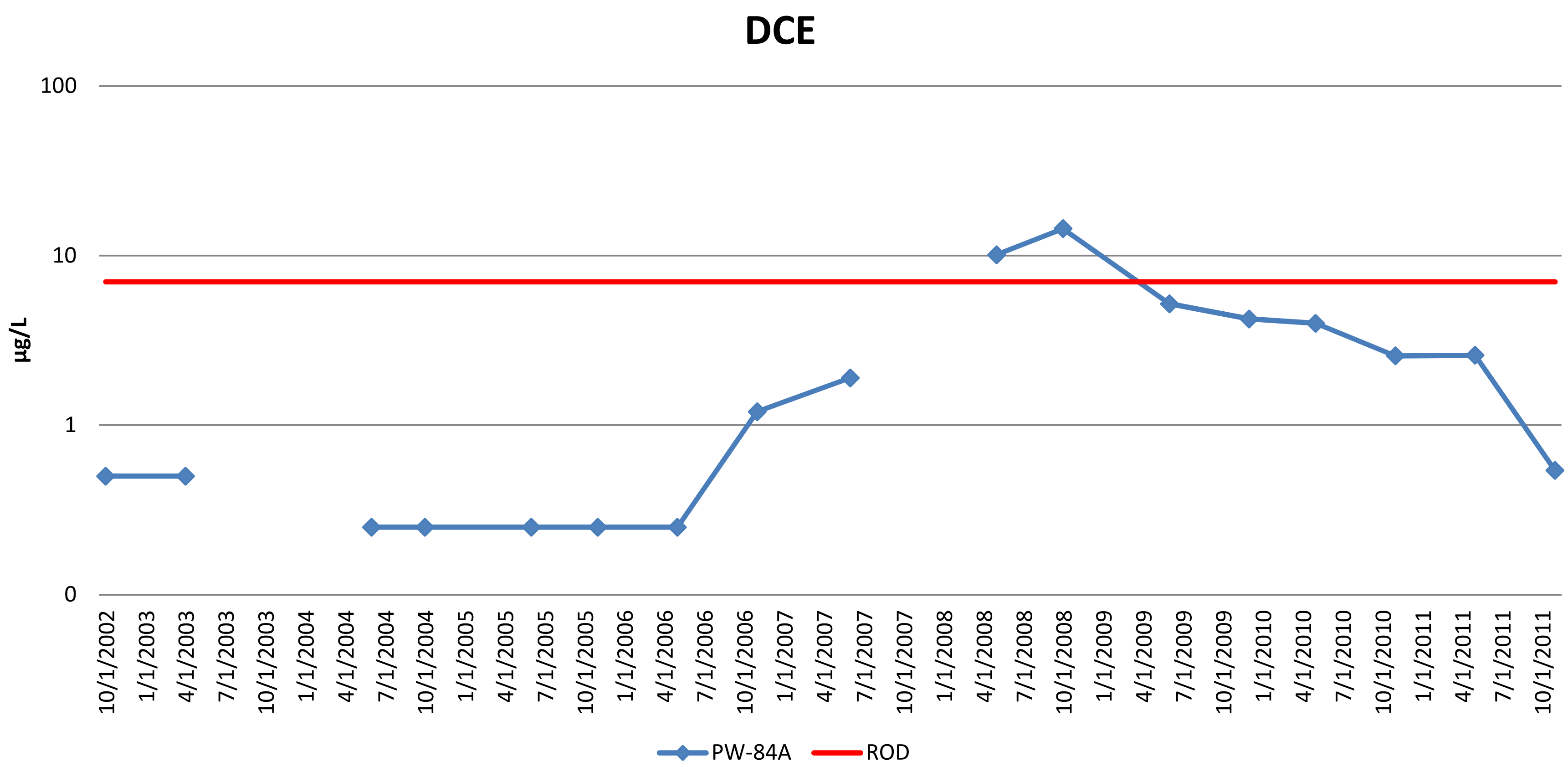


Figure 6-16. VOC Concentrations for Dump Master Area Non-Hot Spot Wells in the Fabrication Area



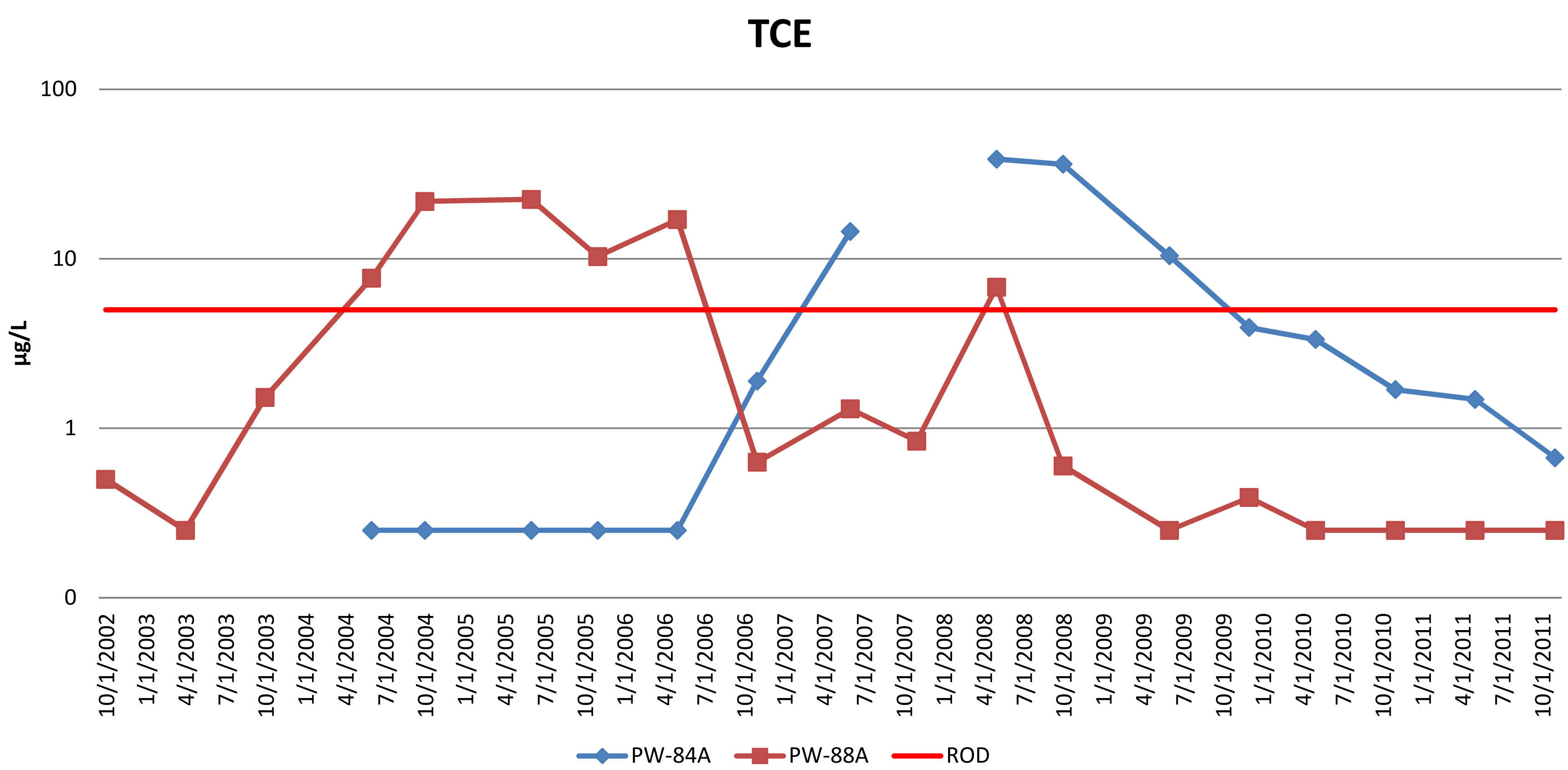


Figure 6-17. VOC Concentrations for Material Recycle Area Non-Hot Spot Wells in the Fabrication Area

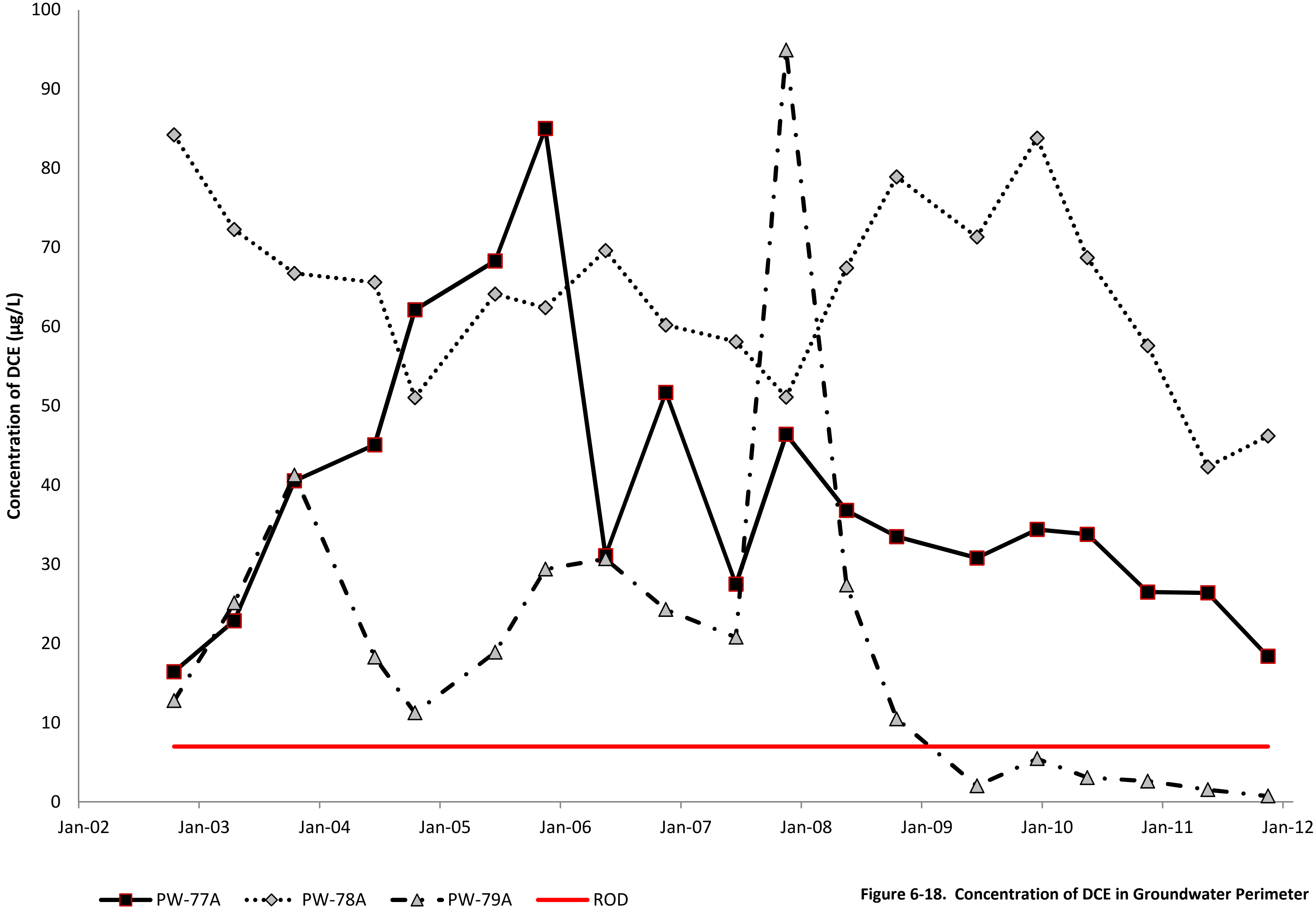


Figure 6-18. Concentration of DCE in Groundwater Perimeter Wells in the Fabrication area

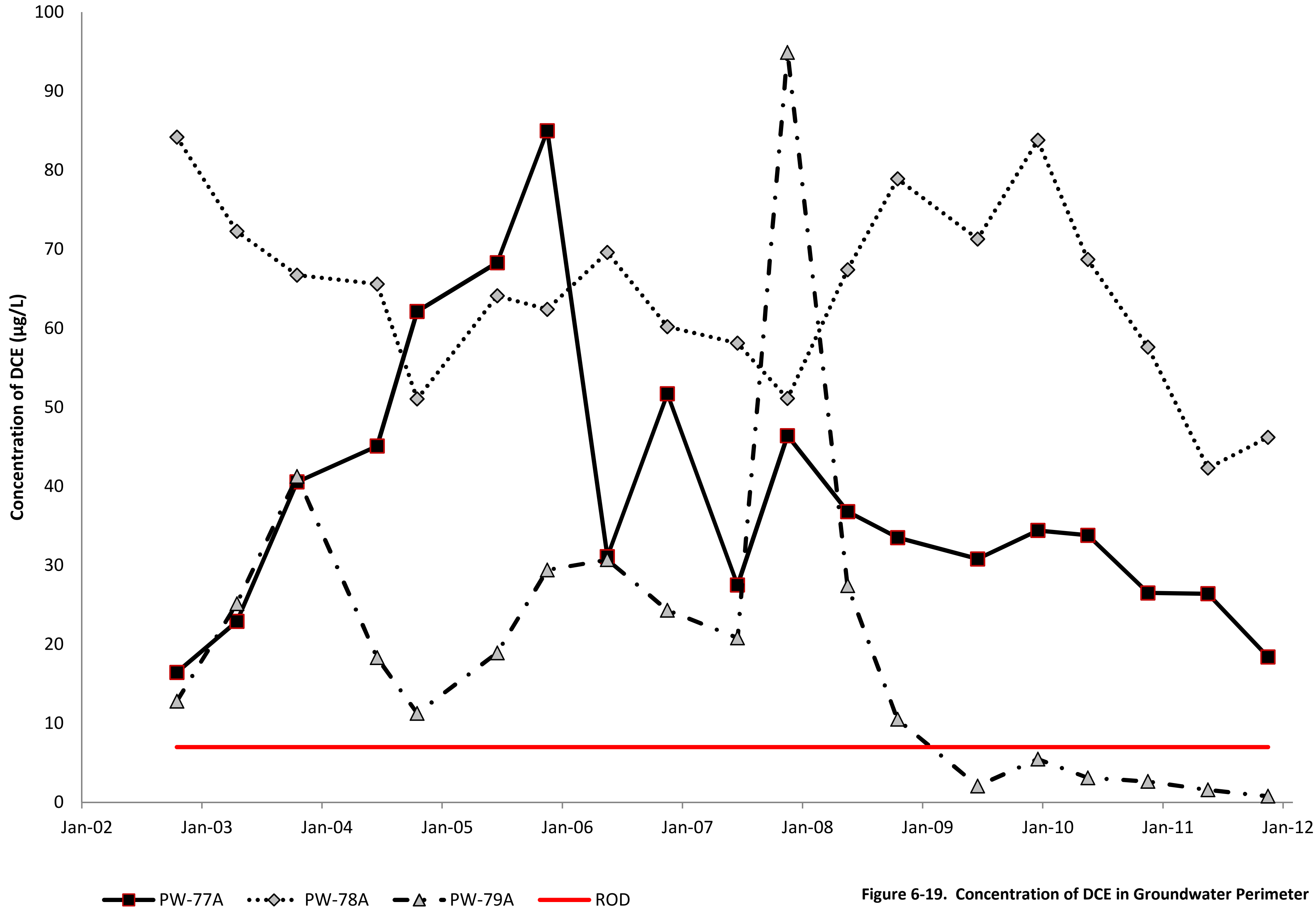
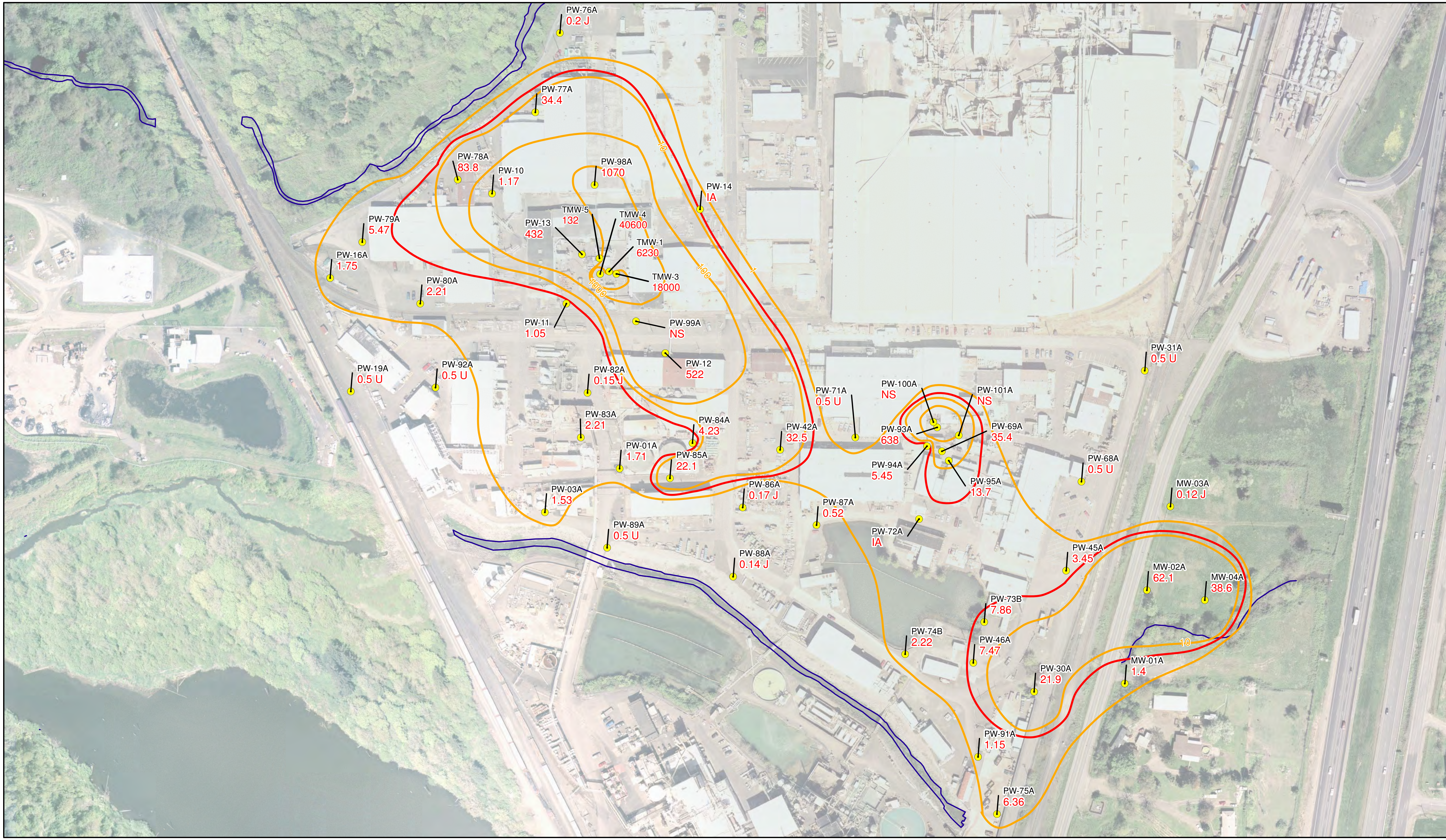


Figure 6-19. Concentration of DCE in Groundwater Perimeter wells in the Fabrication area



DATE: May, 2012 FILE: P:\GIS\Projects\415_WahChang\MXD\FiveYearReview\F_6-20_Fab_DCE_2009.mxd

N

0 250 500

Scale in Feet

Monitoring Well with Concentration in µg/L

DCE Isoconcentration Line

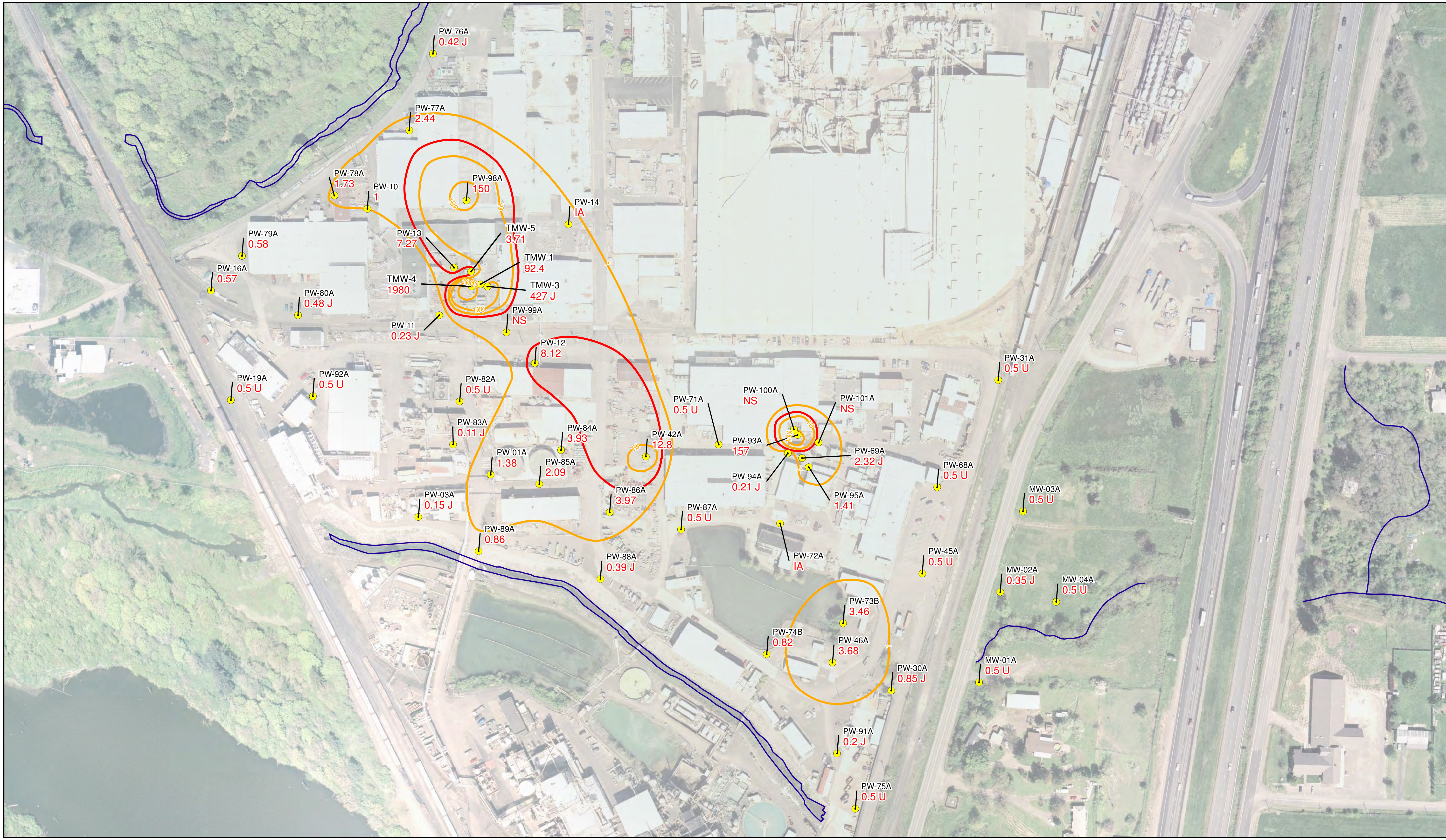
ROD (7 µg/L)

Figure 6-19

DCE Concentrations, Fall 2009

Fabrication Area

Teledyne Wah Chang
Albany, Oregon



DATE: May, 2012 FILE: P:\GIS\Projects\415_WahChang\MXD\FiveYearReview\F_6-21_Fab_TCE_2009.mxd

N

0 250 500

Scale in Feet

Monitoring Well with Concentration in µg/L

TCE Isoconcentration Line

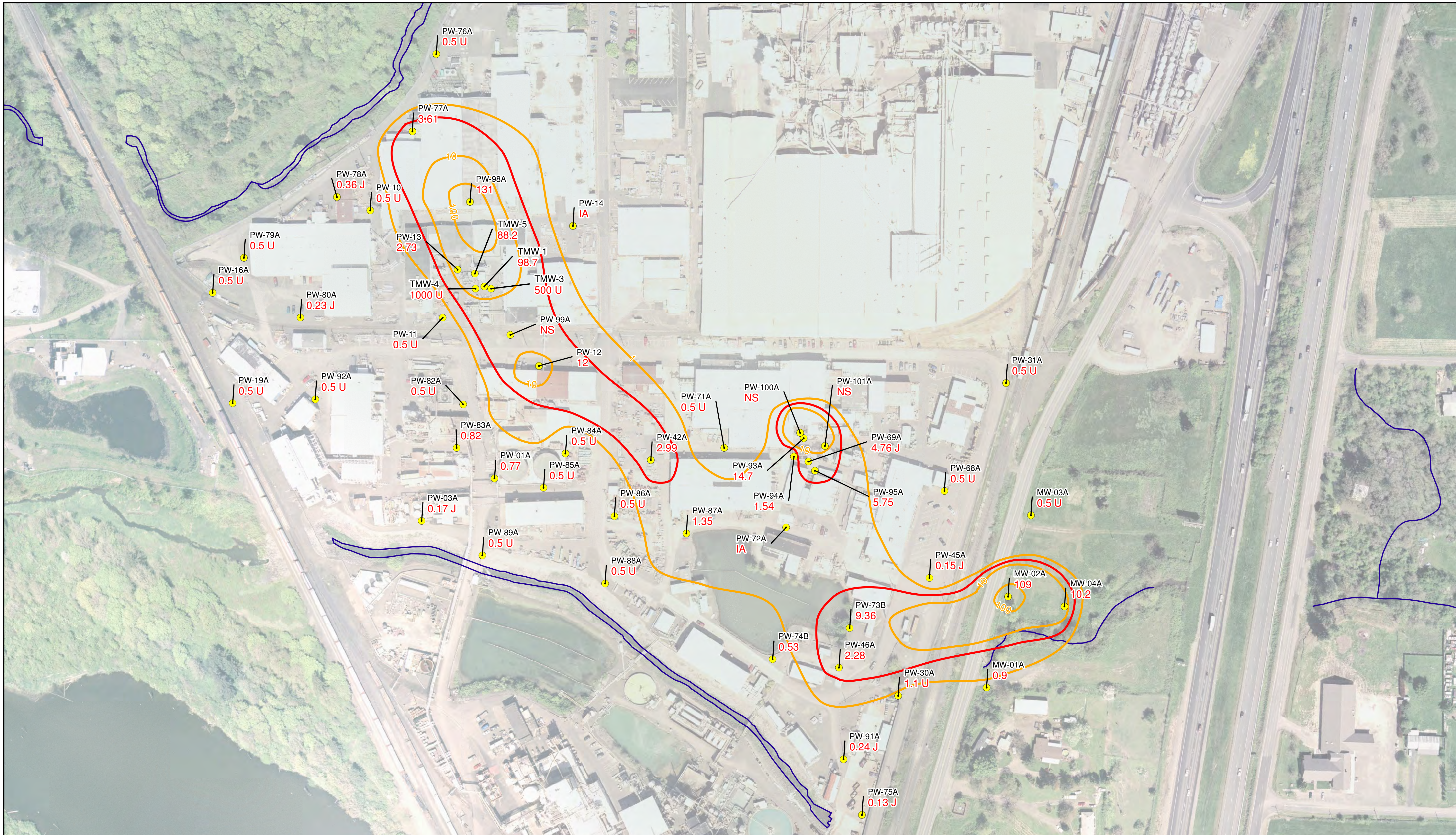
ROD (5 µg/L)

Figure 6-20

TCE Concentrations, Fall 2009

Fabrication Area

Teledyne Wah Chang
Albany, Oregon



DATE: May, 2012 FILE: P:\GIS\Projects\415_WahChang\MXD\FiveYearReview\F_6-22_Fab_VC_2009.mxd

N

0 250 500

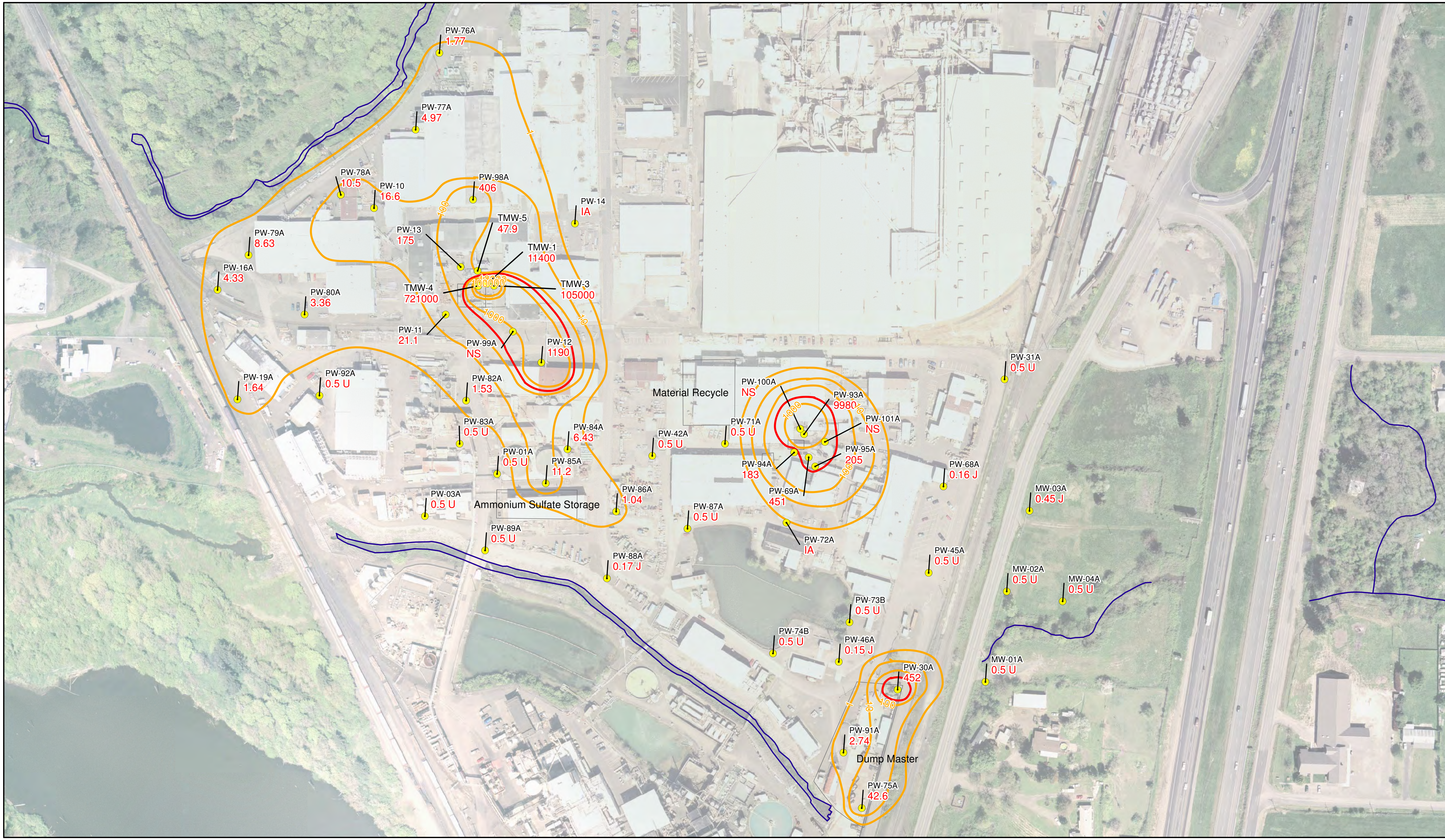
Scale in Feet

- Fab_VC_2009
- VC Isoconcentration Line
- ROD (2 µg/L)

Figure 6-21

VC Concentrations, Fall 2009
Fabrication Area

Teledyne Wah Chang
Albany, Oregon



DATE: May, 2012 FILE: P:\GIS\Projects\415_WahChang\MXD\FiveYearReview\F_6-23_Fab_TCA_2009.mxd

N

0 250 500

Scale in Feet

Monitoring Well with Concentration in µg/L

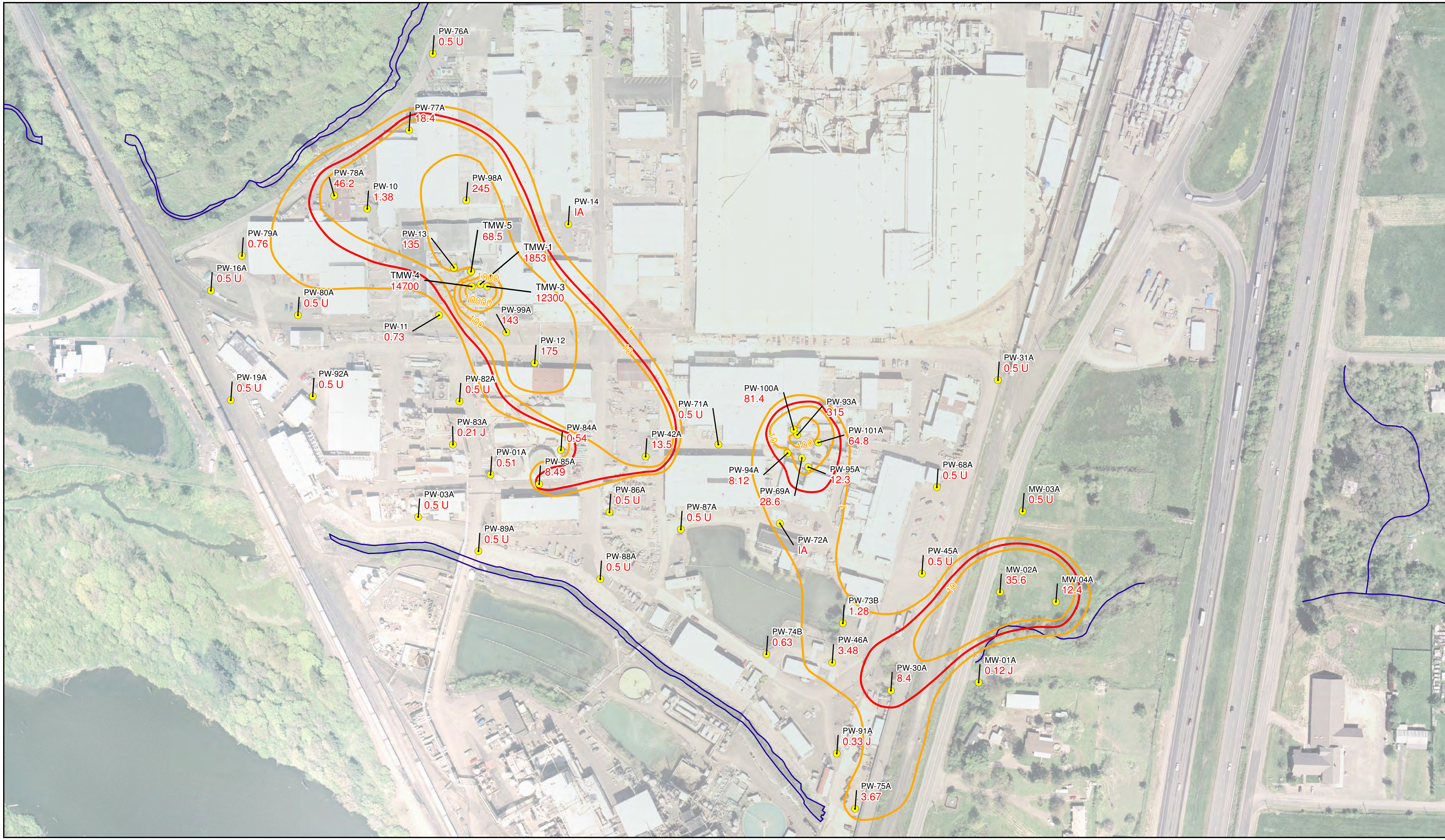
TCA Isoconcentration Line

ROD (200 µg/L)

Figure 6-22

1,1,1 TCA Concentrations, Fall 2009
Fabrication Area

Teledyne Wah Chang
Albany, Oregon



DATE: May, 2012 FILE: P:\GIS\Projects\415_WahChang\MXD\FiveYearReview\F_6-24_Fab_DCE_2011.mxd

N

0 250 500

Scale in Feet

Monitoring Well with Concentration in µg/L

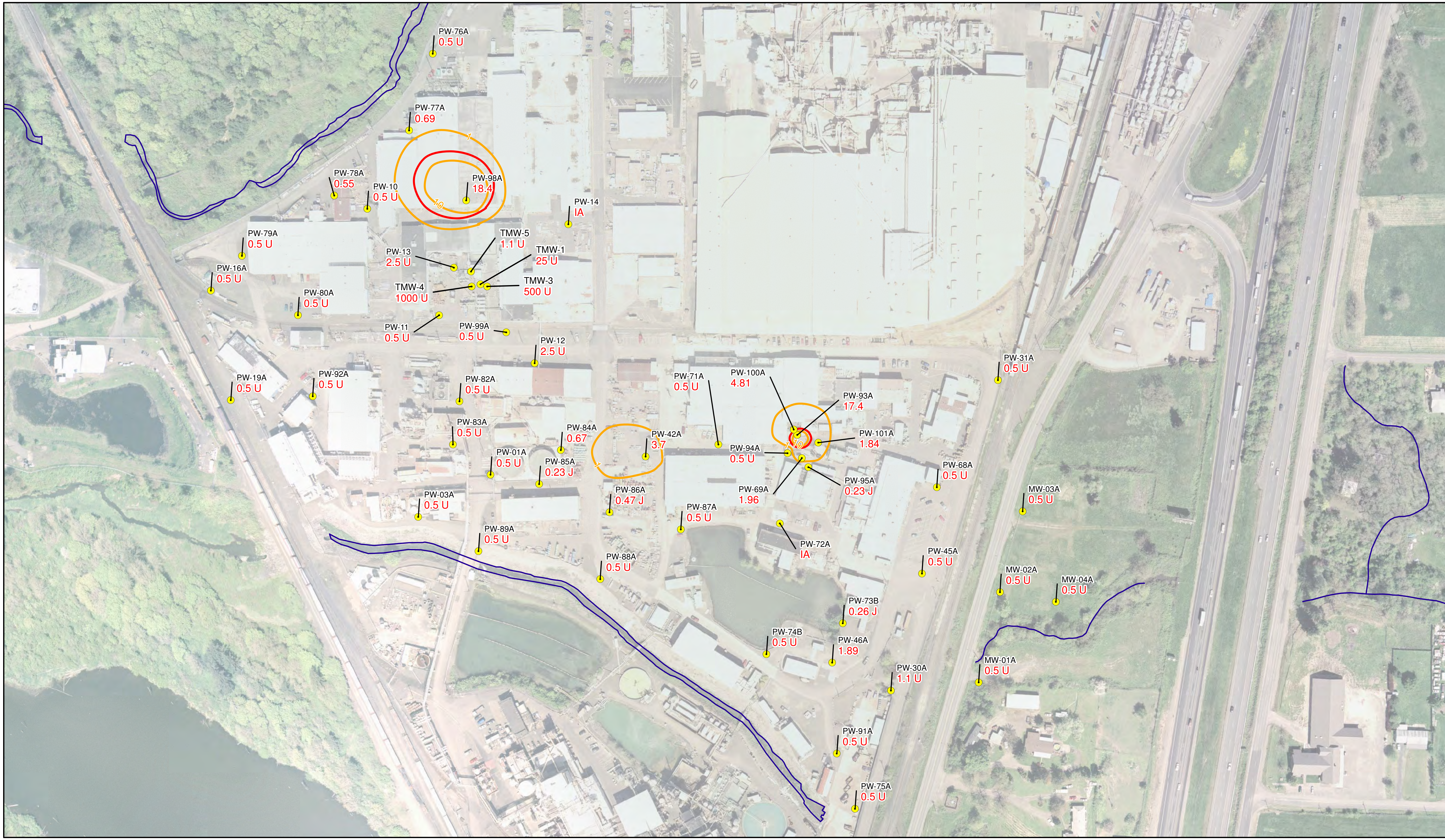
DCE Isoconcentration Line

ROD (7 µg/L)

Figure 6-23

DCE Concentrations, Fall 2011
Fabrication Area

Teledyne Wah Chang
Albany, Oregon



DATE: May, 2012 FILE: P:\GIS\Projects\415_WahChang\MXD\FiveYearReview\F_6-25_Fab_TCE_2011.mxd

N

0 250 500

Scale in Feet

Monitoring well with concentration in µg/L

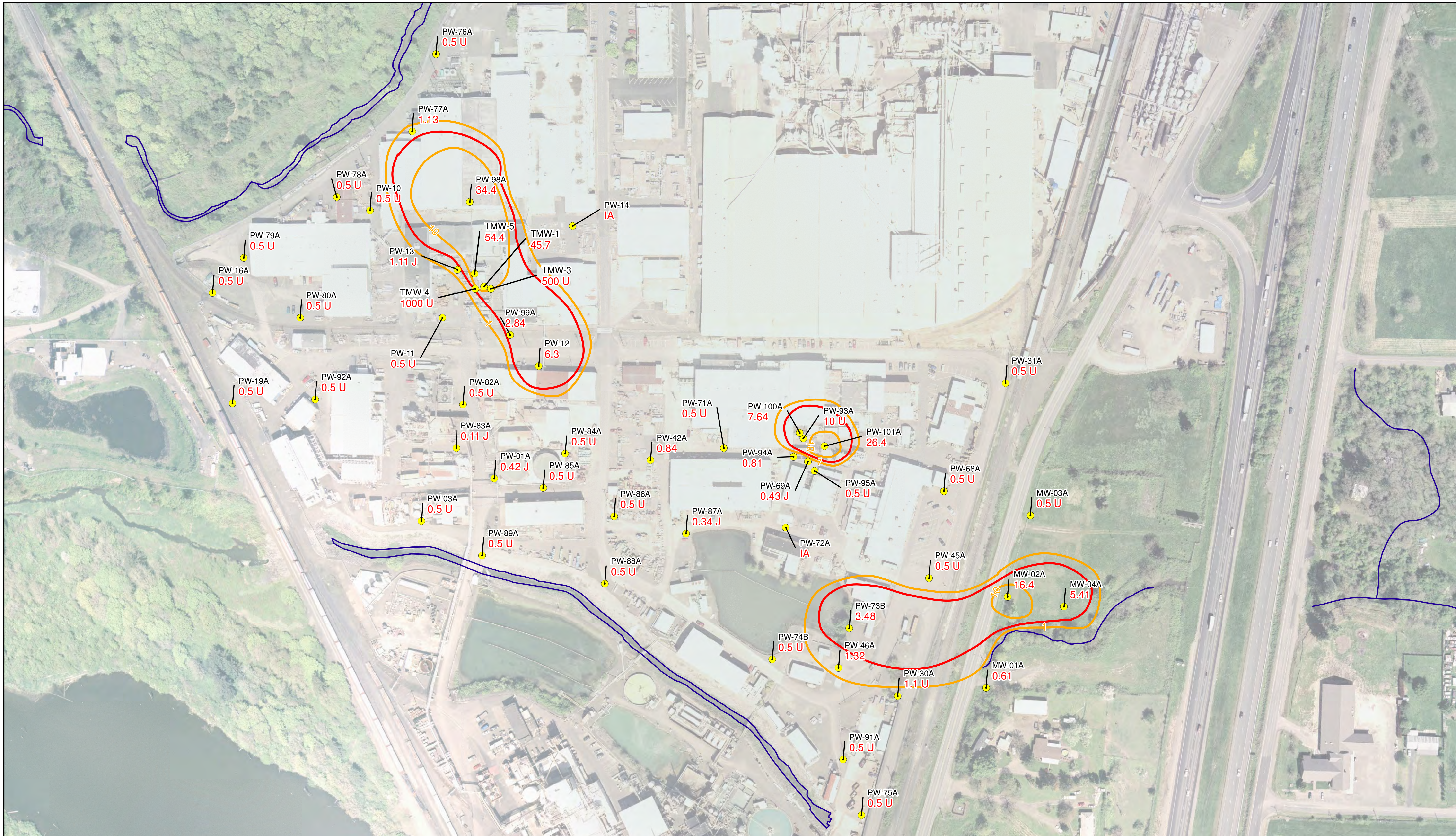
TCE Isoconcentration Line

ROD (5 µg/L)

Figure 6-24

TCE Concentrations, Fall 2011
Fabrication Area

Teledyne Wah Chang
Albany, Oregon



DATE: May, 2012 FILE: P:\GIS\Projects\415_WahChang\MXD\FiveYearReview\F_6-26_Fab_VC_2011.mxd

N

0 250 500

Scale in Feet

Monitoring Well with Concentration in µg/L

VC Isoconcentration Line

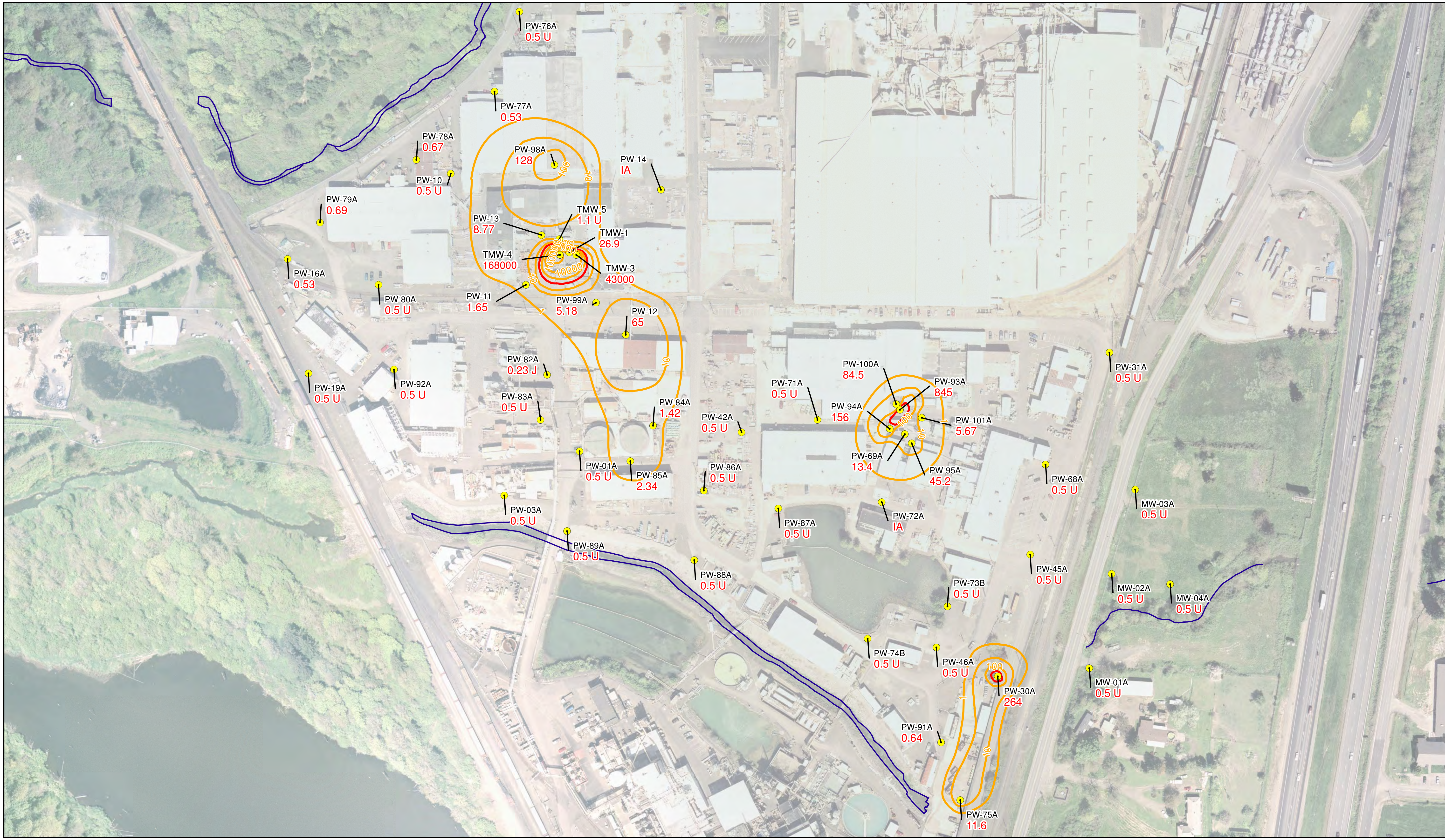
ROD (2 µg/L)

Figure 6-25

VC Concentrations, Fall 2011

Fabrication Area

Teledyne Wah Chang
Albany, Oregon



DATE: May, 2012 FILE: P:\GIS\Projects\415_WahChang\MXD\FiveYearReview\F_6-27_Fab_TCA_2011.mxd

N

0 250 500

Scale in Feet

Note: Due to steep concentration gradient, TMW-1 is not used for contouring on this figure.

- Monitoring Well with Concentration in µg/L
- TCA Isonconcentration Line
- ROD (200 µg/L)

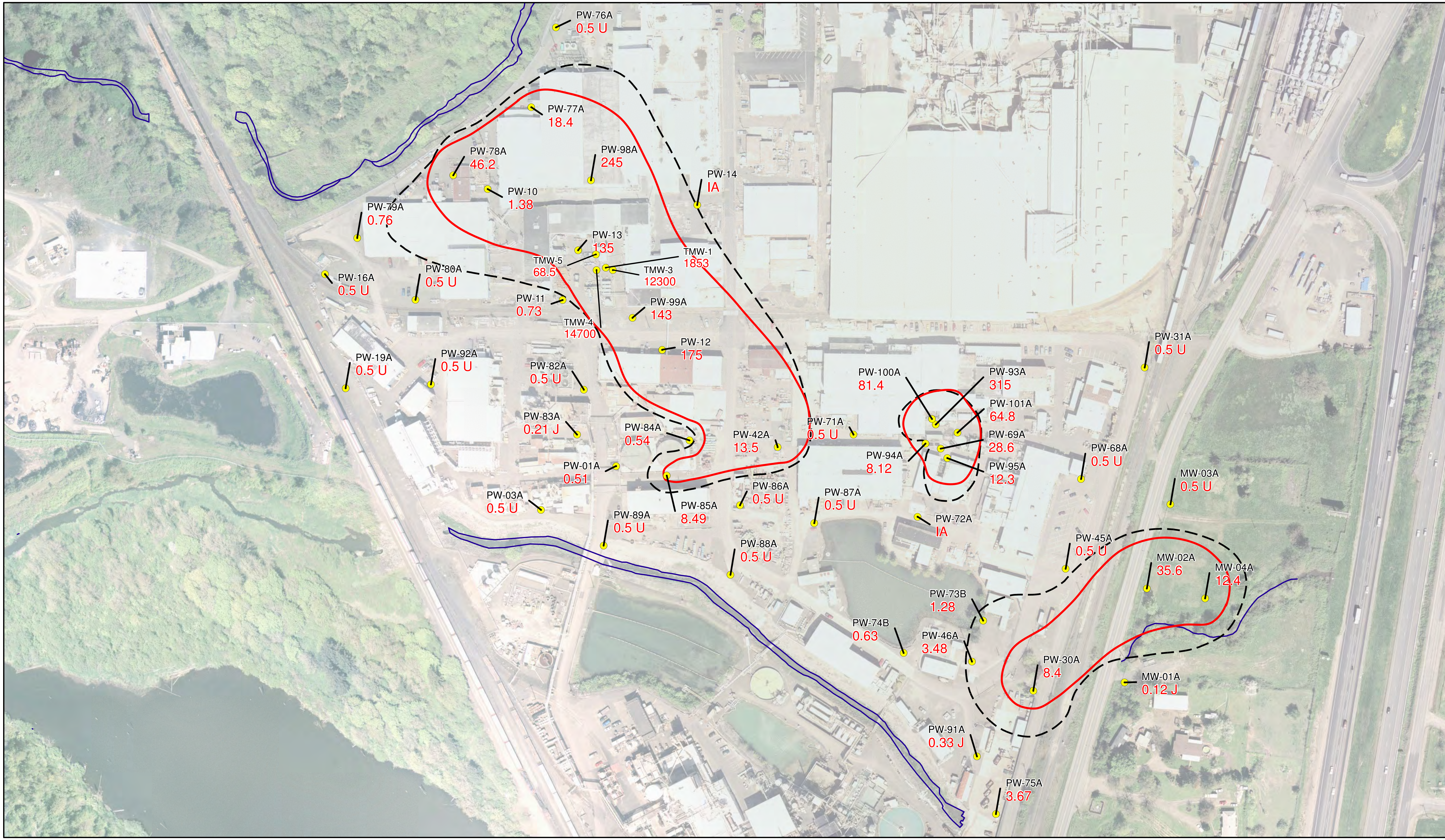
Figure 6-26

TCA Concentrations, Fall 2011

Fabrication Area

Teledyne Wah Chang

Albany, Oregon



DATE: May, 2012 FILE: P:\GIS\Projects\415_WahChang\MXD\FiveYearReview\F_6-28_Fab_DCE.mxd

N

0 250 500

Scale in Feet

Monitoring Well with 2011 DCE Concentration (µg/L)

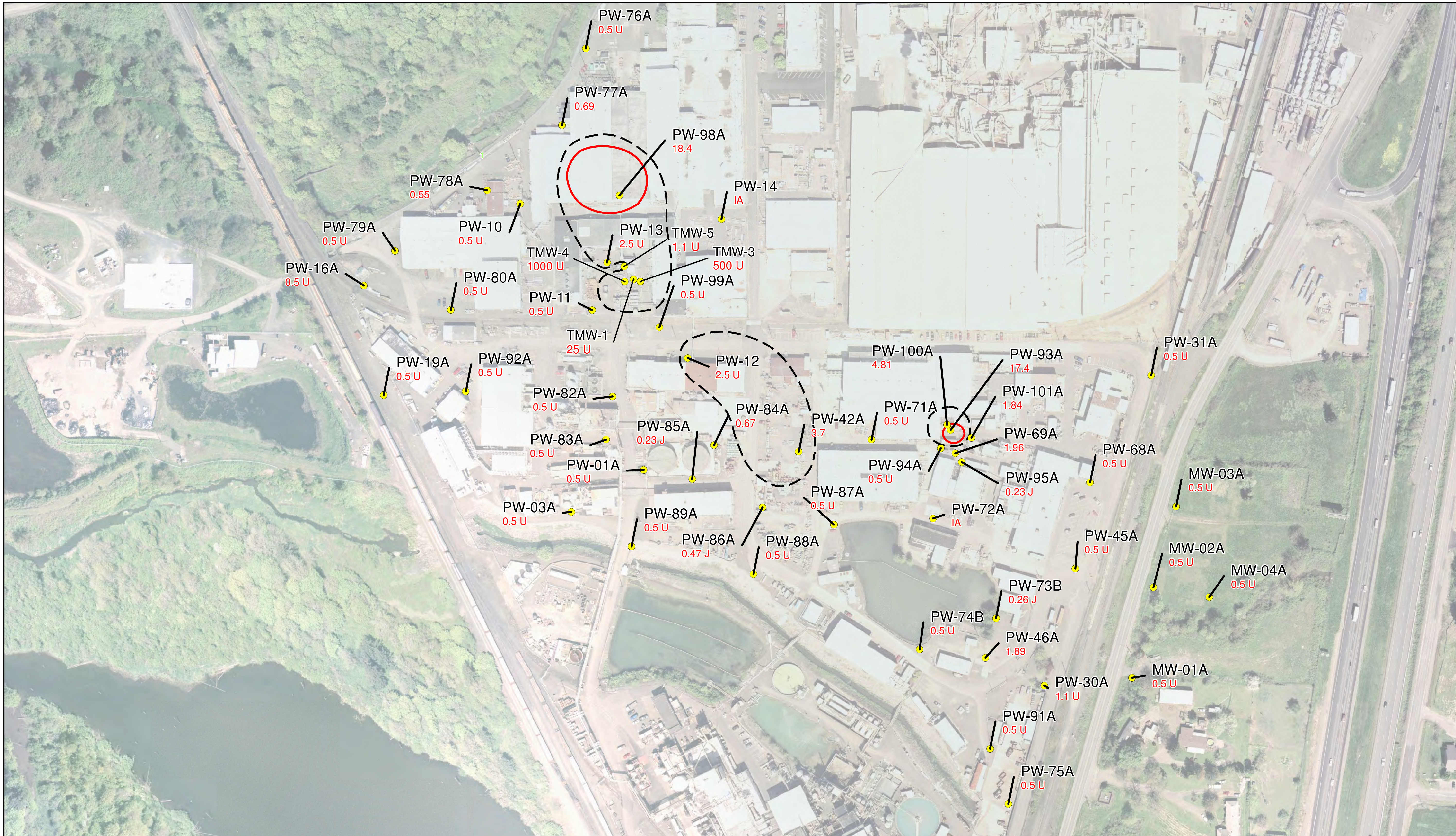
2011 ROD (7 µg/L)

2009 ROD (7 µg/L)

Figure 6-27

DCE Concentrations, Above ROD Fall 2009 and 2011 Fabrication Area

Teledyne Wah Chang
Albany, Oregon



DATE: May, 2012 FILE: P:\GIS\Projects\415_WahChang\MXD\FiveYearReview\F_6-29_Fab_TCE.mxd

N

0 250 500

Scale in Feet

Monitoring well with 2011 concentration in µg/L

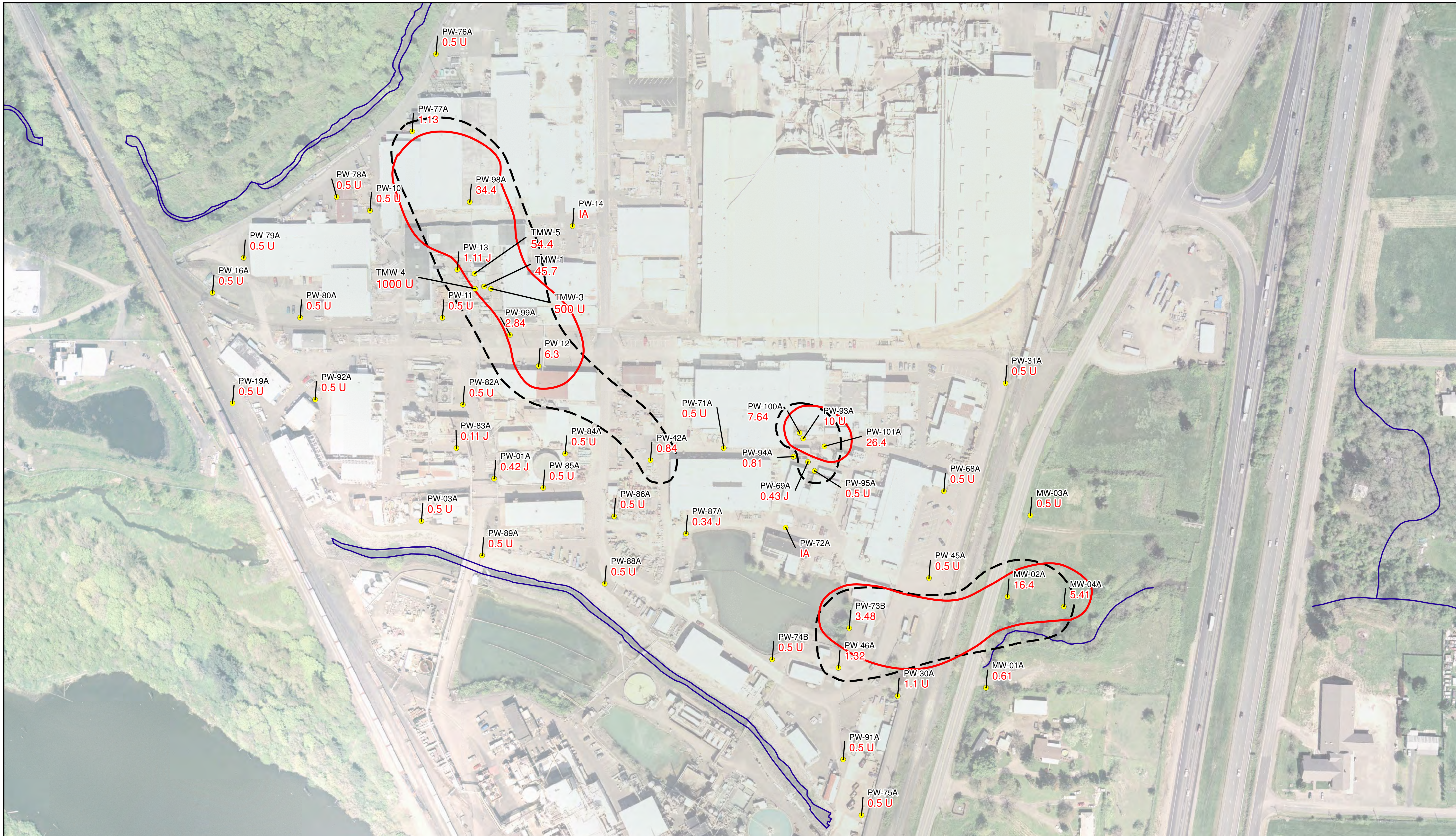
2011 ROD (5 µg/L)

2009 ROD (5 µg/L)

Figure 6-28

TCE Concentrations, Above ROD Fall 2009 and 2011 Fabrication Area

Teledyne Wah Chang
Albany, Oregon



DATE: May, 2012 FILE: P:\GIS\Projects\415_WahChang\MXD\FiveYearReview\F_6-30_Fab_VC.mxd

N

0 250 500

Scale in Feet

Monitoring well with 2011 VC concentration (µg/L)

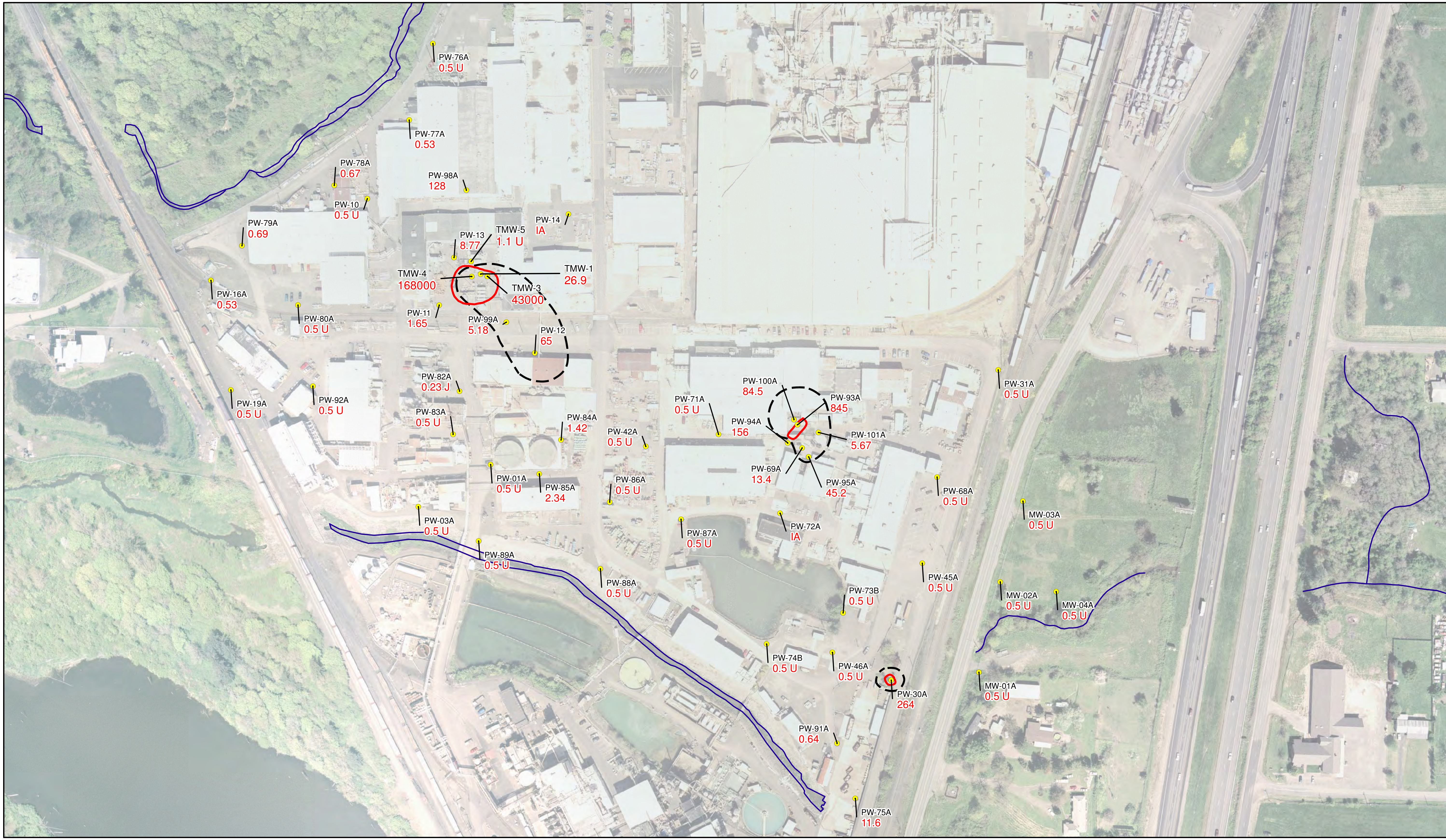
2011 ROD (2 µg/L)

2009 ROD (2 µg/L)

Figure 6-29

VC Concentrations Above ROD
Fall 2009 and 2011
Fabrication Area

Teledyne Wah Chang
Albany, Oregon



DATE: May, 2012 FILE: P:\GIS\Projects\415_WahChang\MXD\FiveYearReview\F_6-31_Fab_TCA.mxd

N

0 250 500

Scale in Feet

Monitoring Well with 2011 TCA concentration (µg/L)

2011 ROD (200 µg/L)

2009 ROD (200 µg/L)

Figure 6-30

TCA Concentrations Above ROD Fall 2009 and 2011 Fabrication Area

Teledyne Wah Chang
Albany, Oregon

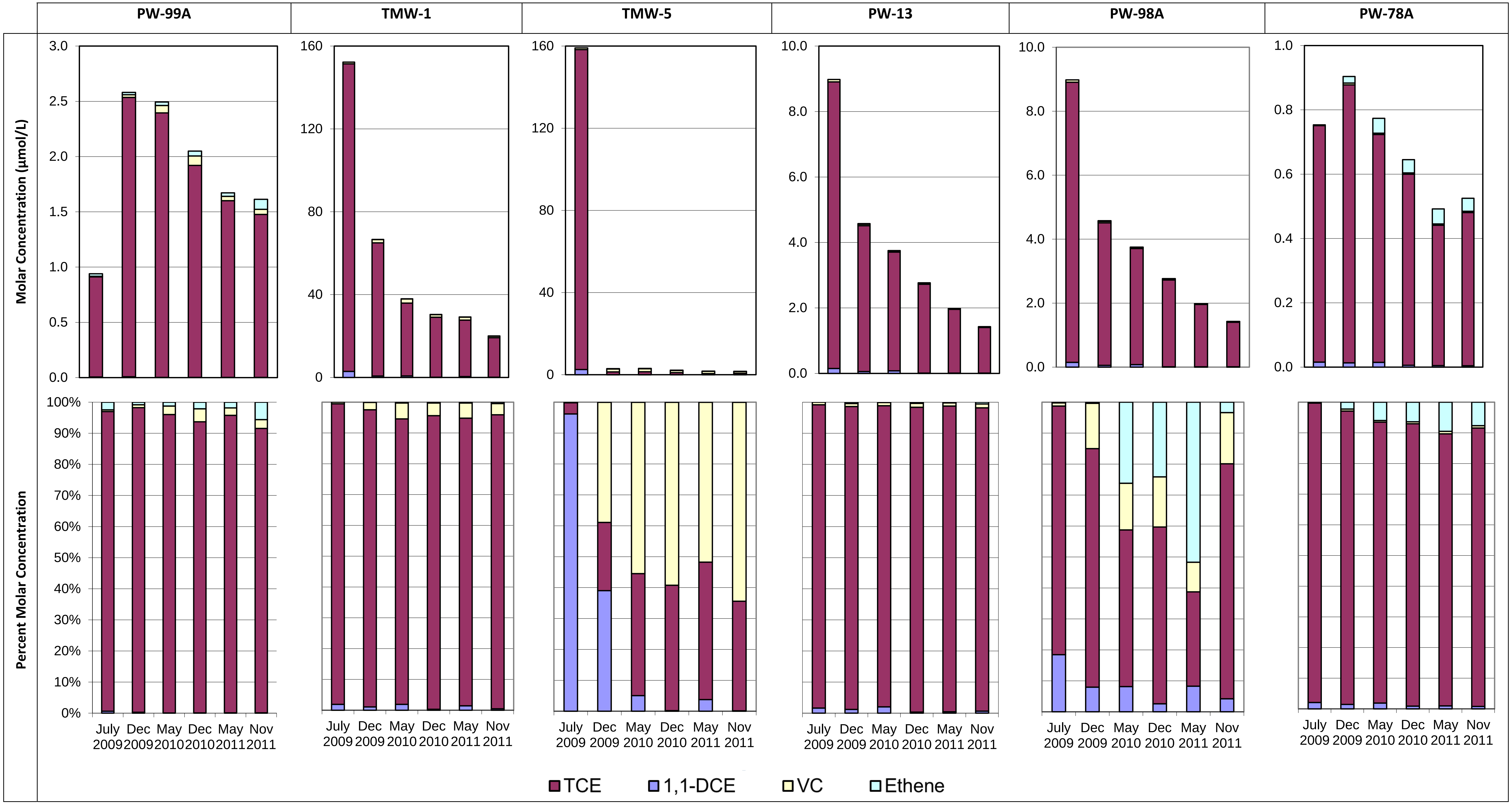


Figure 6-31a. **Time Series Charts Showing Chlorinated Ethene Reductive Dechlorination from the ASA Source Area to Down Gradient Wells**
Wah Chang Five Year Review Report

Source area

Groundwater flow Direction

Figure 6-31a. **Time Series Charts Showing Chlorinated Ethene Reductive Dechlorination from the ASA Source Area to Down Gradient Wells**
Wah Chang Five Year Review Report

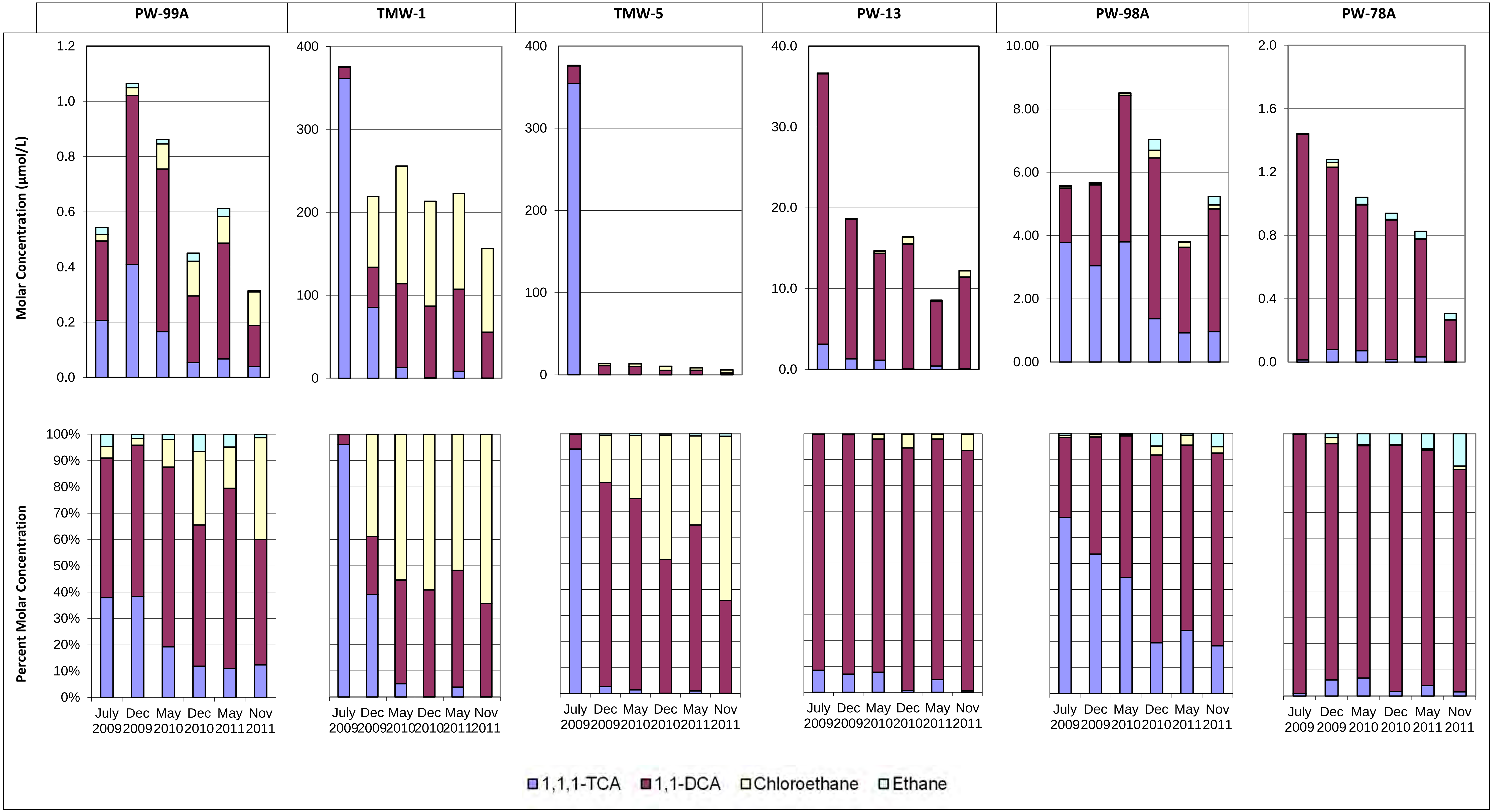


Figure 6-31b. Time Series Charts Showing Chlorinated Ethane Reductive Dechlorination from the ASA Source Area to Down Gradient Wells
Wah Chang Five Year Review Report

Source area

Groundwater flow Direction

Figure 6-31b. **Time Series Charts Showing Chlorinated Ethane Reductive Dechlorination from the ASA Source Area to Down Gradient Wells**
Wah Chang Five Year Review Report

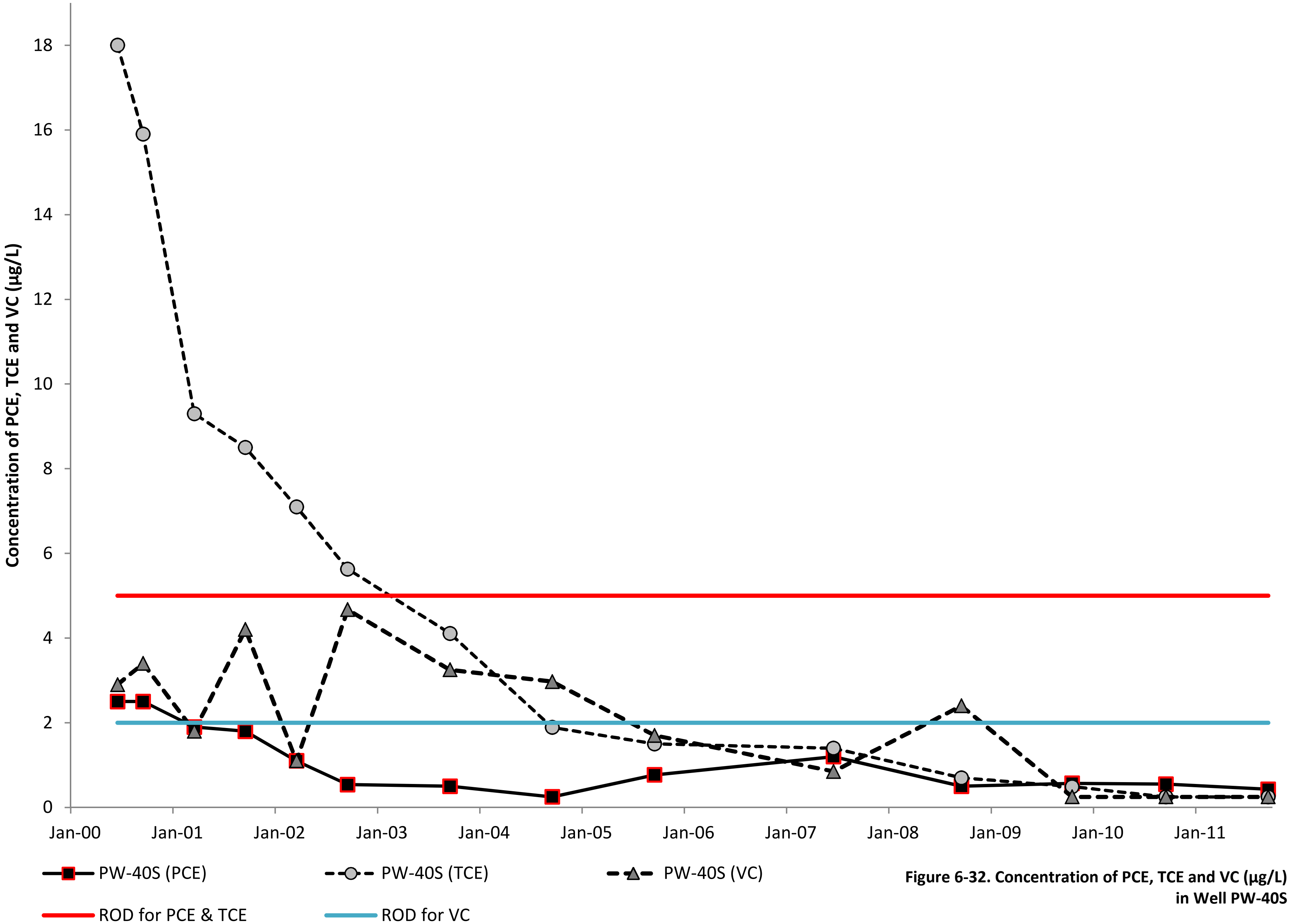


Figure 6-32. Concentration of PCE, TCE and VC (µg/L) in Well PW-40S

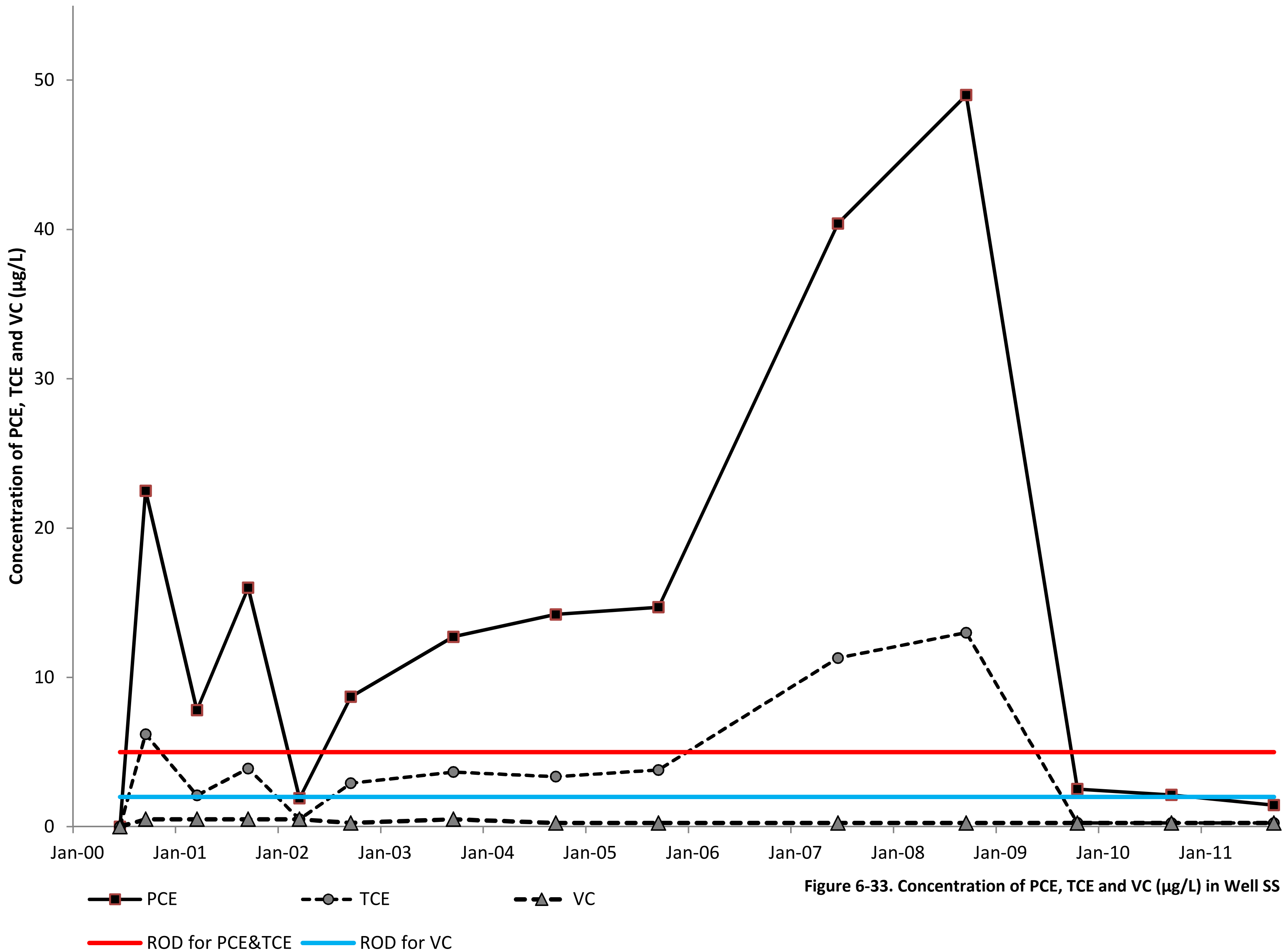


Figure 6-33. Concentration of PCE, TCE and VC (µg/L) in Well SS

TABLES

Table 6-1. FMA Summary of arsenic, radium 228, radium 226, fluoride, ammonia, ammonium, cadmium, and nickel in groundwater
Wah Chang Five Year Review Report

Well	Well Type	Parameter	Unit	ROD	Oct-02	Apr-03	Oct-03	Apr-04	Sep-04	May-05	Sep-05	May-06	Sep-06	May-07	Oct-07	May-08	Oct-08	Jun-09	Dec-09	Apr-10	Nov-10	Apr-11	Dec-11
PW-21A	P	AMMONIA	mg/L													19.4	50.5	25	73	22	20	21	15
PW-22A	P	AMMONIA	mg/L		196	200.7	91.06			156					102	217	212	222	240	236	212	215	189
PW-23A	P	AMMONIA	mg/L		104	92.7	89.23			86.4				34.7	68.2	65.6	64.1	34	62	31	28	28	23
PW-24A	P	AMMONIA	mg/L		171	72	172.3			146				45.5	27.2	139	186	152	53	148	132	132	118
PW-27A	NHS	AMMONIA	mg/L		21.3	21.4	27.03			40.3				26.8	24.3	26.7	20.5	20	5	18	12	16	12
PW-28A	HS	AMMONIA	mg/L		362	294	331.34			236				106	118	122		164	230	145	123	133	116
PW-50A	HS	AMMONIA	mg/L		92.6	100	114.5			25.9				18.5	22.2	32.8	38	33	27	0.28	0.12	0.26	0.11
PW-51A	HS	AMMONIA	mg/L		92.6	90.1	69.65			55				49.1	61.5	50.5	50.5	48		43	33	38	22
PW-52A	HS	AMMONIA	mg/L		316	254	239.81			215				179	84.5	166	154	154		130	125	105	125
PW-21A	P	AMMONIUM	mg/L	250														31.0	93.0	33.0	28.0	31.0	18.0
PW-22A	P	AMMONIUM	mg/L	250				240.0	200.0		180.0		180.0					278.0	310.0	255.0	234.0	265.0	236.0
PW-23A	P	AMMONIUM	mg/L	250				120.0	87.0		70.0		58.0					43.0	79.0	42.0	36.0	35.0	29.0
PW-24A	P	AMMONIUM	mg/L	250				140.0	89.0		160.0		160.0					190.0	68.0	180.0	156.0	165.0	148.0
PW-27A	NHS	AMMONIUM	mg/L	250				24.0	7.0		24.0		26.0					25.0	6.0	22.0	18.0	20.0	18.0
PW-28A	HS	AMMONIUM	mg/L	250					350.0		230.0		250.0					205.0	290.0	190.0	157.0	167.0	145.0
PW-50A	HS	AMMONIUM	mg/L	250				76.0	80.0		40.0	20.0	20.0					41.0	35.0	0.3	0.2	0.3	0.1
PW-51A	HS	AMMONIUM	mg/L	250				72.0	83.0		43.0	50.0	45.0					60.0		55.0	44.0	48.0	28.0
PW-52A	HS	AMMONIUM	mg/L	250				220.0	220.0		160.0	150.0	93.0					193.0		185.0	175.0	131.0	175.0
PW-21A	P	ARSENIC	mg/L	0.05												0.001 U	0.001 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
PW-22A	P	ARSENIC	mg/L	0.05	0.005 U	0.0148	0.0087	0.02 U	0.02 U	0.015 U	0.02 U		0.02 U		0.01 U	0.0057	0.01 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
PW-23A	P	ARSENIC	mg/L	0.05	0.0107	0.01 U	0.0112	0.02 U	0.02 U	0.015 U	0.02 U		0.02 U	0.025 U	0.01 U	0.108	0.0118	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
PW-24A	P	ARSENIC	mg/L	0.05	0.005 U	0.01 U	0.005 U	0.02 U	0.02 U	0.015 U	0.02 U		0.02 U	0.025 U	0.01 U	0.01 U	0.01 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
PW-27A	NHS	ARSENIC	mg/L	0.05	0.005 U	0.01 U	0.005 U	0.02 U	0.02 U	0.015 U	0.02 U		0.02 U	0.025 U	0.01 U	0.001 U	0.002 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
PW-28A	HS	ARSENIC	mg/L	0.05	0.05 U	1.05 U	10 U	0.06	0.02 U	1.5 U	0.02 U		0.02 U	2.5 U	1 U	0.106		0.14	0.14	0.12	0.11	0.09	0.09
PW-50A	HS	ARSENIC	mg/L	0.05	0.05 U	0.0322	0.0162	0.02 U	0.02 U	0.075 U	0.02 U	0.02 U	0.02 U	0.05 U	0.05 U	0.05 U	0.05 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
PW-51A	HS	ARSENIC	mg/L	0.05	0.005 U	0.014	0.02 U	0.02 U	0.02 U	0.015 U	0.02 U	0.02 U	0.02 U	0.025 U	0.05 U	0.05 U	0.05 U	0.02 U		0.02 U	0.02 U	0.02 U	0.02 U
PW-52A	HS	ARSENIC	mg/L	0.05	0.005 U	0.105 U	0.067	0.03	0.02 U	0.0307	0.02 U	0.02 U	0.02 U	0.05 U	0.2 U	0.05 U	0.2 U	0.02 U		0.02 U	0.02 U	0.02 U	0.02 U
PW-21A	P	CADMIUM	mg/L	0.005												0.0056	0.0005 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
PW-22A	P	CADMIUM	mg/L	0.005	0.001 U	0.005 U	0.001 U	0.01 U	0.01 U	0.005 U	0.01 U		0.01 U		0.005 U	0.0025 U	0.005 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
PW-23A	P	CADMIUM	mg/L	0.005	0.001 U	0.005 U	0.001 U	0.01 U	0.01 U	0.005 U	0.01 U		0.01 U	0.005 U	0.005 U	0.005 U	0.005 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
PW-24A	P	CADMIUM	mg/L	0.005	0.001 U	0.005 U	0.001 U	0.01 U	0.01 U	0.005 U	0.01 U		0.01 U	0.005 U	0.005 U	0.0079	0.005 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
PW-27A	NHS	CADMIUM	mg/L	0.005	0.001 U	0.005 U	0.001 U	0.01 U	0.01 U	0.005 U	0.01 U		0.01 U	0.005 U	0.005 U	0.0102	0.001 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
PW-28A	HS	CADMIUM	mg/L	0.005	0.01 U	0.526 U	5 U	0.04	0.05	0.5 U	0.04		0.05	0.5 U	0.5 U	0.5 U		0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
PW-50A	HS	CADMIUM	mg/L	0.005	0.01 U	0.0219	0.0121	0.01	0.01	0.025 U	0.01 U	0.01 U	0.01 U	0.01 U	0.025 U	0.05 U	0.025	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
PW-51A	HS	CADMIUM	mg/L	0.005	0.003	0.0076	0.0119	0.01 U	0.01 U	0.0052	0.01 U	0.01 U	0.01 U	0.005 U	0.025 U	0.025 U	0.025 U	0.01 U		0.01 U	0.01 U	0.01 U	0.01 U
PW-52A	HS	CADMIUM	mg/L	0.005	0.0024	0.0524 U	0.0177	0.03	0.02	0.0066	0.02 U	0.02	0.02	0.01 U	0.1 U	0.025 U	0.1 U	0.01 U		0.01 U	0.01 U	0.01 U	0.01 U
PW-21A	P	FLUORIDE	mg/L	2												0.73	1.92	1.2	2	1.1	1	1.1	1.1
PW-22A	P	FLUORIDE	mg/L	2	0.39	2.41	1.75	3	3	2.78	3		5		3	3.8	13.1	3.1	2	2.6	2.5	2.4	2.4
PW-23A	P	FLUORIDE	mg/L	2	12.8	14.6	12.1	15	12	10.4	10		15	17.8	20.4	19.9	0.98	17	21	14	12	12	11
PW-24A	P	FLUORIDE	mg/L	2	0.32	0.29	0.35	1 U	1 U	0.1 U	1 U		1	0.68	0.7	0.92	9.76	1 U	1 U	1 U	1 U	1 U	1 U
PW-27A	NHS	FLUORIDE	mg/L	2	1.87	2 U	0.1 U	1 U	1 U	0.5 U	1 U		1 U	0.1 U	0.1 U	0.1 U	3.17	1 U	1 U	1 U	1 U	1 U	1 U
PW-28A	HS	FLUORIDE	mg/L	2	6.88	25 U	4.98	8	9	1 U	8		9	0.1 U	0.1 U	0.1 U		1 U	12	1 U	1 U	1 U	1 U
PW-50A	HS	FLUORIDE	mg/L	2	5.62	35.8	25.87	8	26	0.5 U	8	6	5	1.9	1.1	0.13	0.17	1.1	2	1 U	1 U	1 U	1 U
PW-51A	HS	FLUORIDE	mg/L	2	4.77	13	10.09	11	9	6.56	6	6	5	2.7	2.8	3.3	0.4	1.5		1.4	1.2	1.2	1.1
PW-52A	HS	FLUORIDE	mg/L	2	5.7	35.2	22.99	34	25	1.86	25	22	17	0.28	0.26	0.24	0.19	0.21		0.18	0.16	0.16	0.15
PW-21A	P	NICKEL	mg/L	2												0.0047	0.0129	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
PW-22A	P	NICKEL	mg/L	2	0.01 U	0.02 U	0.01 U	0.02 U	0.02 U	0.02 U	0.02 U		0.02 U		0.02 U	0.01 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
PW-23A	P	NICKEL	mg/L	2	0.01 U	0.02 U	0.01 U	0.02 U	0.02 U	0.02 U	0.02 U		0.02	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
PW-24A	P	NICKEL	mg/L	2	0.01 U	0.02 U	0.01 U	0.02 U	0.02 U	0.02 U	0.02 U		0.02	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
PW-27A	NHS	NICKEL	mg/L	2	0.01 U	0.02 U	0.01 U	0.02 U	0.02 U	0.02 U	0.02 U		0.02	0.02 U	0.02 U	0.0059	0.0258	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
PW-28A	HS	NICKEL	mg/L	2	6.13	3.79	20 U	2.7	4.1	2.46	3		2.6	2 U	2.86	2.36		1.8	3.4	1.5	1.25	1.4	1.16
PW-50A	HS	NICKEL	mg/L	2	1.75	1.87	1.74	0.55	1	0.536	0.56	0.38	0.33	0.326	0.342	0.618	0.565	0.25	0.13	0.23	0.15	0.21	0.12
PW-51A	HS	NICKEL	mg/L	2	0.472	1.08	1.07	0.69	0.65	0.523	0.45	0.41	0.36	0.297	0.343	0.311	0.367	0.3		0.25	0.22	0.19	0.22
PW-52A	HS	NICKEL	mg/L	2	0.38	3.46	3.42	2.3	1.9	2.23	1.8	1.7	1.4	2.25	1.92	1.56	1.85	1.6		1.3	1.1	1.1	1.1
PW-21A	P	RADIUM 226	pCi/L	5												0.65		3.2	40 U	1.5	1.4	0.21 J	0.18 J
PW-21A	P	RADIUM 228	pCi/L	5												3.5	2.9	2.1	40 U	0.92 J	0.84 J	0.11 J	0.07 J
PW-22A	P	RADIUM 226	pCi/L	5	0.4	0.2 U	0.4	10 U	10 U	0.2 U	10 U		10 U		0.2 U	0.37	0.49	3.3	40 U	0.83	0.75	0.12 J	0.11 J
PW-22A	P	RADIUM 228	pCi/L	5	3.6	5.1	1 U	10 U	10 U	1 U	10 U		10 U		2.9	3.7	2.9	2.4	40 U	0 J	0.1 J	0.11 J	0.11 J
PW-23A	P	RADIUM 226	pCi/L	5	0.2 U	0.2 U	0.2 U	10 U	10 U	0.2 U	10 U		10 U		0.2 U	0.77	1	1.4	40 U	0.12 J	0.1 J	0.01 J	0.01 J
PW-23A	P	RADIUM 228	pCi/L	5	1 U	1 U	1 U	10 U	10 U	1 U	10 U		10 U		1 U	2	1.6	1.6	40 U	0 J	0.05 J	0.01 J	0.01 J
PW-24A	P	RADIUM 226	pCi/L	5	0.2 U	0.2 U	0.2 U	10 U	10 U	0.2 U	10 U		10 U		0.2 U	0.22	1.6	2.4	40 U	0.1 J	0.2 J	0.12 J	0.06 J
PW-24A	P	RADIUM 228	pCi/L	5	1 U	1 U	4	10 U	10 U	1 U	10 U		10 U		1 U	3.5	2.2	3.1	40 U	0.29 J	0.2 J	0.11 J	0.05 J
PW-27A	NHS	RADIUM 226	pCi/L	5	0.2 U	0.2 U	0.2 U	10 U	10 U	0.2	10 U		10 U		0.2 U	0.79	0.68	2.4	40 U	0.15 J	0.12 J	0.02 J	0.01 J
PW-27A	NHS	RADIUM 228	pCi/L	5	1 U	1 U	1 U	10 U	10 U	1 U	10 U		10 U		1.5 U	2.2	2.9	2.1	40 U	1.5	1.3	0.05 J	0.04 J
PW-28A	HS	RADIUM 226	pCi/L	5	168	91.3	139	11	10 U	75.6	10 U		10 U		3.6	44		25	40 U	65	32	1.1 J	1.13 J
PW-28A	HS	RADIUM 228	pCi/L	5	352	25.1	56	25	10 U	60.8	10 U		10 U		67	53		12	54	11	5	1.12 J	1.4 J
PW-50A	HS	RADIUM 226	pCi/L	5	28.3	21	15.4	10 U	10 U	5.7	10 U	10 U	10 U		2.6	10		6.5	40 U	0.75	0.67	0.04 J	0.03 J
PW-50A	HS	RADIUM 228	pCi/L	5	44.7	25.6	19	10 U	10 U	10.8	10 U	10 U	10 U		5.1	8.8	13	5.3	40 U	1.9	1.7	0.02 J	0.02 J
PW-51A	HS	RADIUM 226	pCi/L	5	0.7	1	0.5 U	10 U	10 U	0.2 U	10 U	10 U	10 U		0.2 U	0.37		2.1		0.39 J	0.31 J	0.21 J	0.18 J
PW-51A	HS	RADIUM 228	pCi/L	5	2.8	1 U	1 U	10 U	10 U	1 U	10 U	10 U	10 U		2.4	2.5	2.4	2.6		0.59 J	0.49 J	0.11 J	0.1 J
PW-52A	HS	RADIUM 226	pCi/L	5	6.1	8.7	6.3	10 U	10 U	2	10 U	10 U	10 U		0.2 U	3.3		3.2		3.1	2.1	0.06 J	0.05 J
PW-52A	HS	RADIUM 228	pCi/L	5	7.3	3.7	1 U	10 U	10 U	1.8	10 U	10 U	10 U		2.1	2.9	5.1	1.8		2.7	2.7	0.11 J	0.08 J

Notes:
U = not detected above reporting limit shown
D = Dilution
J = estimated value
Blank cells indicate no analysis performed
Shading indicates that ROD concentration was exceeded

Table 6-2. pH in groundwater for monitoring wells in the FMA Extraction Area

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Station	Well Type	Oct-02	Apr-03	Oct-03	Apr-04	Sep-04	May-05	Sep-05	Oct-05	May-06	Sep-06	May-07	Oct-07	May-08	Jun-08	Jun-09	Dec-10	Apr-10	Nov-10
PW-21A	P													5.79		6.09	6.14	6.87	6.32
PW-22A	P	6.50	6.73	6.76	6.81	6.65	6.51	6.30		6.63			6.55	6.53		6.82	6.77	6.14	6.67
PW-23A	P	6.77	6.99	6.97	7.03	6.85	6.67	6.60		6.77	6.46	6.92	6.79	6.70		6.03	5.99	7.02	6.01
PW-24A	P	6.24	6.33	6.60	6.49	6.44	6.31	6.14		6.30	6.17	6.45	6.45	6.35		5.11	5.16	6.42	5.78
PW-27A	NHS	6.23	5.61	6.08	6.01	6.28	6.05		5.68	5.97	5.73	6.01	5.98		5.87	5.72	5.78	4.02	5.98
PW-28A	HS	1.44	1.40	1.89	2.30	2.15	1.91	1.92		2.30	1.68	1.92	1.62		1.75	1.97	2.46	2.42	2.52
PW-28B	HS																		
PW-50A	HS	2.44	2.40	2.89	3.62	3.53	3.08		1.97	3.45	3.00	3.74	3.50		2.56	4.13	4.45	4.50	4.32
PW-51A	HS	3.48	3.37	4.00	4.03	4.36	4.30		3.16	4.17	3.85	4.40	4.33		4.04	4.45		5.60	5.51
PW-52A	HS	2.97	3.02	3.39	3.54	3.68	3.64		2.33	3.64	3.20	3.69	3.66		3.38	3.72		3.43	3.59

Blank cells indicate no analysis performed or data is missing

Shading indicates that ROD Cleanup level was exceeded

P = Perimeter well

NHS = Non hot spot well

HS = Hot spot well

Table 6-3. FMA Extraction Well Summary of arsenic, radium 228, radium 226, fluoride, ammonia, ammonium, cadmium, and nickel in groundwater
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Well	Parameter	Unit	ROD	Oct-02	Apr-03	Oct-03	Apr-04	Sep-04	May-05	Sep-05	May-06	Sep-06	May-07	Oct-07	May-08	Oct-08	Jun-09	Dec-09	Apr-10	Nov-10	Apr-11	Dec-11
EW-01	AMMONIA	mg/L	--						41.2				8	44.7	33.8		25	62	20	15	15	13
EW-02	AMMONIA	mg/L	--						159				80	82.5	59.5		51	46	45	30	42	20
EW-03	AMMONIA	mg/L	--			24.47			18.8				19.3	24.1	20.1		20	22	22	18	18	17
EW-01	AMMONIUM	mg/L	250				57.0	45.0			40.0						31.0	79.0	34.0	20.0	19.0	16.0
EW-02	AMMONIUM	mg/L	250				150.0	150.0		120.0	100.0						64.0	59.0	60.0	40.0	53.0	25.0
EW-03	AMMONIUM	mg/L	250				19.0	20.0		25.0	40.0						25.0	28.0	24.0	24.0	23.0	22.0
EW-01	ARSENIC	mg/L	0.05				0.02 U	0.02 U	0.075 U		0.02 U	0.02 U	0.25 U	0.1 U	0.1 U		0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
EW-02	ARSENIC	mg/L	0.05				0.02 U	0.02 U	1.5 U	0.02 U	0.04	0.02 U	2.5 U	1 U	0.1 U		0.05	0.05	0.05	0.05	0.05	0.04
EW-03	ARSENIC	mg/L	0.05			0.005 U	0.02 U	0.02 U	0.015 U	0.02 U	0.02 U	0.02 U	0.025 U	0.02 U	0.05 U		0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
EW-01	CADMIUM	mg/L	0.005				0.02	0.02	0.025 U		0.02	0.02	0.05 U	0.05 U	0.05 U		0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
EW-02	CADMIUM	mg/L	0.005				0.02	0.03	0.05 U	0.02	0.02	0.02	0.5 U	0.5 U	0.5 U		0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
EW-03	CADMIUM	mg/L	0.005			0.0061	0.01 U	0.01 U	0.005 U	0.01 U	0.01 U	0.01 U	0.005 U	0.0121	0.05 U		0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
EW-01	FLUORIDE	mg/L	2				14	14	7.3		23	18	0.25	0.33	0.32		1.2	24	1.1	1	1.2	1.2
EW-02	FLUORIDE	mg/L	2				8	8	1.51	7	9	10	0.1 U	0.1 U	0.1 U		0.1 U	6	0.1 U	0.1 U	0.1 U	0.1 U
EW-03	FLUORIDE	mg/L	2			11.4	10	11	2.25	8	8	7	5	4.6	4.2		5.1	7	4.2	3.8	3.8	3.3
EW-01	NICKEL	mg/L	2				0.98	1	1.1		1.3	1	0.2 U	1.13	1		0.95	0.82	0.77	0.75	0.69	0.66
EW-02	NICKEL	mg/L	2				1.6	1.8	2.01	2.1	1.6	1.3	2 U	2.36	1.87		1.7	1.8	1.6	1.5	1.5	1.4
EW-03	NICKEL	mg/L	2			0.492	0.31	0.32	0.269	0.3	0.24	0.18	0.18	0.183	0.223		0.23	0.24	0.22	0.21	0.18	0.18
EW-01	RADIUM 226	pCi/L	5	18.2	29		10 U	10 U	4.8	10 U	10 U	10 U		1.4	4.6		3.5	40 U	1.6	1.5	0.01 J	0.01 J
EW-01	RADIUM 228	pCi/L	5	60	17		10 U	10 U	8.4	10 U	10 U	10 U		3.2	6.2		5.9	40 U	3.1	3.2	0.01 J	0.01 J
EW-02	RADIUM 226	pCi/L	5	65	20		10 U	10 U	36.1	10 U	10 U	10 U		4.9	37		35	40 U	18	12	0.11 J	0.12 J
EW-02	RADIUM 228	pCi/L	5	198	59		22	10 U	1.7	10	12	10 U		83.2	23		21	55 U	14	16	0.56 J	0.47 J
EW-03	RADIUM 226	pCi/L	5	10 U		0.5 U	10 U	10 U	0.2 U	10 U	10 U	10 U		0.2 U	3.6		2.5	40 U	3.3	2.3	0.22 J	0.23 J
EW-03	RADIUM 228	pCi/L	5	10 U		1 U	10 U	10 U	1 U	10 U	10 U	10 U		1 U	4.2		3.6	40 U	4.1	3.3	0.18 J	0.17 J

Notes:
U = not detected above reporting limit shown
D = Dilution
J = estimated value
Blank cells indicate no analysis performed or data is missing
Shading indicates that ROD performance standard was exceeded

Table 6-4. SEA Summary of VOCs in groundwater

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Well ID	Parameter	Well Type	Units	ROD	Oct-02	Apr-03	Oct-03	Apr-04	Sep-04	May-05	Sep-05	May-06	Aug-06	May-07	Oct-07	Jun-08	Oct-08	Jun-09	Dec-09	Apr-10	Nov-10	Apr-11	Dec-11
EW-04	TCA	R	µg/L	200	1.10	163.00		2.56	193.37 D	18.10	0.67	1.4	2.00	0.78	150 D	66.4	2.37	3.27	0.76	1.02	0.5 U	0.5 U	0.5 U
EW-05	TCA	R	µg/L	200	100	96.08		30.10	176.15 D	13.70	10.00	38.9	30.30	55.30	35.10	62.8	14.80	0.85	0.75	0.32 J	0.5 U	0.5 U	0.5 U
EW-06	TCA	R	µg/L	200	248	35.75		170 D	149 D	180 D	179 D	125 D	142 D	190 D	169 D		34.90	0.5 U	1.67	0.29 J	0.5 U	0.5 U	0.5 U
PW-25A	TCA	P	µg/L	200	2.90	1 U	1.17	1.79	1.00	0.59	1.90	1.3	2.00	1.20	0.75	1.1	0.44 J	0.63	0.42 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-26A	TCA	P	µg/L	200	1.90	1 U	2.54	0.64	1.45	0.5 U	0.5 U	0.5 U	0.34 J	0.62	0.49 J	0.6	1.93	2.64	0.20 J	0.31 J	0.5 U	0.5 U	0.5 U
PW-29A	TCA	P	µg/L	200				0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.16 J	0.5 U	0.14 J	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-47A	TCA	NHS	µg/L	200	54.90	95.77	75.68	134 D	117.81 D	86.50	49.90	99.3	130 D	116 D	95	32.3	29.10	3.84	0.08 J	0.08 J	0.5 U	0.5 U	0.5 U
PW-48A	TCA	NHS	µg/L	200			1 U			0.5 U		0.5 U		0.5 U	0.50 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-49A	TCA	P	µg/L	200	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.50 U	0.2 J	0.50 U	0.5 U	0.50 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-57A	TCA	P	µg/L	200	76.60	9.10	73.48	48.65	61.93	52.10	60.70	41.1	45.00	42.6	69.10	43	19.60	0.09 J	0.50 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-96A	TCA	NHS	µg/L	200		1 U										132 D	12.40	0.13 J	0.29 J	2.23 J	0.5 U	0.5 U	0.5 U
PW-97A	TCA	P	µg/L	200		1.83										81.4	61.80	12.80	4.61	2.54	0.5 U	0.5 U	0.5 U
EW-04	DCA	R	µg/L		1.10	34.00		1.46	127.44 D	11.50	0.61	0.75	1.10	0.45 J	75.40	19.8 J	1.42	2.78	1.00	1.13	0.5 U	0.5 U	0.5 U
EW-05	DCA	R	µg/L		71.40	1 U		12.94	115.23 D	8.00	5.40	14.7	11.00	19.10	12.70	23.7	9.11	4.53	4.58	11.40	0.5 U	0.5 U	0.5 U
EW-06	DCA	R	µg/L		161	164.00		111 D	75.55	114 D	110 D	87.1	86.30	91.00	76.00		26.20	1.33	1.48	0.78	0.5 U	0.5 U	0.5 U
PW-25A	DCA	P	µg/L		6.00	1 U	2.86	3.92	3.03	1.40	5.20	3.7	6.00	2.70	1.70	2.5	3.31	2.53	1.74	0.5 U	0.5 U	0.5 U	0.5 U
PW-26A	DCA	P	µg/L		1.80	1 U	2.07	0.5 U	0.98	0.5 U	0.5 U	0.5 U	0.11 J	0.18 J	0.50 U	0.15 J	1.88	3.25	0.40 J	0.35 J	0.5 U	0.5 U	0.5 U
PW-29A	DCA	P	µg/L					1.39	2.01	0.93	0.57	0.51	0.75	0.58	0.64	0.64	0.86	0.59	0.50 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-47A	DCA	NHS	µg/L		24.30	26.57	28.90	45.50	41.00	26.80	18.70	34.7	46.40	44.90	31.40	15.7	36.40	35.90	2.04	1.33	0.5 U	0.5 U	0.5 U
PW-48A	DCA	NHS	µg/L				1 U			0.5 U		0.5 U		0.5 U	0.50 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-49A	DCA	P	µg/L		1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-57A	DCA	P	µg/L		40.00	9.10	37.06	26.58	33.89	25.60	30.10	22.2	22.60	20.8	29.30	20.5	26.90	2.76	0.16 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-96A	DCA	NHS	µg/L			1 U										42.4	16.00	3.41	18.40	40.30	10.20	0.5 U	0.5 U
PW-97A	DCA	P	µg/L			1 U										61.5	67.00	59.30	30.20	20.90	2.35	0.5 U	0.5 U
EW-04	DCE	R	µg/L	7	1 U	1 U		0.5 U	32.84	3.30	0.5 U	0.5 U	0.26 J	0.16 J	23.40	4.2 J	0.39 J	0.36 J	0.21 J	0.17 J	0.5 U	0.5 U	0.5 U
EW-05	DCE	R	µg/L	7	21.10	1 U		2.91	30.22	2.40	1.80	3	2.20	4.20	3.50	3.9	0.50 U	0.1 J	2.54	1.16	0.5 U	0.5 U	0.5 U
EW-06	DCE	R	µg/L	7	50.20	1 U		32.52	19.92	31.00	30.00	27.4	26.10	29.00	22.20		9.48	1.44	0.31 J	0.58	0.5 U	0.5 U	0.5 U
PW-25A	DCE	P	µg/L	7	1.50	1 U	1 U	1.22	0.82	0.5 U	1.30	1.1	1.80	0.71	0.49 J	0.5	0.69	0.51	0.36 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-26A	DCE	P	µg/L	7	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.50 U	0.5 U	0.84	0.31 J	0.50 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-29A	DCE	P	µg/L	7				0.53	0.75	0.5 U	0.5 U	0.5 U	0.12 J	0.19 J	0.18 J	0.27 J	0.34 J	0.22 J	0.50 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-47A	DCE	NHS	µg/L	7	2.60	6.00	2.78	7.73	5.42	6.40	2.90	7.4	10.80	11.30	5.50	1.9	2.82	0.94	0.39 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-48A	DCE	NHS	µg/L	7			1 U			0.5 U		0.5 U		0.5 U	0.50 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-49A	DCE	P	µg/L	7	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-57A	DCE	P	µg/L	7	10.10	9.10	8.30	6.32	8.45	7.00	8.30	6.1	5.80	5.6	8.50	5.5	3.46	0.11 J	0.50 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-96A	DCE	NHS	µg/L	7		1 U										7.1	1.89 J	0.42 J	1.13	0.88	0.5 U	0.5 U	0.5 U
PW-97A	DCE	P	µg/L	7												34.4	28.60	6.80	3.55	3.02	0.5 U	0.5 U	0.5 U
EW-04	cis-1,2-DCE	R	µg/L	70	6.60			1.24	22.52	4.50	2.40	1.8	1.50	1.10	20.70	7.8 J	2.42	1.65	1.06	0.86	0.5 U	0.5 U	0.5 U
EW-05	cis-1,2-DCE	R	µg/L	70	8.90			3.90	20.58	2.10	1.50	6.1	4.50	7.40	4.60	8.9	3.26	0.90	2.44	2.59	0.5 U	0.5 U	0.5 U
EW-06	cis-1,2-DCE	R	µg/L	70	16.20			17.45	14.90	21.70	22.60	21	20.80	29.30	20.80		80.80	6.53	1.57	0.95	0.5 U	0.5 U	0.5 U
PW-25A	cis-1,2-DCE	P	µg/L	70	1.90	1 U	1.05	0.94	0.78	0.5 U	2.30	0.73	0.95	0.51	0.21 J	0.75	0.88	0.60	0.27 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-26A	cis-1,2-DCE	P	µg/L	70	2.40	1 U	1.96	0.5 U	0.73	0.5 U	0.5 U	0.5 U	0.5 U	0.1 J	0.50 U	0.08 J	1.26	1.32	0.54	0.1 J	0.5 U	0.5 U	0.5 U
PW-29A	cis-1,2-DCE	P	µg/L	70				0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U	0.5 U	0.5 U	0.5 U

Well ID	Parameter	Well Type	Units	ROD	Oct-02	Apr-03	Oct-03	Apr-04	Sep-04	May-05	Sep-05	May-06	Aug-06	May-07	Oct-07	Jun-08	Oct-08	Jun-09	Dec-09	Apr-10	Nov-10	Apr-11	Dec-11
PW-47A	cis-1,2-DCE	NHS	µg/L	70	3.50	5.17	4.68	9.04	8.16	7.30	4.00	12.1	13.70	13.50	11.20	5.4	16.30	9.70	2.25	1.06	0.5 U	0.5 U	0.5 U
PW-48A	cis-1,2-DCE	NHS	µg/L	70			1 U			0.5 U		0.5 U		0.5 U	0.50 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-49A	cis-1,2-DCE	P	µg/L	70	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.50	0.5 U	0.50 U	0.5 U	0.07 J	0.5 U	0.50 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-57A	cis-1,2-DCE	P	µg/L	70	6.00	9.10	6.78	4.62	6.32	5.20	6.10	5.3	5.90	5.2	8.10	5	18.40	1.06	0.66	0.46 J	0.5 U	0.5 U	0.5 U
PW-96A	cis-1,2-DCE	NHS	µg/L	70		1 U										19.6	34.50	2.12	3.80	10.90	0.98	0.5 U	0.5 U
PW-97A	cis-1,2-DCE	P	µg/L	70		50.55										19.9	28.70	13.20	5.59	3.89	0.5 U	0.5 U	0.5 U
EW-04	PCE	R	µg/L	5	1 U	1 U		0.5 U	3.29	0.54	0.5 U	0.5 U	0.21	0.14 J	3.20	25 U	0.27 J	0.29	0.17 J	0.29 J	0.5 U	0.5 U	0.5 U
EW-05	PCE	R	µg/L	5	3.10			1.94	3.14	1.60	1.40	1.8	1.50	2.30	2.30	1.8	0.68	0.18	0.44 J	0.5 U	0.5 U	0.5 U	0.5 U
EW-06	PCE	R	µg/L	5	4.10			3.57	2.11	3.30	3.10	2.9	2.70	3.30	2.90		0.90	0.5	0.32 J	0.12 J	0.5 U	0.5 U	0.5 U
PW-25A	PCE	P	µg/L	5	2.80	1 U	1.47	1.38	1.19	0.59	2.30	1.1	1.50	0.85	0.53	0.49 J	0.24 J	0.51	0.29 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-26A	PCE	P	µg/L	5	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.07	0.13 J	0.09 J	0.5 U	0.20 J	0.27	0.50 U	0.27 J	0.5 U	0.5 U	0.5 U
PW-29A	PCE	P	µg/L	5				0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.10	0.5 U	0.50 U	0.5 U	0.09 J	0.5 U	0.50 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-47A	PCE	NHS	µg/L	5	3.20	3.40	3.13	4.81	3.71	2.80	1.60	3.1	3.80	4.10	3.30	1.4	0.37 J	0.42 J	0.16 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-48A	PCE	NHS	µg/L	5			1 U			0.5 U		0.5 U		0.5 U	0.50 U	0.5 U	0.50 U	0.5	0.50 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-49A	PCE	P	µg/L	5	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.50	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-57A	PCE	P	µg/L	5	4.30	9.10	4.84	3.93	3.73	2.90	3.50	3	2.70	2.4	3.60	2.1	0.26 J	0.5 U	0.50 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-96A	PCE	NHS	µg/L	5		1 U										1.2	2.50 U	0.5 U	0.50 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-97A	PCE	P	µg/L	5		1 U										1.9	1.22	0.26 J	0.17 J	0.14 J	0.5 U	0.5 U	0.5 U
EW-04	TCE	R	µg/L	5	30.40	1 U		4.67	137.23 D	21.80	9.80	6.5	8.90	4.40	90.20	46.8	11.60	9.46	6.05	6.32	0.58	0.5 U	0.5 U
EW-05	TCE	R	µg/L	5	78.50	1.12		31.95	127.64 D	16.70	11.80	37.1	30.30	44.20	31.70	45.4	16.40	0.53	4.32	1.24	0.5 U	0.5 U	0.5 U
EW-06	TCE	R	µg/L	5	129.00	1 U		125 D	85.99	130 D	124 D	114 D	118.00	119 D	87.30		15.90	6.00	7.40	1.01	0.5 U	0.5 U	0.5 U
PW-25A	TCE	P	µg/L	5	5.60	1 U	3.13	3.50	2.53	1.30	4.70	2.4	3.80	1.80	0.98	1.3	1.52	1.22	0.61	0.5 U	0.5 U	0.5 U	0.5 U
PW-26A	TCE	P	µg/L	5	12.30	9.10	6.46	2.39	3.70	1.90	1.10	1.5	1.30	1.70	1.50	1.1	3.73	3.66	0.63	0.57	0.5 U	0.5 U	0.5 U
PW-29A	TCE	P	µg/L	5				0.5 U	0.58	0.5 U	0.5 U	0.5 U	0.16	0.18 J	0.18 J	0.21 J	0.29 J	0.2 J	0.50 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-47A	TCE	NHS	µg/L	5	34.60	50.55	48.18	72.77	68.47	52.30	34.50	69.6	78.90	63.30	53.90	21.8	12.90	1.94	1.18	0.76	0.5 U	0.5 U	0.5 U
PW-48A	TCE	NHS	µg/L	5			1 U			0.5 U		0.5 U		0.5 U	0.50 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-49A	TCE	P	µg/L	5	6.10	1 U	1.21	5.18	0.5 U	1.40	4.20	2.5	1.10	2.20	0.60	2.2	1.49	0.70	0.13 J	0.25 J	0.5 U	0.5 U	0.5 U
PW-57A	TCE	P	µg/L	5	46.70	9.10	50.41	34.56	44.22	35.10	42.30	39.9	41.60	30.7	43.80	25.6	2.58	0.23 J	0.33 J	0.31 J	0.5 U	0.5 U	0.5 U
PW-96A	TCE	NHS	µg/L	5		1 U										62	0.57 J	0.66	1.08	1.90	0.5 U	0.5 U	0.5 U
PW-97A	TCE	P	µg/L	5												67.3	43.20	9.98	4.73	4.58	0.5 U	0.5 U	0.5 U
EW-04	VC	R	µg/L	2	1 U			0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.50	0.5 U	0.50 U	25 U	0.50 U	0.5 U	0.50 U	0.5 U	0.5 U	0.5 U	0.5 U
EW-05	VC	R	µg/L	2	1 U			0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.50	0.5 U	0.50 U	0.5 U	0.50 U	2.51	0.48 J	1.49	0.5 U	0.5 U	0.5 U
EW-06	VC	R	µg/L	2	1 U			0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.13	0.31 J	0.50 U		1.55	3.11	0.25 J	0.58	0.5 U	0.5 U	0.5 U
PW-25A	VC	P	µg/L	2	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.50	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-26A	VC	P	µg/L	2	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.50	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-29A	VC	P	µg/L	2				0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.50	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-47A	VC	NHS	µg/L	2	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.50	0.5 U	0.50 U	0.5 U	1.25	1.25	0.58	0.5 U	0.5 U	0.5 U	0.5 U
PW-48A	VC	NHS	µg/L	2			1 U			0.5 U		0.5 U		0.5 U	0.50 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-49A	VC	P	µg/L	2	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.50	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-57A	VC	P	µg/L	2	1 U	9.10	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.50	0.5 U	0.50 U	0.5 U	0.84	0.59	0.17 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-96A	VC	NHS	µg/L	2		1 U										0.5 U	1.27 J	1.10	2.93	7.25	0.28	0.5 U	0.5 U
PW-97A	VC	P	µg/L	2												0.56	1.43	3.02	1.70	0.93	0.5 U	0.5 U	0.5 U

Notes: U = not detected above reporting limit shown; D = Dilution; J = estimated value; Blank cells indicate no analysis performed or missing data; Shading indicates that ROD Performance level was exceeded

R = Recovery well, P = Perimeter well, NHS = Non hot spot well

Table 6-5. Fabrication Area Summary of groundwater analytical results for TCA
Wah Chang Five Year Review Report

Station	Well Type	ROD	Oct-2002	Apr-2003	Oct-2003	May-June-July2004	Sept-Oct 2004	May-june 2005	Oct-Nov-2005	May-2006	Oct-Nov-2006	May-June 2007	Oct-Nov-2007	May-2008	Oct-2008	June-July 2009	Dec-2009	April May 2010	Nov-Dec-2010	May-2011	Nov-2011
MW-01A	HS	200	2.2	1 U	79.84	0.5 U	9.99	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.12 J	0.5 U	0.14 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
MW-02A	HS	200	22	10.56	11.14	6.24	4.84	0.51	0.5 U	0.5 U	0.5 U	0.5 U	0.12 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
MW-03A	HS	200	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.15 J	0.5 U	0.45 J	0.5 U	0.5 U	0.5 U	0.5 U
MW-04A	HS	200	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.13 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-01A	HS	200	1.2	0.99	0.6	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.12 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-03A	HS	200	10.5	3.88	4.72	2.76	1.62	1.1	0.52	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.17 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-10	NHS	200	136.6 D	82.55	104 D	70.83	73.58	55.9	62.6	58.9	69.2	78.7	68.9	65.8	56.1	16.1	16.6	1.23	0.13 J	0.68	0.5 U
PW-100A	HS	200																0.99	113		84.5
PW-101A	NHS	200																0.08 J	8.93		5.67
PW-11	HS	200	122 D	47.35	227 D	256 D	323 D	37.3	280 D	26.1	83	7.1	12.1	3.7	41.4	16.5	21.1	15.2	4.61	3.1	1.65
PW-12	HS	200	1330 D	207.55	423 D	536 D	583 D	1140 D	2960 D	621 D	738 D	1260 D	663 D	1640 D	1910 D	2490	1190	823	389	364	65
PW-13	HS	200	655 D	280.57	213 D	289.26	144.55	227	239	173	135	49.8	146	340 D	168	417	175	152	15.6	56	8.77
PW-14	NHS	200											2.3								
PW-16A	NHS	200	5.4	1.71	3.98	3.23	5.75	5.1		4.1	10.7	4.3	4.1	2.4	3.85	4.51	4.33	3.78	1.89	1.2	0.53
PW-19A	NHS	200								0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1.64	0.5 U	0.5 U	0.5 U	0.5 U
PW-30A	HS	200	185 E	449.87	1510 D	1660 D	799 D	1250 D	662 D	959 D	1640 D	938 D	952 D	960 D	1480 D	833	452	431	415	286	264
PW-31A	NHS	200								0.5 U	0.5 U	0.5 U	0.5 U	0.1 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-42A	HS	200	1 U	0.5 U	1.29	0.68	0.5 U	0.5 U	3.3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-45A	HS	200	2.5	2.38	4.12	9.9	13	3.2	9.3	1.2	0.5 U	1.9	0.91	0.85	0.36 J	0.11 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-46A	NHS	200	1.5	0.85 J	1 U	0.95	0.5 U	0.57		0.32 J	0.5 U	0.56	0.18 J	0.25 J	0.13 J	0.18 J	0.15 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-68A	HS	200	202 D	0.62	4.17	8.36	1.77	0.87	3.4	0.88	0.54	0.95	0.48 J	0.77	2.61	2.51	0.16 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-69A	HS	200	5810 D	3570	2620	2570 D	1390 D	2100 D	1780 D	885 D	392	482	295 D	473 D	349	386	451	368	28.8	245	13.4
PW-70A	NHS	200																	0.5 U		0.5 U
PW-71A	HS	200	66.9	53.28	33.94	34.77	20.22	63.6	0.5 U	0.5 U	0.5 U	0.5 U	1.5	0.14 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-72A	NHS	200	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U													
PW-73B	HS	200	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.14 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-74B	NHS	200	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.1 J	0.5 U	0.1 J	0.22 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-75A	NHS	200	38.6	134	37.92	313 D	88.85	85.5	14.1	46.9	14.3	44.2	10.2	45.3	17.4	64.2	42.6	39.6	27.5	21.3	11.6
PW-76A	P	200	2.18	0.5 U	75.57	80.55	1.57	1.8	7.3	0.5 U	0.5 U	2.1	0.2 J	1.1	0.11 J	1.14	1.77	0.5 U	0.5 U	0.5 U	0.5 U
PW-77A	NHS	200	2.22	1.28	0.56	5.51	16.35	28.9	26.8	17.7	13.1	14.6	16.2	17.9	11.7	3.57	4.97	2.15	1.08	1.26	0.53
PW-78A	P	200	13.9	10.63	13.35	13.9	7.86	7.5	8.8	8.4	12.1	16.7	5.7	11.7	10.1	1.79	10.5	9.55	2.18	4.38	0.67
PW-79A	P	200	28	81.02	151.95 D	69.12	26.48	48.4	72.6	71.4	67	70.5	188 D	83.3	28.1	0.08 J	8.63	4.19	1.33	4.34	0.69
PW-80A	NHS	200	71.9	48.85	45.57	55.44	16.4	6.9	3.2	6.3	3.8	7.2	8.7	8.4	1.93	0.19	3.36	2.09	0.49 J	1.25	0.5 U
PW-82A	NHS	200	4.8	0.5 U	1.9	1.26	1.14	0.63		0.29 J	0.5 U	0.22 J	0.16 J	0.18 J	0.12 J	0.5 U	1.53	1.22	0.77	0.59	0.23 J
PW-83A	HS	200	9.9	0.5 U	3.97	3.9	2.57	1.9	0.83	0.76	0.5 U	0.46 J	0.5 U	0.26 J	0.12 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-84A	NHS	200	1 U	0.5 U		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.25 J		0.65	0.32 J	0.26 J	6.43	5.25	2.33	2.81	1.42
PW-85A	HS	200	3.2	5.64	3.39	2.04	1.19	2.6	1.5	1.6	18.4	2.1	0.43 J	1.7	1.24	3.28	11.2	8.95	6.18	6.34	2.34
PW-86A	HS	200	2	0.5 U	2.48	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.83	3.7	0.69	0.13 J	2.19	0.27 J	1.04	0.98	0.33 J	0.54	0.5 U
PW-87A	NHS	200	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U		0.5 U	0.5 U	0.5 U	0.5 U	0.1 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-88A	NHS	200	2.6	0.68	1.48	1.31	0.96	1.1	0.73	0.72	0.5	0.49 J	0.39 J	0.47 J	0.26 J	0.19 J	0.17 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-89A	NHS	200	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-91A	NHS	200	160 D	143.28	63.55	97.9 D	6.84	52.5	8.7	43.9	0.16 J	0.5 U	0.14 J	16500 D	0.36 J	8.57	2.74	1.79	1.31	0.54	0.64
PW-92A	NHS	200	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-93A	HS	200											11800 D	15300 D	24900 D	13300	9980	11100	1120	5970	845
PW-94A	HS	200			1 U								220 D	421 D	302 D	43.5	183	39	197	12	156
PW-95A	HS	200											229 D	759 D	224 D	1820	205	348	90.4	234	45.2
PW-98A	NHS	200														504	406	507	183	123	128
PW-99A	HS	200														27.5	54.6	22.1	7.15	8.94	5.18

Notes:
U = not detected above reporting limit shown
D = Dilution
J = estimated value
Blank cells indicate no analysis performed
Shading indicates that ROD concentration was exceeded
P=Perimeter well, =NHS = Non hot spot well, HS = Hot spot well
(1) Initial GW samples were collected in September 2007 for PW-93A(B-07-12), PW-94A(B07-09), and PW-95A(B07-07) during the intial soil and groundwater investigation at the former CCA area.
(2) Initial GW samples were collected in July 2009 for PW-98A and PW-99A.
(3) Initial GW samples were collected in August 2010 for PW-100A and PW-101A.
(4) Initial GW samples were collected in May 2010 for E-11.
(5) Initial GW samples were collected in April 2010 for FW-6.

Table 6-6. Fabrication Area Summary of groundwater analytical results for DCA
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Station	Well Type	ROD	Oct-2002	Apr-2003	Oct-2003	May-June-July2004	Sept-Oct 2004	May-June 2005	Oct-Nov-2005	May-2006	Oct-Nov-2006	May-June 2007	Oct-Nov-2007	May-2008	Oct-2008	June-July 2009	Dec-2009	April-May 2010	Nov-Dec-2010	May-2011	Nov-2011
MW-01A	HS																			0.5 U	0.5 U
MW-02A	HS																			3.81	1.25
MW-03A	HS																			0.5 U	0.5 U
MW-04A	HS																			2.84	2.11
PW-01A	HS		64.5	47.09	47.87	58.4	58.84	64.8	54.4	52.6	56.1	50.8	48.5	39	32	27.2	1.07	1.02	0.98	0.88	0.55
PW-03A	HS		18.3	5.62	6.66	5.33	6.44	4.8	2.5	1.9	1.6	0.77	0.29 J	0.1 J	0.4 J	0.49 J	0.51	0.5 U	0.5 U	0.5 U	0.5 U
PW-10	NHS		328.85 D	161.25	193 D	111 D	129.35 D	69.5	171 D	81.2	114 D	131 D	99.9	63.2	60.2	58.8	31.8	28.6	35.1	23.9	22.2
PW-100A	HS																	5.5	2250		1850
PW-101A	NHS																	1.56	671		513
PW-11	HS		29.9	12.38	27.99	32.28	51.52	6.9	47.3	5.6	18.5	1.6	3.4	1.3	6.49	3.77	3.79	4.12	8.15	2.68	3.12
PW-12	HS		162 D	99.17	71.51	82.26	114.25	139	242 D	78.5	55	125	68.5	159	140	321	255	414	312	189	289
PW-13	HS		1730 D	1260	865 D	1370 D	842 D	1430 D	1440 D	1210 D	545 D	285 D	767 D	977 D	551 D	3310	1710	1310	1524	789	1125
PW-14	NHS												0.64								
PW-16A	NHS		1.8	1.1	1.34	1.05	1.51	1.4		1.5	2.3	1	1.5	0.92	1.13	1.12	0.69	0.5 U	0.5 U	0.5 U	0.5 U
PW-19A	NHS									0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.79	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-30A	HS		39.3	12.9	39.57	32.96	25.25	25.6	18.8	24.8	32.5	17	17.4	13.9	19.9	20.2	10.2	11.1	5.6	4.5	3.9
PW-31A	NHS									0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-42A	HS		7.3	10.14	6.04	6.91	5.25	3.1	4.2	2.6	5.8	8.4	8.2	8	5.87	5.52	4.72	3.82	3.37	2.01	0.84
PW-45A	HS		47.7	71.51	56.7	72.79	91.96	42.5	54.7	27.7	1.6	21.1	13.7	13	8.66	2.06	0.22 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-46A	NHS		15	9.33	8.73	15.63	4.38	6.8		5.7	0.27 J	5.4	3.1	3.7	2.07	4.31	4.27	3.89	2.86	2.64	1.34
PW-68A	HS		76.2	0.5 U	2	7.68	1.09	0.5 U	2.5	0.65	0.32 J	0.78	0.22 J	0.15 J	2.08	4.95	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-69A	HS		2110 D	1540	1390	949 D	736	677	525	748 D	280	205	148 D	196	208	234	299	246	141	189	135
PW-70A	NHS																		0.16 J		0.5 U
PW-71A	HS		8.7	9.88	8.62	10.21	4.78	8.5	10.9	1.9	1.5	0.5 U	1.7	0.98	1.72	0.12 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-72A	NHS		1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U													
PW-73B	HS		43.9	30.14	31.15	23.75	21.99	19	16.9	12.1	10.8	11.8	10.5	9.6	8.38	2.83	4.51	4.23	3.54	1.18	1.65
PW-74B	NHS		10.8	5.7	7.35	5.76	5.96	6.7	8.7	10.5	8.2	7.2	9.5	7.8	10.7	0.5 U	2.86	1.96	0.83	1.15	0.49 J
PW-75A	NHS		24	14.3	22.64	30.14	23.54	17.3	10.8	12	10.2	5.5	4.7	8.5	4.81	8.62	8.13	7.15	9.68	2.33	6.47
PW-76A	P		1.71	3.01	1.96	2.5	4.83	5.4	0.65	0.5 U	0.5 U	0.28 J	0.25 J	0.18 J	0.38 J	0.34 J	2.04	0.5 U	0.5 U	0.5 U	0.5 U
PW-77A	NHS		163.05 D	118.8	127.44 D	341 D	449 D	478 D	483 D	526 D	477 D	515 D	703 D	641 D	462 D	212	227	216	186	143	142
PW-78A	P		95.2 D	143.52	123.09 D	143 D	99.08	130 D	124 D	144 D	99.4	123 D	96.6	87.9	88.7	141	114	91.1	87.2	73.4	25.8
PW-79A	P		18.6	27.93	52.72	30.91	20.49	22.5	34.1	26.8	36.4	26.9	79.5	35.1	15.5	1.88	5.52	2.08	1.64	1.26	1.16
PW-80A	NHS		11.6	9.02	6.97	8.84	4.08	1.8	1.2	1.9	1.3	1.8	2.5	2	0.49 J	0.5 U	1.57	0.65	0.23 J	0.54	0.5 U
PW-82A	NHS		1.6	0.94	0.84	0.61	0.72	0.5 U		0.32 J	0.5 U	0.27 J	0.29 J	0.18 J	0.19 J	0.5 U	0.13 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-83A	HS		4.1	2.87	3.23	3.12	3.12	2.5	2.7	1.6	1.9	1.2	0.48 J	0.75	0.48 J	2	0.57	0.44 J	0.5 U	0.5 U	0.5 U
PW-84A	NHS		1.4	0.94		0.75	0.59	0.62	0.74	0.7	0.86	1.2		2.2	2.75	1.35	3.65	3.15	2.49	2.18	1.98
PW-85A	HS		7.1	13.4	12.53	6.28	5.87	9.3	7.9	5.2	6.7	6.2	4.9	6.5	3.06	6.06	11.2	9.61	8.26	4.18	5.54
PW-86A	HS		198 D	143.65	35.8	73.91	80.89	48.2	39.2	22.8	18.2	2.3	5.7	9.8	0.9	3.97	0.52	0.44 J	0.5 U	0.11 J	0.5 U
PW-87A	NHS		1 U	0.84	1 U	0.77	0.5 U	0.8		0.77	0.5 U	0.62	0.66	0.63	0.54	0.59	0.62	0.52	0.23 J	0.5 U	0.5 U
PW-88A	NHS		1 U	0.5 U	1 U	2.67	6.96	6.2	2.9	4.3	0.28 J	0.57	0.72	1.6	0.21 J	0.5 U	0.2 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-89A	NHS		3.4	0.5 U	1 U	2.86	2.99	2.4	1.9	1.6	0.67	1.4	1.1	1.9	1.47	0.58	0.39 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-91A	NHS		29	11.77	16.72	19.21	6.23	13.1	5.3	10.6	0.23 J	0.5 U	0.41 J	2250	0.56	4.31	1.3	1.21	1.52	0.89	0.84
PW-92A	NHS		1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.08 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-93A	HS												2410	2290	2630	2670	1130	2370	9770	3380	6218
PW-94A	HS				1 U								196 D	269 D	128 D	24.3	88.3	25.7	125	8.96	81
PW-95A	HS												103 D	209 D	123 D	335	108	152	60.6	3.16	45.1
PW-98A	NHS															170	253	458	503	268	384
PW-99A	HS															28.5	60.6	58.3	23.9	41.5	14.8

Notes:
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J = estimated value
Blank cells indicate no analysis performed or missing data
Shading indicates that ROD concentration was exceeded
P=Perimeter well, =NHS = Non hot spot well, HS = Hot spot well
(1) Initial GW samples were collected in September 2007 for PW-93A(B-07-12), PW-94A(B07-09), and PW-95A(B07-07) during the intial soil and groundwater investigation at the former CCA area
(2) Initial GW samples were collected in July 2009 for PW-98A and PW-99A.
(3) Initial GW samples were collected in August 2010 for PW-100A and PW-101A.
(4) Initial GW samples were collected in May 2010 for E-11.
(5) Initial GW samples were collected in April 2010 for FW-6.

Table 6-7. Fabrication Area Summary of groundwater analytical results for DCE
Wah Chang Five Year Review Report

Station	Well Type	ROD	Oct-2002	Apr-2003	Oct-2003	May-June-July2004	Sept-Oct 2004	May-june 2005	Oct-Nov-2005	May-2006	Oct-Nov-2006	May-June 2007	Oct-Nov-2007	May-2008	Oct-2008	June-July 2009	Dec-2009	April May 2010	Nov-Dec-2010	May-2011	Nov-2011
MW-01A	HS	7	3.3	2.45	8.83	4.1	3.89	1.4	0.66	0.25 J	0.5 U	0.5	0.09 J	0.62	0.3 J	0.12 J	1.4	1.31	0.56	0.89	0.12 J
MW-02A	HS	7	375 D	237.22	253.93	219 D	188.7 D	177 D	185 D	151 D	108 D	96.7	77.8	85.9	95.5	71	62.1	58.2	52.8	41.3	35.6
MW-03A	HS	7	1.9	1 U	1 U	0.5 U	0.74	0.5 U		0.1 J	0.19 J	0.5 U	0.21 J	0.5 U	1.58	0.12 J	0.12 J	0.5 U	0.5 U	0.5 U	0.5 U
MW-04A	HS	7	166 D	59.37	101 D	32.4	98.41	34.9	48	27.4	58.4	23.3	23	22.7	40.5	44.8	38.6	35.4	28.6	22.2	12.4
PW-01A	HS	7	99.4	69.33	85.76	106 D	99 D	148 D	89.6	81.1	108 D	94.9	96.6	77.7	50.7	68.4	1.71	1.22	1.13	0.89	0.51
PW-03A	HS	7	71.2	18.31	23.71	17.32	19.21	16.5	9	6.9	5.4	2.3	0.76	0.34 J	1.6	1.33	1.53	1.25	0.72	0.98	0.5 U
PW-10	NHS	7	18.59	9.89	14.04	8.8	9.67	6.6	10.9	7.7	7.1	9.5	7.4	8.2	4.03	1.91	1.17	2.55	3.51	1.45	1.38
PW-100A	HS	7																6.09	103		81.4
PW-101A	NHS	7																0.16 J	286		64.8
PW-11	HS	7	79.2	18.37	100 D	143 D	216 D	9.6	198 D	12.9	54	3.3	8.8	1.3	27.5	11.5	1.05	2.11	1.15	1.64	0.73
PW-12	HS	7	964 D	372	291 D	275 D	333 D	410	922 D	276 D	207	324	267 D	427	420	512	522	611	489	235	175
PW-13	HS	7	825 D	476.21	403 D	547 D	414	462	554 D	493 D	308 D	175 D	392 D	412 D	267 D	849	432	352	263	189	135
PW-14	NHS	7											0.19 J								
PW-16A	NHS	7	3.5	1.16	2.33	1.95	3.95	3.5		3.7	7.3	2.8	3.6	2	2.73	3.04	1.75	0.61	0.5 U	0.5 U	0.5 U
PW-19A	NHS	7								0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-30A	HS	7	113 D	28.15	109.49 D	96.01	56.96	92.3	37.7	85.9	75.3	76.5	78.7	79.1	86.7	42.5	21.9	18.8	12.2	7.5	8.4
PW-31A	NHS	7								0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-42A	HS	7	31.6	19.11	30.05	23.07	19.83	10.9	21.5	6.5	12.2	17.3	20.1	35.8	23.5	24.3	32.5	30.9	27.6	18.1	13.5
PW-45A	HS	7	95.5	105.61	147.53 D	149 D	178 D	124 D	182 D	118 D	11.5	164 D	143 D	128 D	121 D	29.3	3.45	2.22	0.5 U	0.5 U	0.5 U
PW-46A	NHS	7	14.3	9.48	9.4	18.15	5.24	8.8		9.7	0.18 J	9.6	6.1	7.1	3.81	7.22	7.47	6.94	5.69	3.14	3.48
PW-68A	HS	7	154 D	1 U	3.26	6.08	1.38	0.5 U	3.2	0.84	0.37 J	0.88	0.35 J	0.3 J	3.96	1.45	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-69A	HS	7	212 D	159	160.51	127 D	90.14	152	79.8	102	25	48.4	24.9	41.3	35.3	29.2	35.4	31.2	44.3	28.4	28.6
PW-70A	NHS	7																	0.5 U		0.5 U
PW-71A	HS	7	97.5 D	84.9	75.16	73.92	52.07	94.2	10.5	3.8	1.6	0.5 U	0.95	3.1	0.82	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-72A	NHS	7	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U													
PW-73B	HS	7	55.4	33.25	36.42	30.78	28.39	25.6	25.5	18.8	18.5	20.3	18.9	17	15.2	4.77	7.86	6.98	4.18	5.11	1.28
PW-74B	NHS	7	9.4	3.86	4.99	4.48	4.33	5	6.7	8.1	6.4	5.9	8.1	6.6	9.15	0.5 U	2.22	1.82	1.25	0.76	0.63
PW-75A	NHS	7	27.9	10.92	18.13	21.81	15.34	14.6	10.8	8.2	13.7	5.7	5.6	8.8	6.99	7.08	6.36	5.78	5.18	3.16	3.67
PW-76A	P	7	0.7	1 U	29.38	29.27	0.61	0.86	4	0.5 U	0.5 U	0.79	0.5 U	0.38 J	0.06 J	0.18 J	0.2 J	0.54	0.5 U	0.26 J	0.5 U
PW-77A	P	7	16.45	22.89	40.54	45.09	62.12	68.3	85	31.1	51.7	27.5	46.4 D	36.8	33.5	30.8	34.4	33.8	26.5	26.4	18.4
PW-78A	P	7	84.2	72.25	66.72	65.59	51.04	64.1	62.4	69.6	60.2	58.1	51.1	67.4	78.9	71.3	83.8	68.7	57.6	42.3	46.2
PW-79A	P	7	12.8	25.13	41.25	18.29	11.25	18.9	29.4	30.7	24.3	20.8	94.9	27.4	10.5	2.05	5.47	3.09	2.64	1.56	0.76
PW-80A	NHS	7	57.4	37.71	30.6	38.02	14.73	6	3.5	5.8	2.9	5.6	8.7	7.2	1.64	0.2	2.21	0.99	0.25 J	0.88	0.5 U
PW-82A	NHS	7	5.3	1 U	2.88	2.8	2.35	1.5		1	1.9	1	0.83	0.67	1.06	0.5 U	0.15 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-83A	HS	7	31.2	1 U	22.47	18.25	16.76	11.1	14.2	6.4	9.2	4.7	1.6	2.4	1.78	6.76	2.21	1.89	1.26	1.11	0.21 J
PW-84A	NHS	7	1 U	1 U		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1.2	1.9		10.1	14.4	5.19	4.23	3.98	2.56	2.58	0.54
PW-85A	HS	7	13.7	30.74	23.72	11.16	11.68	14.4	14	7.1	4.4	4.9	5.4	10.5	4.45	7.31	22.1	18.2	11.8	10.2	8.49
PW-86A	HS	7	97.7	67.32	18.82	49.91	50.42	36.3	37	28.7	17.5	1.1	7.2	12.4	0.62	7.96	0.17 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-87A	NHS	7	1.2	1 U	1 U	0.94	0.5 U	1		0.94	0.5 U	0.7	0.69	0.72	0.5	0.49 J	0.52	0.5 U	0.5 U	0.5 U	0.5 U
PW-88A	NHS	7	1 U	1 U	1 U	1.28	3.01	2.9	1.3	2	0.14 J	0.32 J	0.38 J	0.95	0.14 J	0.5 U	0.14 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-89A	NHS	7	1 U	3.14	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.21 J	0.22 J	0.67	0.56	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-91A	NHS	7	29.3	10.43	11.48	10.76	5.67	9	7.7	9.3	0.23 J	0.1 J	0.45 J	1030	1.22	2.54	1.15	0.88	0.69	0.76	0.33 J
PW-92A	NHS	7	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-93A	HS	7											1460	1080	1600	918	638	905	512	785	315
PW-94A	HS	7			1 U								15	31.2	13.8	2.11	5.45	1.9	11.1	0.23 J	8.12
PW-95A	HS	7											25.2	98.1	29.3	296	13.7	15.2	15.5	8.18	12.3
PW-98A	NHS	7														1080	1070	495	427	125	245
PW-99A	HS	7														87.8	245	232	186	155	143

Notes:
U = not detected above reporting limit shown
D = Dilution
J = estimated value
Blank cells indicate no analysis performed or data missing
Shading indicates that ROD concentration was exceeded
P=Perimeter well, =NHS = Non hot spot well, HS = Hot spot well
(1) Initial GW samples were collected in September 2007 for PW-93A(B-07-12), PW-94A(B07-09), and PW-95A(B07-07) during the intial soil and groundwater investigation at the former CCA area.
(2) Initial GW samples were collected in July 2009 for PW-98A and PW-99A.
(3) Initial GW samples were collected in August 2010 for PW-100A and PW-101A.
(4) Initial GW samples were collected in May 2010 for E-11.
(5) Initial GW samples were collected in April 2010 for FW-6.

Table 6-8. Fabrication Area Summary of groundwater analytical results for cis-DCE
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Station	Well Type	ROD	Oct-2002	Apr-2003	Oct-2003	May-June-July2004	Sept-Oct 2004	May-june 2005	Oct-Nov-2005	May-2006	Oct-Nov-2006	May-June 2007	Oct-Nov-2007	May-2008	Oct-2008	June-July 2009	Dec-2009	April-May 2010	Nov-Dec-2010	May-2011	Nov-2011
MW-01A	HS	70	1 U	1 U	1.12	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
MW-02A	HS	70	3.4	2.02	1.86	1.72	1.47	1.3	1.2	1.1	0.97	0.83	0.77	0.71	0.73	0.58	0.49 J	0.41 J	0.5 U	0.5 U	0.5 U
MW-03A	HS	70	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
MW-04A	HS	70	4.5	1.71	3.14	1.06	2.94	1.3	1.3	0.85	1.7	0.84	0.76	0.87	1.38	1.74	1.29	0.98	0.67	0.71	0.5 U
PW-01A	HS	70	42.5	23.11	34.6	36.44	36.65	39.3	36	32.8	35.4	30	29.2	24.8	20.8	26.3	1.28	0.88	0.68	0.62	0.36 J
PW-03A	HS	70	1.3	1 U	0.53	0.5001	0.83	0.81	0.5 U	0.5 U	0.5 U	0.16 J	0.5 U	0.5 U	0.1 J	0.14 J	0.17 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-10	NHS	70	5.63	1.93	3.4	2.07	1.88	1.5	2.3	1.5	2.3	2.6	2.4	2.1	2.23	1.68	1.67	1.52	0.75	1.1	0.66
PW-100A	HS	70																83.4	57.2		43.4
PW-101A	NHS	70																0.19 J	25.4		15.7
PW-11	HS	70	5.9	3.5	18.7	30.83	49.54	2.2	52.2	4.3	19.5	0.95	2.8	0.46 J	10.2	4.91	0.28 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-12	HS	70	3.4	1.59	1.72	1.6	1.95	2.5	2.6	1.9	2.3	2.5	2.1	2.8	2.36 J	1.84 J	1.14 J	2.52	0.14 J	1.38	2.5 U
PW-13	HS	70	4.1	1 U	1 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	1.1 U	0.5 U	1.1 U	1.1 U	1.1 U	5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U
PW-14	NHS	70											0.5 U								
PW-16A	NHS	70	1 U	1 U	1 U	0.5 U	0.89	0.86		0.98	2.1	0.96	1.2	0.67	1.01	1.25	0.72	0.5 U	0.5 U	0.5 U	0.5 U
PW-19A	NHS	70								0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-30A	HS	70	2.4	1 U	1.86	2.5 U	2.5 U	2.5 U	1.1 U	0.9 J	1.2	1.4	0.81 J	1.1	1.1 J	1.08 J	0.57 J	1.1 U	1.1 U	1.1 U	1.1 U
PW-31A	NHS	70								0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-42A	HS	70	22.4	41.07	19.84	47.65	39.7	54.3	160 D	35.4	35.9	38.4	35.2	40.3	30.3	34.1	21.4	19.2	16.7	6.54	5.6
PW-45A	HS	70	5	3.78	3.62	3.73	2.84	2.8	2.1	2.3	0.12 J	2.2	1.9	2	1.86	0.39 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-46A	NHS	70	5.7	4.13	4.07	8.52	2.32	4.4		4.6	0.08 J	4.8	2.7	3.7	1.96	4.14	4.54	4.12	3.59	3.55	2.81
PW-68A	HS	70	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-69A	HS	70	9.2	2.54	10 U	2.28	5 U	5 U	5 U	4.5	1.2 J	2.2 J	1.5	3.2	3.74 J	4.86 J	2.71 J	5.2 J	16.6	5.2	12.2
PW-70A	NHS	70																	0.5 U		0.5 U
PW-71A	HS	70	3.4	1.97	2.06	1.59	2.59	2.1	2	1.5	0.38 J	0.5 U	0.35 J	0.49 J	0.43 J	0.09 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-72A	NHS	70	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U													
PW-73B	HS	70	44.1	32.52	37.77	30.61	29.75	27.8	25.8	18.9	17.5	19.5	18.1	16.3	14.5	4.68	7.58	7.18	5.86	3.64	2.69
PW-74B	NHS	70	3	1.34	1.81	1.65	1.41	1.8	2.1	2.7	1.9	2	2.6	2.2	3.05	0.5 U	0.76	0.59	0.5 U	0.44 J	0.5 U
PW-75A	NHS	70	2.5	1 U	1.54	0.5 U	0.5 U	0.56	0.5 U	0.16 J	2.5	0.46 J	0.73	0.5 U	0.28 J	0.37 J	0.24 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-76A	P	70	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1.89	1.23	0.56	0.22 J
PW-77A	NHS	70	0.5 U	1.57	5.4	6.5	8.78	9.9	10	2.3	6.3	1.5	3.1	0.5 U	1.69	1.74	1.85	1.79	1.37	1.39	0.84
PW-78A	P	70	1 U	1 U	1 U	0.75	0.68	0.84	0.71	0.87	0.78	0.9	0.66	1	1.05	0.56	1.34	1.33	0.76	1.21	0.39 J
PW-79A	P	70	1 U	1 U	1.69	0.92	0.92	1.8	2.1	2.5	2.1	1.5	2.1	1.2	0.81	0.15 J	0.51	0.5 U	0.5 U	0.5 U	0.5 U
PW-80A	NHS	70	4.8	4.87	4.28	6.32	2.48	1.1	0.58	1.5	0.88	1.9	2.8	2.7	0.63	0.1	1.13	0.5 U	0.5 U	0.5 U	0.5 U
PW-82A	NHS	70	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-83A	HS	70	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.1 J	0.5 U	0.5 U	0.5 U	0.22 J	0.09 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-84A	NHS	70	1.8	2.55		2.46	2.07	2.3	1.4	1.2	3.7	3.9		9.3	13.3	6.69	5.17	4.98	3.16	3.48	2.37
PW-85A	HS	70	1.5	1.71	1.44	1.27	1.34	1.4	1.7	1.3	1.9	1.7	2.1	3.4	3.04	4.4	2.81	2.43	2.28	1.56	1.34
PW-86A	HS	70	77.7	96.4	29.52	124 D	153 D	193 D	197 D	192 D	124 D	1.7	105 D	223 D	4.59	156	0.5	0.32 J	0.5 U	0.5 U	0.5 U
PW-87A	NHS	70	1 U	1 U	1 U	0.5 U	0.5 U	0.5		0.5 U	0.5 U	0.37 J	0.37 J	0.36 J	0.31 J	0.31 J	0.33 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-88A	NHS	70	1 U	1 U	1.93	10.36	29.28	26.5	12.3	22.2	0.74	1.6	1.4	9.1	0.54	0.5 U	0.48 J	0.32 J	0.5 U	0.5 U	0.5 U
PW-89A	NHS	70	4.1	2.8	1 U	2.61	2.88	2.8	1.4	1.8	1	1.6	1.2	2.2	2.39	0.38 J	0.46 J	0.22 J	0.5 U	0.5 U	0.5 U
PW-91A	NHS	70	1.2	1 U	1 U	0.57	0.6	0.5 U	0.65	0.47 J	0.5 U	0.5 U	0.2 J	193	0.33 J	0.37 J	0.31 J	0.12 J	0.08 J	0.33 J	0.5 U
PW-92A	NHS	70	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-93A	HS	70											124	190	141	276	299	31.9	70.7	26.2	34.4
PW-94A	HS	70			1.49								0.5 U	1.4	0.7	1.31	0.86	1.2	0.83	0.76	0.54
PW-95A	HS	70											1.6	1.7	1.66	5.8	3.01	4.2	0.43 J	2.74	0.5 U
PW-98A	NHS	70														32.9	77.5	25.9	18.2	12.1	14.5
PW-99A	HS	70														0.19 J	0.36 J	0.5 U	0.5 U	0.5 U	0.5 U

Notes:
U = not detected above reporting limit shown
D = Dilution
J = estimated value
Blank cells indicate no analysis performed or data missing
Shading indicates that ROD concentration was exceeded
P=Perimeter well, =NHS = Non hot spot well, HS = Hot spot well
(1) Initial GW samples were collected in September 2007 for PW-93A(B-07-12), PW-94A(B07-09), and PW-95A(B07-07) during the intial soil and groundwater investigation at the former CCA area
(2) Initial GW samples were collected in July 2009 for PW-98A and PW-99A.
(3) Initial GW samples were collected in August 2010 for PW-100A and PW-101A.
(4) Initial GW samples were collected in May 2010 for E-11.
(5) Initial GW samples were collected in April 2010 for FW-6.

Table 6-9. Fabrication Area Summary of groundwater analytical results for PCE
Wah Chang Five Year Review Report

Station	Well Type	ROD	Oct-2002	Apr-2003	Oct-2003	May-June-July2004	Sept-Oct 2004	May-june 2005	Oct-Nov-2005	May-2006	Oct-Nov-2006	May-June 2007	Oct-Nov-2007	May-2008	Oct-2008	June-July 2009	Dec-2009	April-May 2010	Nov-Dec-2010	May-2011	Nov-2011
MW-01A	HS	5	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
MW-02A	HS	5	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.1 J	0.5 U	0.5 U	0.5 U	0.07 J	0.06 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
MW-03A	HS	5	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
MW-04A	HS	5	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-01A	HS	5	1 U	1 U	0.51	0.5 U	0.52	0.5 U	0.5 U	0.18 J	0.2 J	0.15 J	0.5 U	0.12 J	0.12 J	0.5 U	0.33 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-03A	HS	5	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.12 J	0.5 U	0.07 J	0.1 J	0.1 J	0.1 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-10	NHS	5	3.33	2.69	2.62	2.39	2.8	1.9	2.1	1.9	2	3	1.3	2.3	1.21	0.52	0.6	0.5 U	0.5 U	0.5 U	0.5 U
PW-100A	HS	5																7.23	2.99		1.45
PW-101A	NHS	5																0.5 U	5.28		4.18
PW-11	HS	5	4	1.85	8.87	11.56	19.32	2.4	16.2	1.9	7.6	1.1	1.1	0.4 J	1.96	0.96	0.33 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-12	HS	5	5.7	1.97	2.14	2.72	3.5	7.7	10.5	3.2	3.2	7.3	3.2	6.4	7.42	9.21	3.94	2.5 U	2.5 U	2.5 U	2.5 U
PW-13	HS	5	3.4	1.54	1.39	2.5 U	2.5 U	5.1	2.5 U	2.5 U	1.5	0.62	0.96 J	1.7	1.3	3.5 J	1.35 J	2.1 J	2.5 U	2.5 U	2.5 U
PW-14	NHS	5											0.28 J								
PW-16A	NHS	5	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U		0.32 J	0.8	0.45 J	0.35 J	0.23 J	0.29 J	0.29 J	0.21 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-19A	NHS	5								0.11 J	0.5 U	0.21 J	0.5 U	0.12 J	0.11 J	0.09 J	0.1 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-30A	HS	5	1.2	1 U	1 U	2.5 U	2.5 U	2.5 U	1.1 U	0.75 J	1	0.77	2.5 U	0.63 J	1.14 J	0.68 J	0.32 J	1.1 U	1.1 U	1.1 U	1.1 U
PW-31A	NHS	5								0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-42A	HS	5	2.4	1.33	1.62	0.63	0.56	1.5	40.7	0.5 U	0.39 J	3.8	2.6	3.5	4.36	0.08 J	0.41 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-45A	HS	5	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.13 J	0.5 U	0.2 J	0.5 U	0.15 J	0.11 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-46A	NHS	5	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-68A	HS	5	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-69A	HS	5	15.5	11.41	10.27	13.04	8.98	14.3	12	13.4	7.6	11.7	3.9	11.8	8.27	15.5	10.5	8.21	6.69	7.12	4.26
PW-70A	NHS	5																	0.5 U		0.5 U
PW-71A	HS	5	8.5	8.54	10.06	4.91	13.39	11.3	0.75	0.5 U	0.09 J	0.5 U	0.2 J	0.16 J	0.09 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-72A	NHS	5	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U													
PW-73B	HS	5	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-74B	NHS	5	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-75A	NHS	5	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-76A	P	5	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-77A	NHS	5	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	1.1 U	0.36 J	0.37 J	0.53 J	1.1 U	0.48 J	1.1 U	0.47 J	0.42 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-78A	P	5	1 U	1 U	1 U	0.61	0.5 U	0.6	0.5 U	0.5	0.54	0.66	0.23 J	0.65	0.57	0.68	0.6	0.72	0.5 U	0.44 J	0.5 U
PW-79A	P	5	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.59	0.5 U	0.76	0.63	0.63	0.23 J	0.5 U	0.15 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-80A	NHS	5	1.9	2.25	1.5	2.56	1.13	0.5 U	0.5 U	0.55	0.5 U	0.59	0.54	0.46 J	0.12 J	0.5 U	0.14 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-82A	NHS	5	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U		0.13 J	0.5 U	0.13 J	0.11 J	0.1 J	0.14 J	0.15 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-83A	HS	5	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.1 J	0.5 U	0.5 U	0.5 U	0.5 U	0.09 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-84A	NHS	5	1 U	1 U		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.11 J		0.15 J	0.15 J	0.1 J	0.31 J	0.11 J	0.5 U	0.5 U	0.5 U
PW-85A	HS	5	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.17 J	0.26 J	0.21 J	0.2 J	0.25 J	0.18 J	0.26 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-86A	HS	5	5.8	1 U	9.1	4.41	2.62	3.6	3.1	2.1	2.1	0.82	1.7	1.2	0.44 J	3.21	0.41 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-87A	NHS	5	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-88A	NHS	5	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.14 J	0.14 J	0.22 J	0.12 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-89A	NHS	5	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.36 J	0.26 J	0.26 J	0.26 J	0.31 J	0.16 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-91A	NHS	5	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	35	0.5 U	0.08 J	0.4 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-92A	NHS	5	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-93A	HS	5											36.8	34.1	40.8 J	40	79	31.5	5.26 J	14.3	1.18 J
PW-94A	HS	5			1 U								0.39 J	1.2	0.25 J	0.12 J	0.19 J	0.5 U	0.1 J	0.5 U	0.5 U
PW-95A	HS	5											1.7	2.7	2.21	4.28	1.72	1.51	1.12	0.65	0.78
PW-98A	NHS	5														16.3	8.46	6.84	3.59	3.11	1.57
PW-99A	HS	5														0.21 J	0.37 J	0.5 U	0.5 U	0.5 U	0.5 U

Notes:
U = not detected above reporting limit shown
D = Dilution
J = estimated value
Blank cells indicate no analysis performed or missing data
Shading indicates that ROD concentration was exceeded or data missing
P=Perimeter well, =NHS = Non hot spot well, HS = Hot spot well
(1) Initial GW samples were collected in September 2007 for PW-93A(B-07-12), PW-94A(B07-09), and PW-95A(B07-07) during the intial soil and groundwater investigation at the former CCA area.
(2) Initial GW samples were collected in July 2009 for PW-98A and PW-99A.
(3) Initial GW samples were collected in August 2010 for PW-100A and PW-101A.
(4) Initial GW samples were collected in May 2010 for E-11.
(5) Initial GW samples were collected in April 2010 for FW-6.

Table 6-10. Fabrication Area Summary of groundwater analytical results for TCE
Wah Chang Five Year Review Report

Station	Well Type	ROD	Oct-2002	Apr-2003	Oct-2003	May-June-July2004	Sept-Oct 2004	May-june 2005	Oct-Nov-2005	May-2006	Oct-Nov-2006	May-June 2007	Oct-Nov-2007	May-2008	Oct-2008	June-July 2009	Dec-2009	April-May 2010	Nov-Dec-2010	May-2011	Nov-2011
MW-01A	HS	5	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
MW-02A	HS	5	2.1	1.55	1.32	1.41	1.11	1	0.87	0.89	0.83	0.66	0.64	0.57	0.56	0.54	0.35 J	0.2 J	0.5 U	0.5 U	0.5 U
MW-03A	HS	5	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U		0.5 U	0.5 U	0.1 J	0.5 U	0.5 U	0.5 U	0.11 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
MW-04A	HS	5	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.09 J	0.5 U	0.12 J	0.24 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-01A	HS	5	10.1	9.01	8.51	10.79	9.77	13.3	9.6	10.9	10	10.4	6.7	7.2	5.29	5.23	1.38	0.56	0.5 U	0.33 J	0.5 U
PW-03A	HS	5	2.4	0.87	0.92	0.84	1.13	0.97	0.56	0.5 U	0.5 U	0.21 J	0.5 U	0.5 U	0.17 J	0.16 J	0.15 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-10	NHS	5	9.15	3.73	4.65	3.63	3.67	2.9	3.7	2.5	3.4	3.4	2.3	2.3	2.39	2.07	1	0.5 U	0.5 U	0.5 U	0.5 U
PW-100A	HS	5																43	5.37		4.81
PW-101A	NHS	5																0.12 J	4.02		1.84
PW-11	HS	5	13.4	6.3	31.35	43.99	70.72	4	65	5.5	27.6	1.9	2.8	0.64	7.19	3.86	0.23 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-12	HS	5	20.9	9.85	7.99	8.55	10.75	14.3	24.8	8.7	7.7	15.4	7.1	13.7	15.1	18.3	8.12	5.52	1.02 J	2.5 U	2.5 U
PW-13	HS	5	15.1	10.13	7.88	10.48	7.69	11	11	10.5	5.6	3.7	5	7.8	5.12	19.5	7.27	10.1	2.5 U	1.2 J	2.5 U
PW-14	NHS	5											0.5 U								
PW-16A	NHS	5	1.3	0.51 J	1 U	0.68	1.38	1.2		1.4	3	1.4	1.1	0.76	1.08	1.2	0.57	0.5 U	0.5 U	0.5 U	0.5 U
PW-19A	NHS	5								0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-30A	HS	5	4.6	1.14	3.75	3.55	2.6	4	1.9	3.1	3.9	2.4	1.8 J	2.1	3.08	2.17	0.85 J	1.1 U	1.1 U	1.1 U	1.1 U
PW-31A	NHS	5								0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.1 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-42A	HS	5	84	54.49	105.24 D	66.36	92.99	82	1100 D	20.4	39.4	77.3	52.2	59.5	83.6	6.76	12.8	8.7	6.2	5.7	3.7
PW-45A	HS	5	2.5	2.14	2.04	2.04	1.82	1.7	1.6	1.4	0.12 J	1.8	0.98	1.3	1.16	0.37 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-46A	NHS	5	7.4	6.25	5.61	11.41	3.24	5.8		5.7	0.5 U	5.4	2.6	3.8	2.07	4.18	3.68	3.33	2.11	1.86	1.89
PW-68A	HS	5	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-69A	HS	5	8.4	8.51	10 U	8.65	5 U	8.8	6	5.9	2.5 J	3.2 J	1.1	3.3	2.99 J	5.48	2.32 J	5.3	4.23	3.96	1.96
PW-70A	NHS	5																	0.17 J		0.5 U
PW-71A	HS	5	324 D	221.1	249.1 D	88.71	330 D	244 D	21.5	2	0.55	0.5 U	0.3 J	0.8	0.47 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-72A	NHS	5	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U													
PW-73B	HS	5	24	19.14	18.51	14.58	14.46	14.5	13.1	9.7	8.1	10.8	10.7	8.9	8	2.15	3.46	2.52	1.29	0.89	0.26 J
PW-74B	NHS	5	4.9	2.91	3.19	2.67	2.27	2.7	3.7	3.8	2.8	3	2.8	2.8	4	0.5 U	0.82	0.67	0.5 U	0.33 J	0.5 U
PW-75A	NHS	5	3.5	1 U	2.24	0.91	0.65	0.9	0.5 U	0.31 J	4	0.58	1.3	0.29 J	0.37 J	0.49 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-76A	P	5	0.53	0.79	0.5 U	0.5 U	0.84	1.4	0.5 U	0.5 U	0.5 U	0.12 J	0.16 J	0.08 J	0.2 J	0.16 J	0.42 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-77A	NHS	5	2.89	2.41	3.04	2.74	4	4.1	4.2	3.4	3.7	3.8	2.9	3.2	3.27	3.09	2.44	1.98	1.72	1.45	0.69
PW-78A	P	5	1 U	1.9	1.51	1.5	1.28	1.8	1.3	1.7	1.5	1.9	0.78	1.9	1.8	2.05	1.73	1.94	0.75	0.63	0.55
PW-79A	P	5	1 U	2.24	3.21	1.96	1.44	2.4	2.5	3.2	2.6	2.8	3.3	2.5	1.11	0.5 U	0.58	0.5 U	0.5 U	0.5 U	0.5 U
PW-80A	NHS	5	11.1	11.88	8.64	11.25	4.69	2	1	2	1.3	2.3	1.9	2.1	0.55	0.09	0.48 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-82A	NHS	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-83A	HS	5	0.8	0.5 U	0.58	0.51	0.50001	0.5 U	0.5 U	0.5 U	0.5 U	0.24 J	0.5 U	0.1 J	0.17 J	0.34 J	0.11 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-84A	NHS	5	1 U	0.5 U		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1.9	14.5		38.7	36.1	10.4	3.93	3.34	1.69	1.48	0.67
PW-85A	HS	5	1 U	1.37	1.05	0.62	0.57	0.77	0.76	0.55	1.1	4.3	4.6	8.3	7.62	6.11	2.09	1.89	0.68	0.81	0.23 J
PW-86A	HS	5	289 D	215.4	359.61 D	281 D	272 D	275 D	258 D	205 D	137 D	11.2	116 D	124 D	8.01	164	3.97	3.56	0.74	2.41	0.47 J
PW-87A	NHS	5	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.08 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-88A	NHS	5	1 U	0.5 U	1.52	7.68	21.79	22.4	10.3	17	0.63	1.3	0.84	6.8	0.6	0.5 U	0.39 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-89A	NHS	5	8.6	3.02	2.56	3.39	3.56	3.4	2.6	2.7	1.8	3	1.6	3.1	3.01	0.9	0.86	0.77	0.62	0.26 J	0.5 U
PW-91A	NHS	5	2.2	0.97	1.01	0.86	0.5 U	0.59	0.5 U	0.49 J	0.5 U	0.5 U	0.11 J	69	0.13 J	0.33 J	0.2 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-92A	NHS	5	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-93A	HS	5											57.1	71.8	87.9	60.3	157	16.7 J	29.4	2.13 J	17.4
PW-94A	HS	5			1 U								0.25 J	0.81 J	0.29 J	0.32 J	0.21 J	0.31 J	0.23 J	0.5 U	0.5 U
PW-95A	HS	5											0.73	1.3	0.8	9.94	1.41	2.3	0.68	1.9	0.23 J
PW-98A	NHS	5														336	150	108	26.3	46.1	18.4
PW-99A	HS	5														0.77	1.04	0.23 J	0.5 U	0.5 U	0.5 U

Notes:
U = not detected above reporting limit shown
D = Dilution
J = estimated value
Blank cells indicate no analysis performed or data missing
Shading indicates that ROD concentration was exceeded
P=Perimeter well, =NHS = Non hot spot well, HS = Hot spot well
(1) Initial GW samples were collected in September 2007 for PW-93A(B-07-12), PW-94A(B07-09), and PW-95A(B07-07) during the intial soil and groundwater investigation at the former CCA area.
(2) Initial GW samples were collected in July 2009 for PW-98A and PW-99A.
(3) Initial GW samples were collected in August 2010 for PW-100A and PW-101A.
(4) Initial GW samples were collected in May 2010 for E-11.
(5) Initial GW samples were collected in April 2010 for FW-6.

Table 6-11. Fabrication Area Summary of groundwater analytical results for VC
Wah Chang Five Year Review Report

Station	Well Type	ROD	Oct-2002	Apr-2003	Oct-2003	May-June-July2004	Sept-Oct 2004	May-june 2005	Oct-Nov-2005	May-2006	Oct-Nov-2006	May-June 2007	Oct-Nov-2007	May-2008	Oct-2008	June-July 2009	Dec-2009	April-May 2010	Nov-Dec-2010	May-2011	Nov-2011
MW-01A	HS	2	1.2	0.69 J	1 U	2.14	0.5 U	0.74	0.5 U	0.5 U	0.5 U	0.17 J	0.5 U	0.5 U	0.5 U	0.5 U	0.9	0.99	0.82	0.62	0.61
MW-02A	HS	2	161 D	143.6	172 D	160 D	141 D	100	136 D	125 D	128 D	123 D	87.3	83.6	85.7	68.2	109	52.7	36.5	42.1	16.4
MW-03A	HS	2	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.39 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
MW-04A	HS	2	22.4	12.91	19.21	7.75	14.27	6.9	7.2	6.4	10.2	4.6	4.4	4.6	8.27	9.23	10.2	8.51	7.93	6.21	5.41
PW-01A	HS	2	28.2	22.42	24.71	34.07	31.83	29.1	23.7	18	34.5	28.6	50	22.4	21.6	23.4	0.77	0.61	0.51	0.43 J	0.42 J
PW-03A	HS	2	1.7	0.5 U	0.79	0.77	0.69	0.78	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.17 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-10	NHS	2	1.18	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.25 J	0.5 U	0.5 U	0.21 J	0.13 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-100A	HS	2																5.18	19.9		7.64
PW-101A	NHS	2																0.5 U	36.5		26.4
PW-11	HS	2	1 U	0.65 J	1.9	0.53	0.93	0.5 U	2.9	0.5 U	0.84	0.5 U	0.5 U	0.5 U	1.07	0.43 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-12	HS	2	11.2	9.81	9.41	9.68	10.91	11.2	12.3	12.1	8	18.7	27.6	34.6	15.8	15.1	12	10.1	8.1	4.3	6.3
PW-13	HS	2	10	10.5	9.96	13.58	7.64	7.7	7.1	7.7	4.8	3.4	10.4	4.9	4.93	4.62 J	2.73	2.43 J	2.13 J	2.5 U	1.11 J
PW-14	NHS	2											0.5 U								
PW-16A	NHS	2	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-19A	NHS	2								0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-30A	HS	2	1 U	0.5 U	1 U	**2.5 U**	**2.5 U**	**2.5 U**	1.1 U	**2.5 U**	0.5 U	0.14 J	**2.5 U**	1.1 U	2.5 U	0.24 J	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U
PW-31A	NHS	2								0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-42A	HS	2	2	6.63	1.53	6.98	2.84	3	1.4	2.6	3.7	2.5	4.7	3.6	2.04	5.14	2.99	2.59	2.11	2.11	0.84
PW-45A	HS	2	25.6	21.33	15.25	27.64	11.81	14.1	6.6	23.1	0.57	24.8	47.3	30.4	34	0.33 J	0.15 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-46A	NHS	2	1 U	0.98 J	1 U	2.35	0.63	1		1.4	0.5 U	1.4	1.5	0.97	0.67	1.65	2.28	2.03	1.99	1.89	1.32
PW-68A	HS	2	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-69A	HS	2	17.6	2.32	10 U	3.29	5 U	5 U	5 U	4.1	5 U	1.4 J	0.96	1.4	5 U	3.18 J	4.76 J	4.8 J	1.06	3.8 J	0.43 J
PW-70A	NHS	2																	0.5 U		0.5 U
PW-71A	HS	2	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	4.2	0.5 U	0.5 U	0.5 U	0.7	0.5 U	0.47 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-72A	NHS	2	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U													
PW-73B	HS	2	10.4	11.47	11.94	16.36	13.84	12.4	12.2	12.9	12.1	13.4	12.1	11.3	12	5.14	9.36	7.62	6.85	6.58	3.48
PW-74B	NHS	2	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.52	0.7	0.61	0.58	1.5	0.73	1.42	0.5 U	0.53	0.49 J	0.5 U	0.5 U	0.5 U
PW-75A	NHS	2	1 U	1 U	1 U	0.51	0.5 U	0.5 U	0.5 U	0.5 U	0.62	0.5 U	0.5 U	0.5 U	0.22 J	0.5 U	0.13 J	0.5 U	0.12 J	0.5 U	0.5 U
PW-76A	P	2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-77A	NHS	2	0.5 U	3.18	9.55	14.8	19.4	12.5	11.5	3.7	5.5	2.7	6.4	1.7	3.14	0.49 J	3.61	3.15	2.86	1.89	1.13
PW-78A	P	2	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.21 J	0.2 J	0.5 U	0.18 J	0.27 J	0.14 J	0.36 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-79A	P	2	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-80A	NHS	2	1 U	0.95	1 U	0.82	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.23 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-82A	NHS	2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-83A	HS	2	3.1	0.5 U	2.5	2.4	1.86	1.5	2.8	1.2	2.3	0.84	0.57	0.5 U	0.38 J	1.65	0.82	0.67	0.43 J	0.33 J	0.11 J
PW-84A	NHS	2	1 U	0.5 U		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-85A	HS	2	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-86A	HS	2	20.3	22.74	2.97	26.69	21.69	16.1	14.3	15.8	7.9	0.17 J	10	11.1	0.3 J	7.62	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-87A	NHS	2	1 U	0.78	1 U	1.22	0.5 U	1.2		1.4	0.5 U	1	1.9	1.3	0.85	0.93	1.35	1.12	0.98	0.89	0.34 J
PW-88A	NHS	2	1 U	0.5 U	1 U	0.5 U	1.1	0.95	0.5 U	0.98	0.5 U	0.5 U	0.5 U	0.31 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-89A	NHS	2	1 U	0.73	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.51	0.54	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-91A	NHS	2	1 U	0.5 U	1 U	0.5 U	0.99	0.5 U	0.77	0.53	0.5 U	0.5 U	0.4 J	39.9	0.49 J	0.35 J	0.24 J	0.5 U	0.5 U	0.5 U	0.5 U
PW-92A	NHS	2	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PW-93A	HS	2											40.6	40.2	34.9 J	31.3	14.7	13.5 J	**10 U**	**25 U**	**10 U**
PW-94A	HS	2			1 U								2.5	3.6	1.71	1.63	1.54	1.7	1.39	0.68	0.81
PW-95A	HS	2											7.1	1.9	3.75	1.98	5.75	3.8	0.24 J	2.1	0.5 U
PW-98A	NHS	2														8.86	131	95.2	78.2	25.3	34.4
PW-99A	HS	2														0.32 J	1.53	4.23	5.33	2.48	2.84

Notes:
Bold values are MRL above the ROD performance standard
U = not detected above reporting limit shown
D = Dilution
J = estimated value
Blank cells indicate no analysis performed or data missing
Shading indicates that ROD concentration was exceeded
P=Perimeter well, =NHS = Non hot spot well, HS = Hot spot well
(1) Initial GW samples were collected in September 2007 for PW-93A(B-07-12), PW-94A(B07-09), and PW-95A(B07-07) during the intial soil and groundwater investigation at the former CCA area.
(2) Initial GW samples were collected in July 2009 for PW-98A and PW-99A.
(3) Initial GW samples were collected in August 2010 for PW-100A and PW-101A.
(4) Initial GW samples were collected in May 2010 for E-11.
(5) Initial GW samples were collected in April 2010 for FW-6.

Table 6-12. Fabrication Area Summary of groundwater analytical results for Fluoride
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Station	Well Type	ROD	Oct-02	Apr-03	Oct-03	May-June-July2004	Sept-Oct 2004	May-june 2005	Oct-Nov-2005	May-06	Oct-Nov-2006	May-June 2007	Oct-Nov-2007	May-08	Oct-08	June-July 2009	Dec-09	April May 2010	Nov-Dec-2010	May-11	Nov-11
PW-01A	HS	2	0.92	1.01	0.68	0.17	0.55	0.67													
PW-03A	HS	2	1.39	1.02	1.57	0.89	1.54	0.86													
PW-10	NHS	2	53.5	39.9	38.5	23.3	32.5	25.4	25	24.2	27.7	23.3		26.2	16.1	24	25	20	18	15	14
PW-11	HS	2	2.08	1.9	2.3	1.68	1.67	1.59	1.7	2.8	0.36	2	2.1	2.1	1.56	2	2	2 U	2 U	2 U	2 U
PW-12	HS	2	0.95	0.98	1.3	1.17	1.02	0.62	0.7	1.5	1.7	2.1	2.4	2.1	3.27	2	1 U	1 U	1 U	1 U	1 U
PW-13	HS	2	9.67	14.7	12.8	19.6	10.6	10.5	11.8	14.5	18.4	10	9.4	17.6	10.8	69	31	27	24	16	21
PW-14	NHS	2											1.8								
PW-16A	NHS	2								0.12 J	0.11	0.1 U	0.1 U	0.1 U	0.1 U	1 U		1 U	1 U	1 U	1 U
PW-19A	NHS	2			0.11					0.31 J	0.21	0.16		0.14	0.16	1 U					
PW-30A	HS	2					0.25														
PW-31A	NHS	2				0.1	0.1 U	0.1 U													
PW-76A	P	2	0.95	0.3	0.46	0.2	0.31	0.16	0.17	0.48 J	0.52	0.45	0.46	0.41	0.47	1 U	1 U	1 U	1 U	1 U	1 U
PW-77A	NHS	2	1.01	0.19	0.32	0.2	1 U	0.1 U	0.1 U	0.3 J	0.35	0.28	0.29	0.29	0.32	1 U	1 U	1 U	1 U	1 U	1 U
PW-78A	P	2	0.89	0.12	0.2	0.1	0.17	0.1 U	0.1 U	0.28 J	0.36	0.29	0.29	0.3	0.34	1 U	1 U	1 U	1 U	1 U	1 U
PW-79A	P	2	1.32	0.63	0.94	1.12	1.53	1.36	1.2	2.4	3.1	2.8	2.9	3.1	1.74	1 U	1 U	1 U	1 U	1 U	1 U
PW-80A	NHS	2	0.51	0.14	0.2	0.1	0.1 U	0.1 U	0.1 U	0.17 J	0.23	0.18	0.16	0.16	0.16	1 U	1 U	1 U	1 U	1 U	1 U
PW-82A	NHS	2	1.12	0.25	0.49	0.23	0.32	0.23		0.46 J	0.53	0.52	0.48	0.58	0.62	1 U	1 U	1 U	1 U	1 U	1 U
PW-83A	HS	2	0.89	0.13	0.25	0.1 U	0.12	0.1 U													
PW-84A	NHS	2																			
PW-89A	NHS	2	9.16	15.4		16.8	19.9	17.6				17	16.6	17.3	18.8	27	10	8.2	7.5	7.8	6.4
PW-91A	NHS	2				0.44		0.35													
PW-92A	NHS	2	1.25	0.31			0.17														
PW-98A	NHS	2															19				
PW-99A	HS	2															10	9.8	7.3	9.4	3.4

Notes:
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J = estimated value
Blank cells indicate no analysis performed
Shading indicates that ROD concentration was exceeded
P=Perimeter well, =NHS = Non hot spot well, HS = Hot spot well
(1) Initial GW samples were collected in September 2007 for PW-93A(B-07-12), PW-94A(B07-09), and PW-95A(B07-07) during the intial soil and groundwater investigation at the former CCA area
(2) Initial GW samples were collected in July 2009 for PW-98A and PW-99A.
(3) Initial GW samples were collected in August 2010 for PW-100A and PW-101A.
(4) Initial GW samples were collected in May 2010 for E-11.
(5) Initial GW samples were collected in April 2010 for FW-6.

Table 6-13. Fabrication Area Summary of groundwater analytical results for Nitrate
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Station	Well Type	ROD	Oct-2002	Apr-2003	Oct-2003	May-June-July2004	Sept-Oct 2004	May-june 2005	Oct-Nov-2005	May-2006	Oct-Nov-2006	May-June 2007	Oct-Nov-2007	May-2008	Oct-2008	June-July 2009	Dec-2009	April-May 2010	Nov-Dec-2010	May-2011	Nov-2011
PW-01A	HS	10	0.1 U	6.02	0.02																
PW-03A	HS	10	21.9	29.1	14.6																
PW-10	NHS	10	0.75	0.4	0.5224			0.14	0.1 U		0.28	0.34		0.51	0.54	5 U	5 U	5 U	5 U	5 U	5 U
PW-11	HS	10	8.5	6.3	12.4			9.13	18.6	12.1	34.5	9.2	8.6	7.2	15.4	7	6	5.5	5.2	4.8	5 U
PW-12	HS	10	1	1.71	0.3194	0.75	0.446	0.37	0.51	0.4	0.82	1.9	0.35	0.85	0.42	5 U	5 U	5 U	5 U	5 U	5 U
PW-13	HS	10	9.74	47.6	14.5	58.5	26.7	45.2	39.5		26.5	10.1	2.2	30.1	25.1	160	33	29	27	22	22
PW-14	NHS	10											0.84								
PW-16A	NHS	10								3.8	2.5	2.6	1.4	2.8	3.42	5 U		5 U	5 U	5 U	5 U
PW-19A	NHS	10			5.86					3.2	1.5	2.2		1.3	1.82	5 U	5 U	5 U	5 U	5 U	5 U
PW-30A	HS	10			0.5	0.86	2.431														
PW-31A	NHS	10			7.03	11.9	13.4	11.6													
PW-42A	HS	10			0.01 U																
PW-45A	HS	10			0.048																
PW-46A	NHS	10				0.1 U	0.18														
PW-68A	HS	10				2.42	2.43														
PW-69A	HS	10			0.01 U																
PW-71A	HS	10			0.01 U																
PW-75A	NHS	10			0.01 U																
PW-76A	P	10	0.98	0.25	0.01 U	0.1	0.5	0.24	0.45		0.36	0.33	0.41	0.17	0.39	5 U	5 U	5 U	5 U	5 U	5 U
PW-77A	NHS	10	0.92	0.13	0.01 U	0.1	0.17	0.1 U	0.1 U	0.01 U	0.01 U	0.75	0.39	0.4	0.51	5 U	5 U	5 U	5 U	5 U	5 U
PW-78A	P	10	1.08	0.37	0.64	0.61	0.45	0.25	0.21		0.13	0.24	0.15	0.28	0.28	5 U	5 U	5 U	5 U	5 U	5 U
PW-79A	P	10	4.64	9.93	18.1	20.4	5.79	6.27	6.1		9.7	0.85	0.16	6.1	5.75	5 U	5 U	5 U	5 U	5 U	5 U
PW-80A	NHS	10	3.86	4.83	2.13	2.63	1.679	1.78	1.6		1.5	2.6	1.9	2.3	1.6	5 U	5 U	5 U	5 U	5 U	5 U
PW-82A	NHS	10	13.6	25.2	16.4	16.3	12.665	12.7		9	10.6	1.4	8.6	6.5	7.04	9	7	6	5	6	5
PW-83A	HS	10	4	23.6	6.24	11.4	7.98	4.7													
PW-84A	NHS	10						0.38													
PW-86A	HS	10			1.4																
PW-88A	NHS	10			0.49																
PW-89A	NHS	10	191	26.6	91							78.9	173	0.01 U	158	290	45	38	28	23	22
PW-92A	NHS	10	1.17	0.98	2.72																
PW-98A	NHS	10														8.76	5 U	7.5	6.9	2.4	2.4
PW-99A	HS	10														2.31	5 U	5 U	5 U	5 U	5 U

Notes:
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P=Perimeter well, =NHS = Non hot spot well, HS = Hot spot well
(1) Initial GW samples were collected in September 2007 for PW-93A(B-07-12), PW-94A(B07-09), and PW-95A(B07-07) during the intial soil and groundwater investigation at the former CCA area.
(2) Initial GW samples were collected in July 2009 for PW-98A and PW-99A.
(3) Initial GW samples were collected in August 2010 for PW-100A and PW-101A.
(4) Initial GW samples were collected in May 2010 for E-11.
(5) Initial GW samples were collected in April 2010 for FW-6.

Table 6-14. Summary of VOCs detected in Surface Water (Murder and Truax Creeks) from November 2007 to September 2010
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	Station	Parameter	units	Oregon AWQC		Nov-07	May-08	Oct-08	May-09	Dec-09	Apr-10	Nov-10
				Water and Organism	Organism Only							
Murder Creek	MC-D	TCA	µg/L	--	--	1.9	0.73	1.2	0.36 J	0.1 J	0.5 U	0.5 U
	MC-D	DCA	µg/L	--	--	0.79	0.29 J	0.52	0.13 J	0.5 U	0.5 U	0.5 U
	MC-D	DCE	µg/L	230	710	0.71	0.31 J	0.48 J	0.1 J	0.5 U	0.5 U	0.5 U
	MC-D	cis-DCE	µg/L	--	--	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	MC-D	PCE	µg/L	0.24	0.33	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**
	MC-D	TCE	µg/L	1.4	3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	MC-D	VC	µg/L	0.023	0.24	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**
	MC-U	TCA	µg/L	--	--	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	MC-U	DCA	µg/L	--	--	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	MC-U	DCE	µg/L	230	710	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	MC-U	cis-DCE	µg/L	--	--	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	MC-U	PCE	µg/L	0.24	0.33	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**
	MC-U	TCE	µg/L	1.4	3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	MC-U	VC	µg/L	0.023	0.24	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**
Truax Creek	TC-D	TCA	µg/L	--	--	0.14 J	0.1 J	0.5 U	0.09 J	0.5 U	0.5 U	0.5 U
	TC-D	DCA	µg/L	--	--	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.07 J
	TC-D	DCE	µg/L	230	710	0.14 J	0.11 J	0.07 J	0.5 U	0.5 U	0.5 U	0.5 U
	TC-D	cis-DCE	µg/L	--	--	0.22 J	0.17 J	0.14 J	0.5 U	0.5 U	0.5 U	0.5 U
	TC-D	PCE	µg/L	0.24	0.33	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**
	TC-D	TCE	µg/L	1.4	3	0.11 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	TC-D	VC	µg/L	0.023	0.24	**0.15 J**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**
	TC-U	TCA	µg/L	--	--	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	TC-U	DCA	µg/L	--	--	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	TC-U	DCE	µg/L	230	710	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	TC-U	cis-DCE	µg/L	--	--	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	TC-U	PCE	µg/L	0.24	0.33	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**
	TC-U	TCE	µg/L	1.4	3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	TC-U	VC	µg/L	0.023	0.24	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**

Notes:

* Surface water data was not provided for 2006 or 2011

* Bold value indicates that method reporting limit is higher that the AWQC

AWQC = ambient water quality criteria

TCA = 1,1,1-trichloroethane

DCA = 1,1-dichloroethane

cis-DCE = cis-1,2-dichloroethene

PCE = tetrachloroethene

TCE = trichloroethene

VC = vinyl chloride

µg/L = microgram per liter

U = Parameter not detected above the method reporting limit

J = Estimated value below reporting limit

Table 6-15. Summary of EISB Performance Monitoring in the ASA Source area
Wah Chang Five Year Review Report

Well Date	ROD	TMW-1 Baseline (6/30/09)	TMW-1 (12/18/09)	TMW-1 (5/1/10)	TMW-1 1(12/20/10)	TMW-1 (5/18/11)	TMW-1 (11/16/11)	TMW-4 Baseline (6/30/09)	TMW-4 (12/29/09)	TMW-4 (5/7/10)	TMW-4 (12/20/10)	TMW-4 (5/18/11)	TMW-4 (11/16/11)	TMW-5 Baseline (6/30/09)	TMW-5 (12/18/09)	TMW-5 (5/7/10)	TMW-5 (12/20/10)	TMW-5 (5/18/11)	TMW-5 (11/16/11)
CVOCs (µg/L)		Source Area Wells												Injection Area Well					
1,1,1- TCA	200	48,200	11,400	1,720	52.3	1,120	26.9	1,170,000	721,000	583,000	583,000	343,000	168,000	47,300	47.9	25.1	1.34	11.1	1.1 U
1,1-DCA	1,280	1,350	4,790	10,000	8,575	9,800	5,486	43,600	32,000	35,000	35,000	16,800	26,500	2,120	1,050	980	525	540	213
1,2-DCA	5	100 U	25 U	9.35 J	25 U	11.3 J	25 U	1,000 U	1,000 U	1,000 U	1,000 U	1,000 U	1,000 U	100 U	1.32	1.1 U	1.1 U	1.1 U	1.1 U
Chloroethane	-	43.6 J	5,490	9,150	8,150	7,432	6,487	1,000 U	1,000 U	1,000 U	1,000 U	1,000 U	1,000 U	100 U	158	211	318	189	245
TCE	5	382	92.4	95.1	12.3 J	54.5	25 U	6,210	1,980	720 J	720 J	120 J	1,000 U	334	3.71	1.02	1.1 U	0.89 J	1.1 U
cis-1,2-DCE	70	100 U	25 U	25 U	25 U	25 U	25 U	1,000 U	1,000 U	1,000 U	1,000 U	1,000 U	1,000 U	100 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U
trans-1,2-DCE	100	100 U	25 U	25 U	25 U	25 U	25 U	1,000 U	1,000 U	1,000 U	1,000 U	1,000 U	1,000 U	100 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U
1,1-DCE	7	14,400	6,230	3,410	2,810	2,641	1853	128,000	40,600	42,500	42,500	38,200	14,700	15,100	132	141	98.3	54	68.5
Vinyl Chloride	2	100 U	98.7	123	78	89.9	45.7	1,000 U	1,000 U	1,000 U	1,000 U	1,000 U	1,000 U	100 U	88.2	92.1	68.1	68.3	45.4
Tetrachloroethylene	5	83 J	18.9 J	31.4	25 U	16.1	25 U	1,000 U	1,000 U	1,000 U	1,000 U	1,000 U	1,000 U	44.4 J	0.76 J	1.1 U	1.1 U	1.1 U	1.1 U
DHG (µg/L)																			
Methane	-	1.52	3.18	11.7	25.2	13	18.3	1.17 U	3.29 U	33.1	33.1	18.1	113	52.1	389	285	187	243	124
Ethane	-	1.13	3.26	1.08	2.08	1.09	2.15	1.05 U	16.1 U	15.2	15.2	13.1	15.8	1.11	2.31	2.81	1.65	2.18	1.73
Ethene	-	1.14	1.6	2.68	2.34	2.15	2.43	1.06 U	14.9 U	8.1	8.1	8.2	4.4	0.87	4.27	3.78	2.91	2.68	2.54
General Chemistry (mg/L)																			
Chloride	-	35	50	50	41		38	420	550	580	580	480	435	18	25	23	21	21	18
Nitrate-N	-	21	5 U	18	5 U	17	5 U	51	34	28	28	22	14	69	5 U	5 U	5 U	5 U	5 U
Sulfate	-	10 U	10 U	10 U	10 U		10 U	115	110	118	118	108	134	10 U	10 U	10 U	10 U	10 U	10 U
Alkalinity	-	569	923	847	782		467	127	134	128	128	113	142	3.4	3.2	1.8	1.6	1.6	1.2
TOC (mg/L)																			
--	-	5 U	320	800	312		284	7.8	180	175	175	151	164	1.4	2.2	2.1	2	1.8	2
Metals (mg/L)																			
Iron	-	31	66	63	55		46	43	46	42	42	38	26	27	37	35	26	34	21
Parameters																			
ORP (mV)	-	-18.2	-35.2	-79	-55.4	-94	-46.4	180.6	88.7	-11.2	-11.2	-11.2	-12.4	10.3	-43.6	-21.3	-75.8	-19.3	-96.8
Dissolved Oxygen (mg/L)	-	0.89	0.63	0.36	0.48	0.36	0.11	0.64	0.32	0.23	0.23	0.2	0.27	0.89	0.74	0.21	0.55	0.17	0.44
pH	-	6.13	6.98	6.28	6.78	6.23	6.83	5.78	6.53	6.02	6.02	6.12	6.89	6.31	6.78	6.14	6.68	6.13	6.66
Specific Conductance (us/cm)	-	732	840	2,418	813	2,433	885	1,281	1,991	1,168	1,168	1,248	1,767	4,538	5,984	4,681	5,318	4,714	5,341
Temperature (Celcius)	-	15.33	14.84	15.29	14.81	15.28	14.59	15.13	14.46	14.89	14.89	15.45	14.85	15.32	12.78	14.87	14.48	14.96	14.14

Notes:

Shaded indicates concentration exceeds ROD cleanup level
U= not detected above reporting limit shown.
J = Estimated value below reporting limit.
CVOC= Chlorinated volatile organic compound
DHG= Dissolved hydrocarbon gas
DCE= Dichloroethene
TCE= Trichloroethylene
DCA= 1,1- Dichloroethane
TCA= 1,1,1- Trichloroethane
ORP = Oxidation reduction potential
µg/L = micrograms per liter
mg/L = milligrams per liter
mV= millivolts
uS/cm = microSiemens per centimeter
NS = Not sampled.

Table 6-15. Summary of EISB Performance Monitoring in the ASA Source area
Wah Chang Five Year Review Report

Well Date	ROD	E-11 Baseline (5/1/09)	E-11 (12/29/09)	E-11 (5/1/10)	E-11 (12/20/10)	E-11 (5/17/11)	E-11 (11/15/11)	PW-13 Baseline (6/30/09)	PW-13 (12/17/09)	PW-13 (5/1/10)	PW-13 (12/16/10)	PW-13 (5/31/11)	PW-13 (11/29/11)	FW-6 Baseline (5/1/09)	FW-6 (12/29/09)	FW-6 (5/1/10)	FW-6 (11/16/10)	FW-6 (5/17/11)	FW-6 (11/9/11)
CVOCs (µg/L)		Injection Area Well												Perimeter Well					
1,1,1- TCA	200	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	417	175	152	15.6	56	8.77	16.9	11.2	8.17	3.18	6.25	1.11
1,1-DCA	1,280	0.5 U	0.24 J	0.5 U	0.5 U	0.5 U	0.5 U	3,310	1,710	1,310	1,524	789	1,125	4.26	4.59	4.82	6.13	3.1	4.18
1,2-DCA	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1.95 J	0.8 J	0.77 J	2.5 U	2.5 U	2.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Chloroethane	-	2.93	4.77	6.81	7.21	6.91	2.18	5.72	3.25	18.1	56.4	9.8	49.3	0.97	2.67	3.12	4.21	2.89	2.31
TCE	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	19.5	7.27	10.1	2.5 U	1.2 J	2.5 U	0.6	0.5	0.5 U	0.5 U	0.5 U	0.5 U
cis-1,2-DCE	70	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
trans-1,2-DCE	100	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1-DCE	7	0.5 U	0.23 J	0.44 J	0.52	0.5 U	0.5 U	849	432	352	263	189	135	0.5 U	0.12 J	0.22 J	0.5 U	0.18 J	0.5 U
Vinyl Chloride	2	0.11 J	0.38 J	0.5 U	0.5 U	0.5 U	0.5 U	4.62 J	2.73	2.43 J	2.13 J	2.5 U	1.11 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Tetrachloroethylene	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	3.5 J	1.35 J	2.1 J	2.5 U	2.5 U	2.5 U	1.01	0.97	0.44 J	0.5 U	0.5 U	0.5 U
DHG (µg/L)																			
Methane	-	1,580	5,780	4,120	3,815	3,890	2,754	0.73	1.15	8.77	150	9.12	143	5.13 U	14.4 U	14.4 U	0.73 U	14.4 U	0.73 U
Ethane	-	1.07 U	1.09 U	0.55 J	0.43 J	0.53 J	0.68 J	1.16 U	1.17 U	0.65 J	0.87 J	0.71 J	0.66 J	1.21 U	1.38 U	1.38 U	1.38 U	1.25 U	1.38 U
Ethene	-	1.05 U	1.08 U	1.08 U	1.08 U	1.08 U	1.08 U	1.14 U	1.15 U	0.1 J	0.31 J	0.13 J	0.23 J	1.18 U	1.35 U	1.35 U	1.35 U	1.23 U	1.35 U
General Chemistry (mg/L)																			
Chloride	-	9.8	15	14	13	13	12	60	62	58	63	51	58	15	20	18	17	19	16
Nitrate-N	-	5 U	5 U	5 U	5 U	5 U	5 U	160	33	29	27	22	22	5	5 U	5 U	5 U	5 U	5 U
Sulfate	-	10 U	10 U	10 U	10 U	10 U	10 U	49	50	42	35	38	31	10 U	10	9	10	8.7	9
Alkalinity	-	567	878	652	632	632	532	65	101	98	78	73	67	276	436	402	390	401	278
TOC (mg/L)																			
--	-	1.6	85	79	77	72	55	5 U	5 U	5.8	5.7	4.1	4.3	3.2	11	10	9.5	9	7.8
Metals (mg/L)																			
Iron	-	19	23	21	18	20	15	0.23	0.18	0.22	0.21	0.17	0.15	0.14	0.16	0.15	0.16	0.14	0.13
Parameters																			
ORP (mV)	-	-18.2	-121.2	-21.3	-135	-18.3	-175	123.8	185.6	22.1	135.5	21.1	123.5	40.2	36	23.5	22.1	22.5	18.1
Dissolved Oxygen (mg/L)	-	0.42	0.25	0.34	0.22	0.33	0.21	0.38	0.31	0.11	0.27	0.09	0.25	0.78	3.54	0.35	2.15	0.32	1.33
pH	-	6.89	6.75	6.21	6.66	6.19	6.56	6.64	6.32	6.72	6.53	6.68	6.62	7.00	7.01	6.59	6.99	6.62	7.05
Specific Conductance (us/cm)	-	843	1,777	1,421	1,682	1,407	1,702	213	877	181	813	108	770	342	823	251	813	180	852
Temperature (Celcius)	-	14.78	13.69	14.56	14.23	14.61	14.3	14.57	15.2	13.98	14.81	13.67	14.75	15.12	15.96	14.84	15.46	14.95	16.03

Notes:

Shaded indicates concentration exceeds ROD cleanup lev
U= not detected above reporting limit shown.
J = Estimated value below reporting limit.
CVOC= Chlorinated volatile organic compound
DHG= Dissolved hydrocarbon gas
DCE= Dichloroethene
TCE= Trichloroethylene
DCA= 1,1- Dichloroethane
TCA= 1,1,1- Trichloroethane
ORP = Oxidation reduction potential
µg/L = micrograms per liter
mg/L = milligrams per liter
mV= millivolts
uS/cm = microSiemens per centimeter
NS = Not sampled.

Table 6-15. Summary of EISB Performance Monitoring in the ASA Source area
Wah Chang Five Year Review Report

Well Date	ROD	PW-10 Baseline (6/29/09)	PW-10 (12/17/09)	PW-10 (5/1/10)	PW-10 (11/16/10)	PW-10 (5/17/11)	PW-10 (11/9/11)	PW-11 Baseline (6/30/09)	PW-11 4-Month (12/17/09)	PW-11 8-Month (5/1/10)	PW-11 12-Month (10/1/10)	PW-77A Baseline (6/29/09)	PW-77A (12/17/09)	PW-77A (5/1/10)	PW-77A (12/16/10)	PW-77A (5/10/11)	PW-77A (11/9/11)	PW-78A Baseline (6/29/09)	PW-78A (12/17/09)
CVOCs (µg/L)		Perimeter Well																	
1,1,1- TCA	200	16.1	16.6	1.23	0.13 J	0.68	0.5 U	16.5	21.1	15.2	4.61	3.57	4.97	2.15	1.08	1.26	0.53	1.79	10.5
1,1-DCA	1,280	58.8	31.8	28.6	35.1	23.9	22.2	3.77	3.79	4.12	8.15	212	227	216	186	143	142	141	114
1,2-DCA	5	0.15 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.51	0.47 J
Chloroethane	-	6.07	3.55	6.82	7.25	7.21	4.17	0.35 J	0.34 J	1.23	2.54	14.7	2.05	5.86	6.93	5.72	5.48	0.5 J	1.95
TCE	5	2.07	1	0.5 U	0.5 U	0.5 U	0.5 U	3.86	0.23 J	0.5 U	0.5 U	3.09	2.44	1.98	1.72	1.45	0.69	2.05	1.73
cis-1,2-DCE	70	1.68	1.67	1.52	0.75	1.1	0.66	4.91	0.28 J	0.5 U	0.5 U	1.74	1.85	1.79	1.37	1.39	0.84	0.56	1.34
trans-1,2-DCE	100	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1-DCE	7	1.91	1.17	2.55	3.51	1.45	1.38	11.5	1.05	2.11	1.15	30.8	34.4	33.8	26.5	26.4	18.4	71.3	83.8
Vinyl Chloride	2	0.13 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.43 J	0.5 U	0.5 U	0.5 U	0.49 J	3.61	3.15	2.86	1.89	1.13	0.14 J	0.36 J
Tetrachloroethylene	5	0.52	0.6	0.5 U	0.5 U	0.5 U	0.5 U	0.96	0.33 J	0.5 U	0.5 U	0.47 J	0.42 J	0.5 U	0.5 U	0.5 U	0.5 U	0.68	0.6
DHG (µg/L)																			
Methane	-	NS	NS	NS	NS	NS	NS	0.63 U	0.63 U	0.63 U	0.63 U	2.78	3.37	5.68	4.62	6.42	3.84	8.15	21.8
Ethane	-	NS	NS	NS	NS	NS	NS	1.19 U	1.18 U	1.82	1.52	1.17 U	1.37 U	2.01	1.89	1.18	1.64	1.11 U	1.15 U
Ethene	-	NS	NS	NS	NS	NS	NS	1.15 U	1.13 U	1.33	1.18	1.15 U	1.34 U	1.34 U	1.67 U	1.34 U	1.67	1.1 U	1.13 U
General Chemistry (mg/L)																			
Chloride	-	NS	NS	NS	NS	NS	NS	10 U	10 U	10 U	10 U	640	770	680	550	480	425	55	50
Nitrate-N	-	5 U	5 U	5 U	5 U	5 U	5 U	7	6	5.5	5.2	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Sulfate	-	NS	NS	NS	NS	NS	NS	10 U	12	11	10	7 U	7 U	7 U	7 U	7 U	7 U	65	62
Alkalinity	-	NS	NS	NS	NS	NS	NS	11	13	11	12	138	157	168	152	142	133	125	118
TOC (mg/L)																			
--	-	NS	NS	NS	NS	NS	NS	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Metals (mg/L)																			
Iron	-	NS	NS	NS	NS	NS	NS	0.08	0.06	0.07	0.08	0.06	0.07	0.08	0.07	0.07	0.06	0.05 U	0.05 U
Parameters																			
ORP (mV)	-	46.5	83.6	21.2	78.2	27.2	85.2	92.4	118.1	64.2	98.2	143.2	167.6	128.3	124.5	142.3	116.5	98.2	108.8
Dissolved Oxygen (mg/L)	-	0.35	1.39	0.28	1.25	0.27	1.21	0.21	0.47	0.18	0.43	0.42	0.31	0.38	0.29	0.25	0.34	0.41	0.45
pH	-	5.85	5.82	6.23	6.35	6.3	6.31	5.65	5.61	6.23	6.37	6.11	6.09	6.32	6.59	6.23	6.58	5.89	5.74
Specific Conductance (us/cm)	-	154	126	128	108	167	144	132	146	128	183	1,834	2,634	1,723	2,486	1,793	2,460	426	469
Temperature (Celcius)	-	15.33	15.43	14.98	15.15	14.9	15.55	14.33	14.56	14.12	14.81	17.24	17.4	16.23	16.48	16.63	16.64	16.44	16.28

Notes:

Shaded indicates concentration exceeds ROD cleanup lev
U= not detected above reporting limit shown.
J = Estimated value below reporting limit.
CVOC= Chlorinated volatile organic compound
DHG= Dissolved hydrocarbon gas
DCE= Dichloroethene
TCE= Trichloroethylene
DCA= 1,1- Dichloroethane
TCA= 1,1,1- Trichloroethane
ORP = Oxidation reduction potential
µg/L = micrograms per liter
mg/L = milligrams per liter
mV= millivolts
uS/cm = microSiemens per centimeter
NS = Not sampled.

Table 6-15. Summary of EISB Performance Monitoring in the ASA Source area
Wah Chang Five Year Review Report

Well Date	ROD	PW-78A (5/1/10)	PW-78A (11/16/10)	PW-78A (5/10/11)	PW-78A (11/9/11)	PW-98A Baseline (7/7/09)	PW-98A (12/18/09)	PW-98A (5/1/10)	PW-98A (12/16/10)	PW-98A (5/17/11)	PW-98A (11/15/11)	PW-99A Baseline (7/8/09)	PW-99A (12/18/09)	PW-99A (5/1/10)	PW-99A (12/16/10)	PW-99A (5/17/11)	PW-99A (11/15/11)
CVOCs (µg/L)		Perimeter Well															
1,1,1- TCA	200	9.55	2.18	4.38	0.67	504	406	507	183	123	128	27.5	54.6	22.1	7.15	8.94	5.18
1,1-DCA	1,280	91.1	87.2	73.4	25.8	170	253	458	503	268	384	28.5	60.6	58.3	23.9	41.5	14.8
1,2-DCA	5	0.5 U	0.5 U	0.5 U	0.5 U	4.74	3.71	3.42	2.48	1.08	1.54	0.18 J	0.31 J	0.5 U	0.5 U	0.5 U	0.5 U
Chloroethane	-	0.5 U	0.5 U	0.5 U	0.5 U	3	3.28	3.6	15.6	9.4	8.18	1.52	1.78	5.86	8.12	6.18	7.83
TCE	5	1.94	0.75	0.63	0.55	336	150	108	26.3	46.1	18.4	0.77	1.04	0.23 J	0.5 U	0.5 U	0.5 U
cis-1,2-DCE	70	1.33	0.76	1.21	0.39 J	32.9	77.5	25.9	18.2	12.1	14.5	0.19 J	0.36 J	0.5 U	0.5 U	0.5 U	0.5 U
trans-1,2-DCE	100	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1-DCE	7	68.7	57.6	42.3	46.2	1,080	1,070	495	427	125	245	87.8	245	232	186	155	143
Vinyl Chloride	2	0.5 U	0.5 U	0.5 U	0.5 U	8.86	131	95.2	78.2	25.3	34.4	0.32 J	1.53	4.23	5.33	2.48	2.84
Tetrachloroethylene	5	0.72	0.5 U	0.44 J	0.5 U	16.3	8.46	6.84	3.59	3.11	1.57	0.21 J	0.37 J	0.5 U	0.5 U	0.5 U	0.5 U
DHG (µg/L)																	
Methane	-	3.15	5.81	2.43	4.31	16.4	14.8	429	512	418	412	11.2	6.77	8.21	6.23	8.32	5.18
Ethane	-	1.32	1.15	1.43	1.14	1.2	0.84 J	0.81 J	10.3	0.78 J	8.1	0.76 J	0.49 J	0.49 J	0.88	0.89	0.12
Ethene	-	1.3	1.16	1.31	1.13	0.88	1.48	74.1	52.2	61.4	3.15	0.65 J	1.2 U	0.88	1.23	0.87	2.54
General Chemistry (mg/L)																	
Chloride	-	45 U	42	43	28	28.6	30	22.2	18.6	21.5	17	26.7	17	15	14	14	12
Nitrate-N	-	5 U	5 U	5 U	5 U	8.76	5 U	7.5	6.9	2.4	2.4	2.31	5 U	5 U	5 U	5 U	5 U
Sulfate	-	59	57	52	46	17.6	11	18.2	17.3	16.1	15.4	16.8	16	15	14	14	11
Alkalinity	-	110	98	101	77	125	317	111	108	108	84.1	67.5	81	78	65	61	55
TOC (mg/L)																	
--	-	5 U	5 U	5 U	5 U	2.4	5 U	2.3 J	2.2 J	1.8 J	1.8 J	3.11	5 U	6.23	6.18	5.86	5.81
Metals (mg/L)																	
Iron	-	0.05 U	0.05 U	0.05 U	0.05 U	0.697	0.17	0.42	0.38	0.38	0.18	9.77	0.57	0.61	0.58	0.58	0.45
Parameters																	
ORP (mV)	-	143.9	92.4	108.9	65.4	-265.1	126	75.7	98.2	87.7	117.2	22.7	138.4	23.1	85.4	29.1	67.4
Dissolved Oxygen (mg/L)	-	0.17	0.44	0.15	0.32	0.28	0.16	0.42	0.15	0.14	0.11	4.25	0.57	0.31	0.44	0.23	0.21
pH	-	6.42	6.48	6.46	6.42	6.69	6.47	4.86	6.84	4.87	6.74	6.16	6.63	6.82	6.48	6.8	6.55
Specific Conductance (us/cm)	-	491	483	549	577	497	763	808	758	785	703	378	270	512	248	444	262
Temperature (Celcius)	-	15.62	15.57	15.4	15.09	18.15	19.6	17.59	17.54	17.92	17.82	15.96	14.48	14.25	14.95	14.03	15.5

Notes:

Shaded indicates concentration exceeds ROD cleanup lev
U= not detected above reporting limit shown.
J = Estimated value below reporting limit.
CVOC= Chlorinated volatile organic compound
DHG= Dissolved hydrocarbon gas
DCE= Dichloroethene
TCE= Trichloroethylene
DCA= 1,1- Dichloroethane
TCA= 1,1,1- Trichloroethane
ORP = Oxidation reduction potential
µg/L = micrograms per liter
mg/L = milligrams per liter
mV= millivolts
uS/cm = microSiemens per centimeter
NS = Not sampled.

Table 6-16. Summary of COCs detected in Solids area wells from November 2003 to September 2011
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Station	Parameter	Units	ROD Cleanup Level	Nov-03	Oct-04	Sep-05	Aug-06	Jun-07	Nov-08	Sep-09	Sep-10	Sep-11
PW-07	CHLORIDE	mg/L	--	127	48	47		34	24.3	27	25	24
PW-09	CHLORIDE	mg/L	--	591	160	160		89.5	867	670	590	575
PW-17B	CHLORIDE	mg/L	--	2190	1800	1700		2200	1550	820	808	785
PW-18B	CHLORIDE	mg/L	--	85.7	57	57		34.6	70.6	45	50	45
PWA-1	CHLORIDE	mg/L	--	2370	1800	1600		2370	1700	1.6	1.4	1.2
PWA-2	CHLORIDE	mg/L	--	5470	4500	4400		3870	2870	3	2	1.6
PWB-1	CHLORIDE	mg/L	--	111	86	80		57.3	41	53	48	42
PWB-2	CHLORIDE	mg/L	--	117	87	80		66.6	49.9	51	47	43
PWB-3	CHLORIDE	mg/L	--	6760	6300	7600		6440	4860	4.7	4.1	3.8
PWC-1	CHLORIDE	mg/L	--	4.72	10 U	23		7.3	9.22	10	9	7.6
PWC-2	CHLORIDE	mg/L	--	13.6	16	110		13.5	5.92	13	11	10
PWD-1	CHLORIDE	mg/L	--	1890	2000	1500		1760	1500	1780	1580	1430
PWD-2	CHLORIDE	mg/L	--	699	730	880		947	915	592	575	525
PWE-1	CHLORIDE	mg/L	--	324	110	130		106	186	95	94	92
PWE-2	CHLORIDE	mg/L	--	826	700	1100		1460	641	1520	1460	1380
PWF-1	CHLORIDE	mg/L	--	206	99	170		498	439	1.1	1.2	1.1
PWF-2	CHLORIDE	mg/L	--	341	110	190		1400	1170	1.4	1.1	1.1
PW-07	FLUORIDE	mg/L	2	9.21	1 U	1 U		0.12	0.19	1 U	1 U	1 U
PW-09	FLUORIDE	mg/L	2	1.998	3	3		3.6	1.57	2	1 U	1 U
PW-17B	FLUORIDE	mg/L	2	2 U	1 U	1 U		0.37	1.22	1 U	1 U	1 U
PW-18B	FLUORIDE	mg/L	2	2.49	2	2		1.9	1.6	2	2	1.8
PWA-1	FLUORIDE	mg/L	2	1 U	1 U	1 U						
PWA-2	FLUORIDE	mg/L	2	2 U	1 U	1 U						
PWB-1	FLUORIDE	mg/L	2	2.45	2	3		2.1	2.32	2	2	2
PWB-2	FLUORIDE	mg/L	2	2.51	2	3		2.1	2.16	2	1 U	1 U
PWB-3	FLUORIDE	mg/L	2	2 U	2	2		1.7	2.01	2	2	1.7
PWC-1	FLUORIDE	mg/L	2	0.33	1 U	1 U						
PWC-2	FLUORIDE	mg/L	2	0.1 U	1 U	1 U						
PWD-1	FLUORIDE	mg/L	2	0.1 U	1 U	1 U						
PWD-2	FLUORIDE	mg/L	2	0.1 U	1 U	1 U						
PWE-1	FLUORIDE	mg/L	2	3.73	5	4		4.1	4.32	3.9	2.7	2.1
PWE-2	FLUORIDE	mg/L	2	0.3	1 U	1 U		0.18	0.16	1 U	1 U	1 U
PWF-1	FLUORIDE	mg/L	2	0.708	1 U	1						
PWF-2	FLUORIDE	mg/L	2	0.864	1 U	1						
PW-07	MANGANESE	mg/L	--	2.44	1.8	1.5	1.3	1.64	1.35	0.6	0.55	0.53
PW-09	MANGANESE	mg/L	--	3.07	1.4	0.97	4	1.44	10.5	5.1	4.9	4.7
PW-17B	MANGANESE	mg/L	--	24.6	19	20	15	17.3	19.9	7.6	7.2	6.8
PW-18B	MANGANESE	mg/L	--	0.981	0.5	0.82	0.56	0.214	0.636	0.23	0.19	0.17
PWA-1	MANGANESE	mg/L	--	11.9	8.8	8.7	9.7	11.3	10.5	7.9	8.1	7.7
PWA-2	MANGANESE	mg/L	--	20.4	16	17	13	15.9	14.5	13	12.1	12
PWB-1	MANGANESE	mg/L	--	0.984	1	0.91	1.1	0.976	0.974	0.8	0.7	0.6
PWB-2	MANGANESE	mg/L	--	1.05	0.96	0.84	0.8	0.969	0.872	0.84	0.77	0.73
PWB-3	MANGANESE	mg/L	--	19.4	14	14	9.1	14	14.2	13	12	10
PWC-1	MANGANESE	mg/L	--	0.623	0.79	1.4	1	1.2	1.25	0.98	0.87	0.79
PWC-2	MANGANESE	mg/L	--	0.85	0.88	0.98	0.35	0.955	1.09	0.97	0.89	0.86
PWD-1	MANGANESE	mg/L	--	10.5	9.7	8	7.5	9.25	8.74	8.3	8.1	7.5
PWD-2	MANGANESE	mg/L	--	0.948	0.99	1.1	1.1	1.3	1.45	1.2	1	0.98
PWE-1	MANGANESE	mg/L	--	2.01	1.1	1.1	1.1	1.02	1.21	1.1	0.99	0.85
PWE-2	MANGANESE	mg/L	--	6.47	5.6	8.6	13	13.9	7.84	5.1	4.9	4.6
PWF-1	MANGANESE	mg/L	--	1.01	0.68	0.74	0.13	1.72	2.65	2.3	1.8	1.8
PWF-2	MANGANESE	mg/L	--	0.899	0.43	0.5	0.12	3.5	3.42	2.7	2.4	2.3
PW-07	NITRATE	mg/L	10	17.917	5 U	5 U		3.9	1.76	5 U	5 U	5 U
PWF-1	NITRATE	mg/L	10	32.4	7	5 U		0.01 U	0.25	5 U	5 U	5 U
PWF-2	NITRATE	mg/L	10	32.1	8	5 U		0.01 U	0.01 U	5 U	5 U	5 U
PW-07	RADIUM 226	pCi/L	5	2.5	5 U	5.9			0.86	**40 U**	5 U	2.5 U
PW-07	RADIUM 228	pCi/L	5	1 U	5 U	10 U			3.6	**40 U**	5 U	2.5 U

***Bold values indicate samplign results were the method detection limit is above the ROD performance level concentations**

Highlighted cell indicates analyte was detected above the ROD cleanup level

U = Not detected at specified reporting limit

-- = ROD performance level not established

Table 6-17. Summary of VOCs detected in Farm Pond wells from June 2000 to September 2011
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Station	Parameter	ROD	Jun-00	Sep-00	Mar-01	Sep-01	Mar-02	Sep-02	Sep-03	Sep-04	Sep-05	Jun-07	Sep-08	Oct-09	Sep-10	Sep-11
PW-40S	TCA	200	1 U	1 U	1 U	1 U	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.1 U	0.5 U	0.5 U	0.5 U
PW-65S	TCA	200	1 U	1 U	1 U	1 U	1 U	0.5 U				0.5 U	0.1 U	0.5 U	0.5 U	0.5 U
SS	TCA	200		0.6 J	1 U	1 U	1 U	0.5 U	1 U	0.5 U	0.5 U	1.2	1.3	0.16 J	0.5 U	0.5 U
PW-40S	DCA		42.2	9	26.7	35	26.2	31.03	30.78	28.09	30.5	32	35	14.3	12.7	9.8
PW-65S	DCA		3	3	2.2	2.95	2.4	3.38				3.4	6.2	4.17	3.9	2.68
SS	DCA			2.3	1 J	1.7	1 U	1.51	1.83	1.79	2.3	8.4	8.3	0.33 J	0.29 J	0.5 U
PW-40S	DCE	7	2.8	2.5	1.6	1.9	1.2	1.97	1.56	0.87	0.67	0.4 J	0.6	0.5 U	0.5 U	0.5 U
PW-65S	DCE	7	1 U	1 U	1 U	1 U	1 U	0.5 U				0.5 U	0.1 U	0.5 U	0.5 U	0.5 U
SS	DCE	7		1 U	1 U	1 U	1 U	0.5 U	1 U	0.5 U	0.5 U	1.5	1.5	0.5 U	0.5 U	0.5 U
PW-40S	CIS-DCE	70	41.6	7.1	26.5	37.6	22.6	42.22	45.08	31.9	21.8	10.5	23	0.74	0.61	0.52
PW-65S	CIS-DCE	70	1 U	1 U	1 U	1 U	1 U	0.5 U				0.5 U	0.2 J	0.11 J	0.5 U	0.5 U
SS	CIS-DCE	70		2.9	1	1.7	1 U	1.22	1.27	0.88	1.1	3.9	3.7	0.5 U	0.5 U	0.5 U
PW-40S	PCE	5	2.5	2.5	1.9	1.8	1.1	0.54	1 U	0.5 U	0.77	1.2	0.1 U	0.57	0.55	0.43 J
PW-65S	PCE	5	1 U	1 U	1 U	1 U	1 U	0.5 U				0.5 U	0.1 U	0.5 U	0.5 U	0.5 U
SS	PCE	5		22.5	7.8	16	1.9	8.7	12.72	14.22	14.7	40.4	49	2.52	2.13	1.45
PW-40S	TCE	5	18	15.9	9.3	8.5	7.1	5.63	4.11	1.89	1.5	1.4	0.7	0.49 J	0.5 U	0.5 U
PW-65S	TCE	5	1 U	1 U	1 U	1 U	1 U	0.5 U				0.5 U	0.1 U	0.5 U	0.5 U	0.5 U
SS	TCE	5		6.2	2.1	3.9	1 U	2.91	3.66	3.35	3.8	11.3	13	0.26 J	0.25 J	0.5 U
PW-40S	VC	2	2.9	3.4	1.8	4.2	1.1	4.67	3.25	2.97	1.7	0.85	2.4	0.5 U	0.5 U	0.5 U
PW-65S	VC	2	1 U	1 U	1 U	1 U	1 U	0.5 U				0.5 U	0.1 J	0.5 U	0.5 U	0.5 U
SS	VC	2		1 U	1 U	1 U	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.1 U	0.5 U	0.5 U	0.5 U

Notes:

TCA = 1,1,1-trichloroethane

DCA = 1,1-dichloroethane

cis-DCE = cis-1,2-dichloroethene

PCE = tetrachloroethene

TCE = trichloroethene

VC = vinyl chloride

U = Parameter not detected above the method reporting limit

J = Estimated value below reporting limit

Shading indicates that ROD Cleanup level was exceeded