2009 ANNUAL REPORT

GROUNDWATER/SURFACE WATER REMEDY

Simplot Operable Unit

Eastern Michaud Flats Superfund Site

Pocatello, Idaho

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Acronyms and Abbreviations

AFLB	American Falls Lake Bed
ARAR	Applicable of Relevant and Appropriate Requirements
AWQC	Ambient water quality criteria
BRS	Batiste Road Spring
BTS	Batiste Spring
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfs	cubic feet per second
COC	Contaminant of Concern
CSM	Conceptual Site Model for groundwater
DO	Dissolved Oxygen
EMF Site	Eastern Michaud Flats Superfund Site
EPA	Environmental Protection Agency
ft	feet
ft/day	feet per day
gpm	gallons per minute
GWPS	Groundwater Protection Standard
IDEQ	Idaho Department of Environmental Quality
IDWR	Idaho Department of Water Resources
IRODA	Interim Record of Decision Amendment
HDPE	high density polyethylene
i	hydraulic gradient
k	Hydraulic conductivity
kg/day	kilograms per day
lb/day	pounds per day
MCL	Maximum Contaminant Level
mg/L	milligrams per liter
n_e	effective porosity
NTU	Nephelometric Turbidity Units
OU	Operable Unit
PAP	Phosphoric acid plant
pH	hydrogen ion activity
POC	Point of Compliance
POTW	Pocatello Waste Water Treatment Plant
RBC	Risk-Based Concentration
RCRA	Resource Conservation and Recovery Act
ROD	Record of Decision
RODA	Record of Decision Amendment
RDR	Remedial Design Report
SOW	Remedial Design/Remedial Action Consent Decree Statement of Work
t	t-Test Value
t_{cp}	t-Test Value Critical point

Acronyms and Abbreviations (cont.)

TDS	total dissolved solids
TMDL	Total Maximum Daily Load
TSS	Total suspended solids
UCL	Upper Confidence Limit
VCO/CA	Voluntary Consent Order/Compliance Agreement
VFD	variable frequency drive

EXECUTIVE SUMMARY

This report provides a description of the groundwater/surface water remedy implementation and performance in 2009 in the Simplot Operable Unit of the Eastern Michaud Flats Superfund Site near Pocatello Idaho.

A groundwater/surface water remedy has been designed to meet the requirements of a Record of Decision issued by EPA in 1998 and an Interim Record of Decision Amendment for the Simplot Operable Unit issued by EPA in February 2010. The remedy and monitoring also meets the requirements of a Voluntary Consent Order/Compliance Agreement (VCO/CA) between the Idaho Department of Environmental Quality and the J.R. Simplot Company intended to fulfill Simplot's obligations for the Portneuf River Total Maximum Daily Load (TMDL). The two projects are intertwined because groundwater affected by Simplot sources discharges to the Portneuf River, resulting in phosphorus concentrations above TMDL targets.

The remedy contemplated under Superfund and the VCO/CA has the same basic elements:

- Extraction of affected groundwater downgradient of the gypsum stack and phosphoric acid plant area;
- Installation of a high density polyethylene liner on top of the existing gypsum stack with continued placement of gypsum on the liner;
- Control of sources of phosphorus to groundwater in the phosphoric acid plant area; and
- Groundwater and surface water monitoring to assess the performance of the remedial actions.

This report is intended to fulfill the reporting requirements for both the Superfund and VCO/CA projects.

Overall, Simplot implemented significant source control actions in the phosphoric acid plant area and successfully operated the groundwater extraction system in 2009. Groundwater data indicate significant reduction in total phosphorus concentration. Identifying and addressing source control actions are the focus of the 2010 work. The remedy set out in the 1998 Record of Decision had a goal of reducing arsenic concentrations in groundwater near the Portneuf River to below MCLs and this is the basis for the groundwater extraction system. Mass flux modeling does not predict that the current groundwater extraction system will meet arsenic MCLs in groundwater near the Portneuf River. However, additional extraction wells to be installed in 2010 are expected to provide the extraction rates needed to meet this remedy goal. Preparatory work for lining the gypsum stack was performed in 2009 and lining of the lower cell is scheduled to occur in 2010. As a result of extraction system operation and source control

activities, the phosphorus load from Simplot groundwater to the Portneuf River was significantly reduced in 2009. This resulted in a significant reduction in phosphorus concentrations and may have contributed to improved dissolved oxygen levels in the river. In fact, in 2009 the median monthly average phosphorus concentration in the river at Siphon Road was already below the target set out in the VCO/CA for 2013. This indicates that remedial actions are resulting in greater and faster water quality improvements than previously predicted. Because of the travel time from remedial actions to the river (greater than one year and possibly up to 10 years, depending on location), the effect in the river in 2009 is likely due to previous source control in the phosphoric acid plant area and expansion of the extraction system in 2008 (in particular wells 412 and 413 which came on line in January 2008 and pump over 530 gallons per minute combined). The effects of 2009 activities have likely not yet been observed in the river and additional reduction in phosphorus concentrations is anticipated as additional remedial action components are implemented. Additional pump tests to be conducted in 2010 will provide further information for predicting travel times.

The following subsections provide more details of the remedy implementation and assessment of groundwater and surface water data.

Remedial Actions

Source Control

Source control for the gypsum stack will be achieved by lining the entire stack with a high density polyethylene liner in multiple phases of work. In 2009, Simplot completed the construction of the Decant Pond, which is necessary for water management during the operation of a lined stack. The lower gypsum stack cell was taken out of service in October 2009 to begin the process of dewatering in preparation for lining in 2010.

Source control in the phosphoric acid plant in 2009 consisted of pad repair and replacement at the SPA Car Wash, Tank 9, Sump 5, SPA West Aging Pad, and the SPA HPA Re-pulp Launder, as well as numerous smaller projects and operational changes intended to reduce the potential for releases from the phosphoric acid plant area.

Extraction System

The groundwater extraction system currently consists of 14 extraction wells that were installed in two prior phases of work; phase 1 in 2003-2004 and phase 2 in 2007-2008. As part of implementation of the final design, a third phase of extraction well installation is proposed in 2010 that includes replacing well 410 with a new multi-level extraction well (421), converting two of the wells installed during the phosphoric acid plant subsurface investigation into extraction wells (wells 416 and 419), and installation of an additional extraction well east of the existing well 413 (422).

The extraction system was shut down from May 30th to July 1st when the facility was taken offline for routine annual maintenance (plant "turnaround"). All extraction wells except wells 405 and 408 were in operation greater than 90 percent of the year (excluding the down time from the Don Plant turnaround). Wells 405 and 408 were taken off line after showing decreasing water level and insufficient saturated thickness to maintain groundwater extraction. Over 400 million gallons of groundwater were extracted during 2009. The estimated total rate of mass removal by the groundwater extraction system in 2009 was:

- 2.3 lbs arsenic/day
- 1,930 lbs total phosphorus/day
- 17,319 lbs sulfate/day

Groundwater

Groundwater monitoring was performed in four quarterly events in 2009. Water levels were measured at approximately 133 well intervals and water quality was sampled at approximately 94 well intervals. Samples were analyzed for field parameters, general chemistry parameters, and selected metals and nutrients. Analyses were performed in accordance with referenced EPA methods. Data validation was performed and a checklist of the validation process was prepared to document the review process and results.

Data Observations

A review of groundwater monitoring data for 2009 identified the following key conclusions:

- Water levels in the Upper and Lower Zones were highest in May, and lowest in August and March, respectively.
- Groundwater elevations varied by 0.5 -1.0 feet in the Upper Zone, 1.0 -1.5 feet in the Lower Zone and 0.5 feet in Bedrock during the year.
- The general spatial distribution of arsenic, phosphorus, sulfate, and nitrate is consistent throughout the year.
- The highest arsenic concentrations were measured in the target extraction areas (East and West Plant Areas) and in the Upper Zone at and downgradient of the phosphoric acid plant.
- The highest phosphorus concentrations were measured near the current East Plant Area extraction system (Upper and Lower Zones) and at wells

downgradient of the phosphoric acid plant. The Lower Zone is not impacted in this area.

- Phosphorus and arsenic concentrations decrease downgradient as groundwater migrates to the Portneuf River.

- In the phosphoric acid plant area, weekly water quality sampling was conducted at wells 340, 367, 374, 416, and 419 for most of 2009. Phosphorus concentrations in wells 340, 419, and 374 were above levels that would be expected from stack-affected groundwater throughout 2009. However, significant recovery of groundwater (decreased phosphorus and increased pH) was observed in wells 340, 419, and 374. Phosphorus concentrations in well 340 decreased steadily in 2009. Phosphorus concentrations in well 419 have been decreasing since an initial high concentration of over 13,000 mg/L measured in January 2009. The pH has also been recovering, increasing from a low of 1.9 to 2.3 su at the end of 2009. The phosphorus concentration in well 419 was 2,319 mg/L at the end of 2009. Phosphorus in well 367 was generally less than 300 mg/L in 2009, close to levels that would be expected from stack-affected groundwater. Well 416 had phosphorus concentrations at or below 105 mg/L since April, which is less than typical stack-affected concentrations. In the Assessment Area (downgradient of the facility), phosphorus concentrations are typically below 1 mg/L, except at well 503 which shows a recent decreasing trend to less than 4 mg/L and is located downgradient of the gypsum stack and the phosphoric acid plant area. In the Assessment Area, arsenic and phosphorus concentrations are generally lower in deeper wells than in shallow wells.

- Batiste Spring showed a seasonal pattern in arsenic and phosphorus concentrations, with higher concentrations observed in the spring. Batiste Spring showed decreasing trends in arsenic and phosphorus in 2009. Arsenic and phosphorus concentrations at the Spring at Batiste Road were generally lower than at Batiste Springs.

- Groundwater velocities for 2009 in the Don Plant were approximately 9 to 14 ft/day in the Upper Zone and 1 to 3 ft/day in the Lower Zone. In the Assessment Area, groundwater velocities ranged from 1 to 7 ft/day. Given the distance from the foot of the gypsum stack to the discharge point at the Portneuf River, these velocities suggest travel times ranging from 1 to greater than 10 years from the foot of the stack to the river, however, this does not take travel through and beneath the stack into account.

Groundwater Data Analysis

In addition to monitoring the extent and temporal trends of contaminants of concern (COCs) in groundwater, the effectiveness of remedial actions was evaluated by (1) comparing groundwater COC concentrations upgradient to concentrations within and downgradient of the phosphoric acid plant area to evaluate whether source control in the plant area is being achieved, (2) demonstrating hydraulic control in the target capture zones according to EPA's *Systematic Approach for Evaluation of Capture Zones at Pump and Treat Systems* (EPA 2008), and (3) demonstrating that groundwater migration into the Off-Plant Operable Unit is not occurring at concentrations above an applicable groundwater protection standard (GWPS) such as an MCL in the Compliance Area. These analyses indicate the following:

Phosphoric Acid Plant Area

- Analysis of well pairs indicates that downgradient phosphorus concentrations were greater than or equal to the upgradient concentrations at the location of wells 340 and 367. This indicates that active sources existed upgradient of wells 340 and 367 in 2009. Concentrations at well 414 (close to 340) are lower than upgradient concentrations, indicating that the effect of the source is limited. Well pairs not evaluated were either similar in concentration to other wells evaluated (i.e. 370, 369, 374, 417) or noticeably greater in concentration than upgradient wells (i.e. 419).

Demonstrating Hydraulic Control

- Vertical head differences suggesting upward flow were consistently observed in well pairs in the Don Plant and Assessment Areas for each quarter of 2009. No new drawdown tests were performed in 2009.

- Quarterly in 2009, the load of phosphorus in target capture zones ranged from 3,500 to 5,200 lbs/day. Sulfate ranged from 32,000 to 27,000 lbs/day and arsenic ranged from 4.4 to 3.9 lbs/day.

- The estimated concentrations of COCs at the springs discharging to the Portneuf River were in the range of 4.7 to 7.8 mg/L phosphorus, 96 to 129 mg/L sulfate, and 0.011 to 0.016 mg/L arsenic in 2009 (based on the mass flux model).

- Analytical capture numerical particle tracking calculations suggest that wells 404, 405, 406, 407, 408, 409, 412, and 413 in the East Plant Area have limited zones of capture in the Upper Zone. Although the current system does not provide

complete capture, calculations indicate that capture is adequate to meet remedy goals.

- Well 414 in the Upper Zone of the Central Plant has a relatively large zone of capture in the Upper Zone, however, analyses indicate that the location of well 414 is not affected by sources within the phosphoric acid plant area and only stack-affected groundwater is collected and current capture is not adequate. As part of the remedial design, wells 416 and 419 will be converted to extraction wells in 2010 to provide additional extraction at the location of higher concentration groundwater near wells 340 and 419.

- Analytical capture and numerical particle tracking calculations indicate that wells 410, 411, 412, and 413 in the Lower Zone of the East Plant Area have nearly complete capture in the Lower Zone. The well performance data and capture zone analysis indicate that adequate capture of groundwater in this target capture zone can be achieved with additional extraction at the location of well 410 and east of well 413. As part of the remedial design two additional extraction wells are proposed for this area.

- In 2009, groundwater extraction was provided by wells 401, 402, and 415 in the West Plant Area. Analytical capture, numerical particle tracking calculations, and mass flux analyses indicate that the extent of capture at the downgradient extraction well 415 covers a significant portion of the target capture zone and that there is a relatively small mass flux in this area. Current capture in this area is sufficient.

Compliance Area COC Concentrations

- The monitoring goal for the Compliance Area is to demonstrate that groundwater migration into the Off-Plant Operable Unit is not occurring at concentrations above an applicable GWPS such as a MCL. Arsenic concentrations in wells 504, 505, 524, 525, Batiste Spring, and the Spring at Batiste Road were compared to the groundwater MCL using the statistical methods described in Section 5.2.2 of the Groundwater and Surface Water Monitoring Plan (Formation 2009a). A GWPS for phosphorus has not yet been identified. Four of the six locations tested reject the null hypothesis for arsenic (arsenic concentrations <0.01 mg/L). However, because more wells will be installed in the Compliance Area in 2010, the analysis presented in this report is considered preliminary and will be further evaluated in the 2010 annual report, once a more comprehensive data set is available.

Surface Water

Surface water samples were collected on a monthly basis during 2009 and analyzed for a range of constituents, including phosphorus. Assessment of surface water monitoring data for 2009 identified the following key conclusions:

- Batiste Road is not affected by EMF groundwater and can be used as a background monitoring location.
- Phosphorus concentrations at Siphon Road have significantly decreased starting in 2007 with the 12-month median phosphorus concentration for 2009 equal to 0.59 mg/L. This meets the December 31st, 2013 VCO/CA target.
- The reduced phosphorus load at Siphon Road is a reflection of the reduced input from EMF groundwater with the estimated phosphorus loads from EMF groundwater at Siphon Road having reduced to a yearly average of 1260 lb/day in 2009. This represents a 57% reduction from the 2007 average.
- Discharge at Siphon Road in 2009 was within the range of flows for the previous four years, indicating that reduced concentrations in phosphorus at Siphon Road are not due to higher discharges, but due to reduced loads from EMF groundwater.
- Monitoring station T2B may not completely show the total input load amounts from EMF groundwater and the groundwater may be intercepted by the Batiste Springs channel before entering the Portneuf River further downstream.
- Average minimum dissolved oxygen (DO) values at Siphon Road was 5.6 mg/L at Siphon Road and 6.5 mg/L at Batiste Road DO concentrations are affected by multiple processes other than nutrient loading that require further monitoring and evaluation.
- DO levels at Siphon Road showed considerable improvement in 2009 with the average daily minimum concentration equal to 6.44 mg/L. Above average flow conditions in the river in June and early July likely influenced oxygen conditions and confound the ability to attribute this apparent improvement in minimum dissolved oxygen to other water quality attributes including the decreasing trend in phosphorus concentrations.

Remedy Performance

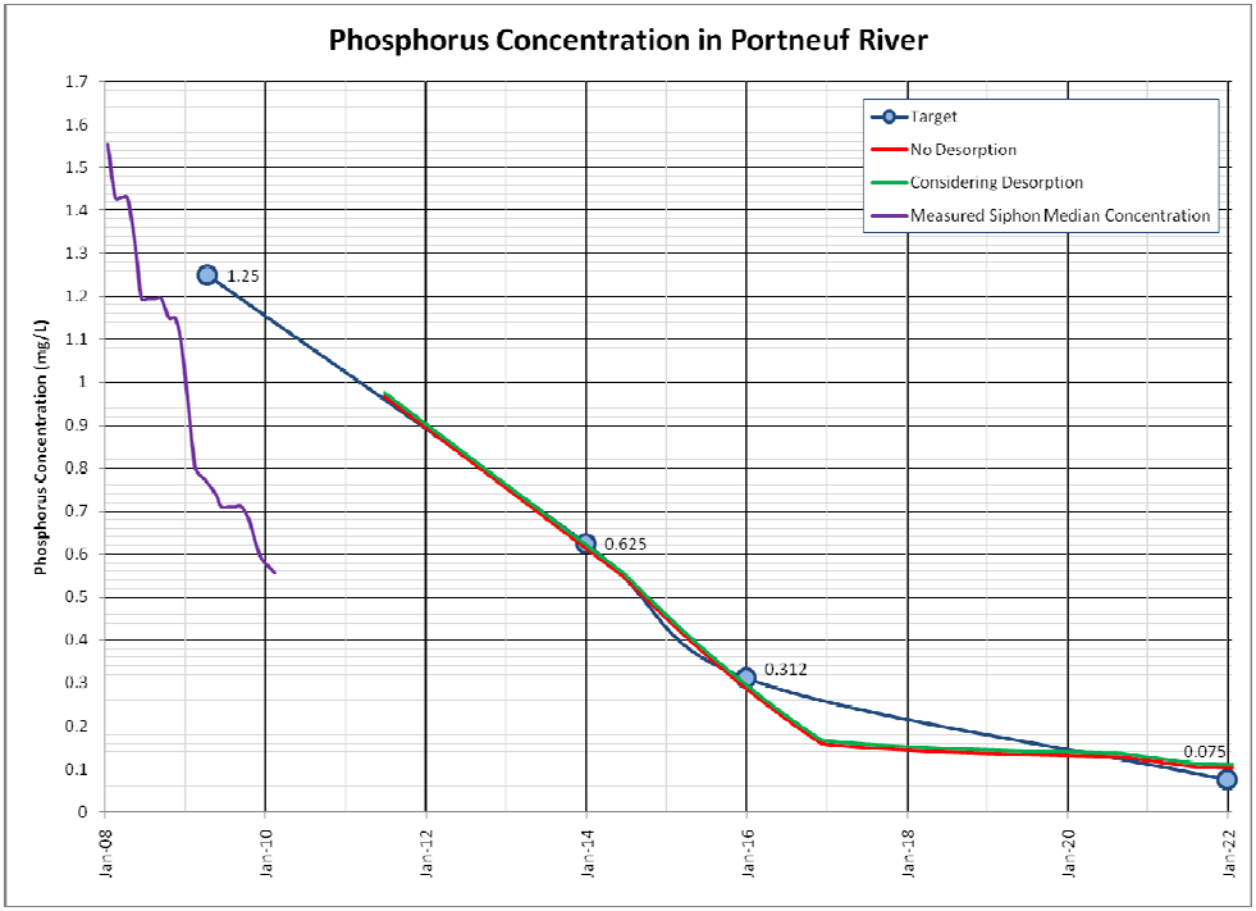
The performance of the remedy was evaluated for 2009. This analysis indicated the following:

- Since no stack lining was completed in 2009, the effects of seepage reduction have not yet been observed.

- The phosphorus load attributable to the phosphoric acid plant decreased by approximately 75% from the first quarter to the end of 2009. Compared to phosphorus loading rates in the phosphoric acid plant from the fourth quarter of 2008, loads in 2009 were approximately 200,000 lbs less on an annual basis.

- The extraction system removed approximately 39% of the estimated phosphorus load in groundwater from the gypsum stack, 59% of the estimated sulfate load and 63% of the estimated arsenic load in 2009. The total mass removed for 2009 was approximately 700,000 pounds of phosphorus. This amount is greater than previous years with 2008 having removed 650,000 pounds and 2007 seeing only 350,000 pounds removed.

The phosphorus concentrations measured in the Portneuf River at Siphon Road have decreased considerably since 2007. This is primarily due to reduction of the phosphorus load from EMF groundwater; from 2,920 pounds per day on average estimated in 2007 to 1,260 pounds per day in 2009. The VCO/CA sets phosphorus concentration targets in the Portneuf River at Siphon Road. These are shown on the figure below, along with lines showing the predicted reduction based on the planned remedy implementation schedule, expected effect of each remedy component, estimated travel times in groundwater to the river, and predicted geochemical effects in groundwater. In addition, the purple line shows the rolling 12 month median phosphorus concentrations at Siphon Road. As shown, concentrations have decreased quickly, indicating that remedial actions are being more effective and/or resulting in a more rapid effect than predicted by modeling. In fact, the VCO/CA target concentration for 2013 was already met in 2009. Because of the travel time from remedial actions to the river the effect of 2009 activities have likely not yet been observed in the river and additional reductions in phosphorus concentrations are anticipated as additional remedial action components are implemented.



Remedy Components Planned for 2010

Consistent with the Superfund and VCO/CA requirements, Simplot will continue remedy implementation in 2010. Planned activities include:

- Conversion of wells 416 and 419 in the phosphoric acid plant area to extraction wells
- Installation of two new extraction wells (421 and 422)
- Installation of thirteen additional monitoring well nests
- Decant Pond seepage testing
- Begin using Decant Pond
- Install a liner on the lower cell of the gypsum stack with an anticipated start date for use of the cell in November 2010.

- Build the final upper road for the upper west stack in late 2010 or early in 2011
- Source control in the phosphoric acid plant area will be achieved though infrastructure improvements which are explained in detail in the Draft Infrastructure Improvement Plan FY2010 (Simplot 2010).

The effect of the remedy will continue to be assessed through quarterly monitoring of groundwater and monthly monitoring in the Portneuf River.

1.0 INTRODUCTION

This report provides a description of the groundwater/surface water remedy implementation and performance in 2009 at the Simplot Operable Unit (OU) of the Eastern Michaud Flats (EMF) Superfund Site near Pocatello Idaho.

The Simplot OU includes the operating Simplot Don Plant facility, which produces a variety of solid and liquid phosphorus- and nitrogen-based fertilizers. The principal raw material for the process is phosphate ore, which is conveyed to the facility via a slurry pipeline from the Smoky Canyon mine, near Afton, Wyoming. The primary byproduct from the Don Plant process is gypsum (calcium sulfate), which is stacked on site (the gypsum stack).

The EMF Site has been divided into three areas in the Record of Decision (ROD; EPA 1998):

- The **FMC OU** includes the FMC Elemental Phosphorus Facility (which ceased operations in December 2001) and contiguous land owned by FMC;
- The **Simplot OU** includes the J.R. Simplot Don Plant, and contiguous land owned by Simplot; and
- The **Off-Plant OU** surrounds the FMC and Simplot OUs.

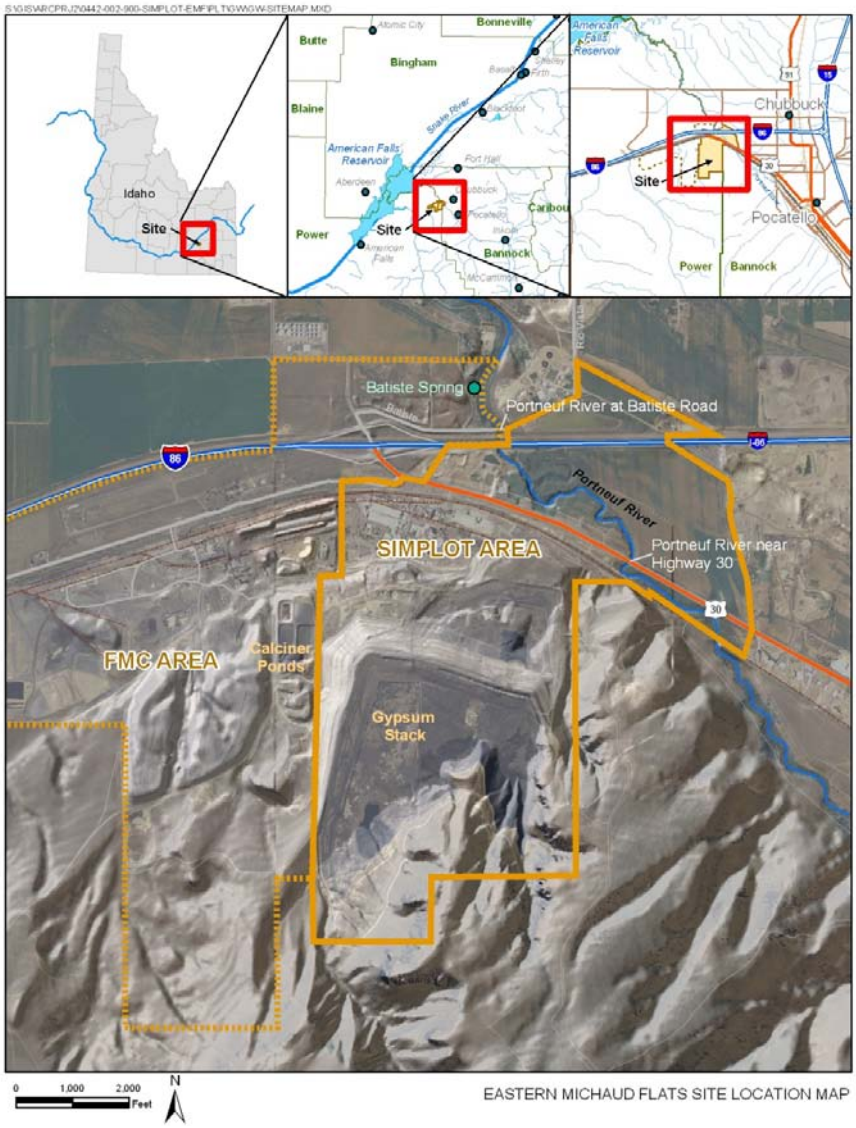


Figure 1-1: Site Location Map.

A groundwater/surface water remedy has been designed and is being implemented in order to meet the requirements of an Interim Record of Decision Amendment (IRODA) issued by EPA in February 2010 (EPA 2010) and the Voluntary Consent Order/Compliance Agreement (VCO/CA) between the Idaho Department of Environmental Quality (IDEQ) and the J.R. Simplot Company (Simplot) (IDEQ 2008). The VCO/CA is intended to implement Simplot's responsibilities at the Don Plant fertilizer manufacturing facility located near Pocatello Idaho under the approved Total Maximum Daily Load (TMDL) for nutrients for the Lower Portneuf River. Groundwater discharging from the Don Plant area has been identified as a source of phosphorus loading to the river. The remedy contemplated under Superfund and the VCO/CA has the same basic elements:

- Extraction of groundwater downgradient of the gypsum stack and phosphoric acid plant (PAP) area;
- Installation of a high density polyethylene (HDPE) liner on top of the existing gypsum stack with continued placement of gypsum on the liner;
- Control of sources of phosphorus in the phosphoric acid plant area; and
- Groundwater and surface water monitoring to assess the performance of the remedial actions.

This report provides a description of remedy implementation in 2009 and groundwater and surface water data to assess the remedy performance. It also provides a brief description of remedy activities planned for 2010. The report is structured as follows:

- Background – Provides an overview of the remedy and monitoring plan, and their respective objectives.
- Source Control – Provides a description of the gypsum stack lining and the source controls in the phosphoric acid plant area completed in 2009.
- Groundwater Extraction System – Provides details of the extraction system well operation, maintenance, and performance during 2009. Also reports Don Plant facility water flows.
- Groundwater Monitoring – Reviews the groundwater monitoring activities conducted in 2009 and presents site-wide trends in groundwater levels and arsenic and phosphorus concentrations.
- Groundwater Data Evaluation – This section presents all analyses of groundwater data prescribed in the Groundwater and Surface Water Monitoring Plan (Formation 2009a), including the six-step evaluation of target capture zones.
- Surface Water Monitoring – Reviews the surface water monitoring activities conducted in 2009, and presents the data results and analyses.
- Remedy Performance – This section provides a summary of the performance of the remedy actions completed in 2009.
- Remedy Components Planned for FY2010 – This section reviews the planned remedy components for the upcoming year.

2.0 BACKGROUND

This section provides a description of the groundwater/surface water remedy for the Don Plant and the remedy objectives and performance standards as set out in the VCO/CA (IDEQ 2008), the 2010 CERCLA IRODA (EPA 2010), and the 2002 CERCLA Consent Decree (EPA 2002).

2.1 Groundwater/Surface Water Remedy Objectives

This section provides information that supports the design of the integrated groundwater and surface water monitoring program.

TMDL

The VCO/CA specifies the remedy goal of meeting the following concentration-based requirements in the Portneuf River as measured at Siphon Road, relative to the baseline condition determined by IDEQ of 1.25 mg/L as the annual median of monthly samples, based on data collected from 2004 to 2007:

- Achieve a 50 percent reduction (or a reduction of 0.625 mg/L) in the concentration of phosphorus in the Portneuf River as measured by the annual median of monthly samples collected at Siphon Road by December 31, 2013.
- Achieve a 75 percent reduction (or a reduction of 0.938 mg/L) in the concentration of phosphorus in the Portneuf River as measured by the annual median of monthly samples collected at Siphon Road by December 31, 2015.
- Achieve a 94 percent reduction (or a reduction of 1.175 mg/L) in the concentration of phosphorus in the Portneuf River as measured by the annual median of monthly samples collected at Siphon Road by December 31, 2021. This level equates to the water quality target of 0.075 mg/L established for phosphorus for this segment of river as set forth in the VCO/CA.

CERCLA

The overall objective of the CERCLA groundwater remedial actions for the Simplot OU of the EMF Site is to provide an effective mechanism for protecting human health and the environment. To address the potential risks from the Site, the following ROD groundwater cleanup objectives were developed:

- Reduce the release and migration of constituents of concern (COCs) to the groundwater from facility sources that may result in concentrations in groundwater exceeding risk-based concentrations (RBCs) or chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs), specifically maximum contaminant levels (MCLs).

- Prevent potential ingestion of groundwater containing COCs having concentrations exceeding RBCs or MCLs (chemical-specific ARARs) (see Table 36 of the ROD). The RBCs shown in Table 36 correspond to a cancer risk of 10-6 or a Hazard Index of 1.0.
- Restore groundwater that has been impacted by Site sources to meet all RBCs or MCLs for the COCs.

EPA's interim ROD amendment (2010) added the following additional remedial action objectives:

- Reduce the release and migration of COCs to surface water from facility sources that result in concentrations exceeding RBCs or chemical specific ARARs, including ambient water quality criteria (AWQC) pursuant to the Clean Water Act.
- Achieve source control for the existing gypsum stack and phosphoric acid plant area within the shortest practicable timeframe.

2.2 Description of Simplot Don Plant Remedy

TMDL

The remedy has the following major components:

- Installation of a geosynthetic liner on the surface of the existing gypsum stack and continued placement of gypsum on top of the liner;
- Source control actions in the phosphoric acid plant area; and
- Groundwater extraction downgradient of the gypsum stack and the phosphoric acid plant area as an interim action until source controls are implemented and become effective.

CERCLA

The major components of the Simplot OU groundwater remedy are presented in the 1998 ROD:

- Remediation of groundwater in the Simplot OU will consist of installation of a network of shallow groundwater wells on the northern edge of the gypsum stack and/or downgradient of the Nitrogen Solutions Plant, and the installation of extraction pumps and conveyance piping. The extracted groundwater will be recycled into the Don Plant process.
- Groundwater monitoring and evaluation shall be conducted as part of the cleanup remedy to determine the effectiveness of the extraction system and other source control measures in reducing the contamination in the Simplot OU and preventing migration of contaminants to the Off-Plant OU.
- Simplot shall implement legally enforceable land-use controls that will run with the land (i.e., deed restrictions, limited access, well restrictions and/or well head protection) to prevent ingestion of groundwater with COCs above MCLs or RBCs.

In the 2002 Remedial Design/Remedial Action Consent Decree SOW, EPA recognizes that operation of the extraction system may not necessarily result in achievement of the MCLs or RBCs throughout the OU and has not identified this as a performance criterion until closure of the gypsum stack. After closure of the gypsum stack, operation and maintenance of this system will continue until COCs in groundwater throughout the Simplot OU are reduced to below MCLs or RBCs, or until EPA determines that continued groundwater extraction would not be expected to result in additional cost effective reduction in contaminant concentrations within the Simplot OU. Institutional controls will remain in place to control groundwater use until MCLs or RBCs are achieved in the Simplot OU.

The interim ROD amendment (EPA 2010) identified the major components of the preferred remedy, as follows:

- Consider phosphoric acid a hazardous substance and Contaminant of Concern (COC) at the site;
- Describe and quantify ongoing and past releases of COCs at or near the phosphoric acid plant;
- Develop and implement a verifiable plan to control the sources of phosphorus and other COC releases to the environment at or from the Simplot OU;
- Install a synthetic liner on the receiving surface of the gypsum stack to reduce infiltration of contaminates through the stack into groundwater;
- Develop protective numerical cleanup levels for COCs in groundwater migrating toward the Portneuf River consistent with the Total Maximum Daily Load (TMDL) established for the River, and identify monitoring points in the River and groundwater;
- Continue to develop, operate, maintain, and augment to the extent necessary, if any, the groundwater extraction system to keep COC levels at or below cleanup standards.

2.3 Monitoring Objectives

Groundwater and surface water monitoring objectives are described in the following sections.

2.3.1 Groundwater

The objective of groundwater monitoring is to collect sufficient data of adequate quality to evaluate the performance of the extraction system and other source control measures in reducing the extent and concentration of arsenic, phosphorus, and other COCs in groundwater in the Simplot OU and in preventing migration of arsenic, phosphorus, and other COCs into the Off-Plant OU at concentrations above MCLs or groundwater RBCs (where there is an MCL, the MCL shall control). Specifically, components of the

monitoring program will provide data to document the effectiveness of the extraction system in capturing seepage from the gypsum stack, to track water quality in areas potentially affected by sources other than gypsum stack seepage, and to confirm the attainment of performance standards and the long-term effectiveness of the remedy.

Performance standards for groundwater monitoring are as follows:

- Groundwater samples will be collected from wells on a quarterly basis for a period of five years and the samples analyzed for arsenic, phosphorus and other site related constituents. The specific wells to be monitored, the analytes, and the data evaluation procedures will be provided in this report.
- After the five-year period, the monitoring locations and frequency will be evaluated and monitoring will continue on at least a semiannual basis.
- Monitoring of Batiste Spring and other locations in the Off-Plant OU will be initiated on a quarterly basis at the time of system startup. After successful demonstration of compliance with the performance standard, samples will be collected semi-annually. The data evaluation procedures are provided in the Groundwater Monitoring Remedial Design Report (RDR).
- The performance monitoring strategy shall provide a mechanism to identify when additional contingency actions are required, and shall measure progress toward achieving final groundwater RBCs as measured at the locations approved by EPA pursuant to the Consent Decree (SOW Section III.D.7.d).

2.3.2 Surface Water

The objective of surface water monitoring is to collect sufficient data of adequate quality to evaluate the performance of the groundwater extraction system and source control measures. The performance monitoring strategy shall provide a mechanism to identify when additional contingency actions are required, and shall measure progress toward achieving final surface water RBCs to be developed by EPA and as measured at the locations approved by EPA. Under the draft 2010 CERCLA Consent Decree SOW, Simplot is required to submit a report documenting proposed RBCs by December 1, 2013. The surface water monitoring program is also required by the VCO/CA, Section 5 (c) (ii), in order to evaluate progress made toward VCO/CA concentration-based requirements.

- The VCO/CA specifies meeting the following concentration-based requirements in the Portneuf River as measured at Siphon Road, as listed below. The baseline condition determined by IDEQ is 1.250 mg/L as the annual median of monthly samples, based on data collected from 2004 to 2007.
- Achieve a 50 percent reduction (0.625 mg/L) in the concentration of phosphorus in the Portneuf River as measured by the annual median of monthly samples collected at Siphon Road by December 31, 2013.
- Achieve a 75 percent reduction (0.938 mg/L) in the concentration of phosphorus in the Portneuf River as measured by the annual median of monthly samples collected at Siphon Road by December 31, 2015.

- Achieve a 94 percent reduction (1.175 mg/L) in the concentration of phosphorus in the Portneuf River as measured by the annual median of monthly samples collected at Siphon Road by December 31, 2021. This level equates to the water quality target of 0.075 mg/L established for phosphorus for this segment of river as set forth in the VCO/CA.

2.4 Groundwater Monitoring System Design

The groundwater and surface water monitoring plan is in the process of being finalized. The groundwater monitoring system in the Simplot OU has been divided into five sub-areas based on monitoring objectives and performance criteria. The sub-areas are shown in Figure 2-1. The sub-areas are as follows:

- Don Plant Area
- Phosphoric acid plant area (in Don Plant Area)
- Target capture zones (in Don Plant Area)
- Assessment Area
- Compliance Area

The Don Plant Area includes potential source areas, areas immediately downgradient of potential source areas, and the target capture zones. The monitoring well network in this area needs to provide groundwater quality data that can be used to track constituent concentration trends, evaluate the migration of and concentrations of constituents in groundwater to the target capture zones, and assess the adequacy of the target capture zones. The network also needs to provide water level data at a sufficient scale so that groundwater gradients and flow paths can be evaluated.

The phosphoric acid plant area is superimposed on the Don Plant Area since this area has additional monitoring requirements. Data collection needs in this area also includes frequent monitoring of groundwater pH and other analytes if necessary to assess the effectiveness of source controls in the area.

The target capture zones are also superimposed on the Don Plant Area due to additional monitoring requirements. Data collection needs in these zones also include tracking groundwater flow and water levels in extraction wells, and the evaluation of the quarterly water level and chemistry data from monitoring and extraction wells to assess extraction well capture.

The Assessment Area is downgradient of the groundwater extraction system and extends to the compliance area. The groundwater monitoring network in this area needs to provide sufficient lateral and vertical spacing to delineate the plume of groundwater affected by Simplot operations. Water quality and water-level data will be collected from the network of wells to confirm the position of the plume, assess trends in water quality, and assess groundwater gradients and flow paths. In addition, a subset of monitoring

wells in the upgradient portion of this area will be used to provide an interim target concentration that can be compared to the concentrations in the Compliance Area.

The Compliance Area is where groundwater concentrations will be measured and compared against applicable water quality standards. Similar to the Assessment Area, monitoring wells need to be placed at appropriate lateral and vertical spacing to delineate the position of the plume of affected groundwater prior to discharge to the Portneuf River.

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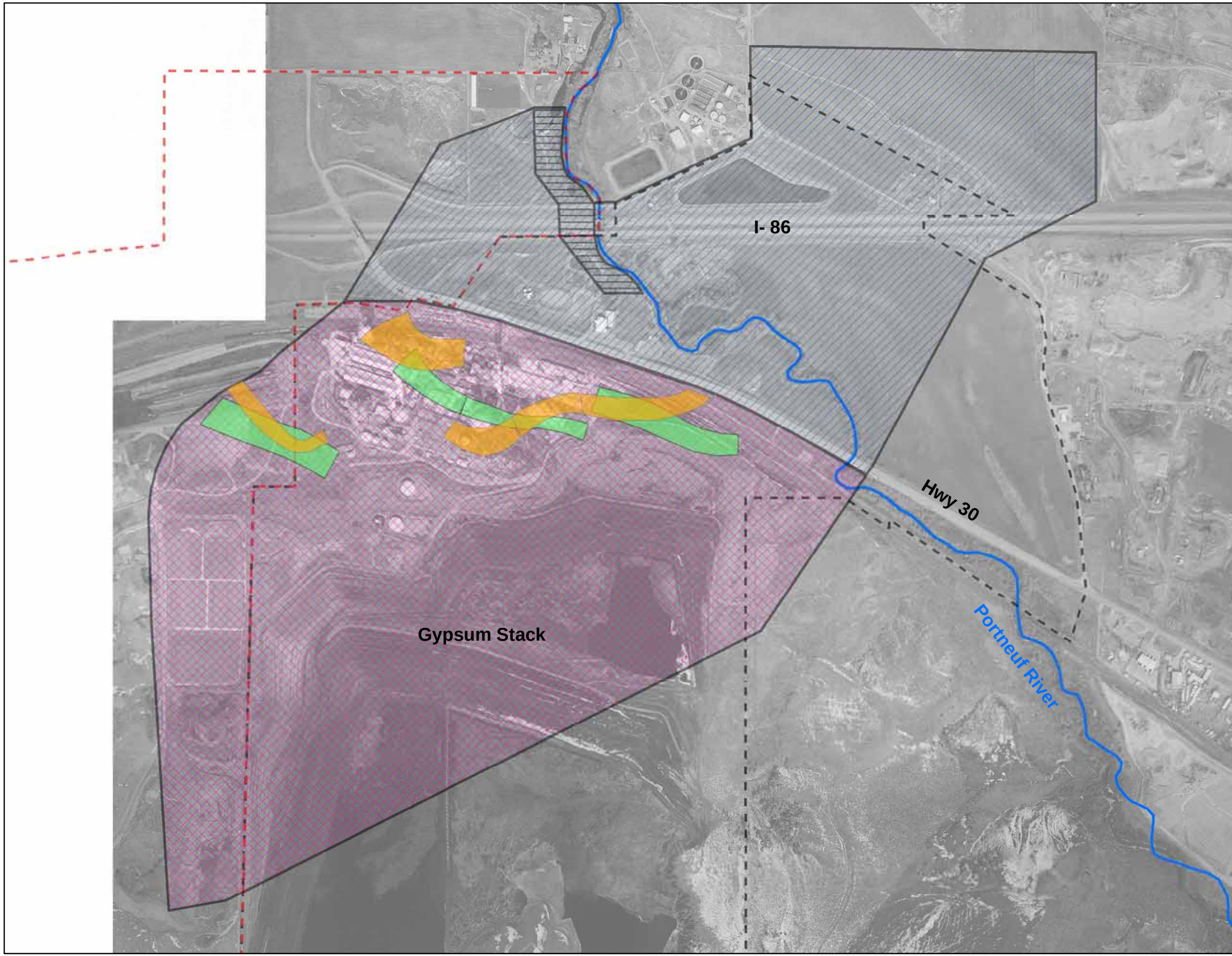

Legend

GW Monitoring Areas

- Compliance Area
- Assessment Area
- Don Plant Area
- Target Capture - Upper Zone
- Target Capture - Lower Zone

Operable Unit

- FMC
- SIMPLOT
- PortneufRiver

Feet

0 1,000 2,000

J.R. SIMPLOT

EASTERN MICHAUD FLATS

FIGURE 2-1

MONITORING AREAS

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FORMATION ENVIRONMENTAL

Items described in either the Groundwater and Surface Water Monitoring Plan (Formation 2009a) or the VCO/CA (IDEQ 2008) for annual reporting include the following:

- Narrative summary of sampling and analysis activities;
- Narrative summary of analytical data quality;
- Tabulated analytical and measurement results, by location;
- Maps illustrating the potentiometric surfaces of the Upper and Lower Zones;
- Maps illustrating distributions of indicator constituents;
- Summary of extraction system performance including an estimate of the gallons of groundwater extracted and the pounds of phosphorus in extracted groundwater;
- Demonstration of extraction well capture by the 6-step capture analysis methodology;
- Results and discussion of statistical tests and calculations performed if needed to evaluate achievement of performance standards;
- Data evaluations and time-series plots of indicator parameters for groundwater and surface water, as appropriate,
- Results of trend tests performed on time-series data, (including evaluation of other sources) as appropriate;
- An estimate of the pounds of phosphorus not released due to remedial actions; and
- Narrative discussion of results and conclusions including an assessment of the effectiveness of the extraction system to remove phosphorus from groundwater with a predicted trend toward compliance with the TMDL at Siphon Road.

3.0 SOURCE CONTROL

The interim ROD amendment (EPA 2010) includes source control for the gypsum stack and the phosphoric acid plant as a remedy objective. Source control for the gypsum stack will be achieved by lining the entire stack with an impermeable membrane. Source control for the phosphoric acid plant area will be achieved through infrastructure improvements. These controls are described in the following sections.

3.1 Gypsum Stack Lining

Lining of the existing gypsum stack will be performed as a source control action to reduce seepage and loading of phosphorus and arsenic to groundwater beneath the stack. As a result, the stack lining is expected to eventually reduce concentrations of phosphorus and arsenic in the plant area below levels of concern. This will allow the groundwater extraction system to be phased out of operation when reduced concentrations are verified by the groundwater monitoring system. A detailed description of the effects of gypsum stack seepage on groundwater quality and loading to the Portneuf River is provided as part of the groundwater conceptual site model (CSM) in the Groundwater RDR (Formation 2009b). The technical challenges of lining the gypsum stack are significant. The gypsum stack is currently operated in three compartments, a lower stack and an upper stack that is divided into two compartments (Figure 3-1). A multi-year approach will be used to execute the lining with the lower stack being lined first followed by the west compartment of the upper stack then the east compartment of the upper stack. A detailed engineering assessment along with preliminary design drawings and specifications for the first phase of the project are included in Appendix A of the Remedial Action Plan (Simplot 2009a). An overview of the lining project is provided in the following paragraphs.

The gypsum stack will be lined in multiple phases of work. Phase I consists of Decant Pond construction and lining of the lower stack. The Decant Pond was excavated, lined and the compacted gypsum cover was applied beginning June 16, 2009 and completed on October 16, 2009. Electrical and pump installations were completed in 2009. In response to DEQ comments, Simplot has agreed to conduct a seepage test during the spring of 2010 to confirm that the lined system and pond leak less than 1/8 of an inch per day. A draft seepage test plan was submitted to DEQ on October 9, 2009 and comments were received on November 9, 2009. A final version of the plan and responses to comments were submitted on December 15, 2009. DEQ approval of the Seepage Test Plan was received on December 29, 2009. The final plan includes the schedule of filling, stabilization and seepage testing of the Decant Pond. Decant Pond piping tie-ins will be finalized after the seepage test is completed. Design drawings for the lining of the lower compartment were submitted to the Agencies in January 2010.

The second and third phases of work include lining the upper west stack and the upper east stack, respectively. Prior to lining, the necessary infrastructure will be installed or existing infrastructure relocated. Slopes will be graded and backfilled when necessary.

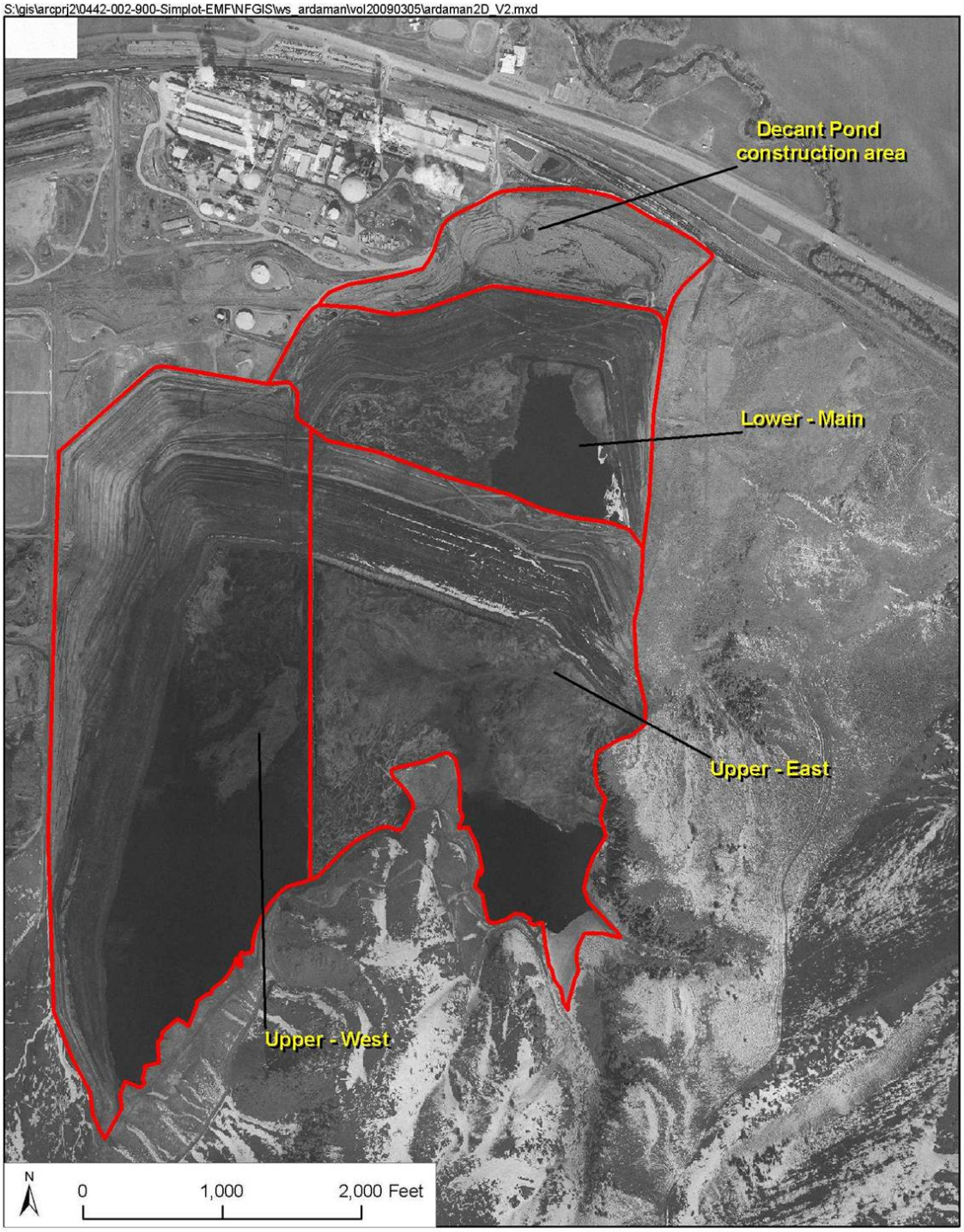


Figure 3-1: Sections of the gypsum stack.

A preliminary schedule that allows for all the elements of work to be completed is as follows:

Decant Pond:

Build new road and begin pond excavation	June 2009
Line Decant Pond	August 2009
Construct piping and control structure	September 2009
Seepage testing	April 2010
Begin using Decant Pond	May 2010

Lower Stack:

Start of supplemental dike building may begin in 2009 and may need to continue for a full year.
In March 2010, construction will start.
Use of the lower stack would occur in November 2010

Upper West Stack:

Build the final upper road late 2010 or early in 2011
Move the power line during the spring of 2011
Prepare the slope during the construction season of 2011
Line the west stack using a schedule similar to that of the lower stack the previously during the construction season of 2012

Upper East Stack:

Prepare the upper slope during the construction seasons of 2011-2013
Rough grade and prepare area for storm water catch basin in 2013
Line the east stack using a schedule similar to that of the west stack during the construction season of 2014. Time management during this construction season will be made more critical by the time required to build additional starter dike in the south-east corner of stack and the storm water diversion ditch.

3.2 Phosphoric Acid Plant Area Controls

Improvements in the phosphoric acid plant area have been and will be performed as both short-term and long-term actions to eliminate the seepage to and loading of phosphorus to soils and groundwater beneath the plant area.

A detailed description of the sources in the phosphoric acid plant area and the influence of sources on groundwater quality and loading to the Portneuf River is provided in Technical Report No. 1 (Simplot 2009b). This section briefly summarizes recent and planned improvements to the Don Plant Production Areas. These improvements include maintenance and repair activities designed to minimize the potential of releases. Projects planned for 2010 are described in detail in the 2010 Draft Infrastructure Improvement Plan (Simplot 2010).

Preventing Releases

Releases will be prevented through source control as well as operational changes, such as modifications to tank cleanout procedures and an enhanced plant management focus on employee awareness.

Suspected past release points have included pads and sumps. Production area improvements have focused repairs in these areas and a comprehensive sump and pad inspection procedure is in place.

At a minimum, every sump and pad area in the plant is inspected on a monthly basis by operations personnel. The inspection involves a detailed walk through of all pad areas which drain to sumps. It also requires an inspection of the process streams, launders, piping and pumping systems contained within the pad areas. The operators look for leaks, deteriorated pad areas, missing bricks, cracks, etc. and report their findings on a formal report. This report is reviewed by area supervision, and then passed on to the Environmental Department for record keeping and tracking purposes. Operators and area supervisors are also responsible for writing work orders and following through with maintenance personnel to insure any necessary repairs are made in as timely a manner as possible. If concerns are identified during a pad or sump inspection, more frequent inspections may be conducted. Process sumps and pads are also visually observed on a daily basis by area supervisors and other plant personnel.

The inspection procedure also requires a detailed inspection of each sump basin to be performed on a quarterly basis. During this inspection, all material is sucked out of the sump basin and a detailed inspection by operating personnel and supervision is conducted. The sump collection basin itself is thoroughly inspected for leaks, cracks and deterioration during this inspection. Any problems are documented, reported and repairs are made before the sump is placed back in service. Work orders associated with vessel and sump repairs from 2006 to February 2009 are included in Table 5.1 of Technical Report No. 1 (Simplot 2009b).

During the monthly inspections, secondary containment ports are opened and any liquid contained in the secondary containment area is measured, sampled, and pumped out. Samples are typically analyzed for pH and phosphorus (measured as P_2O_5). This information is used to track and monitor possible concerns in sump and pad areas. The presence or absence of liquid as well as the pH of any liquid in secondary containments is tracked on at least a monthly basis and is a major factor in identifying areas of concern and prioritizing potential future projects. If more than a de minimis volume of low pH liquid is found in a secondary containment, more frequent (at least twice a month) inspections of the secondary containment system and sump are conducted. The results of these additional inspections (activities, date, volume of liquid removed, etc.) are documented and attached to the monthly sump inspection form. If low pH liquids are

observed in a secondary containment system on a repetitive basis, the necessary resources will be assembled to identify and correct the source of the problem.

The inspection and maintenance of sump and pad areas is monitored by the Don Plant Sump and Pad Team. This team consists of various members of the Don Plant staff representing the engineering, production, maintenance, safety, and environmental departments. The team meets monthly to review inspection reports, track maintenance activities, and set priorities for large scale pad and sump area repairs (capital projects). This team is led by the Don Plant Production Manager. A monthly inspection summary report is generated by this team and distributed to senior plant management.

Many tanks have leak detection ports underneath them. These ports consist of channels in the concrete support underneath the tanks which will direct leaking material from beneath the tank to the side of the tank where it can be detected. Production area supervisors track the inspection and cleaning of these ports which is completed on a weekly basis by operating personnel.

If process material is released to a pad area, it is cleaned up as quickly as possible. It is not our practice to "store" material on the pads. Simplot is very aggressive in keeping all process material contained. Pumps and line leaks are repaired as soon as possible. If a release to a pad is not able to be quickly stopped (such as a pump repair that is awaiting parts), additional containment/release controls, as appropriate, will be put in place until repairs are completed. The additional measures will be inspected daily until the repairs are completed.

3.2.1 Don Plant Projects Completed

The Don Plant engineering staff has completed a number of major improvement projects in the production area. Recent projects are listed in Table 3-1. In addition to these projects, the Don Plant has conducted other maintenance and repair activities. These are described in Technical Report No. 1 (Simplot 2009b) and phosphoric acid plant area projects are reported monthly in the Phosphoric Acid Plant Groundwater Data Summary Reports. Detailed scopes and schedules for these projects were presented as an attachment to the Draft Infrastructure Improvement Plan (Simplot 2010).

Table 3-1 Phosphoric Acid Plant Projects Completed Since January 1, 2009

Project	$
SPA Car Wash Replacement	$1,390,000
Tank 9 Floor Repair/Replacement	$240,000
Concrete Pad Replacement in Sump 5 Pad Area	$155,000
SPA West Aging Pad Evaluation and Repairs (phase I)	$45,000
SPA HPA Re-pulp Launder and Pad Evaluation and Repair (phase I)	$2,500

4.0 GROUNDWATER EXTRACTION SYSTEM

Under CERCLA, the design of the existing groundwater extraction system has been conducted using a "phased and integrated approach" (EPA 1997). In this approach, extraction wells have been installed and tested to provide location-specific performance data. Monitoring wells and exploratory borings have also been installed in phases to address specific data gaps in the site conceptual model for groundwater. Uncertainties in the conceptual site model (CSM) for groundwater have been greatly reduced with the completion of each phase of the extraction system and sufficient information is now available to design the remaining elements of the system, demonstrate that the complete system will meet remedy objectives, and plan the steps necessary to implement the design.

The groundwater extraction system currently consists of 14 extraction wells that were installed in two prior phases of work; phase 1 in 2003-2004 and phase 2 in 2007-2008. In the remedial design report a third phase of extraction well installation is proposed. In the third phase well 410 will be replaced with a new multi-level extraction well (421), two of the wells installed during the phosphoric acid plant subsurface investigation will be converted to extraction wells (wells 416 and 419), and an additional extraction well is proposed east of the existing well 413 (422). The locations of the extraction wells are shown in Figure 4-1. The design of the groundwater extraction and monitoring systems is presented in detail in the Groundwater Extraction and Monitoring System Remedial Design Report (Formation 2009b).

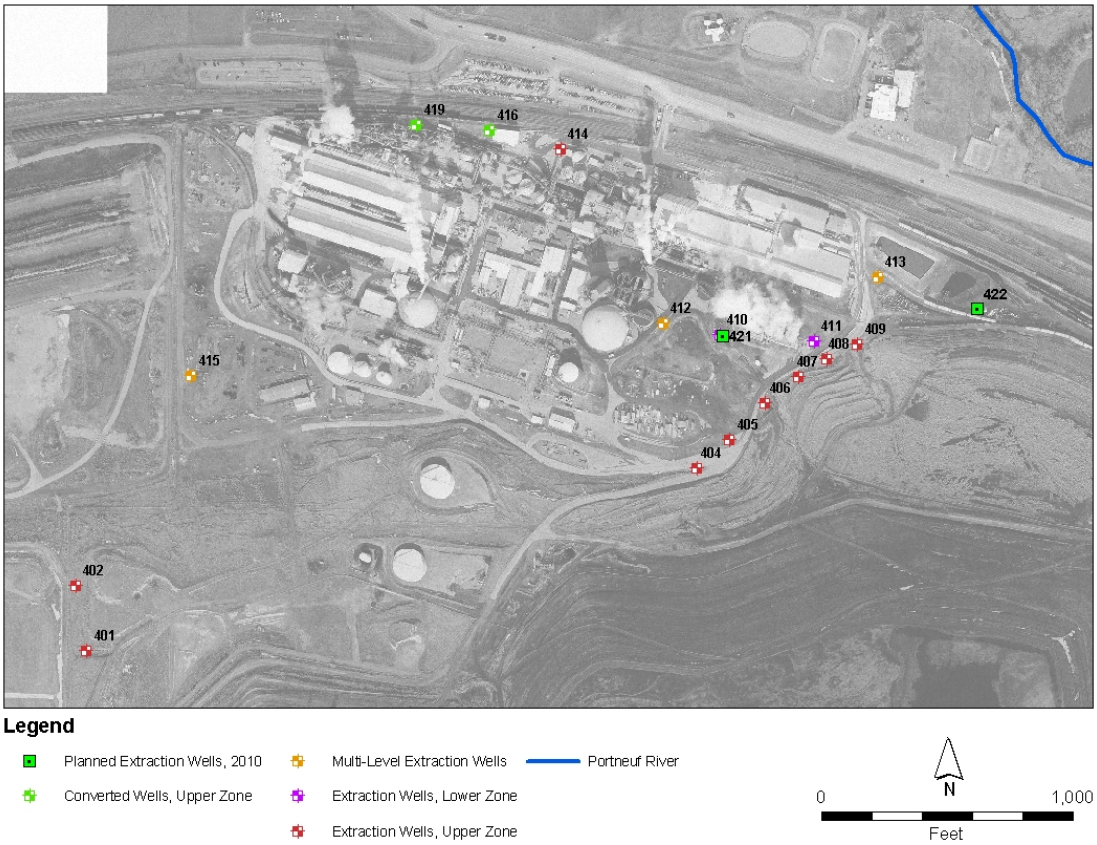


Figure 4-1: Location of existing extraction wells, monitoring wells 416 and 419 to be converted to extraction, and new multi-level wells, 421, and 422.

Data related to the extraction system operation and to groundwater monitoring in 2009 have been provided previously in a variety of reports:

- Groundwater extraction flows, operation data, and maintenance activities have been documented in weekly and monthly reports provided via e-mail;
- Groundwater extraction system operational summaries have been provided in four quarterly reports (NewFields 2009a, b; Formation 2009c; Formation 2010a); and
- Groundwater monitoring data have been provided in four quarterly reports (NewFields 2009c, d; Formation 2009d; Formation 2010b).

This section provides an analysis of annual data, including extraction well performance, and an assessment of the effects of extraction on downgradient groundwater chemistry and other data trends. Information on the groundwater extraction system operation in 2009 is provided in Section 4.1. Section 4.2 provides a well maintenance summary, while Section 4.3 provides a well performance summary. The additional extraction wells are discussed in Section 4.4 and an evaluation of water flows within the Don Plant process is described in Section 4.5.

4.1 Well Operation Summary

The extraction system was operated throughout the year. The system was shut down from May 30th to July 1st when the facility was taken offline for routine annual maintenance (plant "turnaround").

A summary of the operation of the extraction wells, including percent time online, and extraction rates during 2009 for each well is presented in Table 4-1. Using the time each well was online and the average extraction rate, the total groundwater extracted in 2009 was evaluated.

Table 4-1: Extraction Well 2009 Operation Summary.

Extraction Well	Time Well Online (%)[1]	Operating Extraction Rate (gpm)[1]		Remedy Extraction Rate (gpm)[2]	Total Groundwater Extracted in 2009[1] (million gal)
		Maximum	Average		
West Plant Area					
401	96.4	36.8	23.3	40	11.4
402	97.4	52.3	44.8	20	22.1
415	99.9	78	60.7	50	30.6
Central Plant Area – Upper Zone					
414	92.8	24.1	19.2	25	9
East Plant Area – Upper Zone					
404	99.9	4	2.1	2	1.1
405	19	1.2	0.4	3	0
406	99.9	16.9	12	15	6.1
407	97.8	8.1	4.8	6	2.4
408	8.9	1.5	0	0	0
409	99.9	4.6	3.6	4	1.8
East Plant Area – Multi Zone					
410	99.2	91.9	80.4	0	40.3
411	97.7	76.5	60.6	80	29.9
412	99.9	424.3	399.2	400	201.6
413	100	117.7	111.5	125	56.4
		Total:	**822.5 gpm**	**Total:**	**413 million gal**

[1]*Excludes the shut-down time due to the Don Plant turnaround.*
[2]*Remedy extraction rates are final planned extraction rates from the Remedial Design Report. This does not include planned multi-level wells 421 (170 gpm) and 422 (100 gpm). 421 will replace well 410, therefore the remedy flow in well 410 is zero. The remedy flow in well 408 is also planned to be zero.*

All extraction wells except wells 405 and 408 were in operation greater than 90 percent of the year (excluding the down time from the Don Plant turnaround). Well 405 had decreasing water levels during the first part of the year resulting in numerous low-level alarms and the well going off line. After turnaround the well was restarted, however,

low-level alarms continued so it was decided in mid-August to permanently take the well off line and convert it to a monitoring well. Well 408 operated briefly during 2009 but was put off line because of insufficient saturated thickness to maintain groundwater extraction. Both wells will not be monitored while they are not pumping.

A summary of the removal of key constituents by the extraction system is provided in Table 4-2.

Table 4-2: Mass Removal Summary, Extraction System.

Extraction Well	Average Operating Extraction Rate (gpm)[1]	2009 Mass Removal (lb/day)[2]		
		Arsenic	Phosphorus	Sulfate
West Plant Area				
401	23.3	0.10	47.3	597.7
402	44.8	0.23	77.5	1,282.1
415	60.7	0.16	30.6	1,006.9
	Subtotal	0.49	155.4	2,886.7
Central Plant Area – Upper Zone				
414	19.2	0.06	27.2	374.9
East Plant Area – Upper Zone				
404	2.1	0.01	3.8	61.1
405	0.4	0	1.9	10.9
406	12.0	0.04	96.4	373.3
407	4.8	0.02	36.1	122.7
408	0.0	0	0.1	0.7
409	3.6	0.01	16.4	102.5
	Subtotal	0.08	154.7	671.2
East Plant Area – multi-level				
410	80.4	0.29	339.9	2,242.2
411	60.6	0.20	258.8	1,681.1
412	399.2	0.97	754.5	6,777.0
413	111.5	0.36	240.3	2,686.4
	Subtotal	1.67	1,593.5	13,386.7
TOTAL	**823**	**2.3**	**1,930**	**17,319**

[1] *Excludes the shut-down time due to the Don Plant turnaround.*

[2] *Calculated using the average flow volume discharged each quarter multiplied by that quarter's sampling results.*

Stack-affected groundwater was also removed by facility production well SWP-4. Based on the average quarterly flow rate and the measured concentrations each quarter, it is estimated that SWP-4 removed from 0.08 to 0.19 lbs/day of arsenic, 8.6 to 23.5 lbs/day phosphorus, and 738 to 1,632 lbs/day sulfate.

4.2 Well Maintenance Summary

4.2.1 West Plant Extraction Wells

The West Plant extraction wells (401, 402, and 415) were operated without significant problems most of 2009. In early January wells 401 and 402 were shut down because the discharge line was frozen and needed repair. Repairs were completed and both wells were brought on line by January 10th. Well 401 began experiencing low level alarm problems in mid-February. The well was reset to pump at lower rates. After turnaround the well has operated with no problems at higher extraction rates than before turnaround. Well 402 functioned without incident for most of 2009. Well 415 a multi-level extraction well with screened intervals in both the Upper and Lower Zones operated without any significant down time during 2009. The well was shut down for brief periods to allow for repair work to be performed on the discharge line and replace a leaky flange. No shut down period lasted longer than two hours.

Water extracted from these wells is routed to join the flow from the East Plant Extraction wells. The combined flow goes to an extraction well collection tank and is subsequently used in the phosphoric acid plant. During periods of low demand or upset conditions the extraction well water is routed to the phosphoric acid plant cooling towers. Once in the cooling towers the water is recycled into the phosphoric acid plant for cooling use.

4.2.2 Central Plant Extraction Well

Well 414 is a shallow extraction well in the Central Plant and is screened in the Upper Zone. The well was installed as part of the Phase 2 Data Gap Investigation and was brought online in January 2008. Brief interruptions to pumping were encountered due to discharge line maintenance and construction of discharge line tie-ins for future extraction wells 416 and 419.

Extracted water from well 414 is placed in a lined sump that recycles the water into plant processes.

4.2.3 East Plant Upper Zone Extraction Wells

Most of the East Plant Upper Zone extraction wells (404 through 409) were operated without significant problems in 2009. Some of the wells experienced electrical problems that required the wells to be temporarily shut down. However, the shut downs did not last more than a couple of hours. Wells 405 and 408 experienced the most maintenance issues.

Well 405 saw a slow decrease in the suitable amount of water within the well to pump. After turnaround the well was restarted only to be shut off permanently on July 13th. It was at this time that the well was put off line.

Well 408 never operated for any significant amount of time during 2009 due to insufficient saturated volume to allow pumping without damaging pump equipment. The well was put off line.

Extracted water from the shallow wells is collected in the extraction well collection tank and then used in the phosphoric acid or overflowed to the cooling towers.

4.2.4 East Plant Deep Extraction Wells

The East Plant Lower Zone and multi-level extraction wells operated more than 96 percent of the time during 2009 (Table 4-1) with wells 410, 412 and 413 operating greater than 99 percent of the time. Well 411 did not immediately come online after turnaround with the other wells because of repairs being performed at the well head, the well resumed extraction on July 9th. Wells 412 and 413 are multi-level extraction wells that were installed as part of the Phase 2 Data Gap Investigation and were brought online in January 2008.

The water from these wells reports to the extraction well collection tank.

4.3 Well Performance Summary

Flow and water level data are collected continuously for each extraction well. Flow rates are measured with electromagnetic flow meters (manufactured by Krohne). In all the East Plant Upper Zone extraction wells, the water levels are measured with admittance-to-current transducers, otherwise known as capacitance probes (manufactured by Drexelbrook). The Drexelbrook level indicators are configured to provide only a relative reading of water level in the well and are primarily used to control pumping rate. In Wells 401, 402, 410, and 411 the Drexelbrook water level indicators were switched to pressure transducers (manufactured by InSitu) in August 2006. The InSitu level indicators provide more reliable pump control and may provide more accurate water level indication. All of the well pumps are fitted with a variable frequency drive (VFD) which allows the speed of the pump motor to be varied to regulate flow rate. The flow and water level data have been examined and an assessment of the performance of each well has been made, as described in the following subsections.

4.3.1 West Plant Extraction Wells

Well 401

Well 401 maintained a consistent pumping range from about 15 to 25 gpm when in operation from January to July. Some difficulty was experienced controlling the pumping rate in late February due to low-level alarms. The extraction rate was adjusted until a constant water level could be maintained. After turnaround, in early July, the well was able to maintain a pumping rate of about 28 gpm until the end of the year while maintaining a consistent water level in the well and the pump operated at a consistent speed (Figure 4-2). Based on this information, there was no apparent degradation in the performance of this well in 2009.

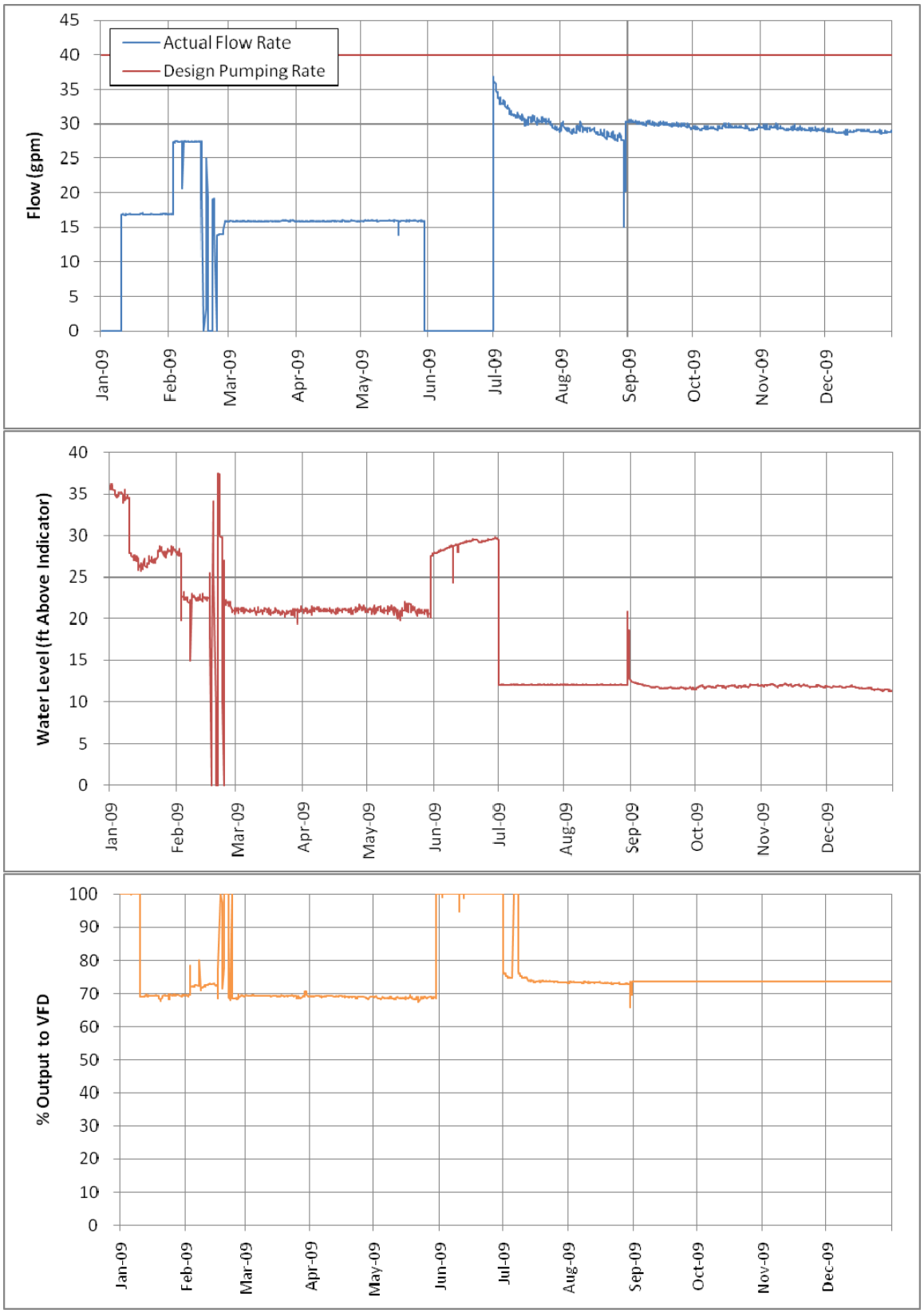


Figure 4-2: Well 401 Flow Rate, Water Level, and Relative Pump Speed.

Well 402

Well 402 operated consistently throughout 2009 maintaining a pumping rate of about 40 to 50 gpm throughout the year with the pump operating at a consistent speed and maintaining a consistent water level (Figure 4-3). Based on this information, there is no apparent degradation in the performance of this well in 2009.

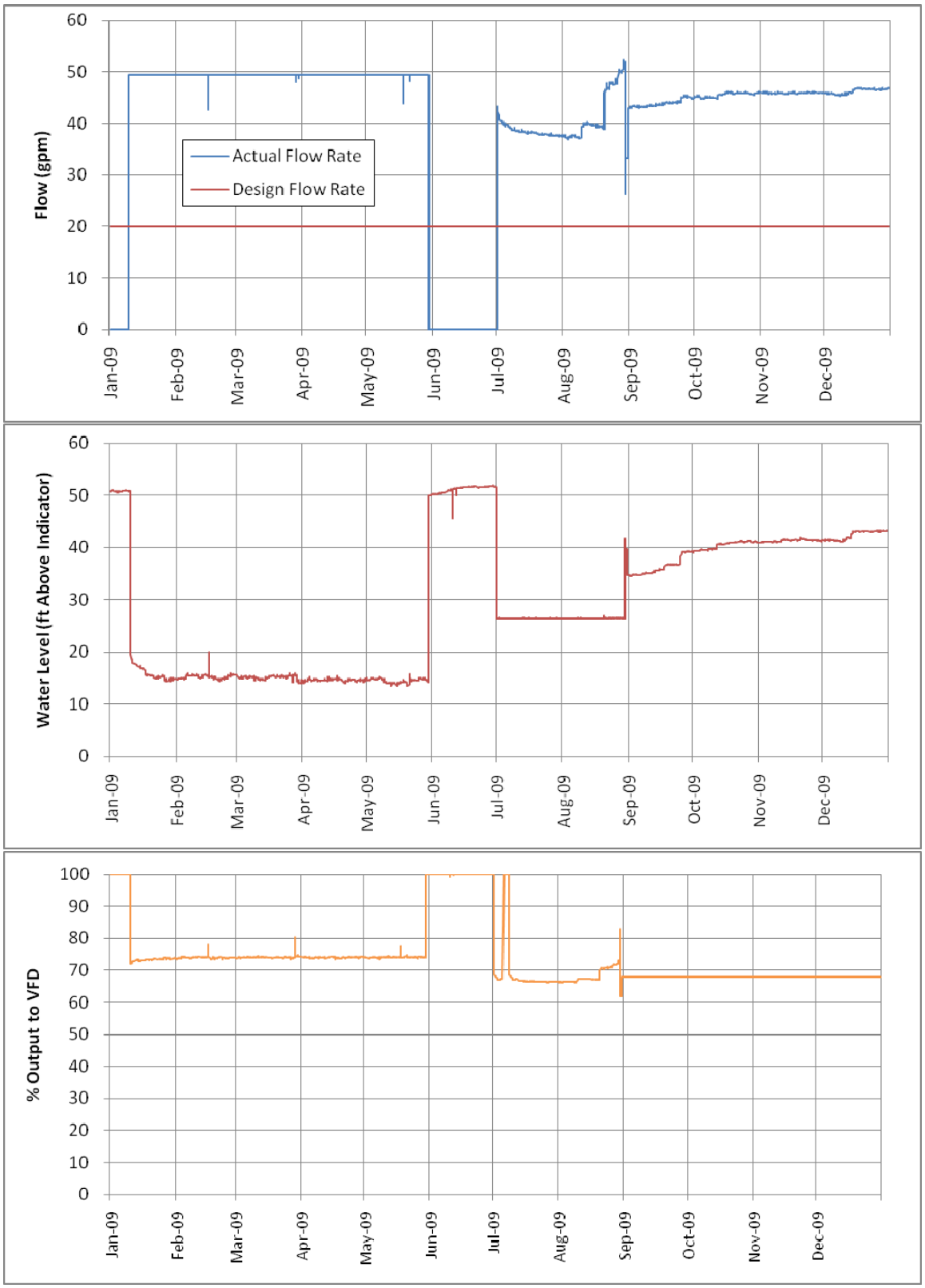


Figure 4-3: Well 402 Flow Rate, Water Level, and Relative Pump Speed.

Well 415

Well 415 is multi-level extraction well located in the West Plant Area near monitoring wells 309 and 310. The well was installed during Phase 2 field activities and began pumping in January 2008. Well 415 operated between 50 and 75 gpm throughout the year (Figure 4-4). Based on this information, there was no apparent degradation in well performance during 2009.

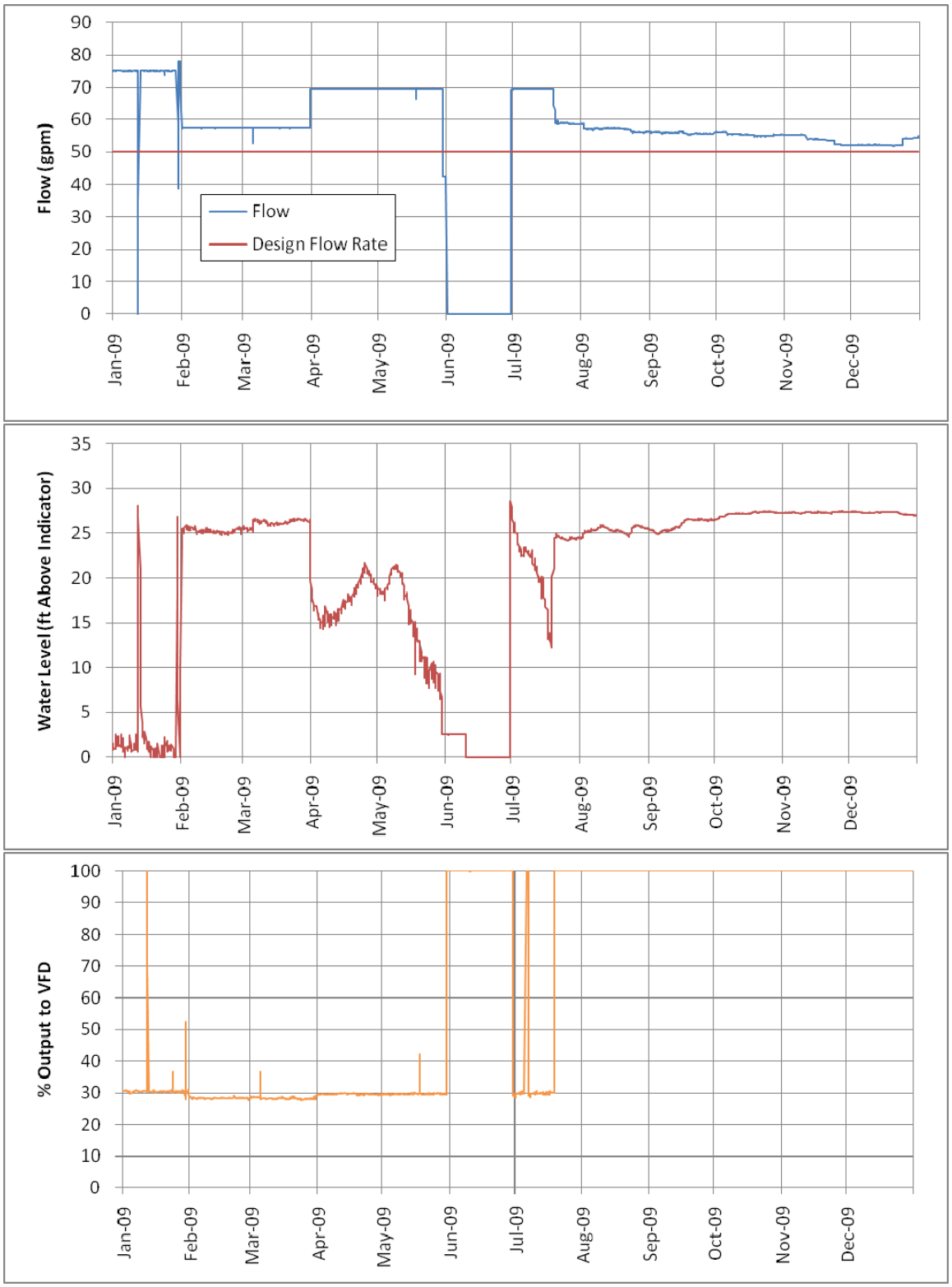


Figure 4-4: Well 415 Flow Rate, Water Level, and Relative Pump Speed.

4.3.2 Central Plant Extraction Wells

The following sub-sections provide details on the operation and performance for each well in the Central Plant Area (Upper Zone).

Well 414

Well 414 operated between approximately 18 and 24 gpm over 92.8% of the plant operational year (not including turn-around time; Figure 4-5). Based on this information, there was no apparent degradation in performance of this well in 2009.

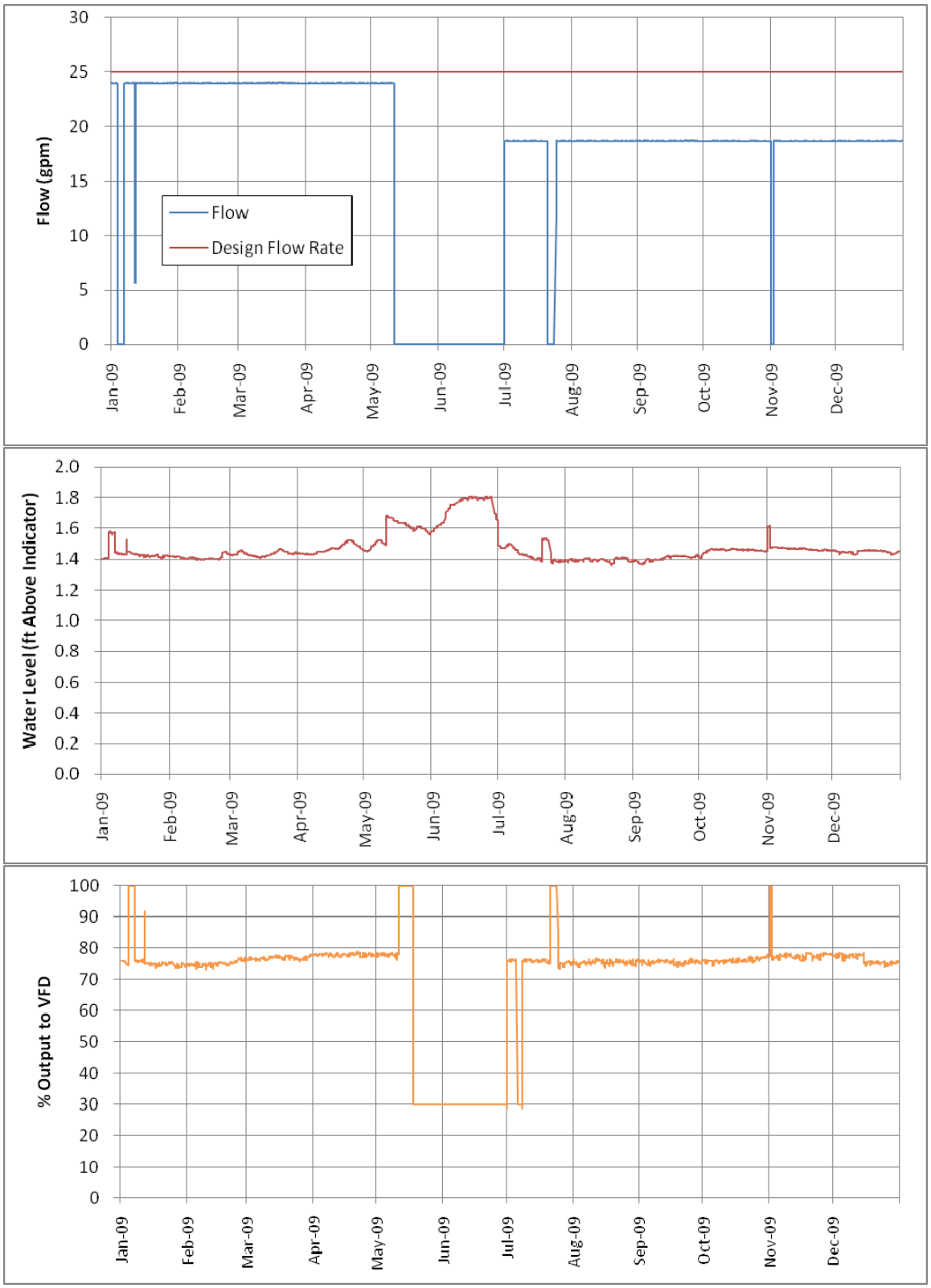


Figure 4-5: Well 414 Flow Rate, Water Level, and Relative Pump Speed.

4.3.3 East Plant Upper Zone Extraction Wells

The following sub-sections provide details on the operation and performance for each well in the East Plant Area (Upper Zone).

Well 404

Well 404 maintained a consistent pumping rate of about 1.5 to 2.5 gpm throughout the year (Figure 4-6). Based on this information, there was no apparent degradation in the performance of this well in 2009.

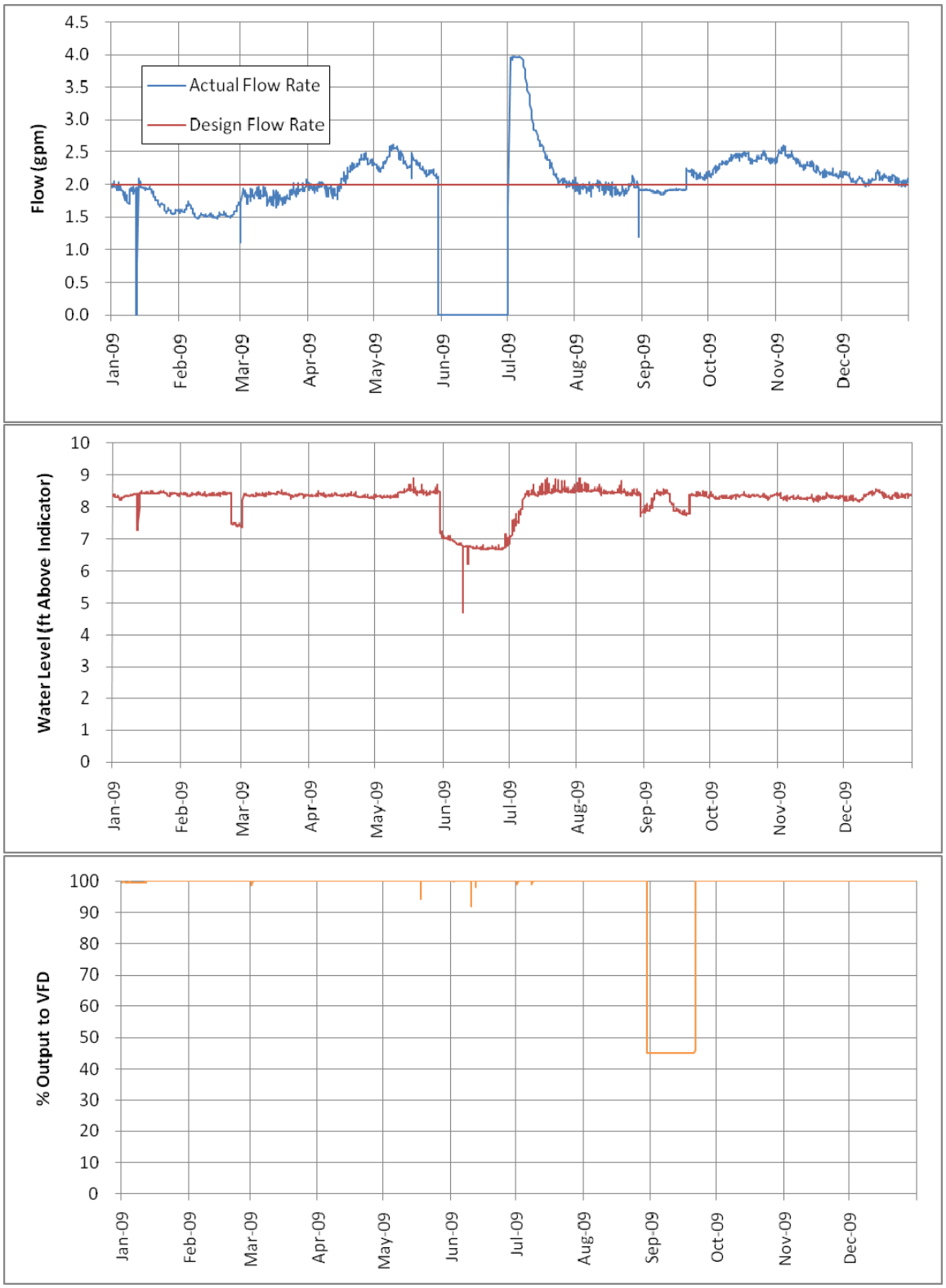


Figure 4-6: Well 404 Flow Rate, Water Level, and Relative Pump Speed.

Well 405

Well 405 began the year pumping at 1.25 gpm but the extraction rate slowly decreased over time until turnaround when it was pumping at 0.7 gpm. When the pump was brought online after turnaround it operated briefly before low water levels required that the pump be turned off to avoid permanent damage to the pump (Figure 4-7). Water level dropped to less than one foot above the pressure transducer during pumping before pumping was stopped. Based on this information, the well could no longer function as an extraction well and was put off line.

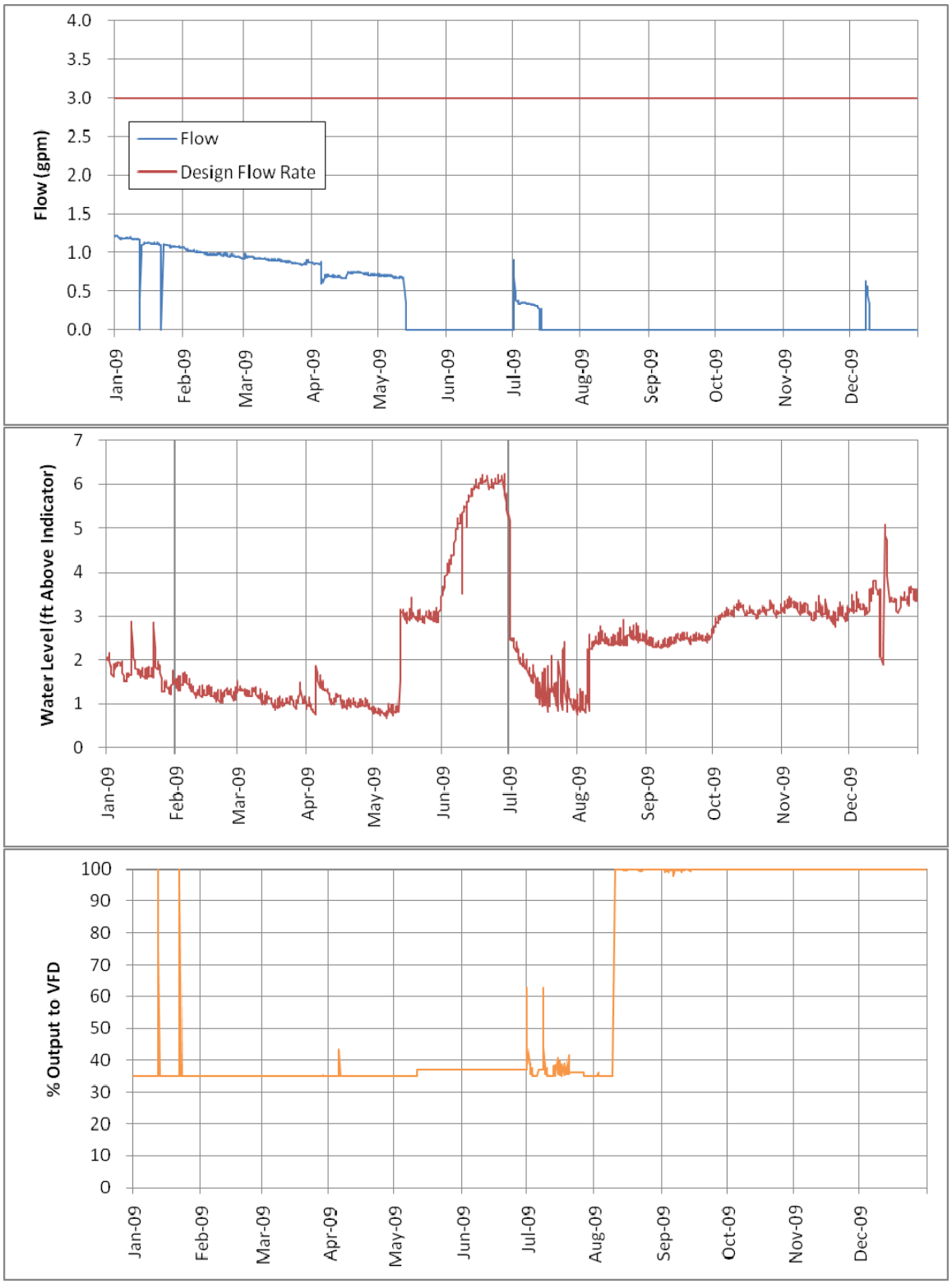


Figure 4-7: Well 405 Flow Rate, Water Level, and Relative Pump Speed.

Well 406

Well 406 operated at a steady flow rate of 10 gpm until turnaround. After turnaround the rate peaked at 16 gpm then slowly declined to a low of 6 gpm. At the beginning of September the rate was increased to 16 gpm and it remained at that level until the end of the year. Water level within the well remained constant relative to pumping rate throughout the year (Figure 4-8). Based on this information, there was no apparent degradation in the performance of this well in 2009.

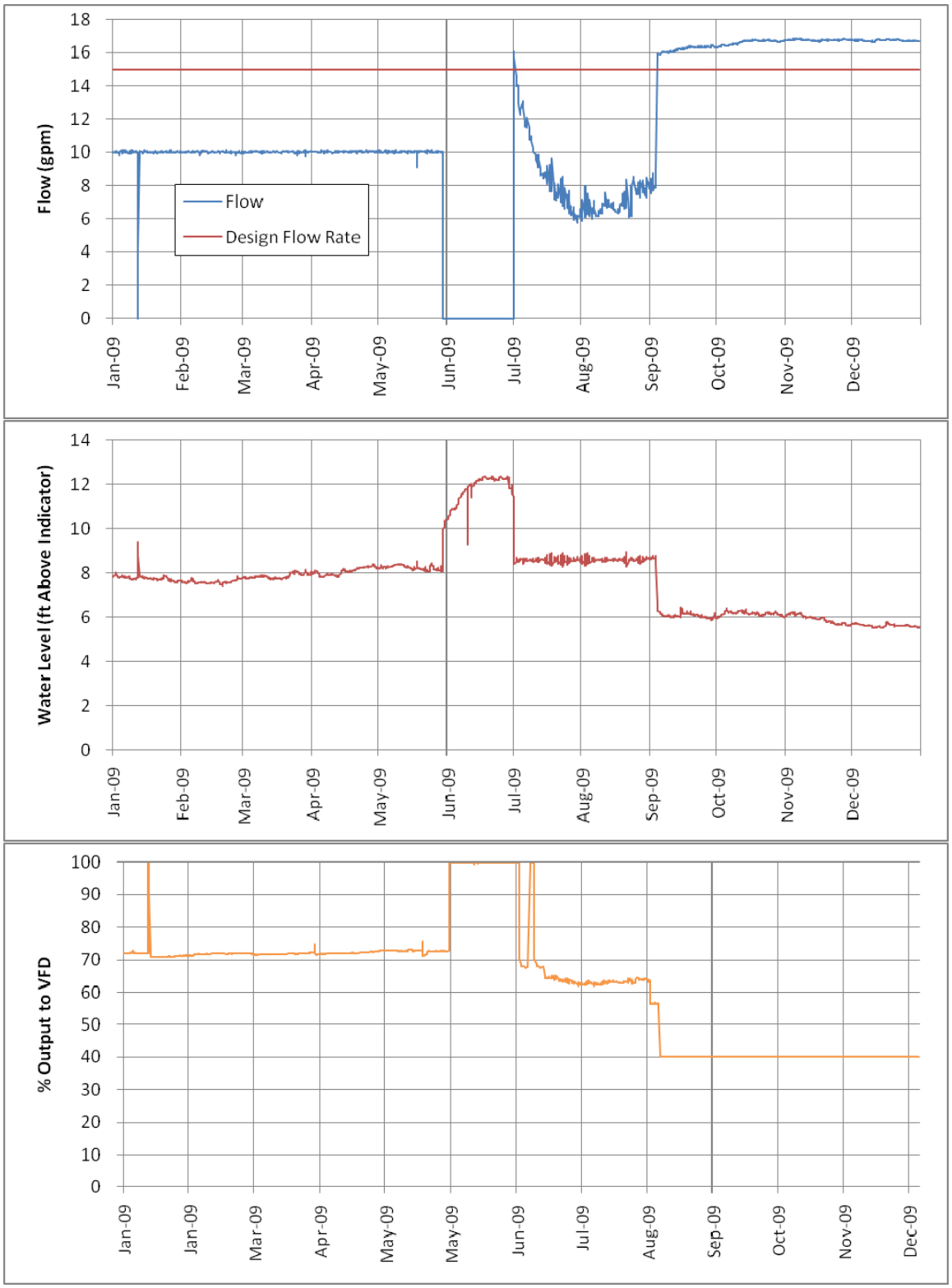


Figure 4-8: Well 406 Flow Rate, Water Level, and Relative Pump Speed.

Well 407

Well 407 maintained a pumping rate of about 4 gpm throughout the majority of the year (Figure 4-9). After turnaround the well operated at a higher rate, 8 gpm, for a couple of months. However this higher rate resulted in a low level alarm and required the well to be shut down for a couple of days. Once the water level recovered the well resumed pumping at a rate of 4 gpm. Based on this information, the well can no longer support previous extraction rate of 8 gpm due to an overall decreasing water level compared to previous years.

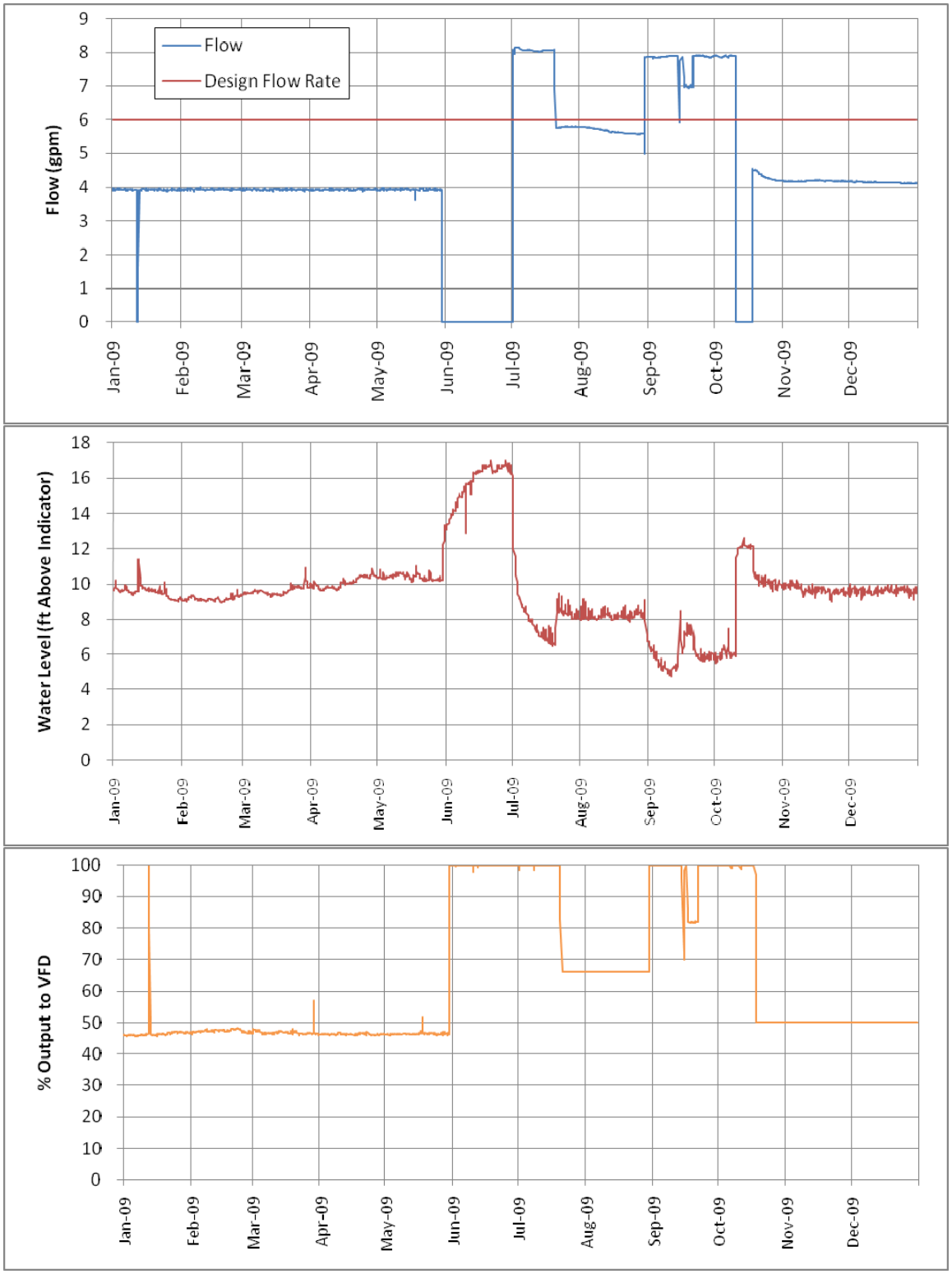


Figure 4-9: Well 407 Flow Rate, Water Level, and Relative Pump Speed.

Well 408

Well 408 did not operate during the year (Figure 4-10). When the well was briefly operated at low flow rates a large amount of drawdown was observed. Low water level during pumping required the pump be shut down to avoid permanent damage to the pump and potentially to the well screen. Well 408 was put off line at the same time as well 405.

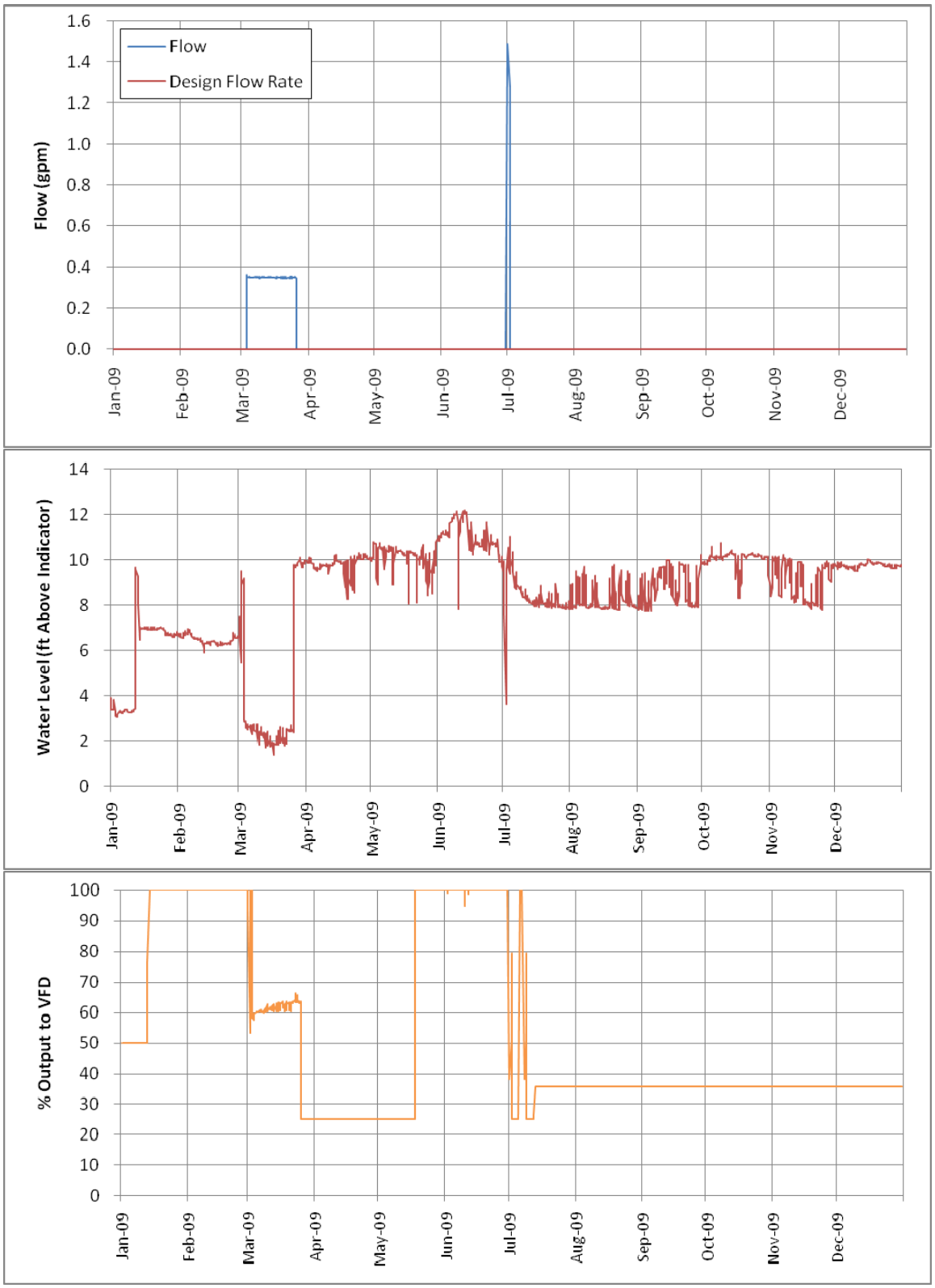


Figure 4-10: Well 408 Flow Rate, Water Level, and Relative Pump Speed.

Well 409

Well 409 maintained a consistent pumping rate of about 3.5 gpm throughout the majority of the year (Figure 4-11). Based on this information, there is no apparent degradation in the performance of this well in 2009.

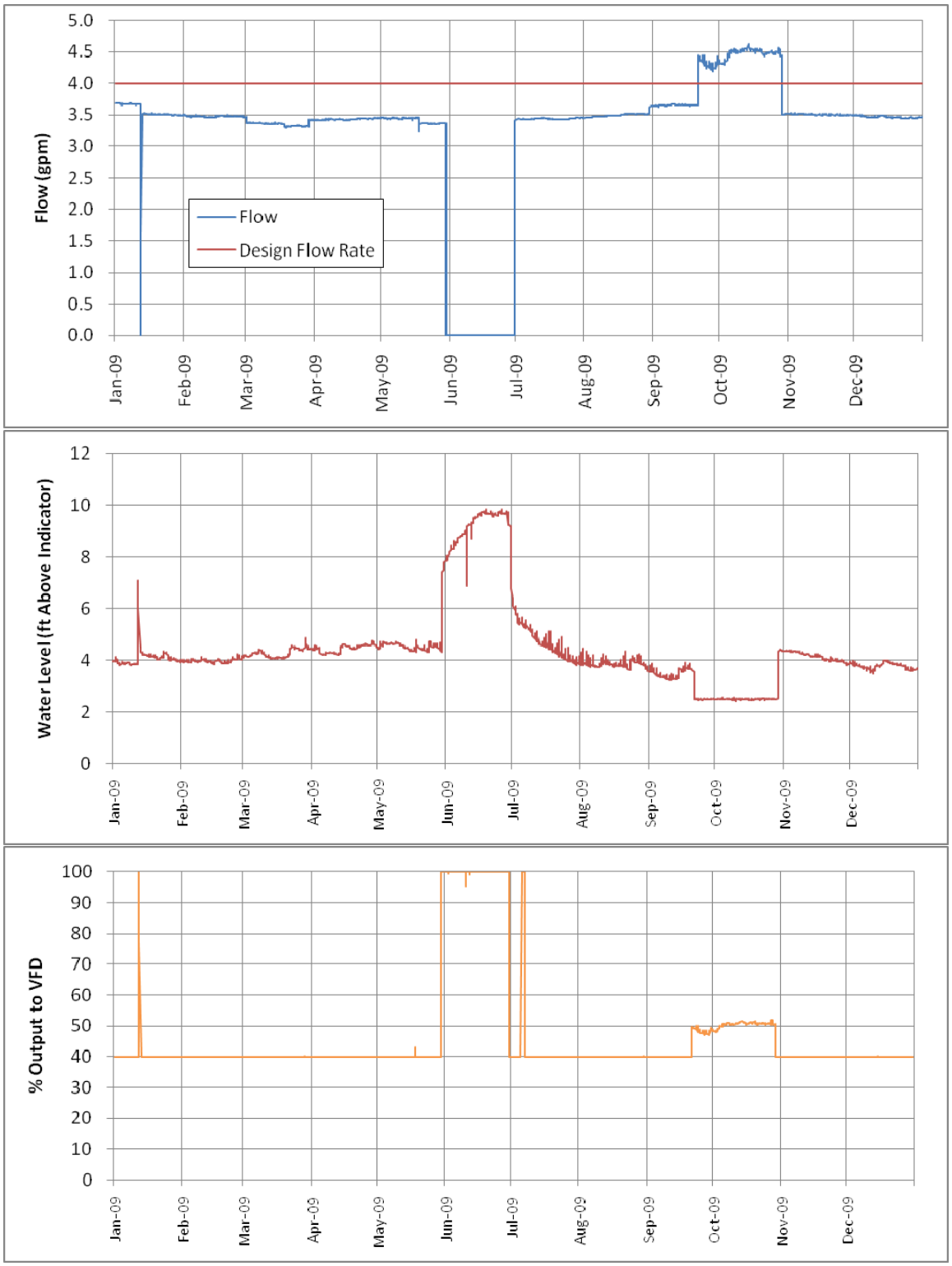


Figure 4-11: Well 409 Flow Rate, Water Level, and Relative Pump Speed.

4.3.4 East Plant Lower Zone and Multi-Level Extraction Wells

The following sub-sections give details on the operation and performance for each well in the East Plant Area (Lower Zone).

Well 410

Well 410 was operated at a flow rate of between 70 and 90 gpm throughout the year. Flow rates were generally higher after a shutdown period when the well was able to recharge, then flow declined with time, stabilizing near 80 gpm (Figure 4-12). There was no indication that the well performance significantly degraded in 2009. Another extraction well, 421, has been proposed to replace well 410 and is scheduled to be installed in 2010. Well 421 will be a multi-level extraction well with screened intervals in both the Upper and Lower Zones and is anticipated to have a greater and more consistent pumping rate.

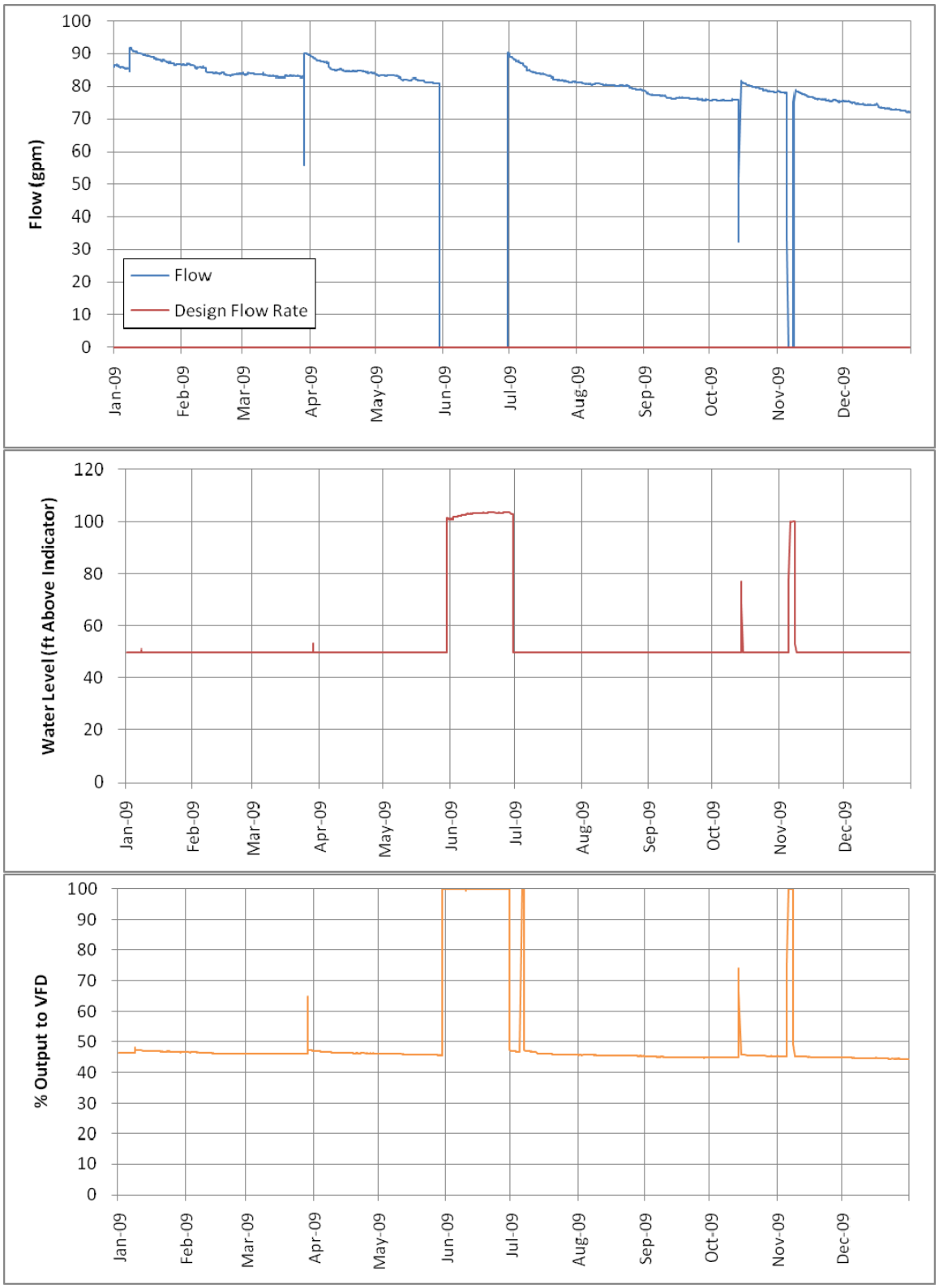


Figure 4-12: Well 410 Flow Rate, Water Level, and Relative Pump Speed.

Well 411

Well 411 was operated at a flow rate of between 55 and 80 gpm throughout the year. Flow rates were generally higher after shutdown periods when the well was able to recharge, then declined with time, stabilizing near 60 gpm (Figure 4-13). Soon after turnaround the well experienced a number of electrical problems that prevented the well from operating at higher rates. The problems were resolved by the end of July and the well resumed normal operation. There was no indication that the well performance significantly degraded in performance in 2009.

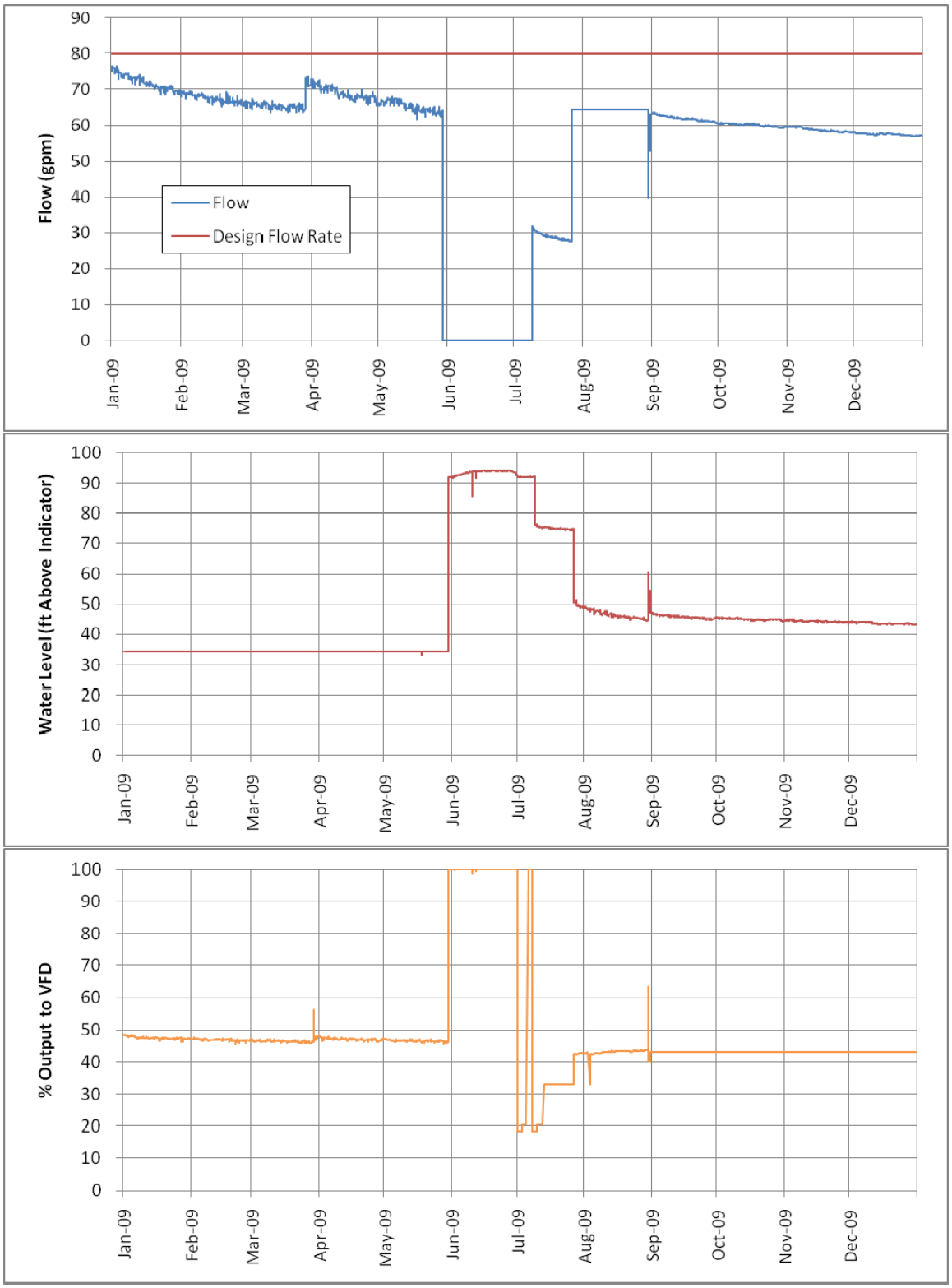


Figure 4-13: Well 411 Flow Rate, Water Level, and Relative Pump Speed.

Well 412

Well 412 was installed during the Phase 2 Data Gap Investigation and was brought online in January 2008. The well was installed as a multi-level well with screened intervals in the Upper and Lower zones. During initial testing the optimal flow rate was determined to be 400 gpm. Well 412 operated at or above 400 gpm with a consistent water level in the well during 2009 (Figure 4-14). Water level in the well was higher after the well had time to recharge and slowly decreased once pumping resumed.

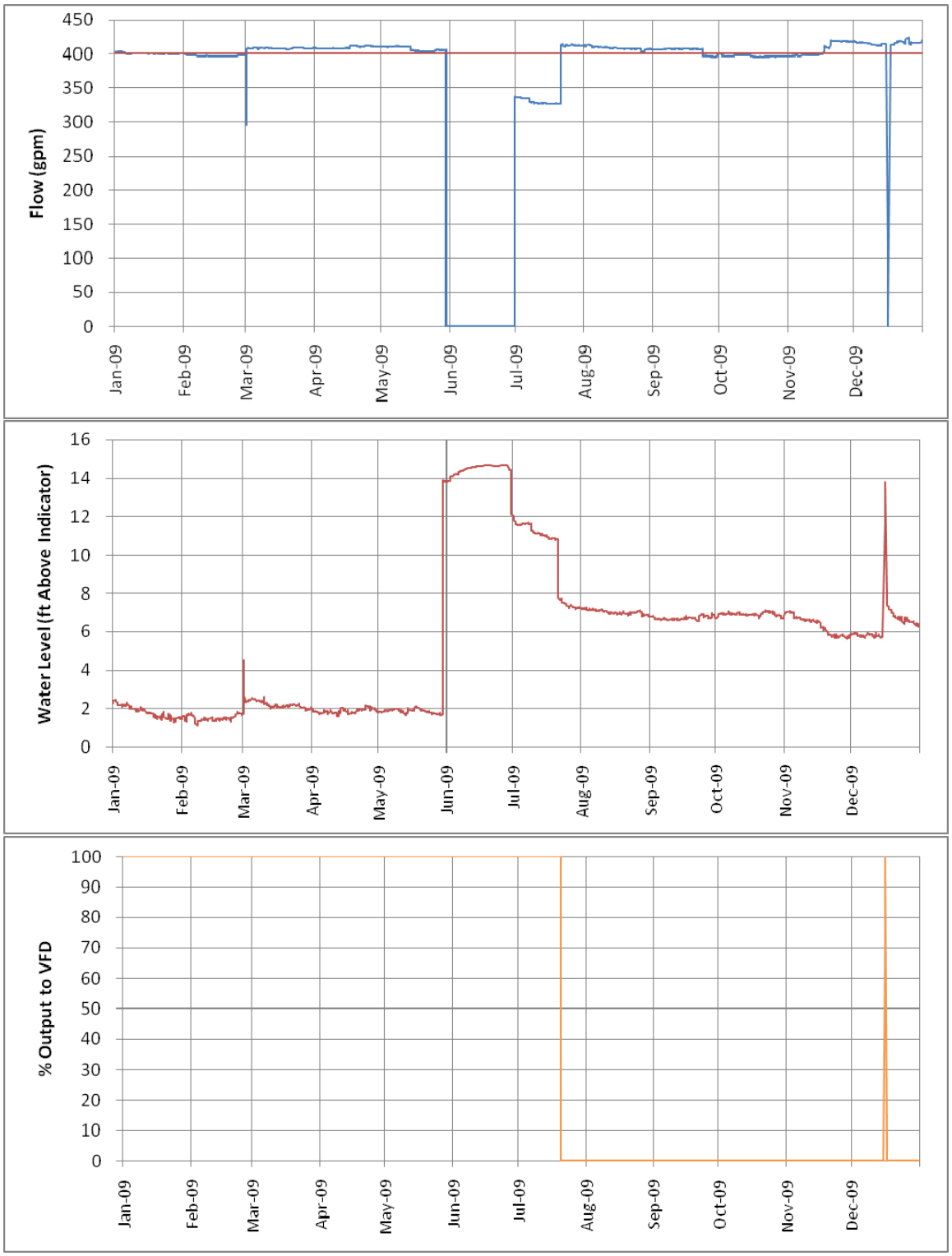


Figure 4-14: Well 412 Flow Rate, Water Level, and Relative Pump Speed.

Well 413

Well 413 was installed during the Phase 2 Data Gap Investigation and was brought online in January 2008. The well was installed as a multi-level well with screened intervals in the Upper and Lower zones. The well consistently operated between 100 to 116 gpm with no interruption (Figure 4-15) for the majority of 2009.

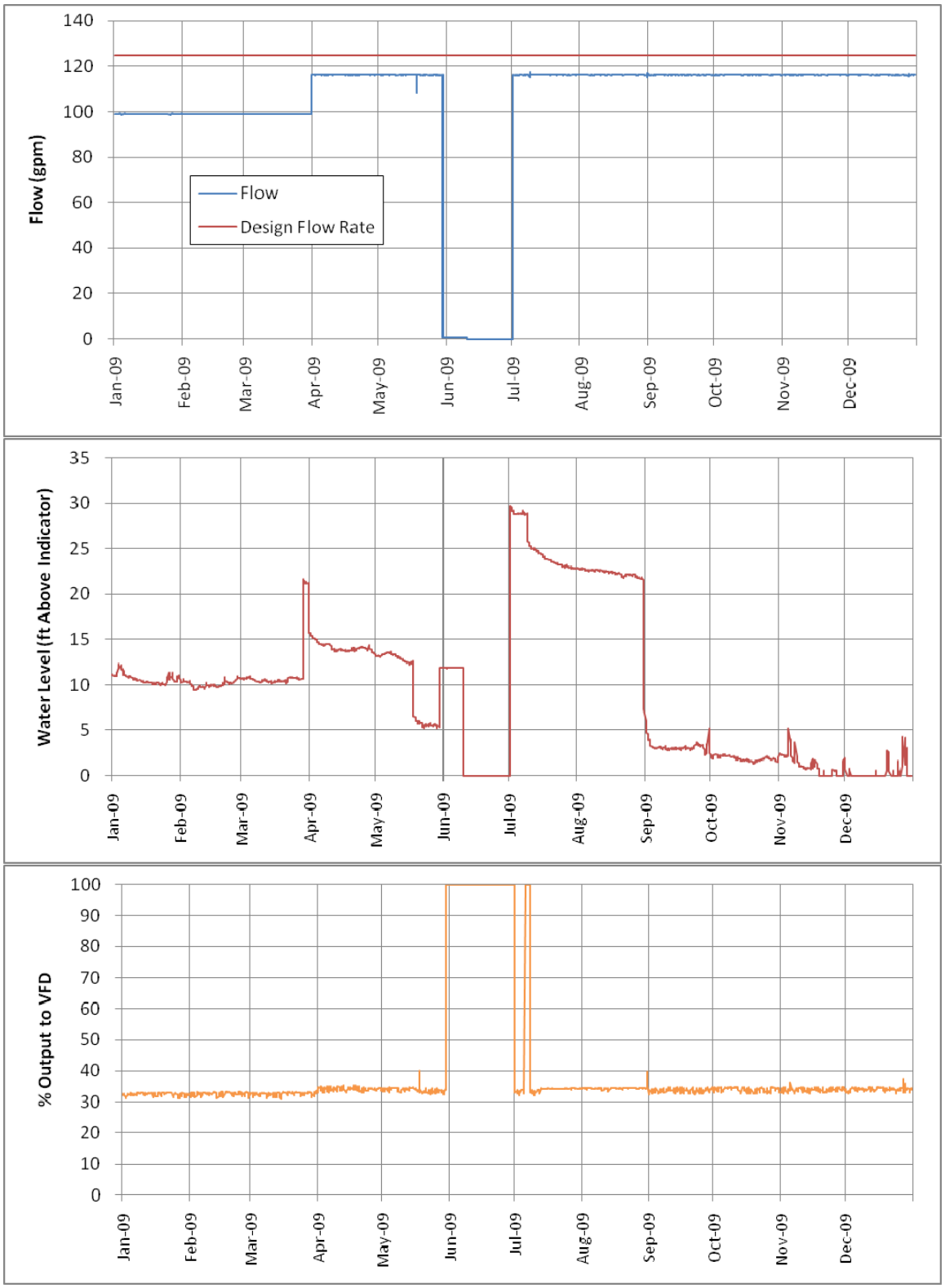


Figure 4-15: Well 413 Flow Rate, Water Level, and Relative Pump Speed.

4.4 New Extraction Wells

Two new extraction wells, 421 and 422, have been proposed (Formation 2009b) to be installed in the East Plant Area (Figure 4-1).

Well 421 will be installed to replace the current extraction well 410 and well 422 will be located East of well 413. Both wells will be constructed of 10-inch casing and screen. The total depth of the individual wells will be based off of conditions encountered during drilling.

After the wells have been installed and developed they will undergo aquifer testing to determine the individual well properties and optimal pumping rates.

4.5 Don Plant Facility Water Flows

The Don Plant water balance is complex and it is integral to successful facility operation. Numerous unit operations require different water flows and have different minimum water quality requirements. Flows are continuously measured at key points within the process as part of routine operation and have been reported to EPA on a monthly basis.

- Production Wells Fresh water is pumped from three production wells (SWP-4, SWP-5, and SWP-7). Flows are measured continuously at SWP-5 and SWP-7 and at various downgradient locations. Flows from SWP-4 are calculated from the total downgradient flows and the other production well flows.

- Phosphoric Acid Plant A portion of the production well water is sent to the phosphoric acid plant. Water requirements are driven by process conditions including production rate and associated cooling needs. Flows are measured at four different locations in the phosphoric acid plant and the total flow is reported.

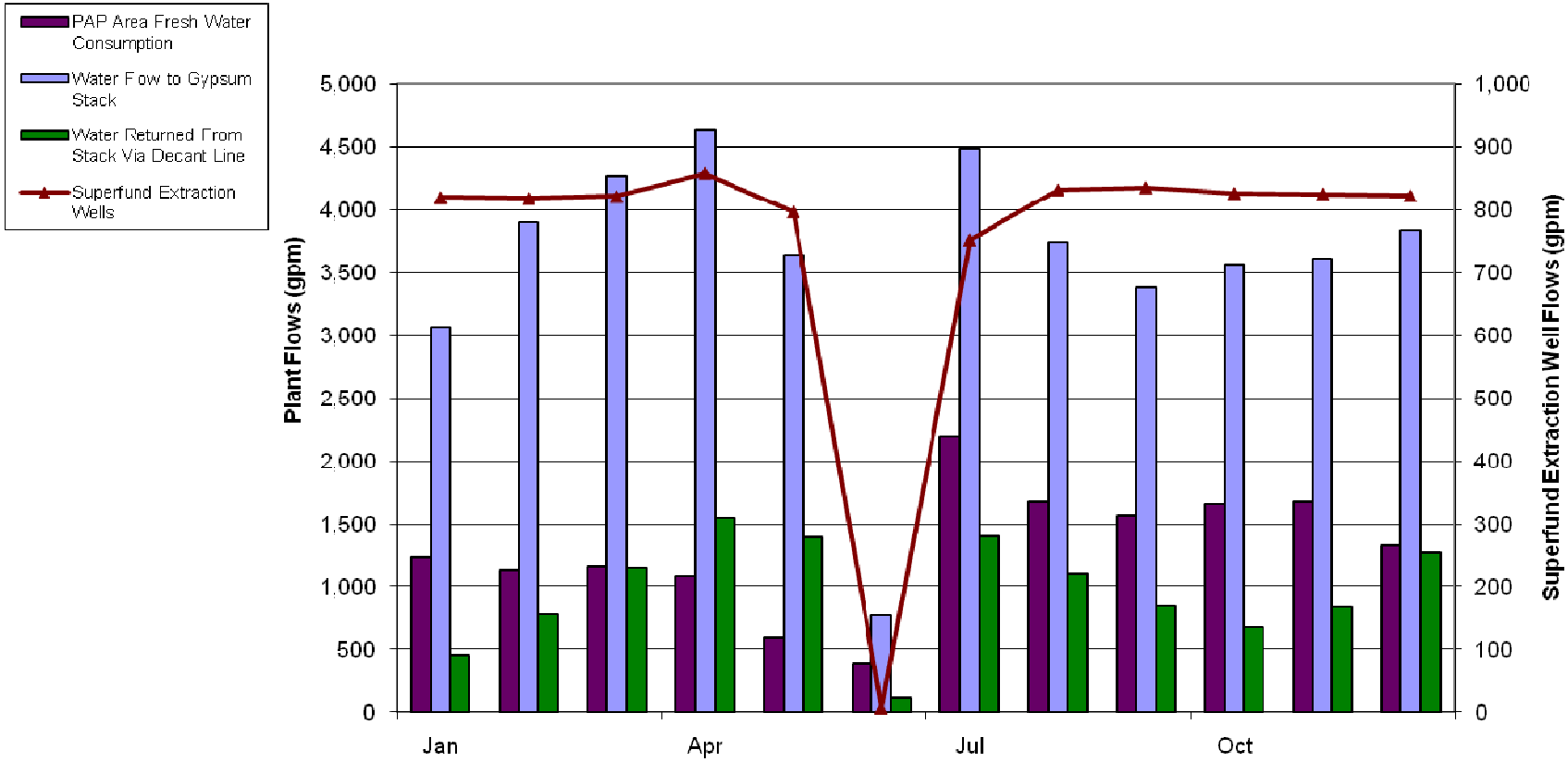
- Extraction Wells Extraction well flows are used in the phosphoric acid plant via the extraction well water collection tank, replacing production well water that was previously used in the phosphoric acid plant. Flows are measured continuously for each extraction well (Section 4.3).

- Water Flows to Gypsum Stack The principal byproduct of the phosphoric acid plant process is gypsum which is slurried to the gypsum stack. The process is operated to maintain the solids content of the slurry within a given range (typically 28 to 32%). Effluent water from the phosphoric acid plant unit operations (such as scrubber water blowdown and reclaim cooling system blowdown) is used as needed to maintain the required solids content. The slurry density, solids content, and total flow are measured continuously at the gypsum thickeners. The water flow is calculated based on the data collected and the density of gypsum.

- Gypsum Stack Decant Return Water from the gypsum slurry forms ponds on the top of the stack as the gypsum settles out. The extent of the ponded water is managed to allow dike building operations to occur. Water is pumped from the ponded area back to the gypsum thickener sluice water tanks. The flow rate is set by the operators on an as-needed basis.

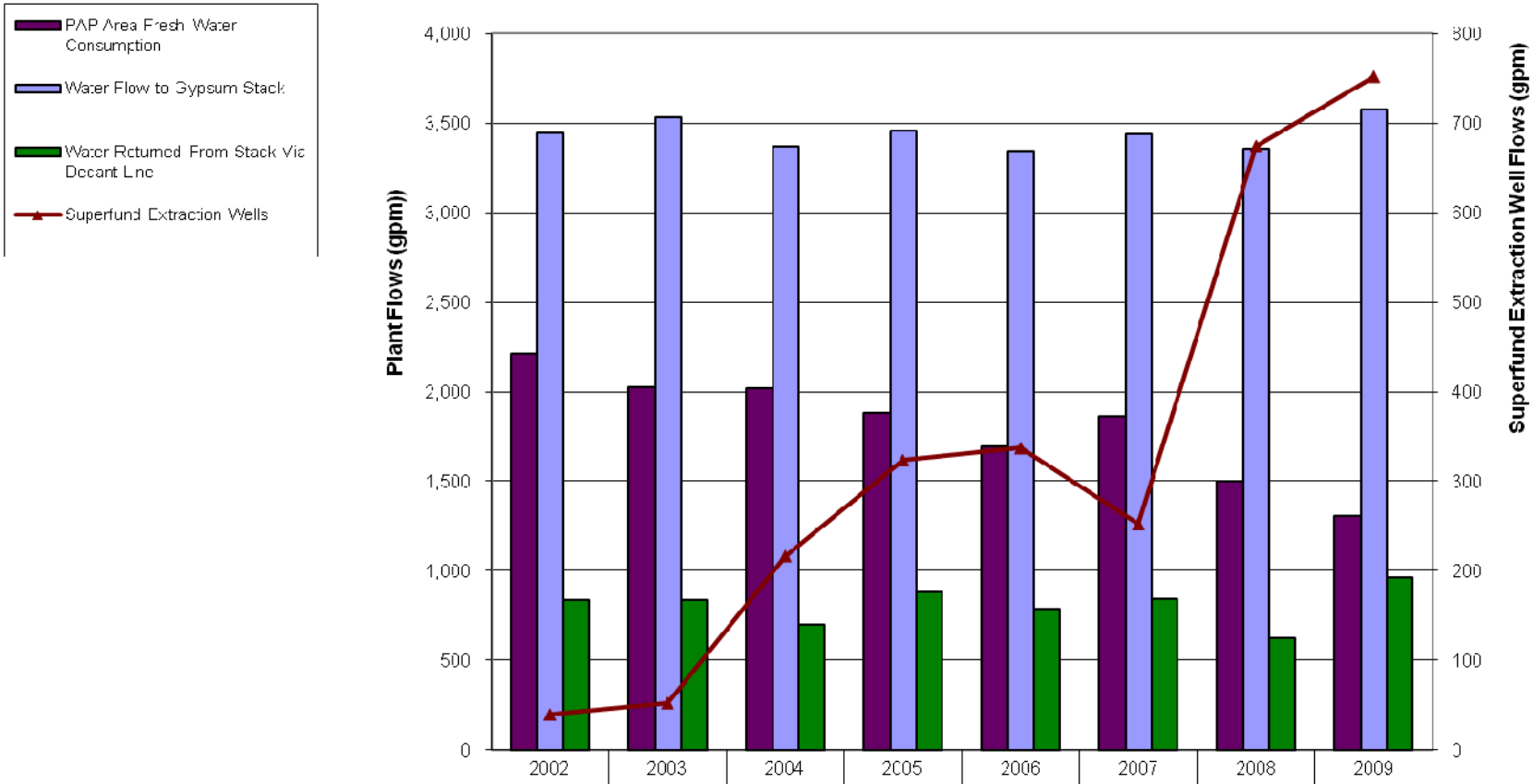
Monthly water flows related to the phosphoric acid plant for 2009 are shown in Figure 4-16. Overall there are relatively minor changes in average flows from month to month and significant seasonal effects are not evident. A decrease for all flows occurred in June when facility turnaround occurred.

As shown on Figure 4-17, flows from the extraction system are relatively small compared to other inputs. Since 2002, the average flow from the extraction wells has increased from less than fifty to approximately 825 gallons per minute. The decrease in the extraction well flows from 2006 to 2007 can be attributed to the number of upgrades being performed at the plant that resulted in well shut downs. As a result, there was a slight increase in fresh water consumption in the phosphoric acid plant area. This is expected because the lower flow from extraction wells to the extraction well water collection tank has increased the demand for fresh water input. The overall water flow to the gypsum stack has not been affected.



	Jan-09	Feb-09	Mar-09	Apr-09	May-09	Jun-09	Jul-09	Aug-09	Sep-09	Oct-09	Nov-09	Dec-09
PAP Area Fresh Water Consumption	1,235	1,127	1,154	1,079	593	390	2,194	1,630	1,569	1,655	1,672	1,326
Water Flow to Gypsum Stack	3,069	3,899	4,276	4,642	3,642	771	4,480	3,741	3,385	3,565	3,612	3,835
Water Returned From Stack Via Decant Line	456	780	1,147	1,550	1,335	114	1,399	1,103	844	672	830	1,272
Superfund Extraction Wells	820	818	822	859	797	7	753	832	836	827	825	823

Figure 4-16: Monthly Plant Flows.



	2002	2003	2004	2005	2006	2007	2008	2009
PAP Area Fresh Water Consumption	2,215	2,023	2,017	1,884	1,696	1,864	1,502	1,306
Water Flow to Gypsum Stack	3,447	3,530	3,373	3,461	3,348	3,438	3,359	3,576
Water Returned From Stack Via Decant Line	834	835	596	880	788	842	627	963
Superfunc Extraction Wells	39	52	216	323	337	252	674	752

Figure 4-17: Yearly Plant Flows.

There were no significant changes to the relative pumping rates from the production wells in 2009 compared to the end of the fourth quarter 2008. As shown in Figure 4-18, flows from SWP-4 ranged from 539 to 1,087 gpm, SWP-5 pumping rates were from 692 to 1,003 gpm, and SWP-7 pumping rates ranged from 668 to 1,043 gpm. Since 2002 the production well pumping rates have been steady decreasing with the largest decrease corresponding to the approximate time when the additional extraction wells, 412, 413, 414, and 415, were brought online in January 2008.

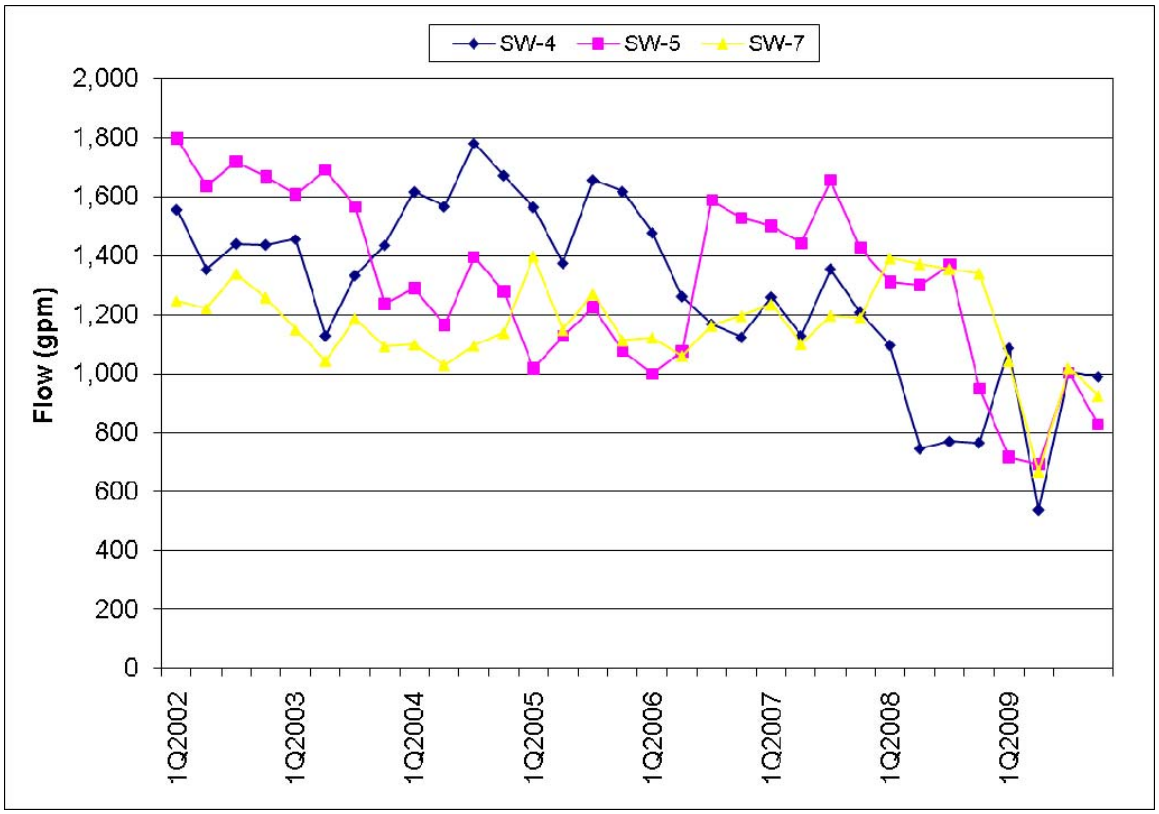


Figure 4-18: Quarterly Production Well Flows.

5.0 GROUNDWATER MONITORING

The groundwater monitoring program was designed to provide adequate and appropriate data to address groundwater monitoring objectives and support future decision making in each monitoring area.

The groundwater monitoring system in the Simplot OU has been divided into five sub-areas based on monitoring objectives and performance criteria. The sub-areas are shown in Figure 2-1. The sub-areas are as follows:

- Don Plant Area
- Phosphoric acid plant area (in Don Plant Area)
- Target capture zones (in Don Plant Area)
- Assessment Area
- Compliance Area

Details of each sub-area are provided in Section 2.4 and a summary of the groundwater monitoring objectives and the monitoring locations for each of the monitoring areas is included in the Groundwater and Surface Water Monitoring Plan.

The approach used to design the monitoring program follows EPA's *Guidance for Monitoring at Hazardous Waste Sites: Framework for Monitoring Plan Development and Implementation* (EPA 2004). Consistent with that guidance, the hypotheses that will be tested through monitoring and the decisions to be made based on monitoring data are described in the Groundwater and Surface Water Monitoring Plan. The results presented in this document serve to test the hypotheses stated in the plan and to guide decisions where applicable.

Depending on the results of the data, several different quantitative and statistical methods may be used to support decision making. The statistical methods that may be used are described in the Groundwater and Surface Water Monitoring Plan and are consistent with the methods presented in EPA's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* (EPA 2009) and widely-accepted statistical practices for groundwater monitoring programs (e.g., EPA 1992; ASTM 2004).

This section provides a summary evaluation of the recent groundwater data with an emphasis on interpretation of conditions in key areas relative to sources. This includes the target extraction areas and downgradient areas. Groundwater sampling methods are discussed in Section 5.1. Section 5.2 reviews the data quality assurance procedures.

Site-wide results are presented in Section 5.3 as well as results analyzed by monitoring area in relation to the specific monitoring goals and hypotheses for that area. The decision to use or not use statistical methods is discussed for each area.

5.1 Sampling Activities

Sampling was performed on a quarterly basis throughout 2009. Table 5-1 lists the analyses performed. Table 5-2 lists the locations where quarterly water quality and water levels were measured and the stations where only water levels were measured. Figures 5-1, 5-2, and 5-3 illustrate the groundwater quality monitoring locations in the Bedrock, Upper, and Lower Zones. The Portneuf River water elevation was also measured at gages at the Highway 30 (Station PTRA30) and Batiste Road (Station PBATR) bridges.

Table 5-1: Quarterly groundwater monitoring analyte list, 2009.

Analyte	Method	Reporting Limit (RL) or Field Meter Sensitivity	Units
Field Parameters			
Oxidation Reduction Potential	Field Meter	1 mV	mV
Oxygen, Dissolved	Field Meter	0.1	mg/L
pH	Field Meter	±0.1	SU
Specific Conductivity	Field Meter	5	µmho/cm
Temperature	Field Meter	0.1	^{o}C
Turbidity	Field Meter	±0.1	NTU
General Chemistry			
Alkalinity	SM 2320B	1	mg/L
Chloride	EPA 300.0	0.2	mg/L
Hardness	SM 2340B	0.347	mg/L
Sulfate	EPA 300.0	0.3	mg/L
TDS	SM 2540C	10	mg/L
Metals			
Arsenic	EPA 200.8	0.003	mg/L
Calcium	EPA 200.7	0.04	mg/L
Magnesium	EPA 200.7	0.06	mg/L
Potassium	EPA 200.7	0.5	mg/L
Sodium	EPA 200.7	0.5	mg/L
Nutrients			
Nitrite+Nitrate (as N)	EPA 353.2	0.02	mg/L
Phosphorus, Total	EPA 365.2	0.01	mg/L

Table 5-2: Summary of Quarterly Monitoring Locations by Objective.

Monitoring Location	Hydro Unit	Monitoring Data	Well Type	Well Used to Meet Objectives					
				Don Plant Area	Phosphoric Acid Plant Area	Target Capture Zones	Assessment Area	Assessment Area (Interim Targets)	Compliance Area
189	Shallow	GWL, WQ	Monitoring Well	X		X			
190[f]	Bedrock	GWL, WQ	Monitoring Well	X					
191[f]	Bedrock	GWL, WQ	Monitoring Well	X					
305[f]	Bedrock	GWL, WQ	Monitoring Well	X					
307	Shallow	GWL, WQ	Monitoring Well	X		X			
308	Shallow	GWL, WQ	Monitoring Well	X		X			
309	Deep	GWL, WQ	Monitoring Well	X		X			
310	Shallow	GWL, WQ	Monitoring Well	X		X			
312	Shallow	GWL, WQ	Monitoring Well	X					
313[f]	Bedrock	GWL, WQ	Monitoring Well	X					
315	Deep	GWL, WQ	Monitoring Well	X					
316	Shallow	GWL	Monitoring Well	X					
317	Deep	GWL, WQ	Monitoring Well	X		X			
318	Shallow	GWL, WQ	Monitoring Well	X		X			
319[a]	Deep	GWL, WQ	Monitoring Well	X					
320	Shallow	GWL, WQ	Monitoring Well	X					
321	Deep	GWL	Monitoring Well	X					
322	Deep	GWL	Monitoring Well	X					
323[f]	Bedrock	GWL	Monitoring Well	X					
324	Shallow	GWL	Monitoring Well	X					
325	Shallow	GWL, WQ	Monitoring Well	X					
326	Deep	GWL, WQ	Monitoring Well	X		X			
327	Shallow	GWL, WQ	Monitoring Well	X					
328	Shallow	GWL, WQ	Monitoring Well	X					

Table 5-2: Summary of Quarterly Monitoring Locations by Objective.

Monitoring Location	Hydro Unit	Monitoring Data	Well Type	Well Used to Meet Objectives					
				Don Plant Area	Phosphoric Acid Plant Area	Target Capture Zones	Assessment Area	Assessment Area (Interim Targets)	Compliance Area
329	Deep	GWL	Monitoring Well	X					
330	Deep	GWL	Monitoring Well	X					
331	Shallow	GWL, WQ	Monitoring Well	X					
332	Shallow	GWL, WQ	Monitoring Well	X					
333	Shallow	GWL, WQ	Monitoring Well	X					
334	Shallow	GWL, WQ	Monitoring Well	X					
335D	Deep	GWL, WQ	Monitoring Well	X					
335S	Shallow	GWL, WQ	Monitoring Well	X					
336	Shallow	GWL, WQ	Monitoring Well	X		X			
337	Deep	GWL	Monitoring Well	X		X			
338	Shallow	GWL, WQ	Monitoring Well	X					
339	Shallow	GWL	Monitoring Well	X		X			
340	Shallow	GWL, WQ	Monitoring Well	X	X	X			
341[a]	Shallow	GWL, WQ	Monitoring Well	X					
342	Shallow	GWL, WQ	Monitoring Well	X					
344	Deep	GWL	Monitoring Well	X		X			
346	Deep	GWL, WQ	Monitoring Well	X					
347	Deep	GWL, WQ	Monitoring Well	X					
348	Shallow	GWL, WQ	Monitoring Well	X					
350	Shallow	GWL, WQ	Monitoring Well	X					
351[f]	Bedrock	GWL, WQ	Monitoring Well	X					
352	Bedrock	GWL	Monitoring Well	X					
353	Shallow	GWL	Monitoring Well	X					
354	Shallow	GWL, WQ	Monitoring Well	X					

Table 5-2: Summary of Quarterly Monitoring Locations by Objective.

Monitoring Location	Hydro Unit	Monitoring Data	Well Type	Well Used to Meet Objectives					
				Don Plant Area	Phosphoric Acid Plant Area	Target Capture Zones	Assessment Area	Assessment Area (Interim Targets)	Compliance Area
355	Shallow	GWL	Monitoring Well	X					
356	Shallow	GWL, WQ	Monitoring Well	X					
357	Shallow	GWL, WQ	Monitoring Well	X					
358	Shallow	GWL, WQ	Monitoring Well	X					
361AR[2]	Deep	GWL, WQ	ZIST Retrofit Well	X		X			
361BR[2]	Deep	GWL	ZIST Retrofit Well	X		X			
361CR	Deep	GWL	ZIST Retrofit Well	X		X			
361DR[f]	Bedrock	GWL	ZIST Retrofit Well	X		X			
362[b]	Shallow	GWL, WQ	Monitoring Well	X		X			
363AR[2]	Deep	GWL, WQ	ZIST Retrofit Well	X		X			
363BR[2]	Deep	GWL	ZIST Retrofit Well	X		X			
363CR[f]	Bedrock	GWL	ZIST Retrofit Well	X		X			
364AR[2]	Deep	GWL, WQ	ZIST Retrofit Well	X		X			
364BR[2]	Deep	GWL	ZIST Retrofit Well	X		X			
364CR[f]	Bedrock	GWL	ZIST Retrofit Well	X		X			
365[c]	Shallow	GWL, WQ	Monitoring Well	X		X			
366AR[2]	Deep	GWL, WQ	ZIST Retrofit Well	X		X			
366BR[2]	Deep	GWL	ZIST Retrofit Well	X		X			
366CR[f]	Bedrock	GWL	ZIST Retrofit Well	X		X			
367	Shallow	GWL, WQ	Monitoring Well	X	X	X			
368AR[2]	Deep	GWL	ZIST Retrofit Well	X		X			
368BR[f]	Bedrock	GWL	ZIST Retrofit Well	X		X			
369	Shallow	GWL, WQ	Monitoring Well	X	X	X			
370	Shallow	GWL, WQ	Monitoring Well	X	X	X			

Table 5-2: Summary of Quarterly Monitoring Locations by Objective.

Monitoring Location	Hydro Unit	Monitoring Data	Well Type	Well Used to Meet Objectives					
				Don Plant Area	Phosphoric Acid Plant Area	Target Capture Zones	Assessment Area	Assessment Area (Interim Targets)	Compliance Area
371	Shallow	GWL, WQ	Monitoring Well	X	X	X			
372	Shallow	GWL, WQ	Monitoring Well	X	X	X			
373	Shallow	GWL, WQ	Monitoring Well	X	X	X			
374	Shallow	GWL, WQ	Monitoring Well	X	X	X			
401	Shallow	GWL, WQ	Extraction Well	X		X			
402	Shallow	GWL, WQ	Extraction Well	X		X			
403	Shallow	GWL, WQ	Monitoring Well	X		X			
404	Shallow	GWL, WQ	Extraction Well	X		X			
405[g]	Shallow	GWL, WQ	Monitoring Well	X		X			
406[d]	Shallow	GWL, WQ	Extraction Well	X		X			
407	Shallow	GWL, WQ	Extraction Well	X		X			
408[g]	Shallow	GWL, WQ	Monitoring Well	X		X			
409	Shallow	GWL, WQ	Extraction Well	X		X			
410	Deep	GWL, WQ	Monitoring Well	X		X			
411	Deep	GWL, WQ	Extraction Well	X		X			
412	Multilev	GWL, WQ	ML Extraction Well	X		X			
413	Multilev	GWL, WQ	ML Extraction Well	X		X			
414	Shallow	GWL, WQ	Extraction Well	X	X	X			
415	Multilev	GWL, WQ	ML Extraction Well	X		X			
416[e]	Shallow	GWL, WQ	Extraction Well	X	X	X			
417	Shallow	GWL, WQ	Monitoring Well	X	X	X			
418	Shallow	GWL, WQ	Monitoring Well	X	X	X			
419[e]	Shallow	GWL, WQ	Extraction Well	X	X	X			
420	Shallow	GWL, WQ	Monitoring Well	X	X	X			

Table 5-2: Summary of Quarterly Monitoring Locations by Objective.

Monitoring Location	Hydro Unit	Monitoring Data	Well Type	Well Used to Meet Objectives					
				Don Plant Area	Phosphoric Acid Plant Area	Target Capture Zones	Assessment Area	Assessment Area (Interim Targets)	Compliance Area
503	Shallow	GWL, WQ	Monitoring Well				X		
504	Deep	GWL, WQ	Monitoring Well				X		X
505	Shallow	GWL, WQ	Monitoring Well				X		X
506	Shallow	GWL	Monitoring Well				X		
507	Shallow	GWL	Monitoring Well				X		
508	Deep	GWL	Monitoring Well				X		
509	Shallow	GWL	Monitoring Well				X		
509A	Shallow	GWL	Monitoring Well				X		
510	Deep	GWL	Monitoring Well				X		
511[c]	Shallow	GWL	Monitoring Well				X		
511A	Shallow	GWL	Monitoring Well				X		
512	Shallow	GWL	Monitoring Well				X		
513	Shallow	GWL	Monitoring Well				X		
518	Shallow	GWL, WQ	Monitoring Well				X		
519	Deep	GWL, WQ	Monitoring Well				X		
520	Shallow	GWL	Monitoring Well				X		
524	Deep	GWL, WQ	Monitoring Well				X		X
525	Shallow	GWL, WQ	Monitoring Well				X		X
526	Deep	GWL, WQ	Monitoring Well				X	X	
527	Shallow	GWL, WQ	Monitoring Well				X	X	
528AR[2]	Shallow	GWL, WQ	ZIST Retrofit Well				X	X	
528BR[2]	Deep	GWL, WQ	ZIST Retrofit Well				X	X	
528CR[2]	Deep	GWL, WQ	ZIST Retrofit Well				X	X	
528DR[2]	Deep	GWL, WQ	ZIST Retrofit Well				X	X	

Table 5-2: Summary of Quarterly Monitoring Locations by Objective.

Monitoring Location	Hydro Unit	Monitoring Data	Well Type	Well Used to Meet Objectives					
				Don Plant Area	Phosphoric Acid Plant Area	Target Capture Zones	Assessment Area	Assessment Area (Interim Targets)	Compliance Area
529AR[2]	Shallow	GWL, WQ	ZIST Retrofit Well				X	X	
529BR[2]	Shallow	GWL, WQ	ZIST Retrofit Well				X	X	
529CR[2]	Deep	GWL, WQ	ZIST Retrofit Well				X	X	
529DR[2]	Deep	GWL, WQ	ZIST Retrofit Well				X	X	
630[c]	Shallow	GWL	Monitoring Well				X		
640[c]	Shallow	GWL	Monitoring Well				X		
650[c]	Shallow	GWL	Monitoring Well				X		
Batiste Spring (BTS)	Shallow	GWL, WQ	Spring				X		X
Spring at Batiste Road (BRS)	Shallow	GWL, WQ	Spring				X		X
Portneuf River at Batiste Road (PBATR)	River	GWL	River				X		
Portneuf River at Hwy 30 (PTRA30)	River	GWL	River				X		
SWP-4[1]	Deep	WQ	Production Well	X		X			
TW-11S	Shallow	GWL, WQ	Monitoring Well				X		
TW-12S	Shallow	GWL, WQ	Monitoring Well				X		

[1] Water levels not measured in SWP-4, -5 and -7, no access
[2] Wells were retrofit before 3rd quarter event; consequently R was added to station name
[a] WL only 1st & 2nd quarter, WL & WQ 3rd & 4th quarters
[b] WL only 1st quarter, WL & WQ 2nd, 3rd, 4th quarters
[c] Not monitored 1st quarter

[d] WL only 3rd quarter, WL & WQ for 1st, 2nd, 4th quarters
[e] WL only 4th quarter
[f] Well was classified as Upper Zone for 1st, 2nd quarters
[g] Wells only sampled if online

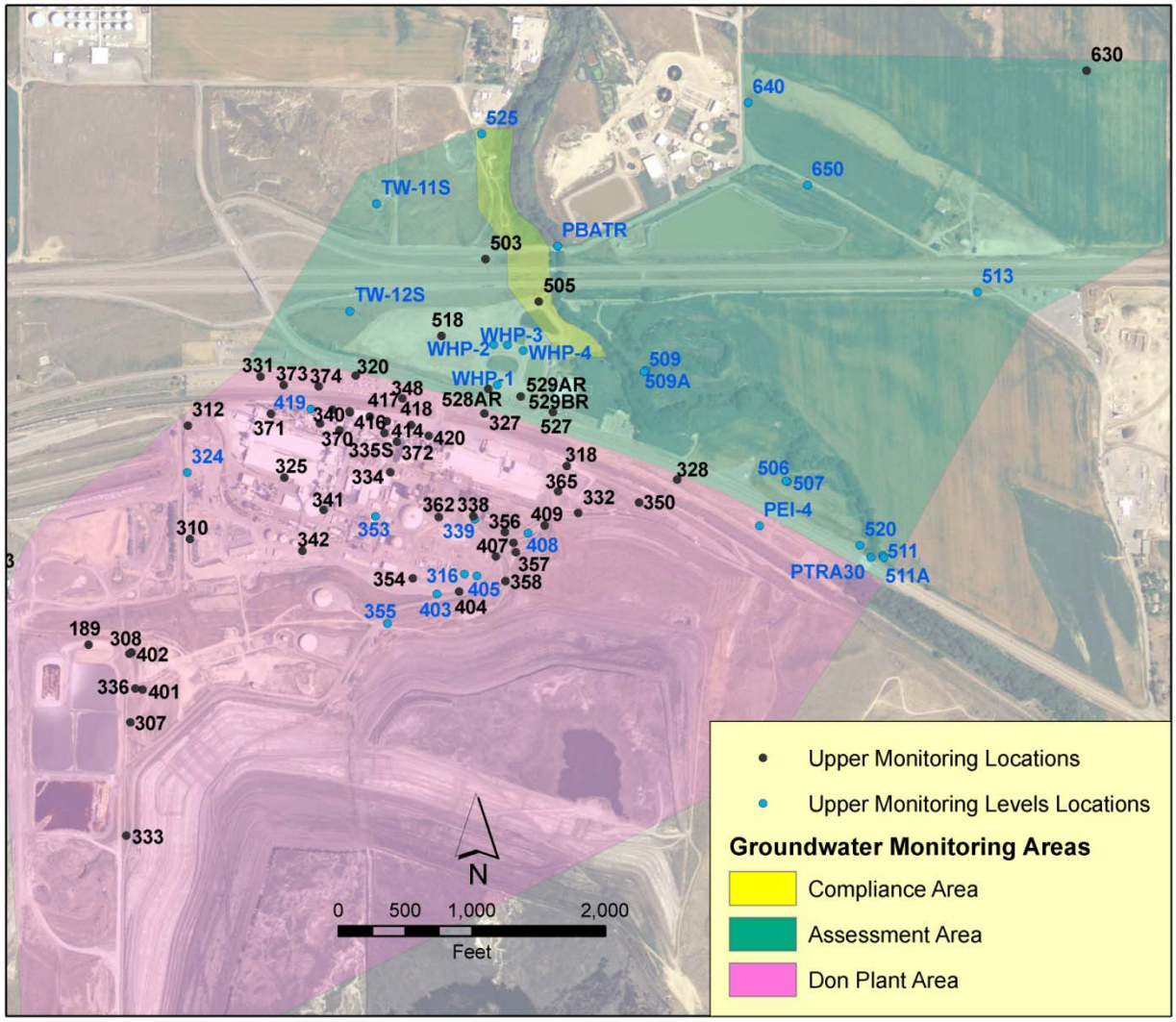


Figure 5-1: Groundwater quality monitoring locations in the Upper Zone, 2009.

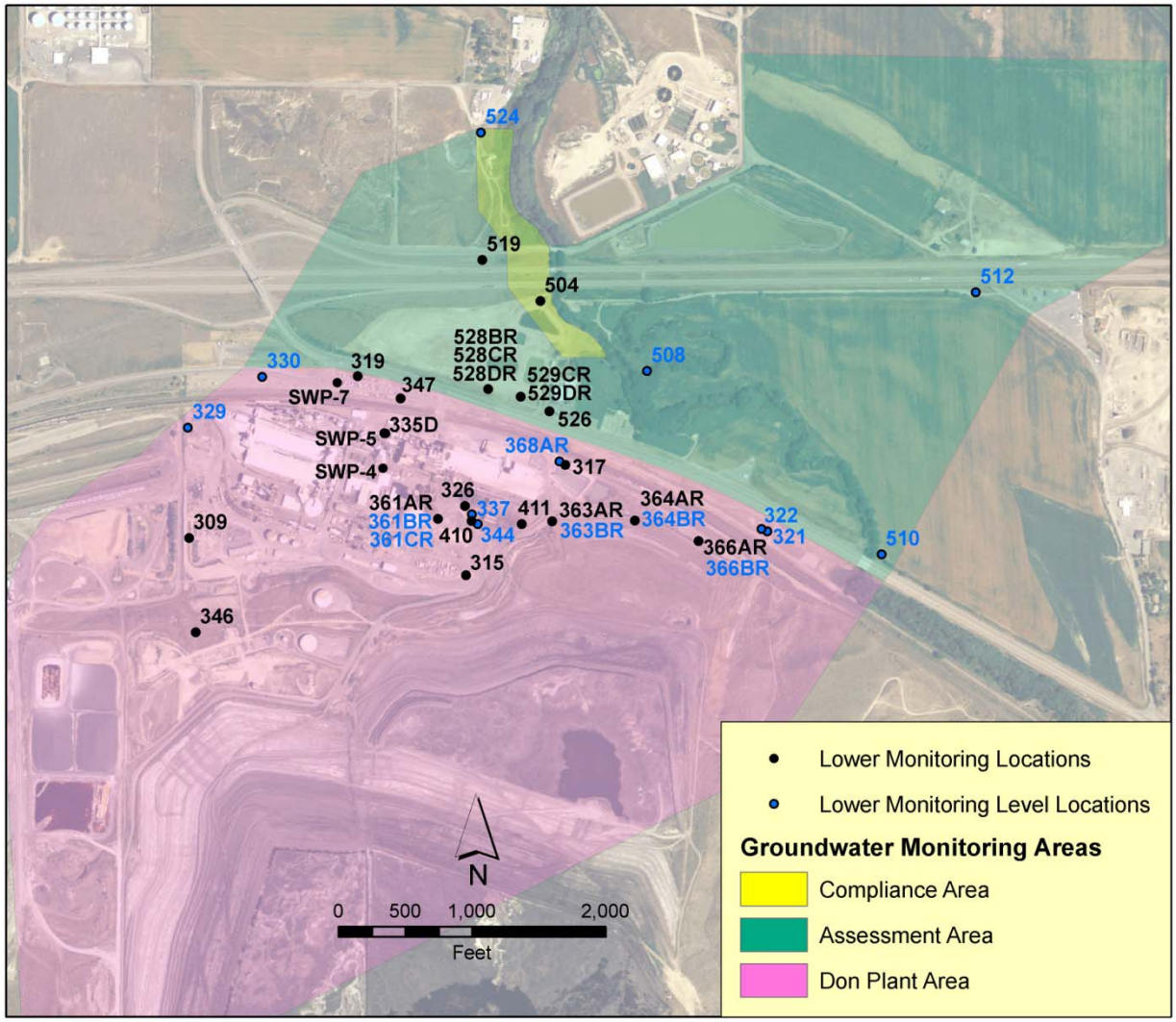


Figure 5-2: Groundwater quality monitoring locations in the Lower Zone, 2009.

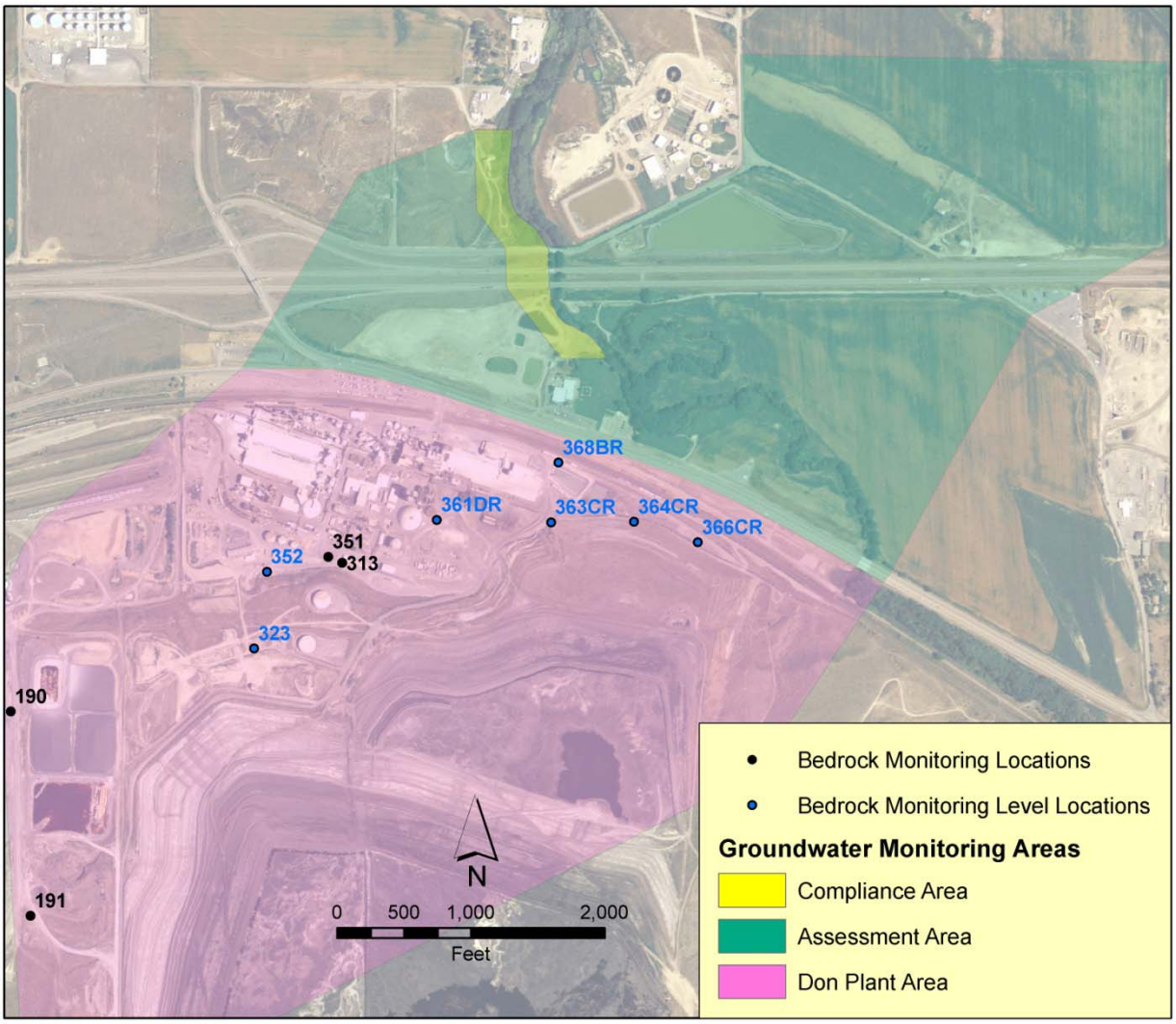


Figure 5-3: Groundwater quality monitoring locations in the Bedrock Zone, 2009.

5.2 Groundwater Data Review and Quality

This section describes the QC policies and procedures which ensured that the data collected in the field and analyzed by the laboratory were of appropriate quality to meet the sampling objectives.

Equipment rinsate samples and field duplicate samples were collected to evaluate the accuracy and reproducibility of the field sampling methods. The equipment rinsates and field duplicates were analyzed for the same suite of analytical parameters as the original sample.

The commercial laboratories (SVL) performed the requested analyses in accordance with referenced EPA methods and operated under an internal QA Management Plan.

The data were reviewed and evaluated along with the sample results (including field duplicate

and bottle/preservation blank and/or equipment blank results) to confirm that the data met the DQOs. Any data not meeting the quality requirements were flagged and appropriately qualified.

Complete raw data packages from the laboratory were evaluated to assess compliance with DQIs. Data review included reviewing Chain of Custody forms, calibration requirements, evaluating accuracy of chemical data, and reviewing data for transcription errors, detection limit discrepancies, data omissions, and suspect or anomalous values.

Data validation was performed and a checklist of the validation process was prepared to document the review process and results.

All 2009 groundwater data is provided in Appendix A. Validated laboratory data for metals and general chemistry is provided in Tables A-1 and A-2, respectively. Field measurement data is provided in Table A-3.

5.3 Site-Wide Groundwater Trends

5.3.1 Groundwater Levels

This section presents the potentiometric surface elevations throughout 2009. The potentiometric surfaces were generally consistent among all quarters and support the basic conceptual site model. Water level data from 2009 is provided in Appendix A, table A-4.

5.3.2 Upper Zone

Groundwater surface elevations and the interpreted potentiometric surfaces for all quarters in the Upper Zone are presented in Figures 5-4 through 5-7.

Water levels were highest across the site in the Upper Zone during the May sampling event, and at the lowest levels in August. Groundwater elevations varied by 0.5 -1.0 feet during the year.

The potentiometric surface in the Upper Zone illustrates a significant decrease in hydraulic gradient at the northern boundary of the Don Plant facility area. This pattern is consistent with an increase in hydraulic conductivity observed in aquifer materials. An increase in hydraulic gradient at the toe of the gypsum stack and in the joint Fenceline area (beneath and south of the closed FMC calciner ponds) is consistent with lower hydraulic conductivities observed in these areas.

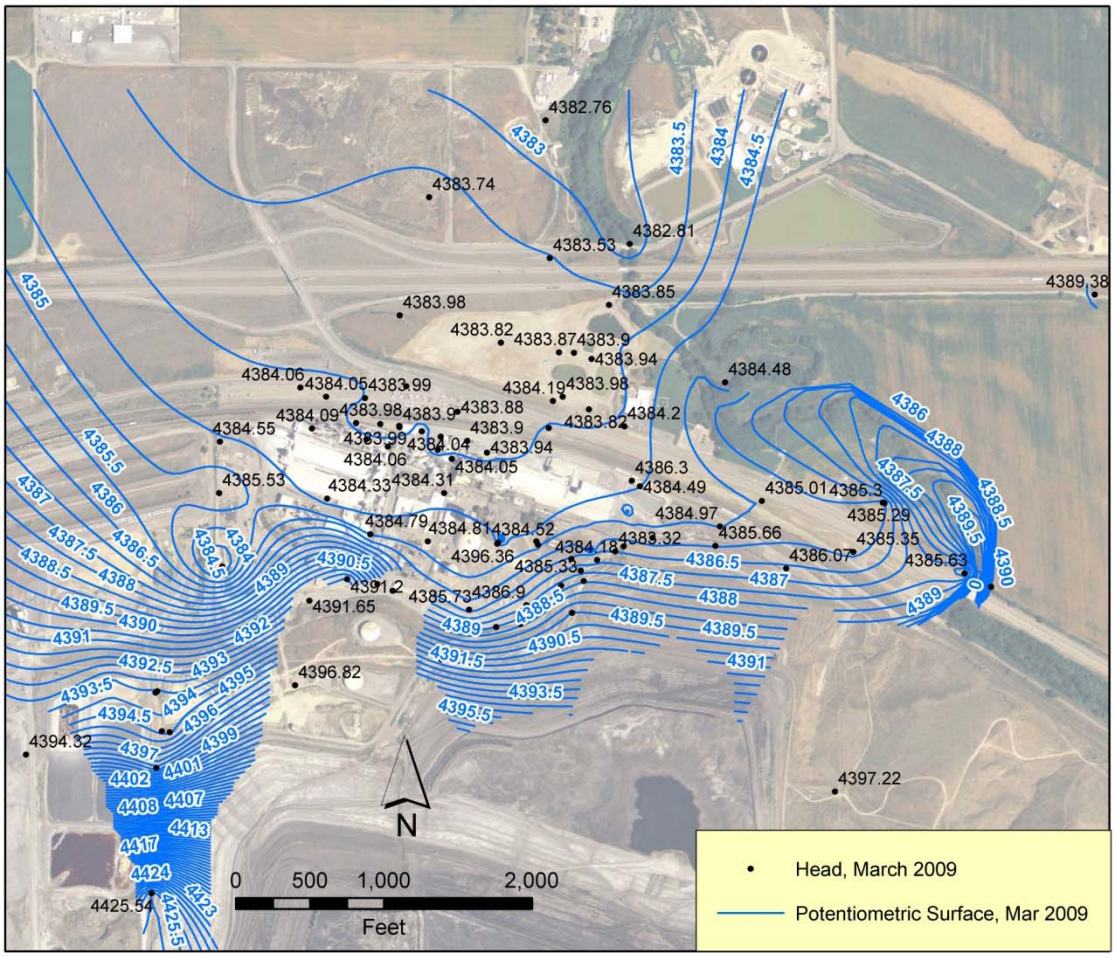


Figure 5-4: Interpreted potentiometric surfaces for Upper Zone, first quarter 2009.

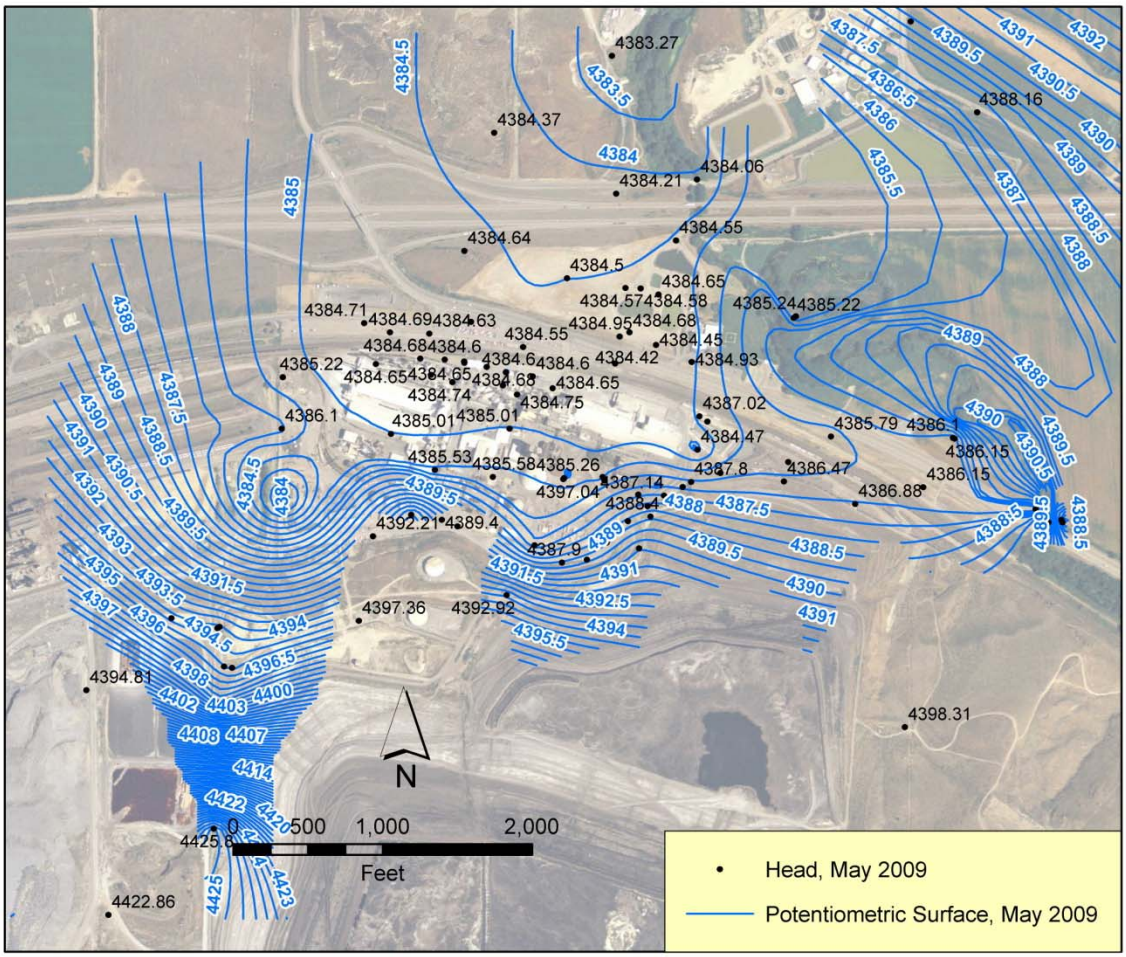


Figure 5-5: Interpreted potentiometric surfaces for Upper Zone, second quarter 2009.

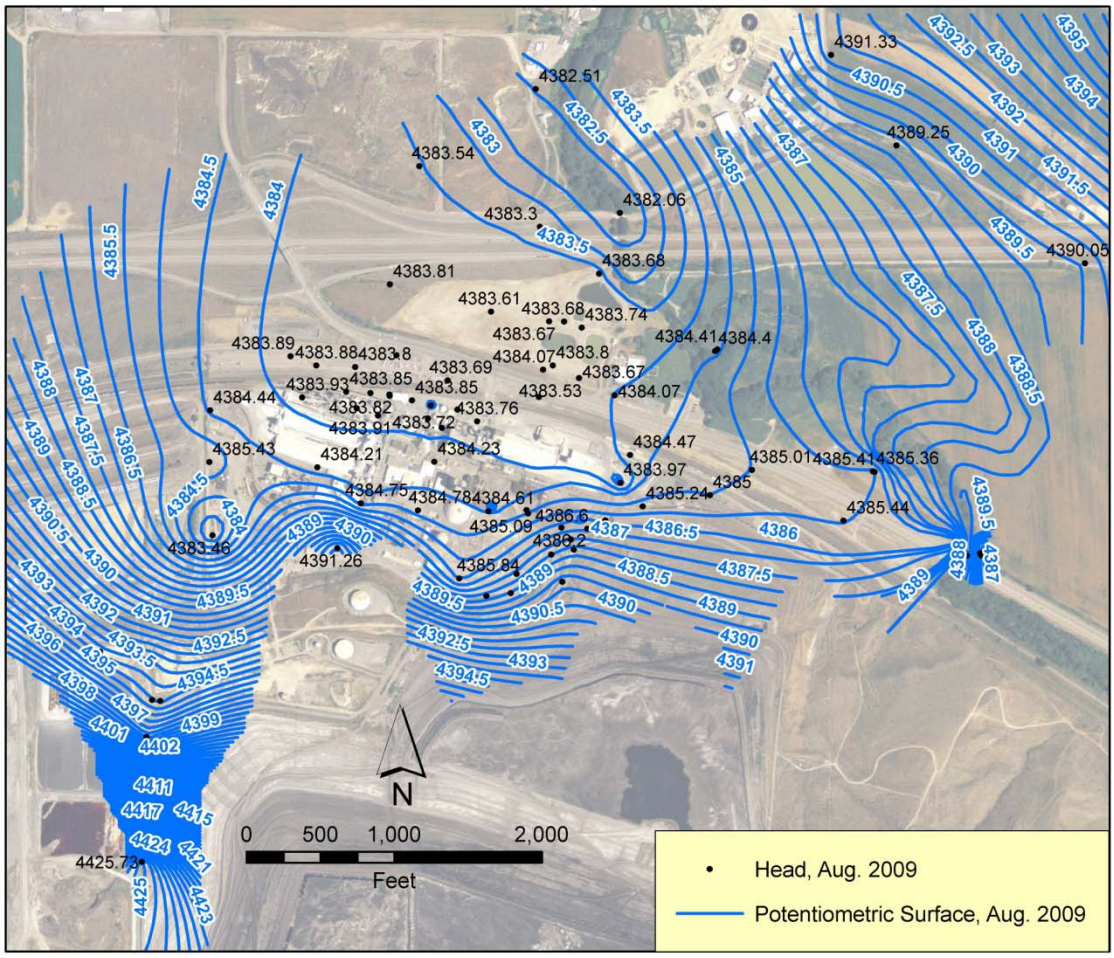


Figure 5-6: Interpreted potentiometric surfaces for Upper Zone, third quarter 2009.

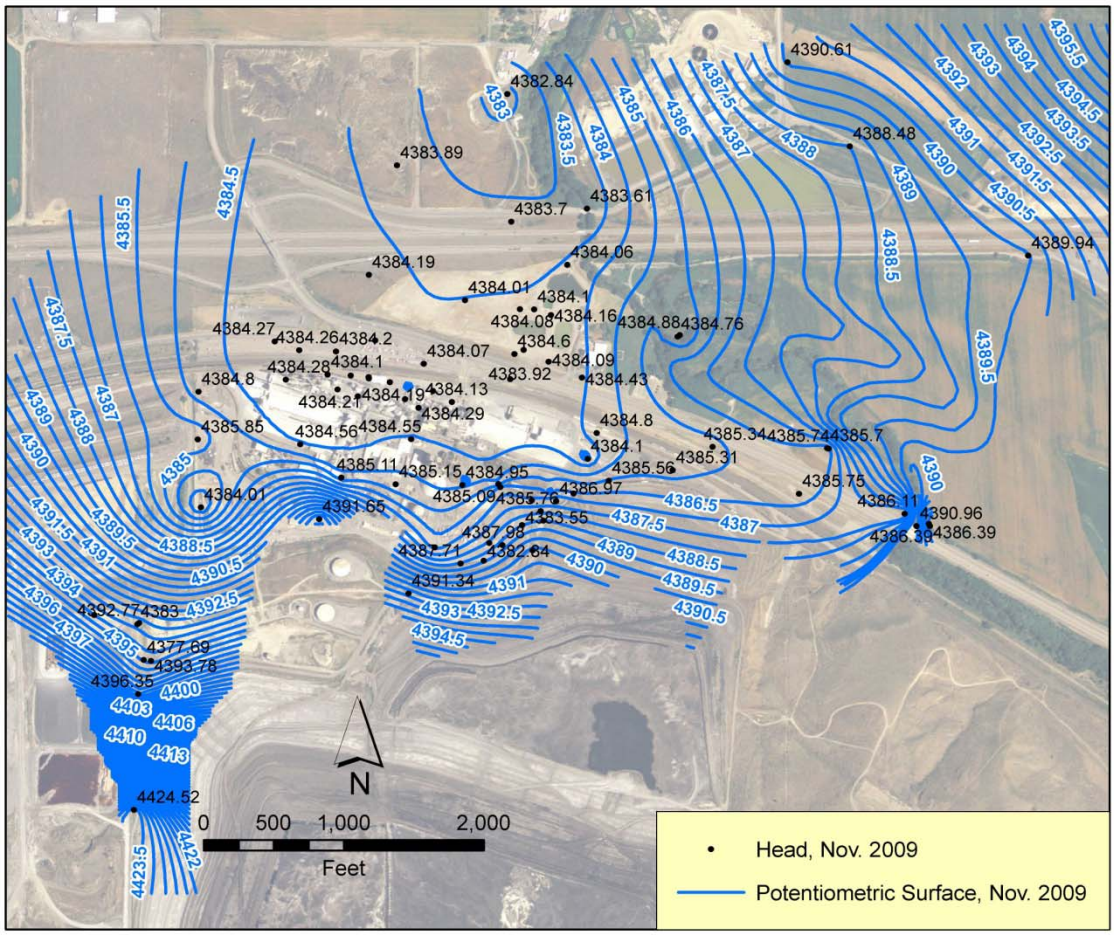


Figure 5-7: Interpreted potentiometric surfaces for Upper Zone, fourth quarter 2009.

5.3.2.1 Lower Zone

Groundwater surface elevations and the interpreted potentiometric surfaces for all quarters in the Lower Zone are presented in Figures 5-8 through 5-11.

Water levels were highest across the site in the Lower Zone during the May sampling event and at the lowest levels in March. Groundwater elevations varied by 1.0 -1.5 feet during the year.

An increase in hydraulic gradient at the toe of the gypsum stack is consistent with lower hydraulic conductivities observed in this area.

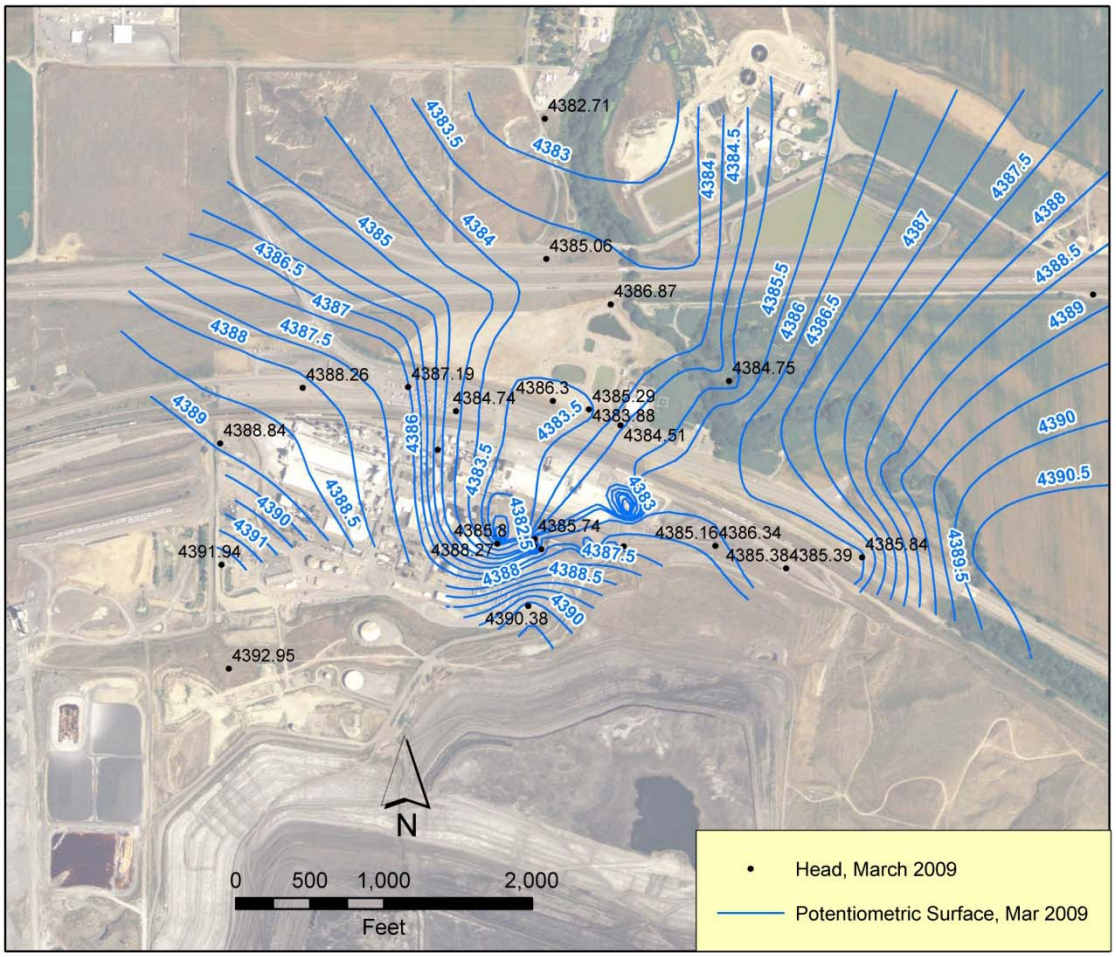


Figure 5-8: Interpreted potentiometric surfaces for Lower Zone, first quarter 2009.

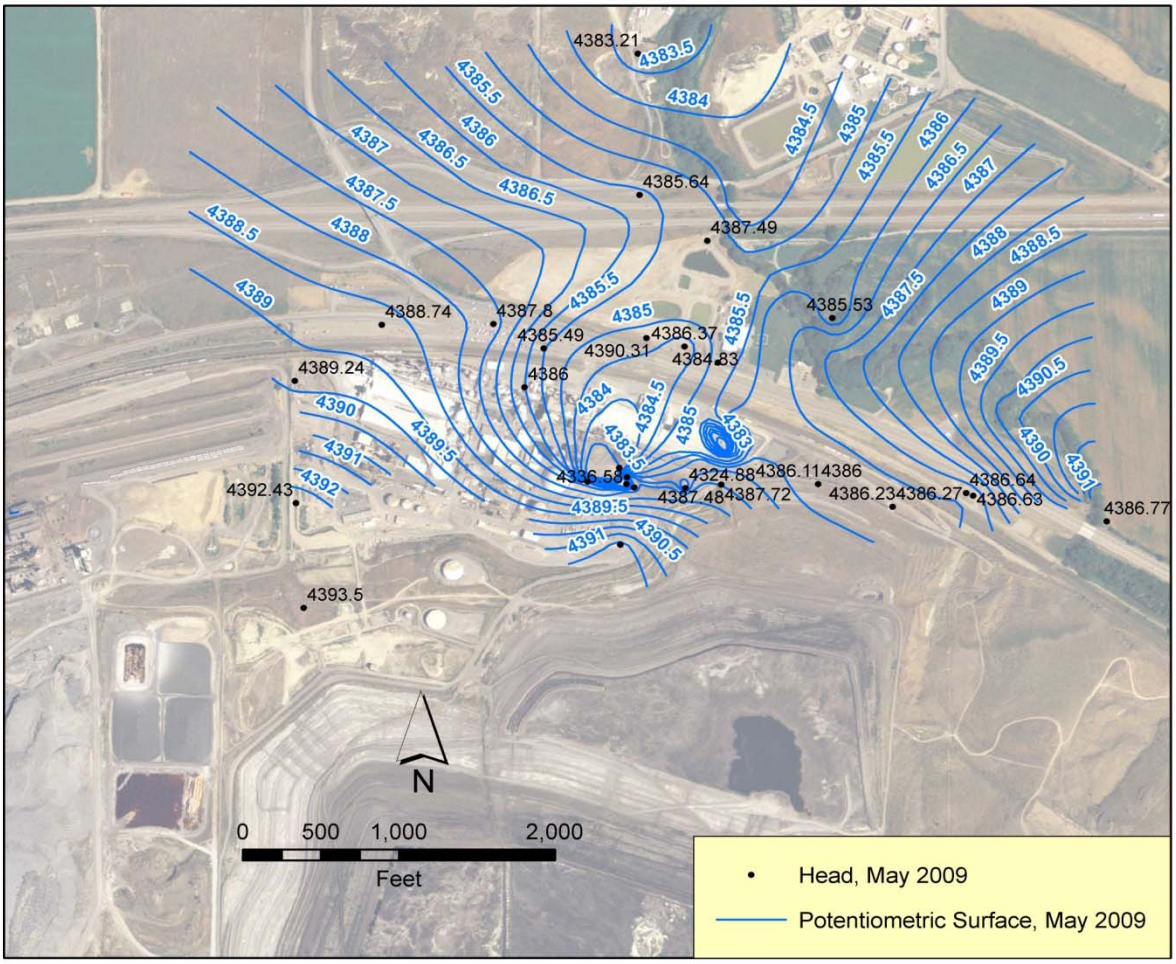


Figure 5-9: Interpreted potentiometric surfaces for Lower Zone, second quarter 2009.

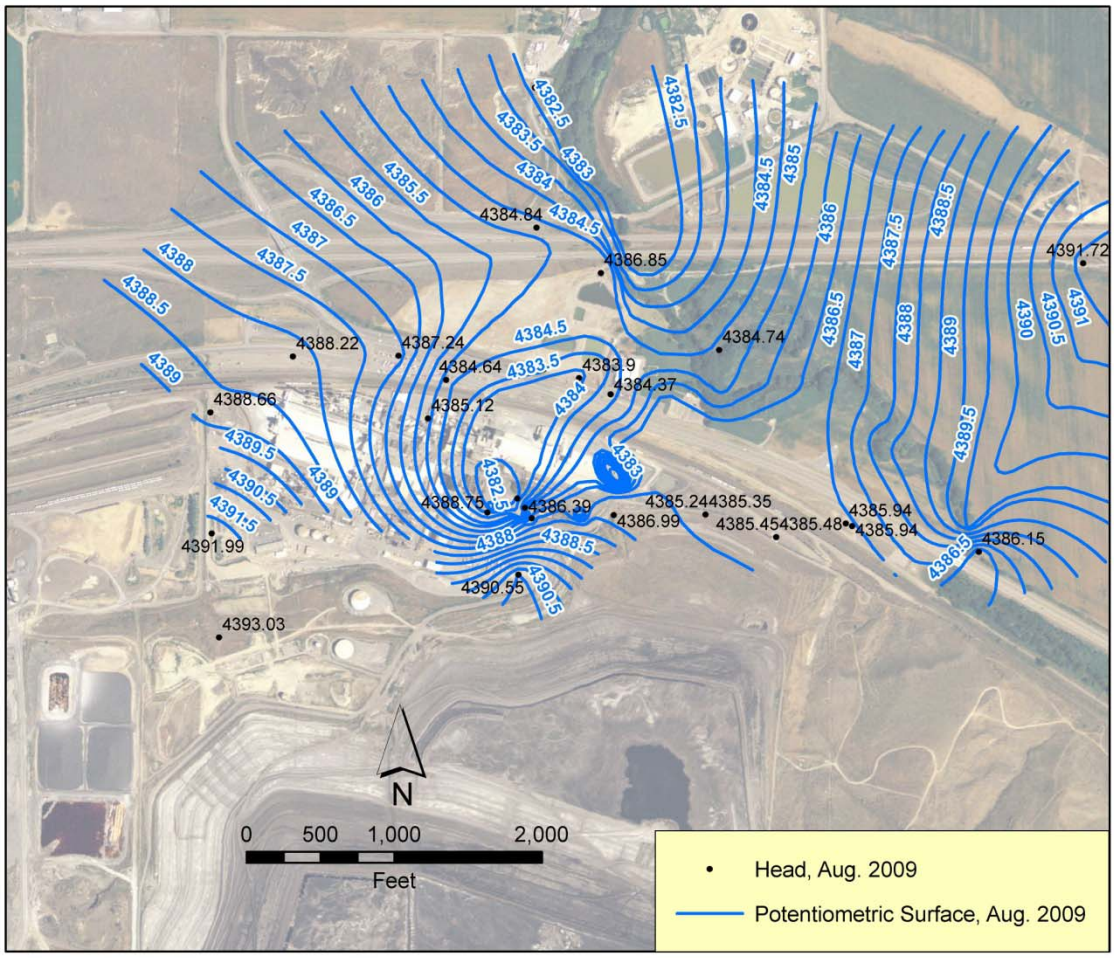


Figure 5-10: Interpreted potentiometric surfaces for Lower Zone, third quarter 2009.

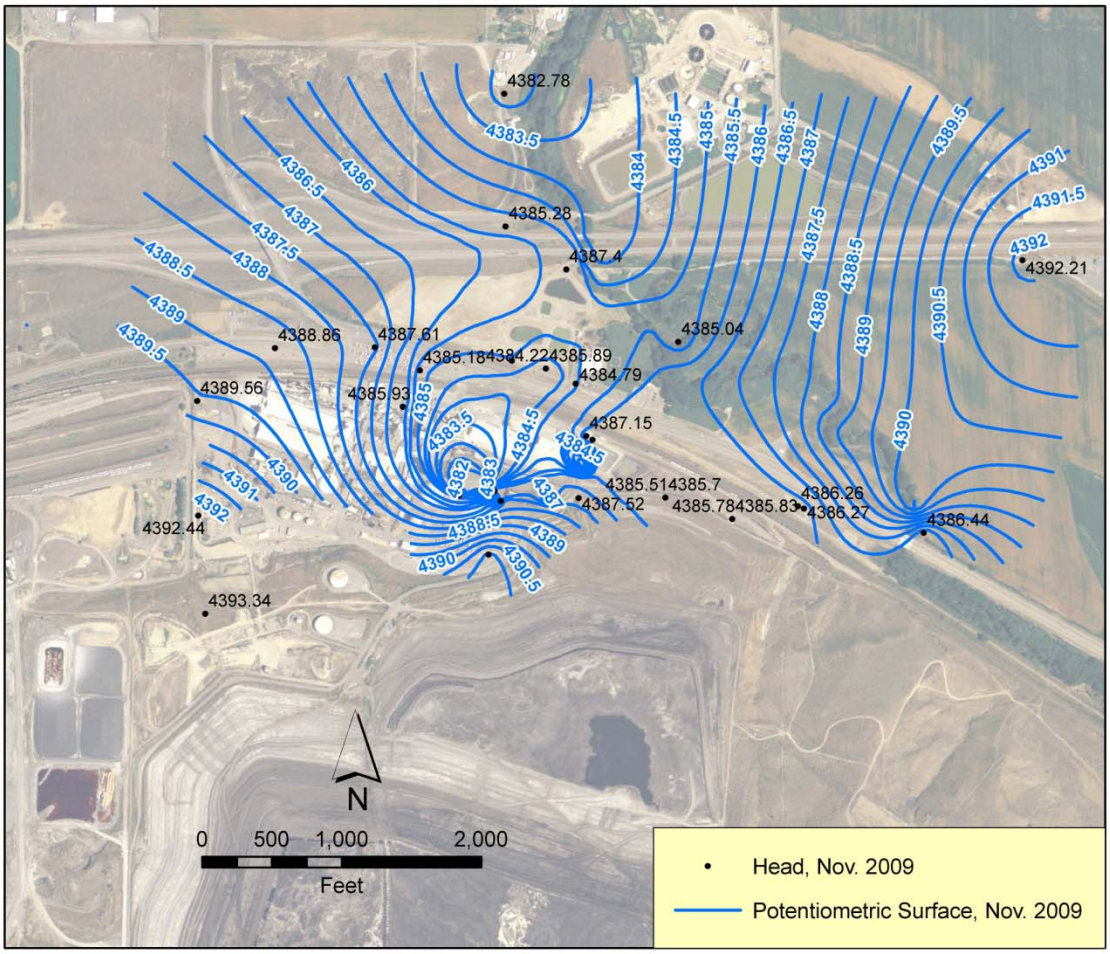


Figure 5-11: Interpreted potentiometric surfaces for Lower Zone, fourth quarter 2009.

5.3.2.2 Bedrock

Groundwater surface elevations and the interpreted potentiometric surfaces for quarters three and four in the Bedrock are presented in Figures 5-12 and 5-13.

Water levels were slightly higher in November than during the August sampling event. Groundwater elevations across the site in Bedrock varied by 0.5 feet between quarters three and four.

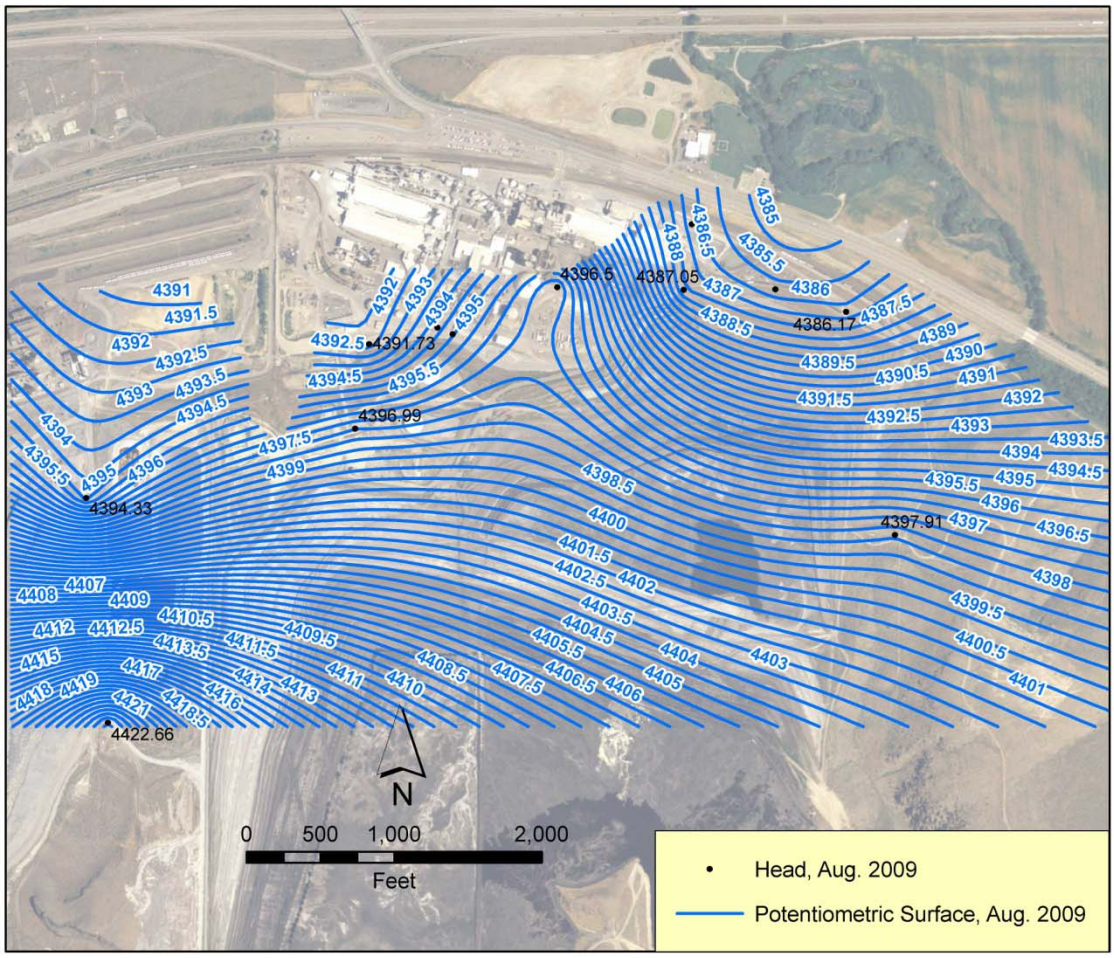


Figure 5-12: Interpreted potentiometric surfaces for Bedrock, third quarter 2009.

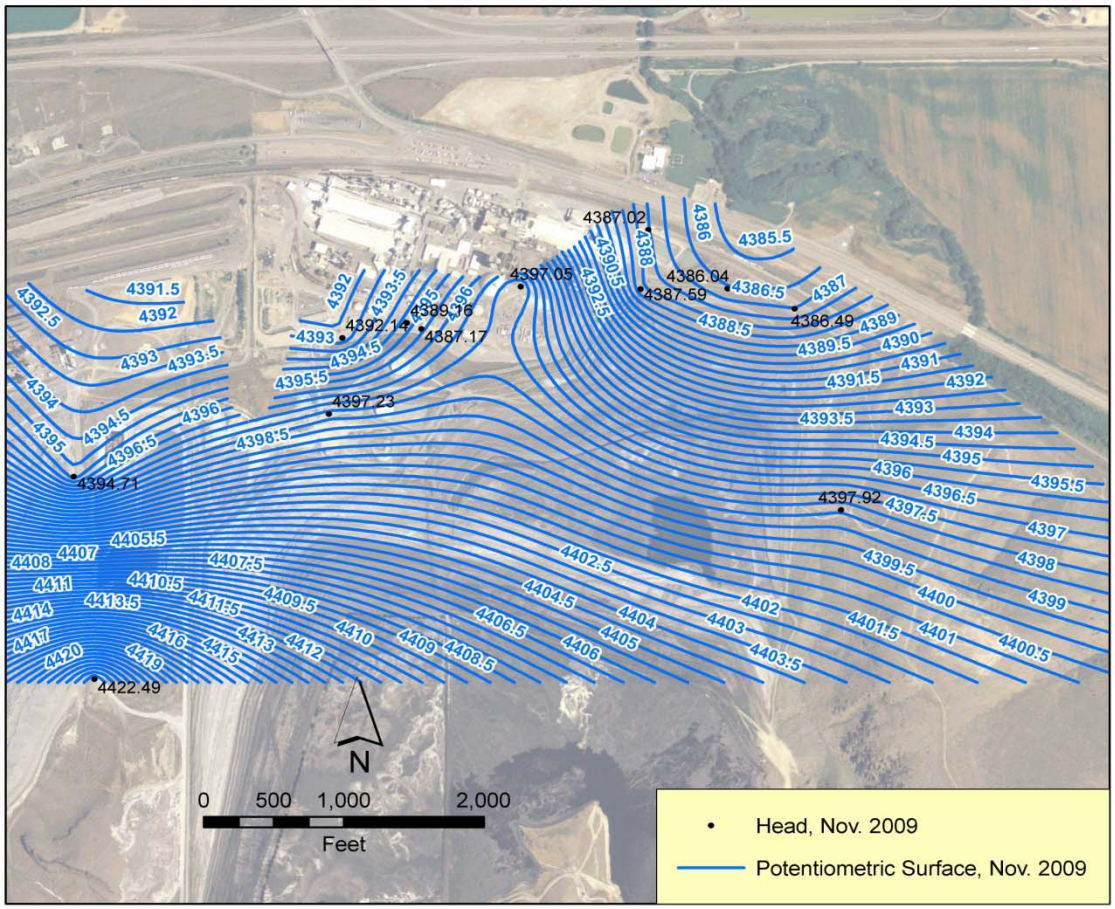


Figure 5-13: Interpreted potentiometric surfaces for Bedrock, fourth quarter 2009.

5.3.3 Groundwater Chemistry

5.3.3.1 Arsenic

Figures 5-14 through 5-17 illustrates the spatial distribution of arsenic in the Bedrock, Upper, and Lower Zones during 2009. The general spatial distribution is consistent throughout the year and supports the basic conceptual site model.

The highest arsenic concentrations were measured in the target extraction areas (East and West Plant Areas) and in the Upper Zone beneath and downgradient of the phosphoric acid plant. The region between the current extraction system and the joint fenceline area (downgradient of the bedrock knob) generally shows lower concentrations.

Concentrations decrease downgradient as groundwater migrates to the Portneuf River area. The highest arsenic concentration measured during the 2009 quarterly monitoring events at Batiste Road Spring (BRS) was 0.0082 mg/L in March, and the highest result at Batiste Spring (BTS) was 0.0175 mg/L in May.

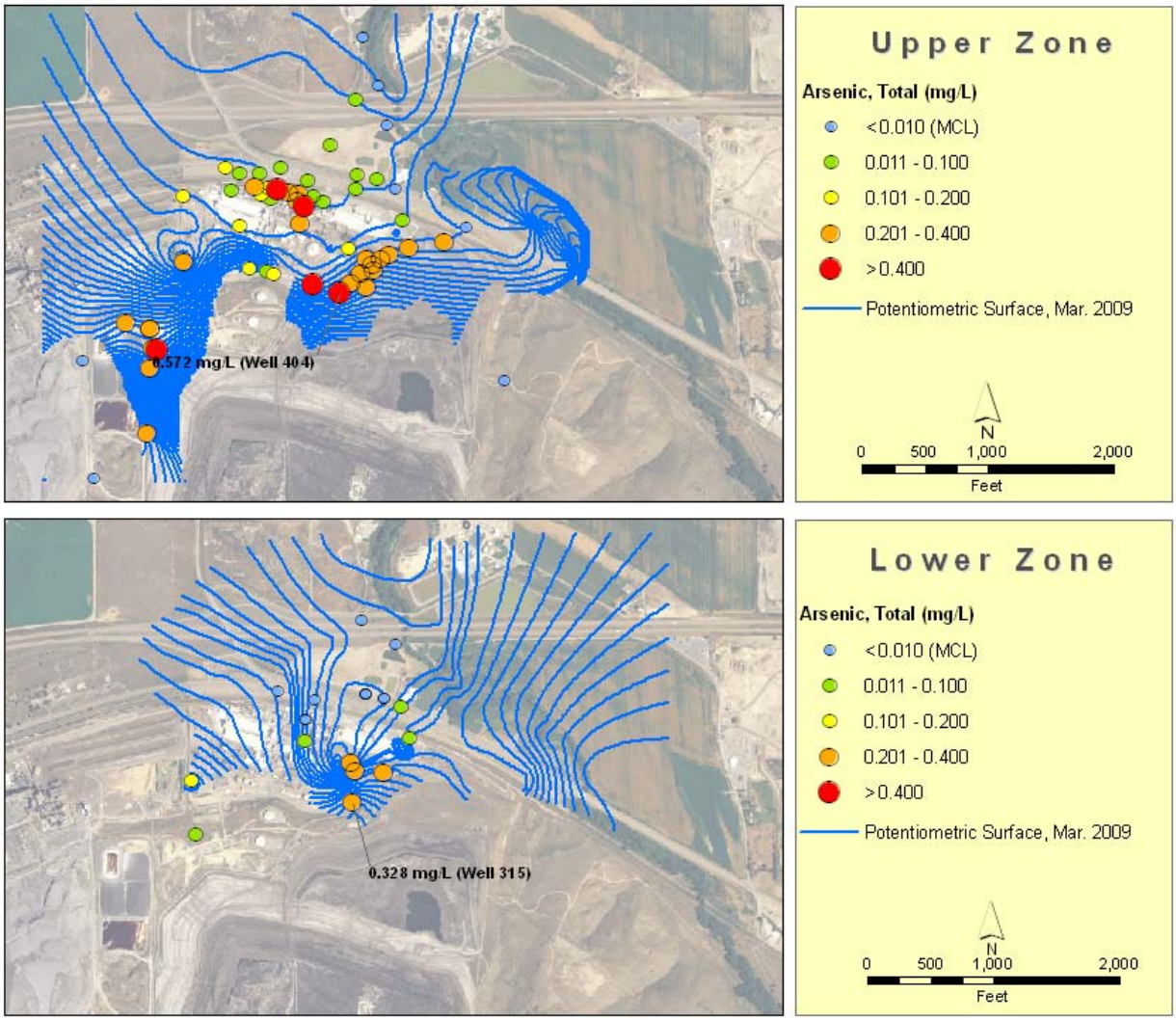


Figure 5-14: Post plots of arsenic (total) in Upper, and Lower Zones, first quarter 2009. Maximum observed concentrations are posted.

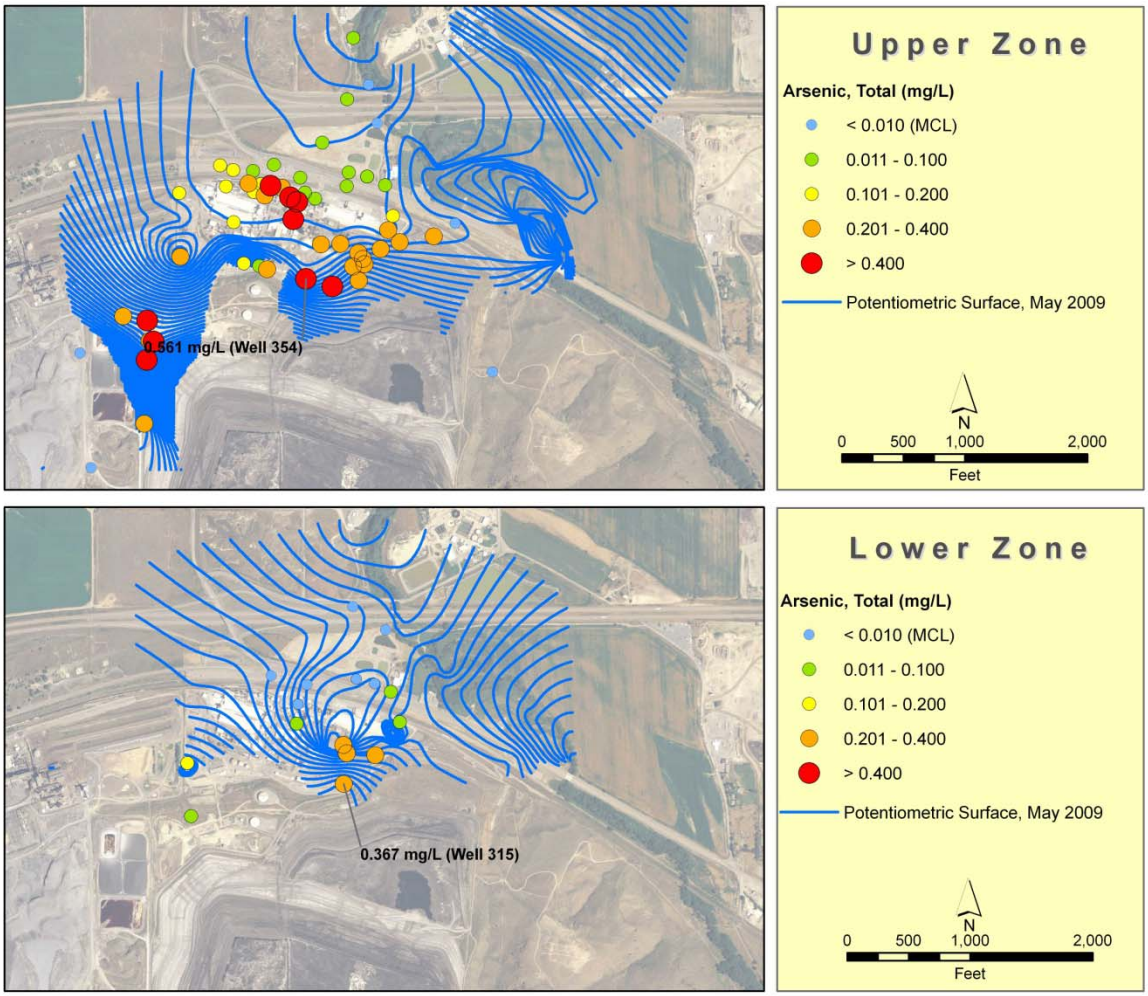


Figure 5-15: Post plots of arsenic (total) in Upper, and Lower Zones, second quarter 2009. Maximum observed concentrations are posted.

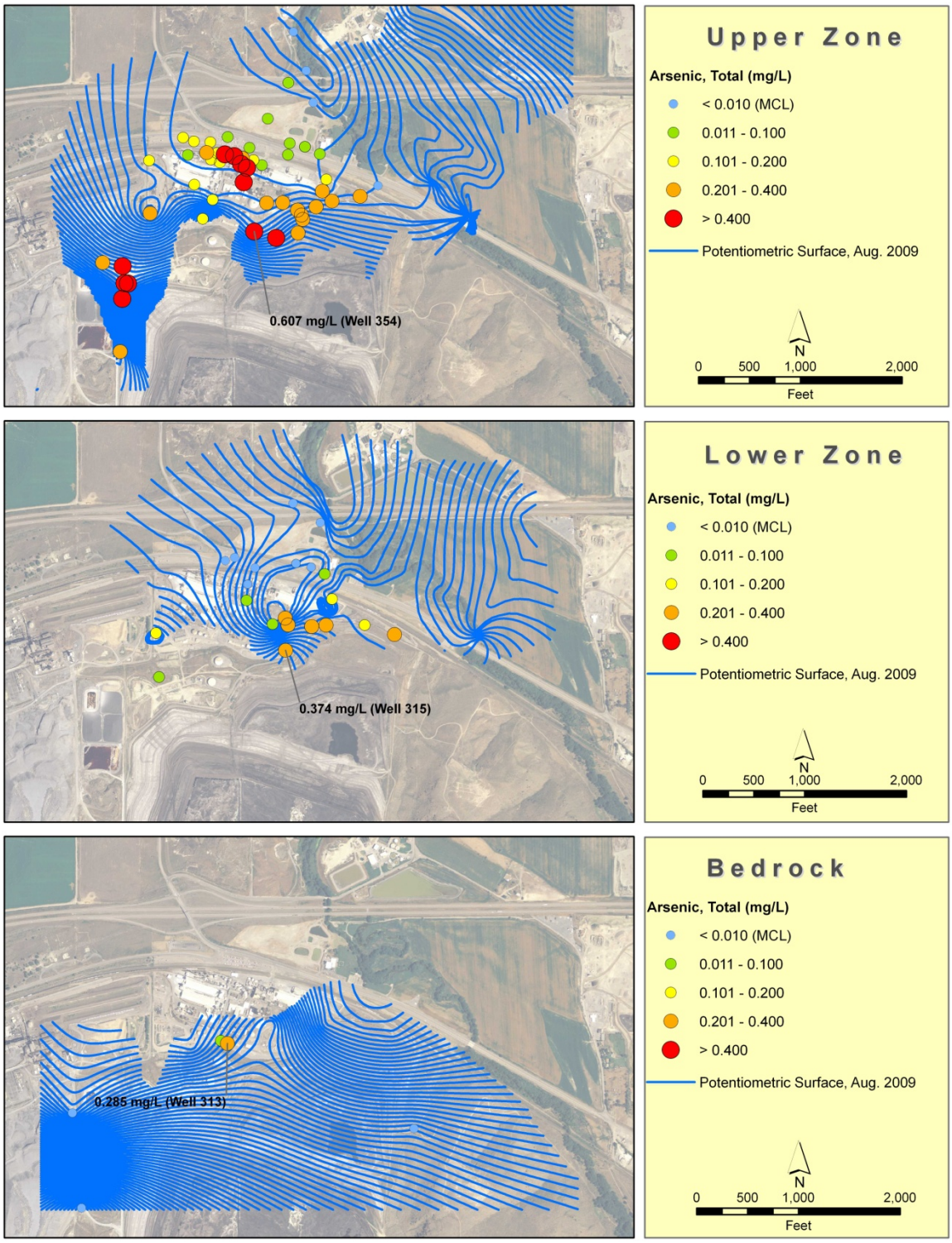


Figure 5-16: Post plots of arsenic (total) in Upper and Lower Zones, and Bedrock, third quarter 2009. Maximum observed concentrations are posted.

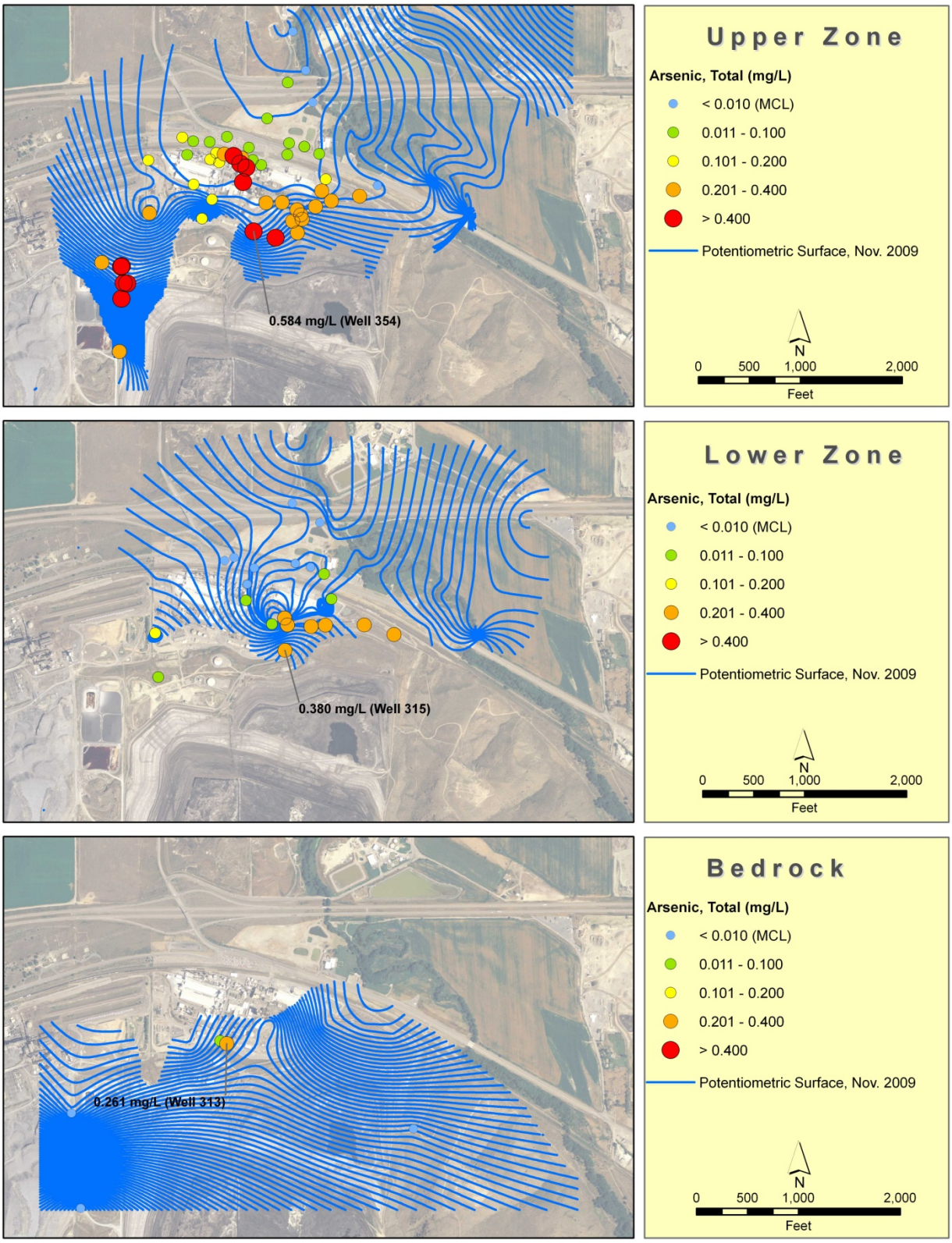


Figure 5-17: Post plots of arsenic (total) in Upper and Lower Zones, and Bedrock, fourth quarter 2009. Maximum observed concentrations are posted.

5.3.3.2 Phosphorus

Figures 5-18 through 5-21 illustrates the spatial distribution of phosphorus in the Bedrock, Upper, and Lower Zones during 2009. The general spatial distribution is consistent throughout the year.

The highest concentrations were measured near the current East Plant Area extraction system (Upper and Lower Zones) and at wells downgradient of the phosphoric acid plant. The isolated elevated concentrations downgradient of the phosphoric acid plant (at well 340, for example) indicate influence of a facility source or sources. The Lower Zone is not impacted in this area.

Joint Fenceline Area wells indicate relatively lower concentrations of phosphorus. The bedrock knob area indicates lower concentrations compared to areas of the current extraction system (East Plant and West Plant Areas).

Concentrations decrease downgradient as groundwater migrates to the Portneuf River area and the highest concentrations during the 2009 quarterly monitoring events were 1.94 mg/L in March and 5.58 mg/L in May at the Spring at Batiste Road and Batiste Spring, respectively.

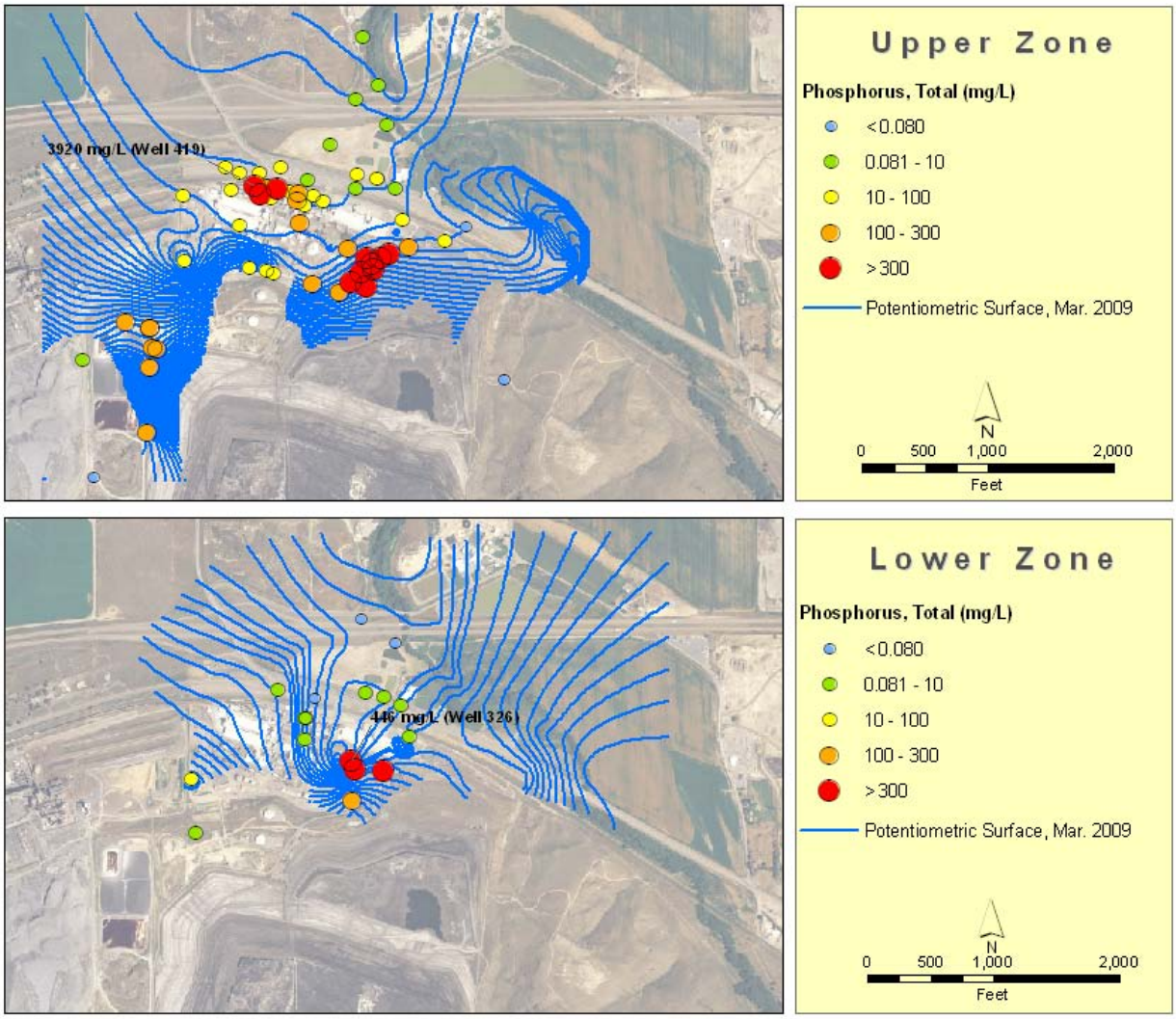


Figure 5-18: Post plots of phosphorus (total) in Upper and Lower Zones, first quarter 2009. Maximum observed concentrations are posted.

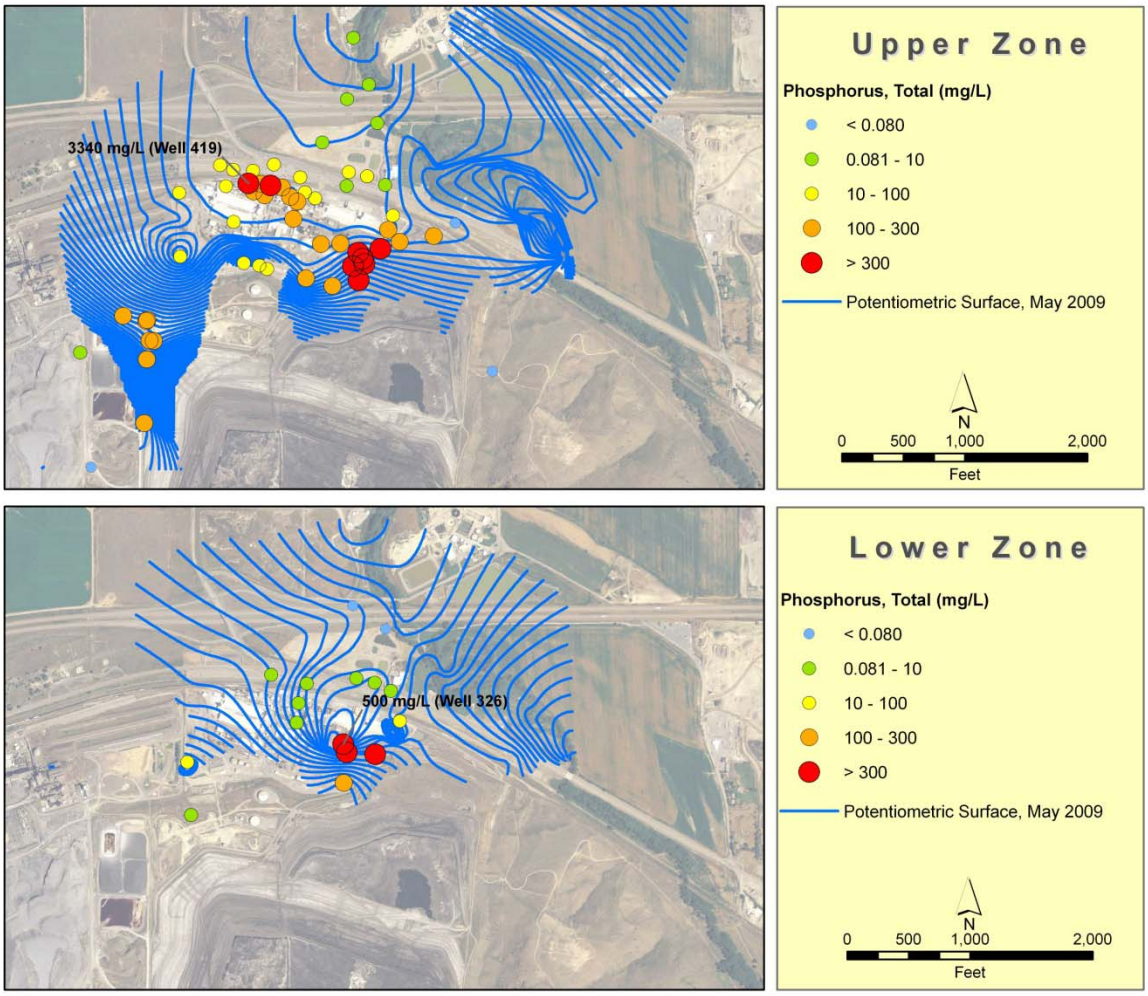


Figure 5-19: Post plots of phosphorus (total) in Upper and Lower Zones, second quarter 2009. Maximum observed concentrations are posted.

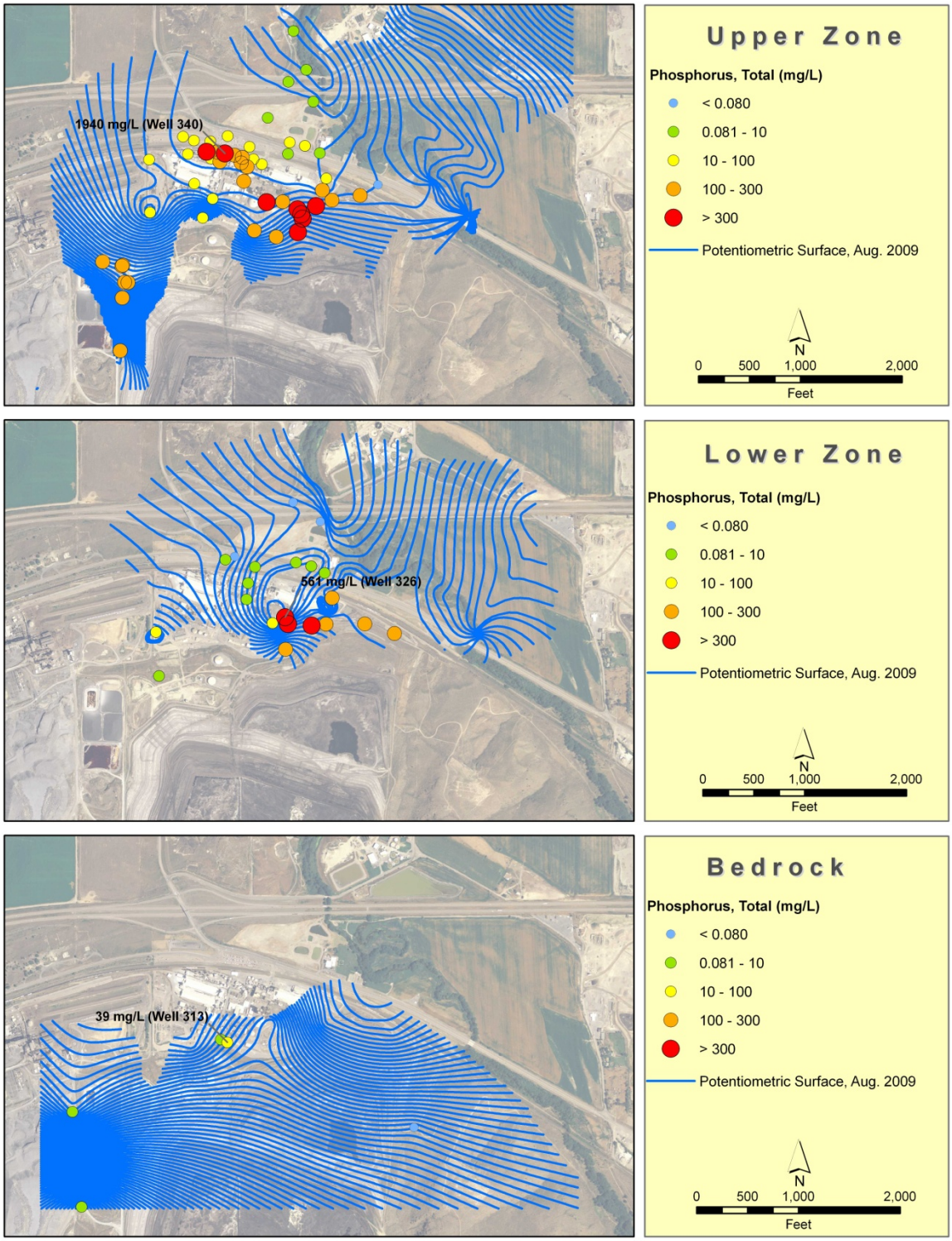


Figure 5-20: Post plots of phosphorus (total) in Upper and Lower Zones, and Bedrock, third quarter 2009. Maximum observed concentrations are posted.

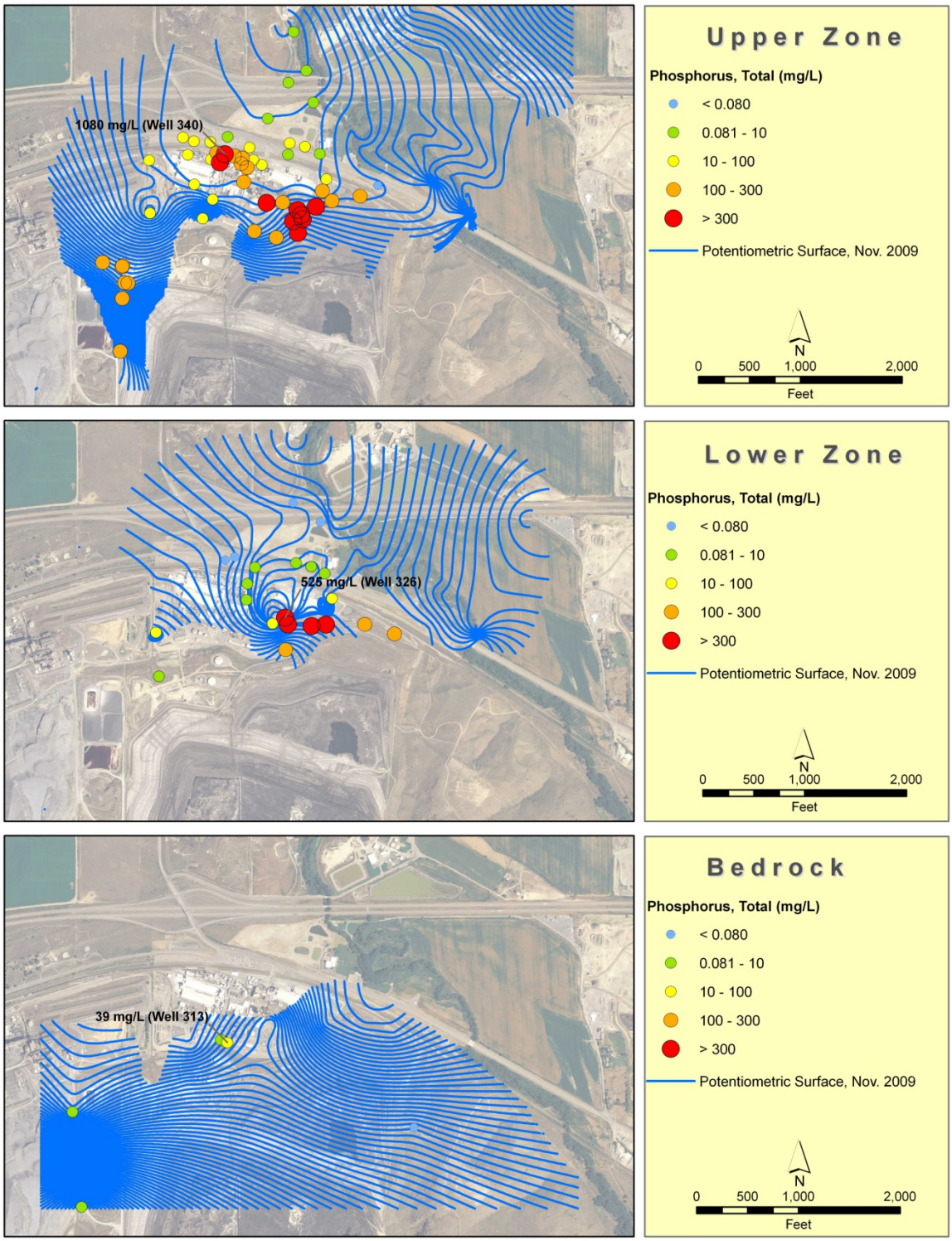


Figure 5-21: Post plots of phosphorus (total) in Upper and Lower Zones, and Bedrock, fourth quarter 2009. Maximum observed concentrations are posted.

5.3.3.3 Sulfate

Figures 5-22 through 5-25 illustrates the spatial distribution of sulfate in the Bedrock, Upper, and Lower Zones during 2009. The general spatial distribution is the same throughout the year and is consistent with the distribution of arsenic associated with the gypsum stack source.

The highest sulfate concentrations were measured in the target extraction areas (East and West Plant Areas) and in the Upper Zone beneath and downgradient of the phosphoric acid plant. The region between the current extraction system and the joint fenceline area (downgradient of the bedrock knob) generally shows lower concentrations.

Concentrations decrease downgradient as groundwater migrates to the Portneuf River area and the highest concentrations during the 2009 quarterly monitoring events were 116 mg/L in September and 167 mg/L in May at the Spring at Batiste Road and Batiste Spring, respectively.

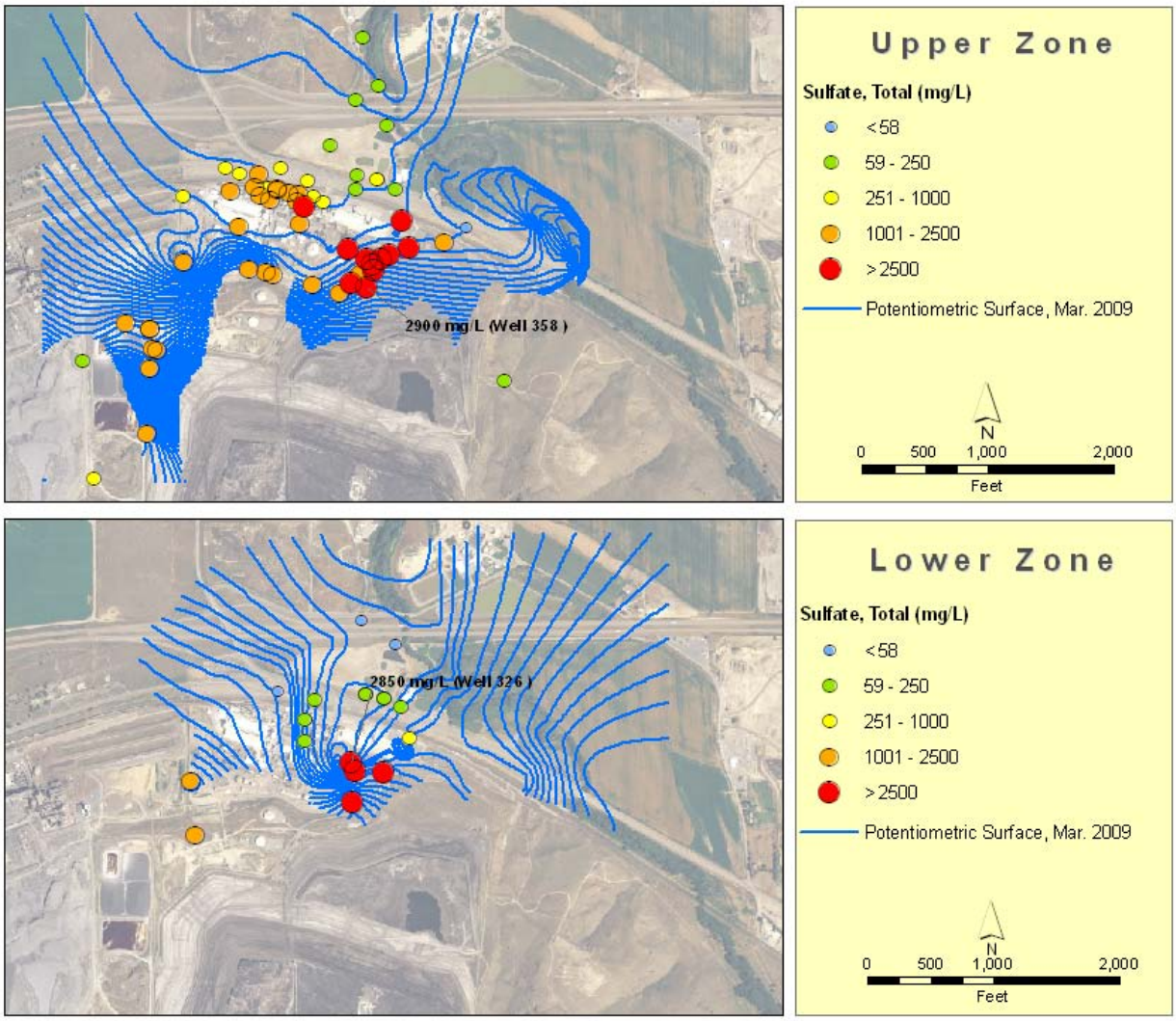


Figure 5-22: Post plots of sulfate in Upper and Lower Zones, first quarter 2009. Maximum observed concentrations are posted.

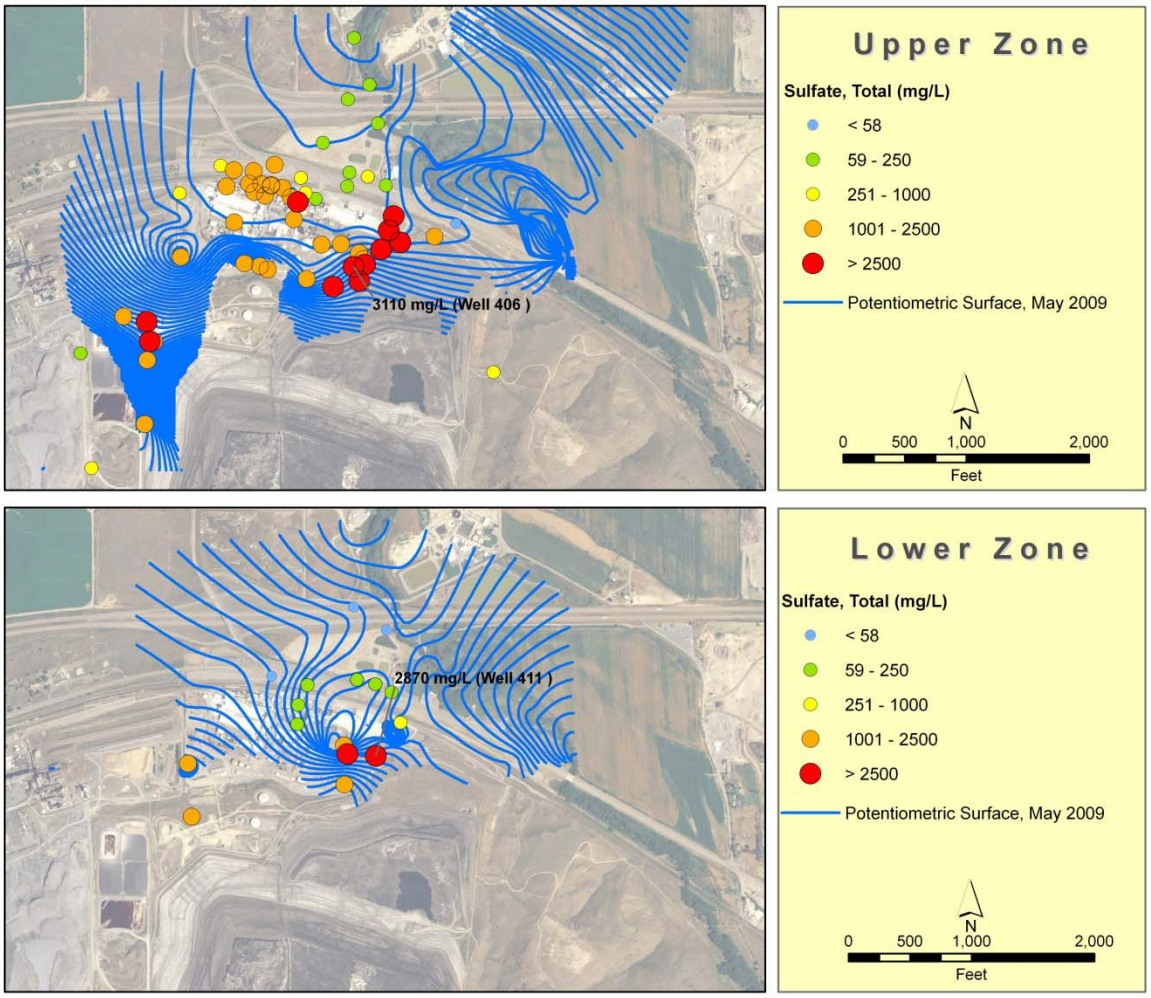


Figure 5-23: Post plots of sulfate in Upper and Lower Zones, second quarter 2009. Maximum observed concentrations are posted.

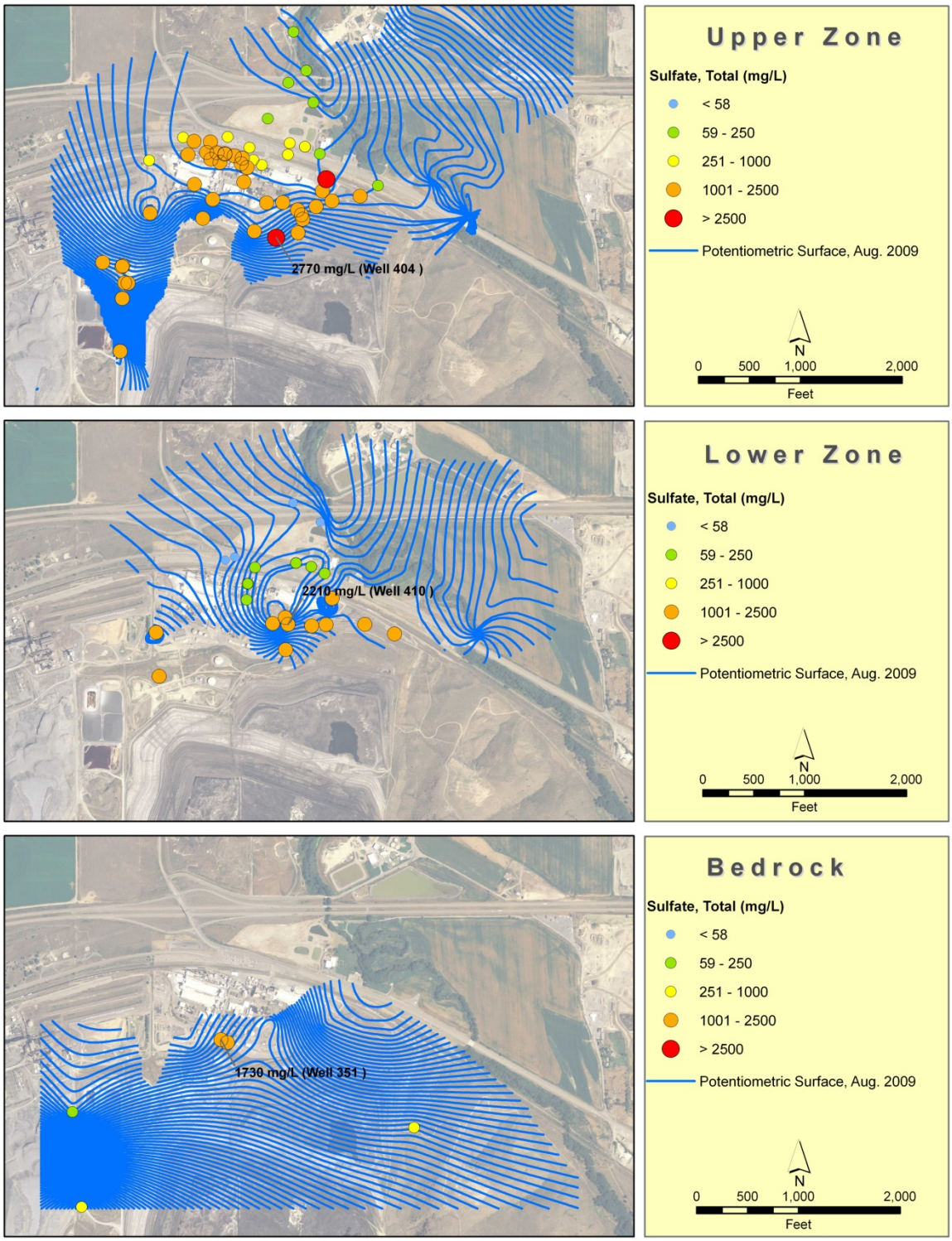


Figure 5-24: Post plots of sulfate in Upper and Lower Zones, and Bedrock, third quarter 2009. Maximum observed concentrations are posted.

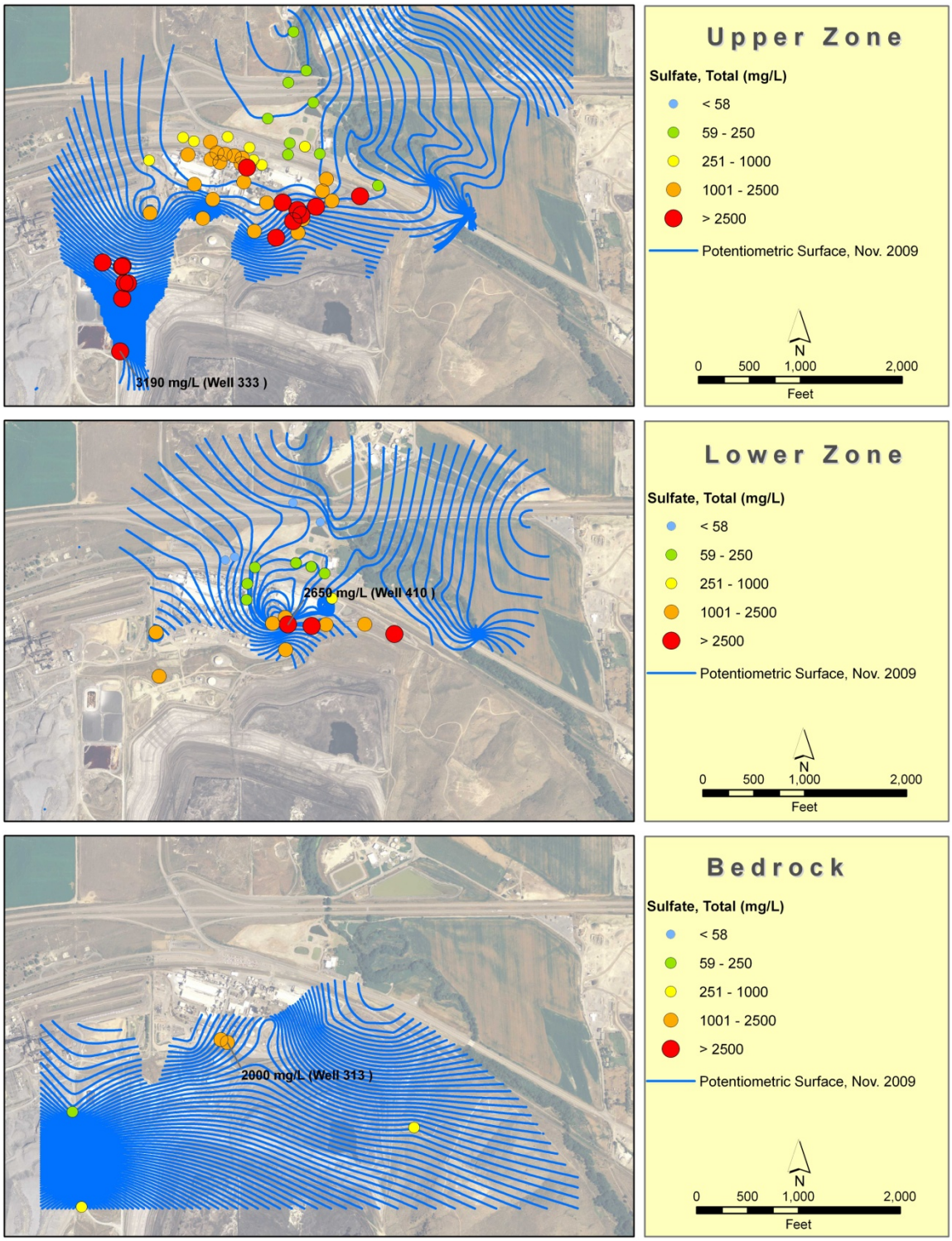


Figure 5-25: Post plots of sulfate in Upper and Lower Zones, and Bedrock, fourth quarter 2009. Maximum observed concentrations are posted.

5.3.3.4 Nitrate+Nitrite

Figures 5-26 through 5-29 illustrates the spatial distribution of nitrate+nitrite in the Bedrock, Upper, and Lower Zones during 2009. The spatial distribution is different than for arsenic, phosphorus, and sulfate. Nitrate+nitrite is not strongly associated with the gypsum stack or the phosphoric acid plant.

The highest concentration during 2009 was 145 mg/L measured in June at well 370. Concentrations reduce along the flow path to the north and are below the MCL of 10 mg/L at the springs. Nitrate+nitrite impacts are limited to the Bedrock and Upper Zone; there is no evidence of nitrate+nitrite impacts in the Lower Zone.

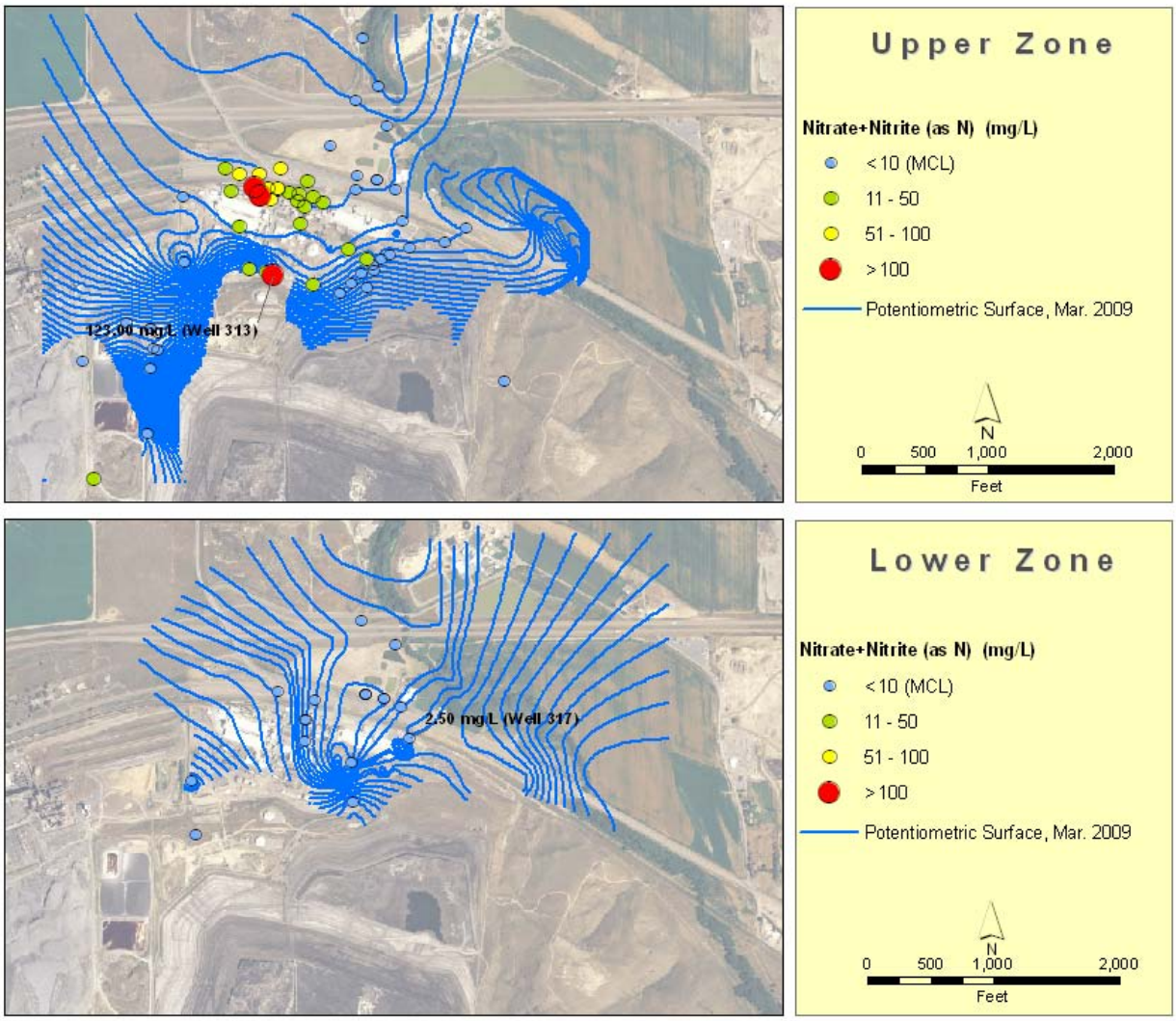


Figure 5-26: Post plots of nitrate+nitrite in Upper and Lower Zones, first quarter 2009. Maximum observed concentrations are posted.

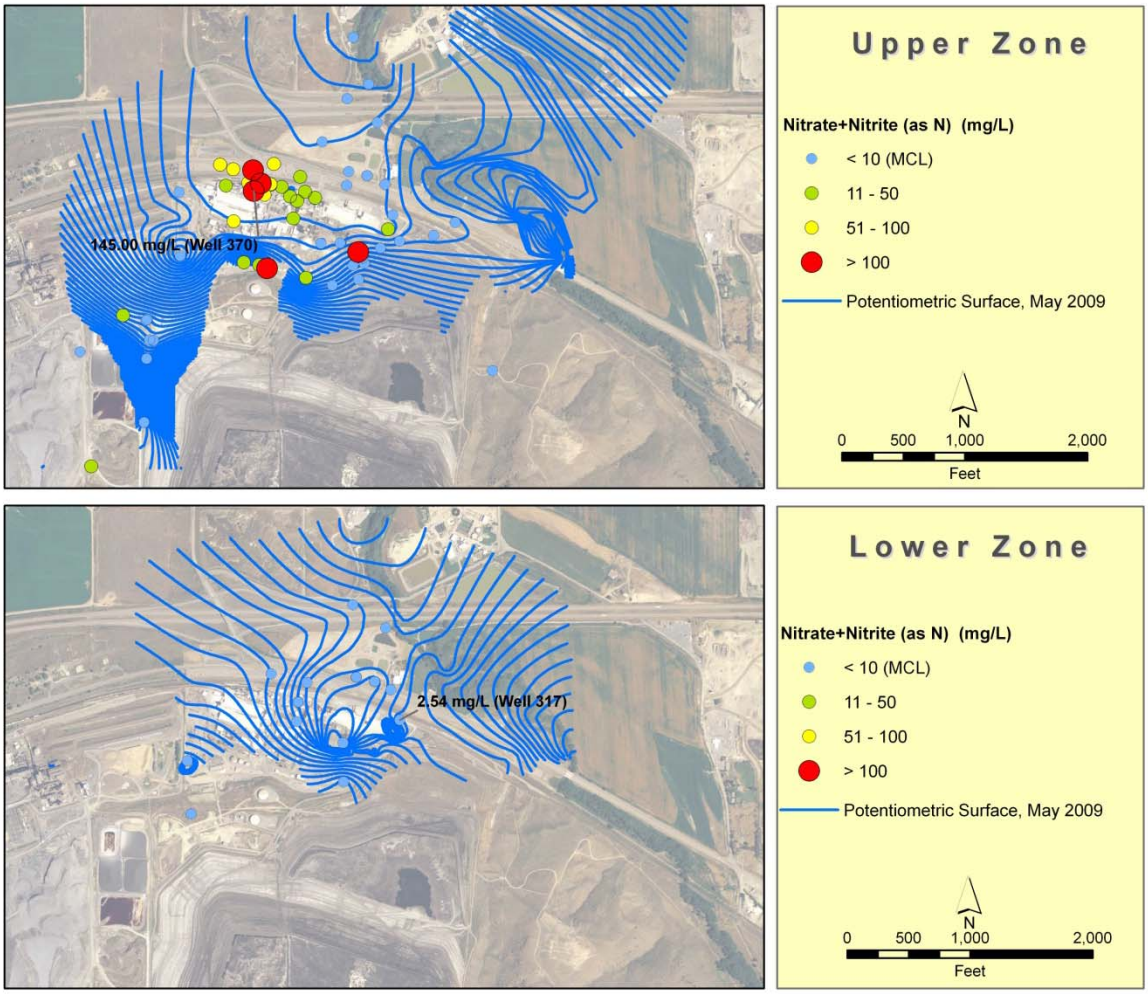


Figure 5-27: Post plots of nitrate+nitrite in Upper and Lower Zones, second quarter 2009. Maximum observed concentrations are posted.

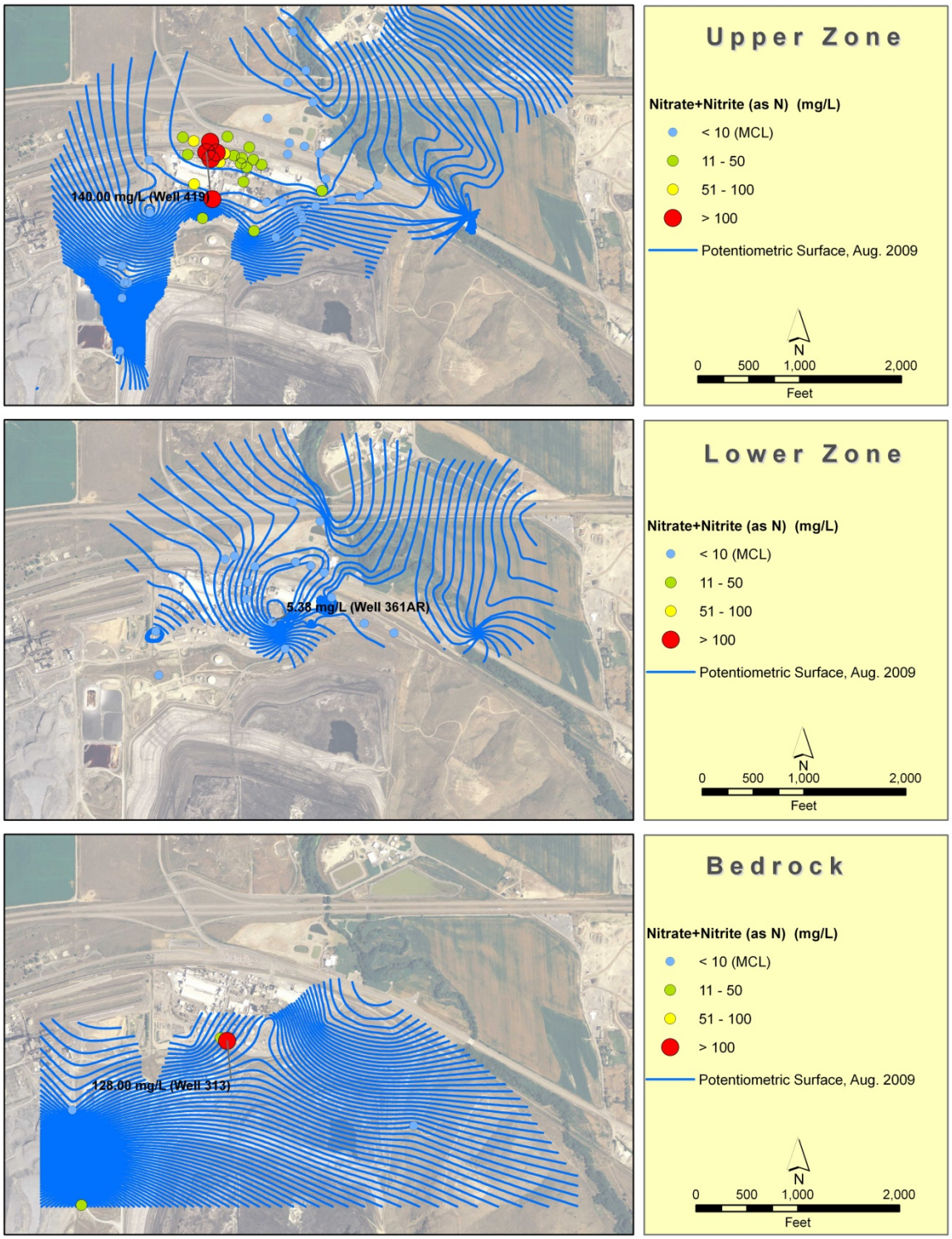


Figure 5-28: Post plots of nitrate+nitrite in Upper and Lower Zones, and Bedrock, third quarter 2009. Maximum observed concentrations are posted.

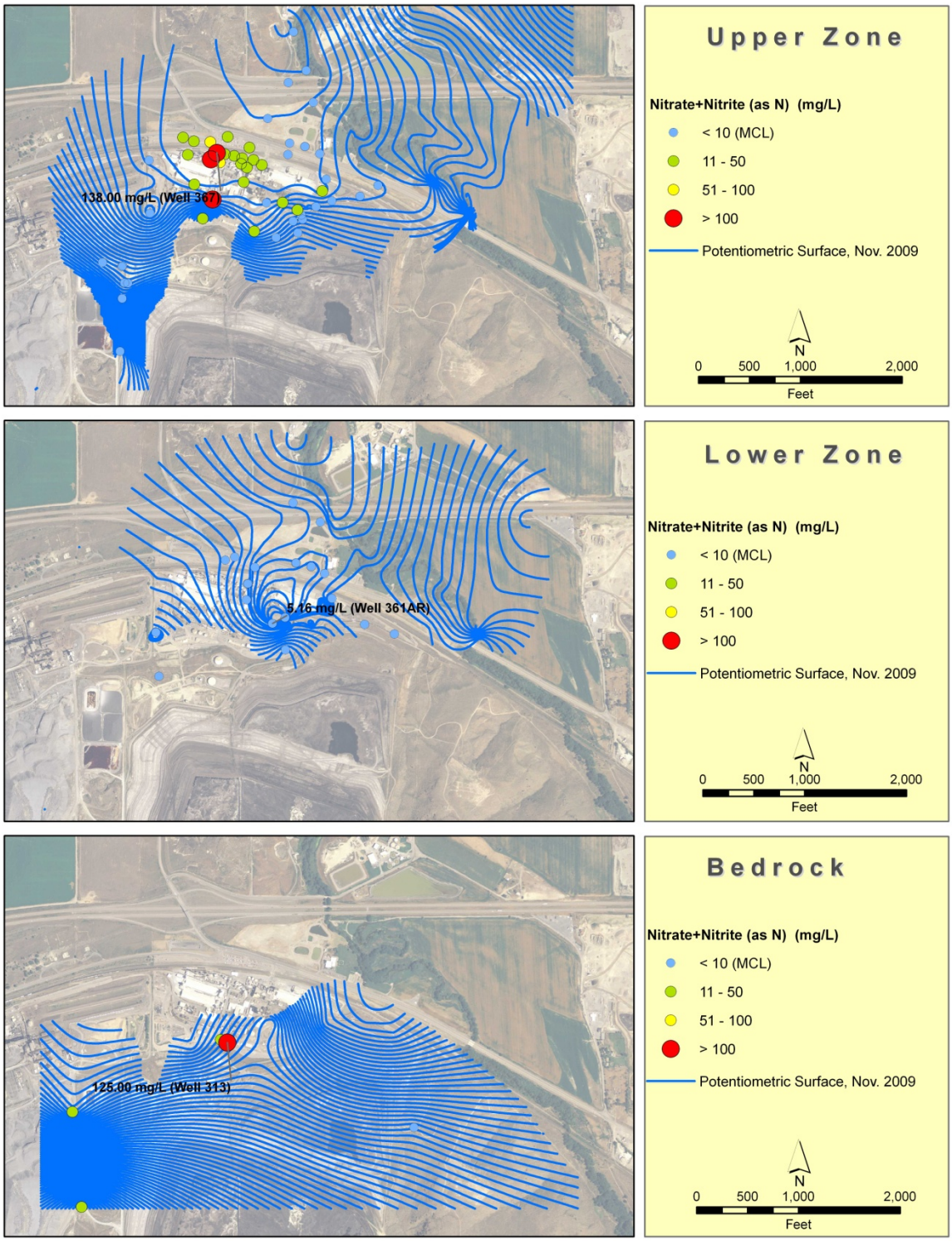


Figure 5-29: Post plots of nitrate+nitrite in Upper and Lower Zones, and Bedrock, fourth quarter 2009. Maximum observed concentrations are posted.

6.0 GROUNDWATER DATA EVALUATION

The discussion in the following paragraphs provides data analysis and discussion that addresses the hypothesis tests and decision rules for the five monitoring program areas as follows:

- Tracking groundwater quality in the Don Plant Area and demonstrating source control;
- Demonstrating source control in the phosphoric acid plant area;
- Demonstrating hydraulic control of the extraction system in the target capture zones;
- Evaluating extraction system reduction towards the extent and concentration of COCs in the Assessment Area;
- Establishing interim target concentrations in selected Assessment Area wells; and
- Evaluating extraction system performance in terms of preventing COC migration into the Off-Plant OU at concentrations above the MCL or RBC in the Compliance Area.

6.1 Tracking Groundwater Quality in the Don Plant Area

Monitoring goals in the Don Plant Area include demonstrating reduction of the extent and concentration of COCs and demonstrating source control of the gypsum stack and phosphoric acid plant area. When the gypsum stack and phosphoric acid plant area source controls are operating as intended, the extent and concentration of COCs will be reduced in the Don Plant Area.

The data collection program in the Don Plant Area will be used to provide data for chemistry trend analysis, site-wide groundwater potentiometric surface mapping, and groundwater elevation trends. Site-wide groundwater potentiometric maps are presented in Section 5.3. The spatial distribution of COCs is evaluated in Section 6.1.1. Transport time calculations are presented in Section 6.1.2 and temporal trends are analyzed for each subarea in Section 6.1.3.

The wells in the Don Plant Area that are monitored and the data that have been collected are listed in Table 5-2, and the monitoring well locations are shown in Figures 5-1 through 5-3. Samples of groundwater were collected and analyzed for the indicator analytes shown in Table 5-1.

6.1.1 Extent of Indicator Analytes

The extent of indicator analytes arsenic, phosphorus, and sulfate, in the Don Plant Area at the

end of 2009 was very similar to that at the end of 2008 (Figures 6-1 through 6-3 and Figures 4-3 through 4-5 in the 2008Q4 Groundwater Monitoring Report). In 2009, arsenic concentrations in the Upper Zone were most elevated near the phase 1 extraction wells and the southern fenceline area. Multiple Upper Zone monitoring wells along the fenceline had arsenic concentrations between 0.05 and 0.25 mg/L. To the west, FMC wells 110 and 517 had lower arsenic concentrations, between 0.01 and 0.05 mg/L. Thus, the fenceline bounds the Upper Zone arsenic plume. To the east, the arsenic plume is bounded by well 328, which consistently had non-detected arsenic concentrations. Lower Zone arsenic concentrations were elevated in wells 410, 411, 326, and 315. Concentrations were between 0.05 and 0.25 mg/L at well 366AR, the furthest east monitoring point. In bedrock, non-detect arsenic concentrations were found in well 305. Arsenic concentrations were higher in the plant area and toward the foot of the gypsum stack, and decreased to the west, for example well 190 ranged from 0.003 to 0.011 mg/L. This spatial extent was relatively constant throughout 2009. Figure 6-1 shows the spatial extent of arsenic in the Don Plant monitoring area in the fourth quarter of 2009.

Phosphorus in the Upper Zone Don Plant Area was elevated at the phase I extraction wells near the foot of the gypstack and in the central zone. The phosphorus plume is bounded to the east by well 328, which consistently had non-detect phosphorus results. To the west, wells 312 and 331, located near the border with FMC property, had phosphorus concentrations less than 100 mg/L throughout 2009. In the Lower Zone, phosphorus concentrations were highest in the eastern plant area, and decreased to the west and north. To the west, wells 309 and 346 had stable concentrations of less than 100 mg/L phosphorus. In bedrock, phosphorus concentrations were highest in the Central Plant Area and in the southern fenceline area. Well 305 bounds the elevated phosphorus concentrations to the west and well 190 to the east. This spatial extent was relatively constant throughout 2009. Figure 6-2 shows the spatial extent of phosphorus in the Don Plant monitoring area in the fourth quarter of 2009.

Elevated sulfate concentrations occur in the Upper Zone near the phase I extraction wells and in the fenceline area. Well 328 to the east had lower sulfate concentrations, less than 100 mg/L. To the west, wells 110, 143, 312, 331, and 517 all had sulfate concentrations less than 1,000 mg/L. In the Lower Zone, elevated sulfate concentrations occur in the East Plant Area. Concentrations decreased toward the Central Plant Area. Outside of the Don Plant Area, FMC well 109 showed reduced sulfate concentrations of less than 100 mg/L. In bedrock, elevated concentrations occur in the Central Plant Area and in the fenceline area. To the west and north, well 190 had decreased sulfate concentrations between 100 and 300 mg/L. This spatial extent was relatively constant throughout 2009. Figure 6-3 shows the spatial extent of sulfate in the Don Plant monitoring area in the fourth quarter of 2009.

Elevated nitrate plus nitrite concentrations occur in the central Upper Zone near the plant area. To the south and east, near the phase I extraction wells, nitrate plus nitrite concentrations were less than the MCL of 10 mg/L. All Lower Zone wells had concentrations less than the MCL. Concentrations in bedrock were variable, with a high concentration of 125 mg/L in well 313 upgradient of the plant area. Figure 6-4 shows the spatial extent of nitrate plus nitrite in the Don

Plant monitoring area in the fourth quarter of 2009. Time-series for these wells are included in Appendix B.

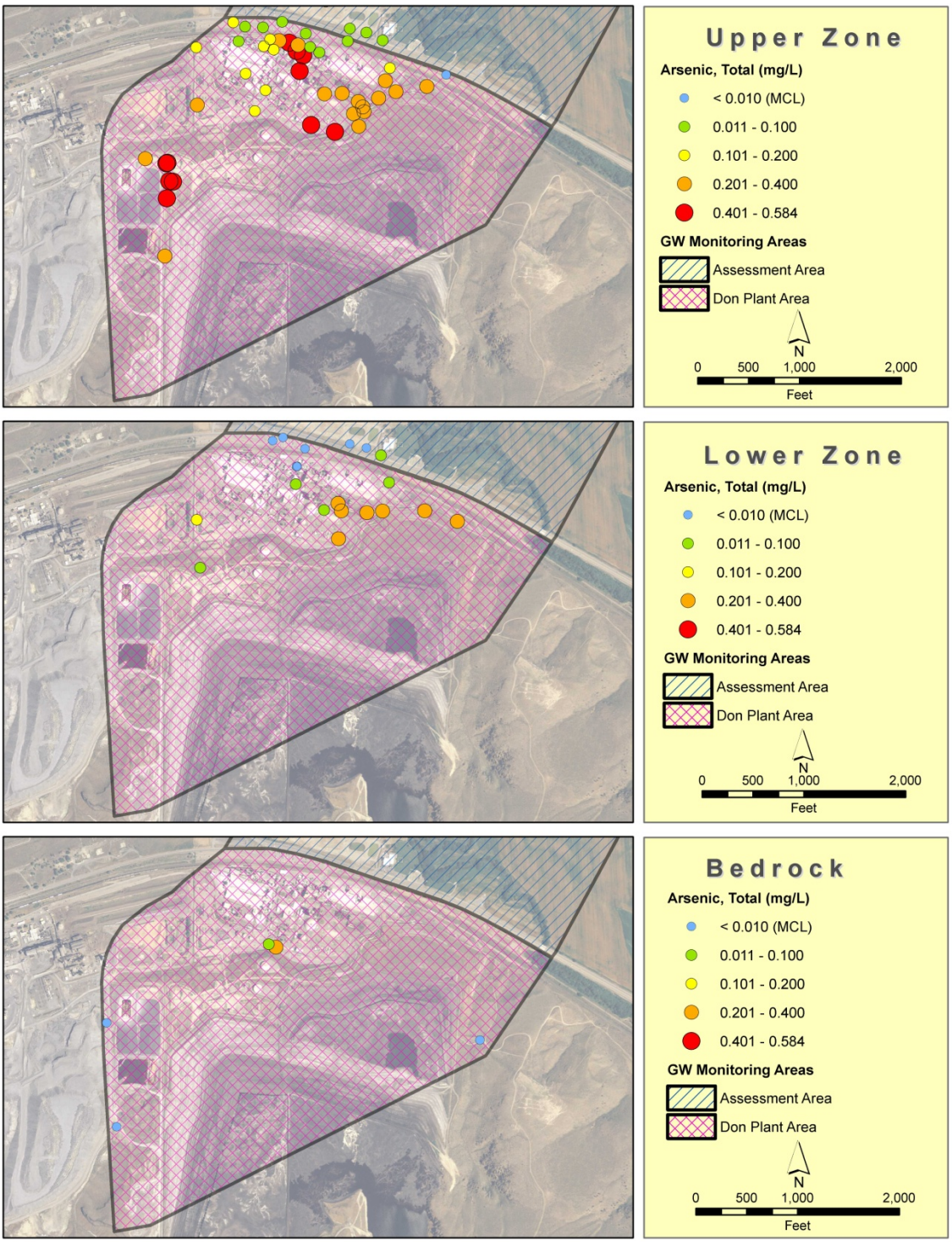


Figure 6-1: Arsenic concentrations at the end of 2009 (fourth quarter) in the Don Plant monitoring area.

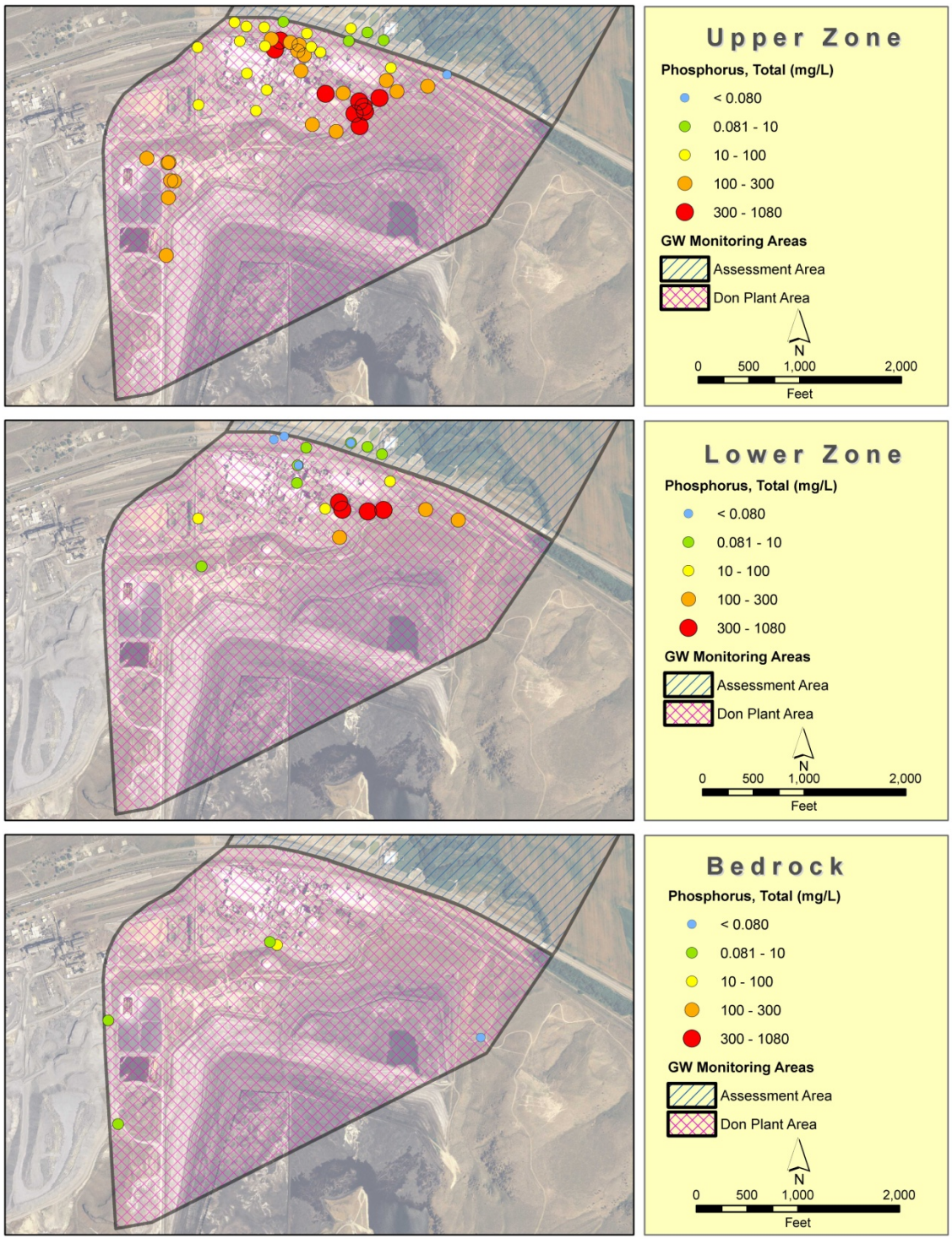


Figure 6-2: Phosphorus concentrations at the end of 2009 (fourth quarter) in the Don Plant monitoring area.

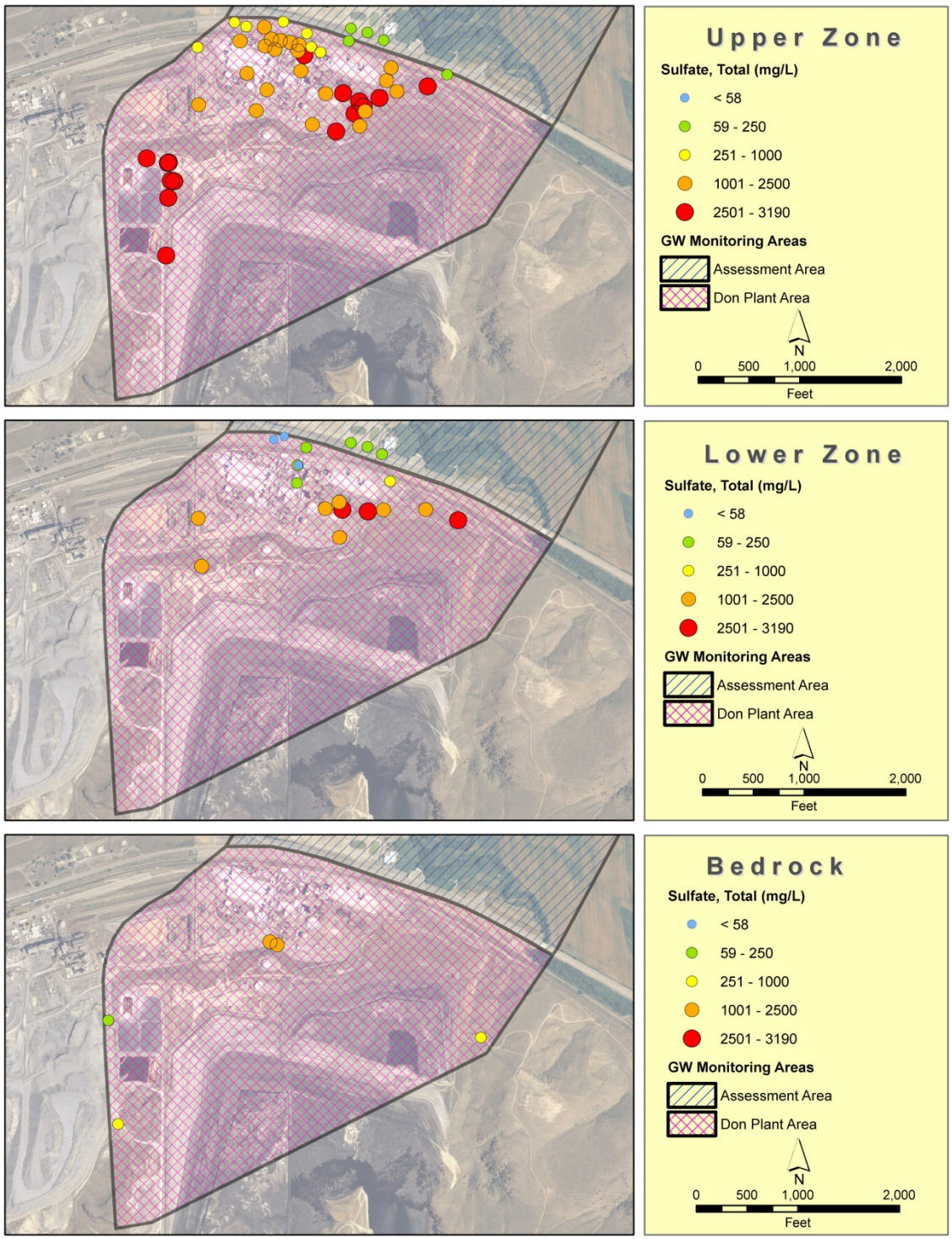


Figure 6-3: Sulfate concentrations at the end of 2009 (fourth quarter) in the Don Plant monitoring area.

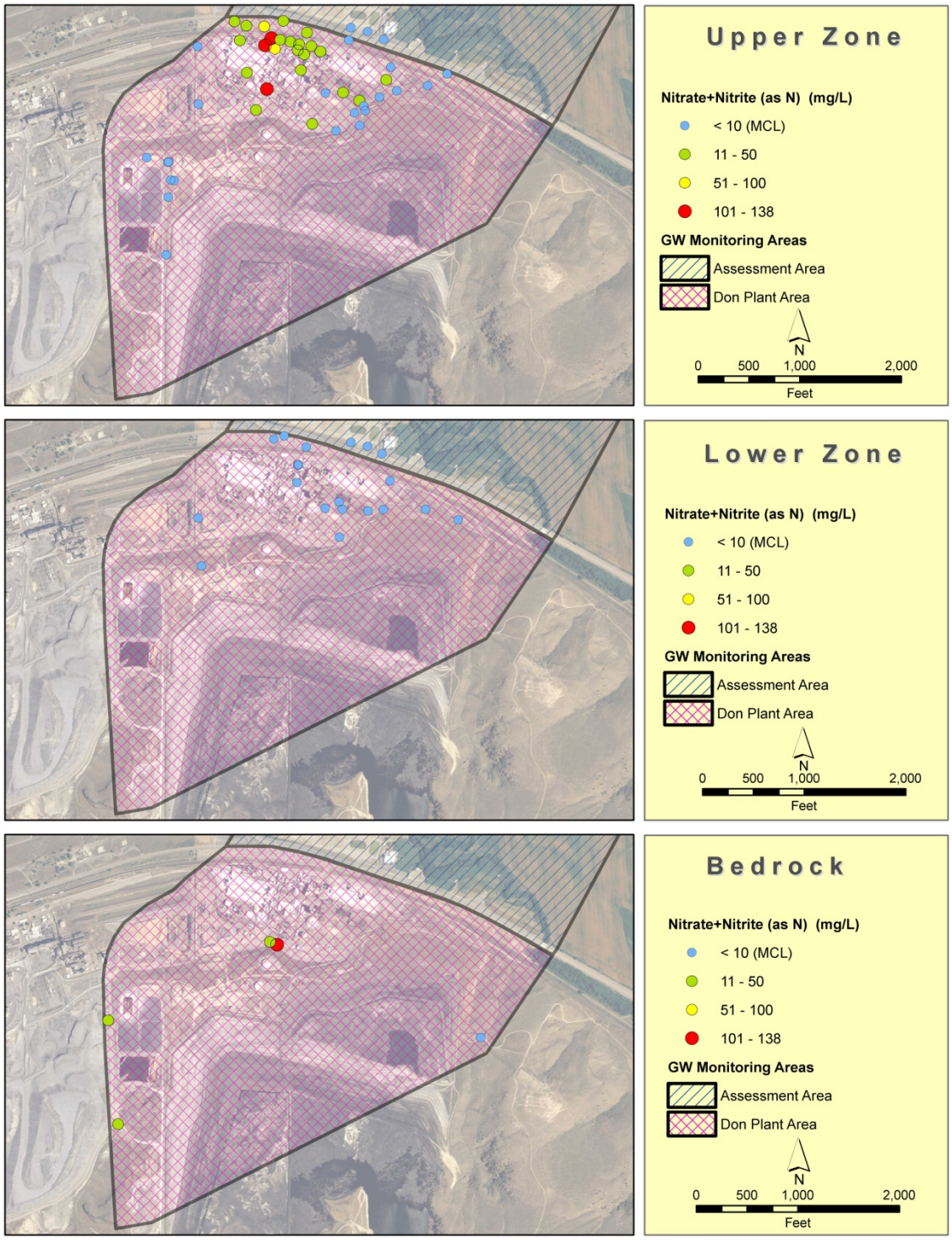


Figure 6-4: Nitrate plus nitrite, as N concentrations at the end of 2009 (fourth quarter) in the Don Plant monitoring area.

6.1.2 Transport Pathways

An estimate of transport time was updated for the 2009 conditions. Groundwater travel times were estimated by subdividing the flow path from the foot of the gypsum stack to the river into three areas: from the foot of the stack to the line of assessment in the target capture zones, from the target capture zones to Highway 30, and from Highway 30 to the Portneuf River (Figure 6-5). The sections from the foot of the gypsum stack to Highway 30 are representative of groundwater flow velocities in the Don Plant Area. This area was subdivided due to variations in hydraulic conductivity in the Upper Zone. Representative flow paths were chosen for the Upper and Lower Zones based on the 2009 potentiometric surface.

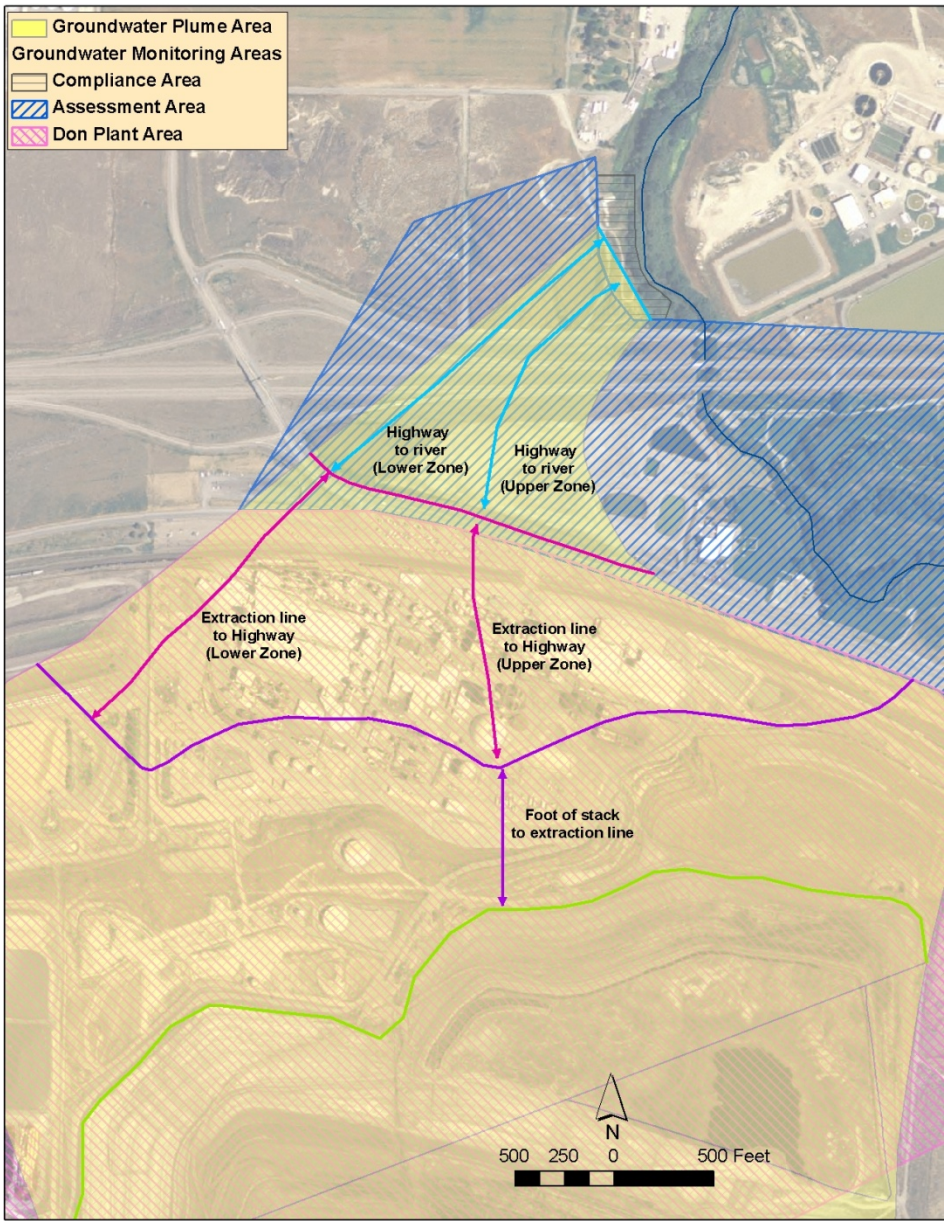


Figure 6-5: Groundwater flow velocity calculation areas within the groundwater plume area.

For each area, hydraulic conductivity, hydraulic gradient, and effective porosity were estimated based on the available water level, pumping test, and soil analytical data.

The calculation of groundwater travel times is performed as follows:

- Hydraulic conductivity (K) values were estimated for the three areas in the Upper Zone, Lower Zone, and bedrock. The mass flux analysis (Appendix E) provides estimates of hydraulic conductivity based on aquifer test data in the Upper and Lower Zones north of the gypsum stack.
- The hydraulic gradient (i) was estimated for each of the three areas in the Upper and Lower Zones. The hydraulic gradients have been calculated for each of the target capture zone areas (Appendix C).
- Effective porosities (n_e) were estimated from Tier 2 soil analytical data from the Phosphoric Acid Plant Investigation.

Average linear groundwater velocity was calculated as:

$$v = Ki/n_e$$

Table 6-1 presents the estimated groundwater travel times for each of the three areas, and for the total flow path from the foot of the stack to the river (travel time from infiltration beneath the stack to the foot of the stack was not included). Groundwater travel times through the Don Plant Area are estimated to take between 0.4 and 1.1 years in the Upper Zone and between 2.3 and 6.2 years in the Lower Zone. This calculation is based on limited information. Pump tests to be conducted in 2010 will provide further information to characterize hydrogeologic conditions.

Table 6-1: Summary of groundwater travel times and parameters used in calculation.

		Effective porosity	Hydraulic conductivity (ft/day)	Gradient (ft/ft)	Average linear groundwater velocity (ft/day)	Flow Length (ft)		Travel time (years)	
						min	max	min	max
Upper Zone	Don Plant Area (Foot of stack to Extraction line)	0.20	200.0	0.0091	9.1	500	2,300	0.2	0.7
	Don Plant Area (Extraction Line to Highway 30)	0.20	2,300.0	0.0012	13.8	800	1,800	0.2	0.4
	Assessment Area (Highway 30 to River)	0.20	2,300.0	0.0006	6.9	1,400	1,800	0.6	0.7
							TOTAL	**1.0**	**1.8**
Lower Zone	Don Plant Area (Foot of stack to Extraction line)	0.20	100.0	0.00067	3.4	500	2,300	0.4	1.9
	Don Plant Area (Extraction Line to Highway 30)	0.20	100.0	0.0023	1.2	800	1,800	1.9	4.3
	Assessment Area (Highway 30 to River)	0.20	100.0	0.0022	1.1	1,400	1,800	3.5	4.5
							TOTAL	**5.8**	**10.7**

6.1.3 Groundwater Concentration Trends in the Don Plant Area

This section discusses temporal trends in groundwater quality in the Don Plant Area. The locations of monitoring and extraction wells in the Don Plant Area are shown in Figures 5-1 through 5-3.

6.1.3.1 Fenceline Area

Arsenic concentrations in monitoring wells upgradient of the target capture zone in the Fenceline area have remained relatively consistent over the past few years (Figure 6-6). In this area, the AFLB is not present, so there is no physical distinction between the Upper and Lower Zones. However, arsenic concentrations in deeper screened wells (346) and bedrock wells (190) are consistently much lower than shallower intervals. A spike was observed in arsenic concentrations in well 189 in the second quarter of 2009, however concentrations in this well were consistent with previous observations in the third and fourth quarters. Phosphorus concentrations in deeper screened wells remain low and consistent, whereas concentrations in shallower wells appear to increase slightly over the past few years (i.e. wells 307, 308, and 336) (Figure 6-7). Sulfate concentrations are consistent around 2,500 mg/L in shallow wells, and lower in deep wells (1,500 mg/L) and bedrock wells (less than 500 mg/L) (Figure 6-8).

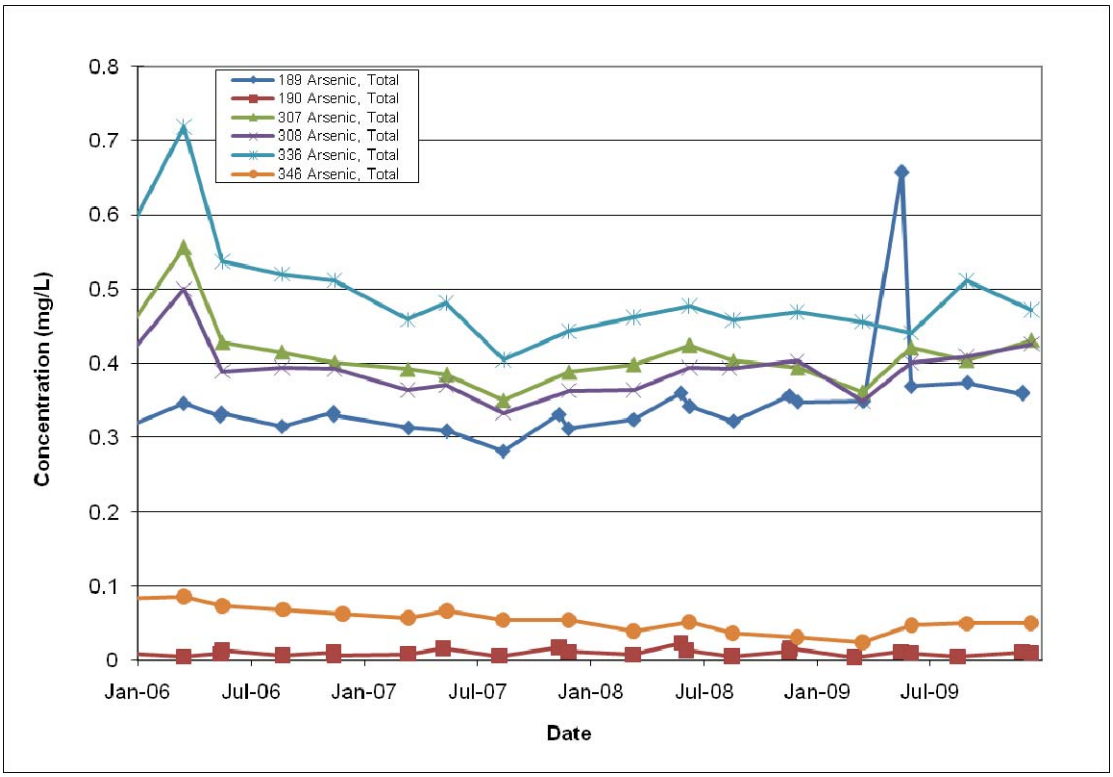


Figure 6-6: Time-series of arsenic concentrations in Fenceline area monitoring wells, south of the target capture zone.

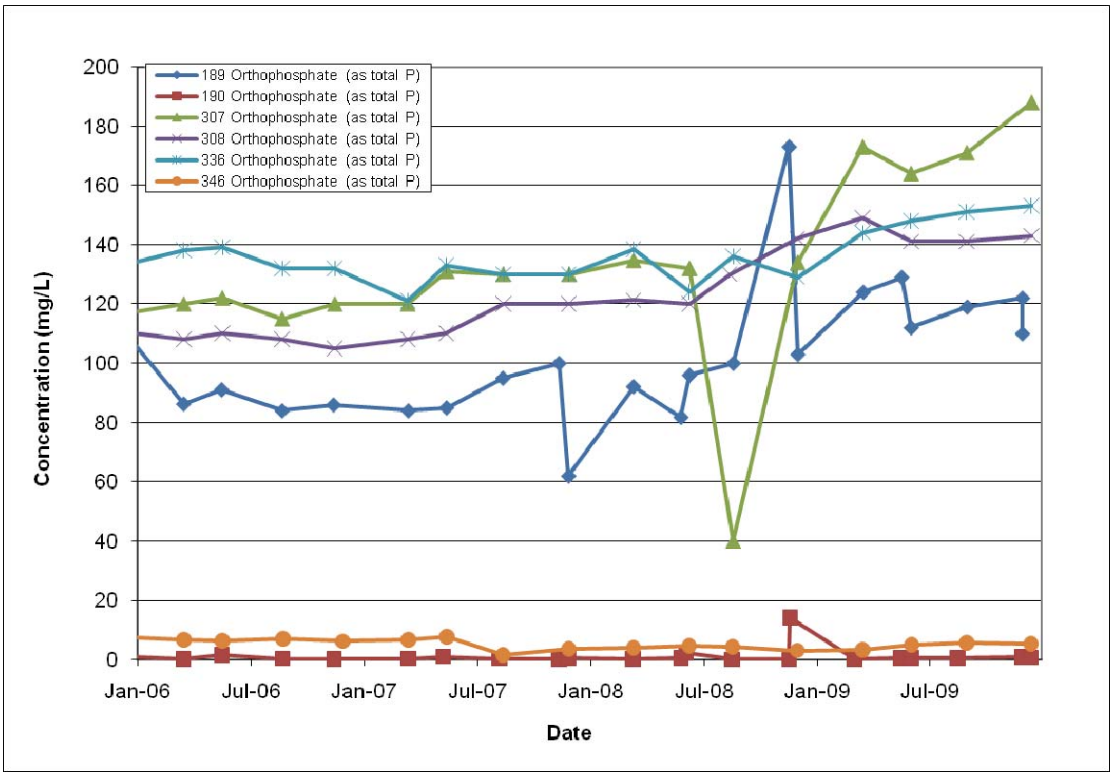


Figure 6-7: Time-series of phosphorus concentrations in Fenceline area monitoring wells, south of the target capture zone.

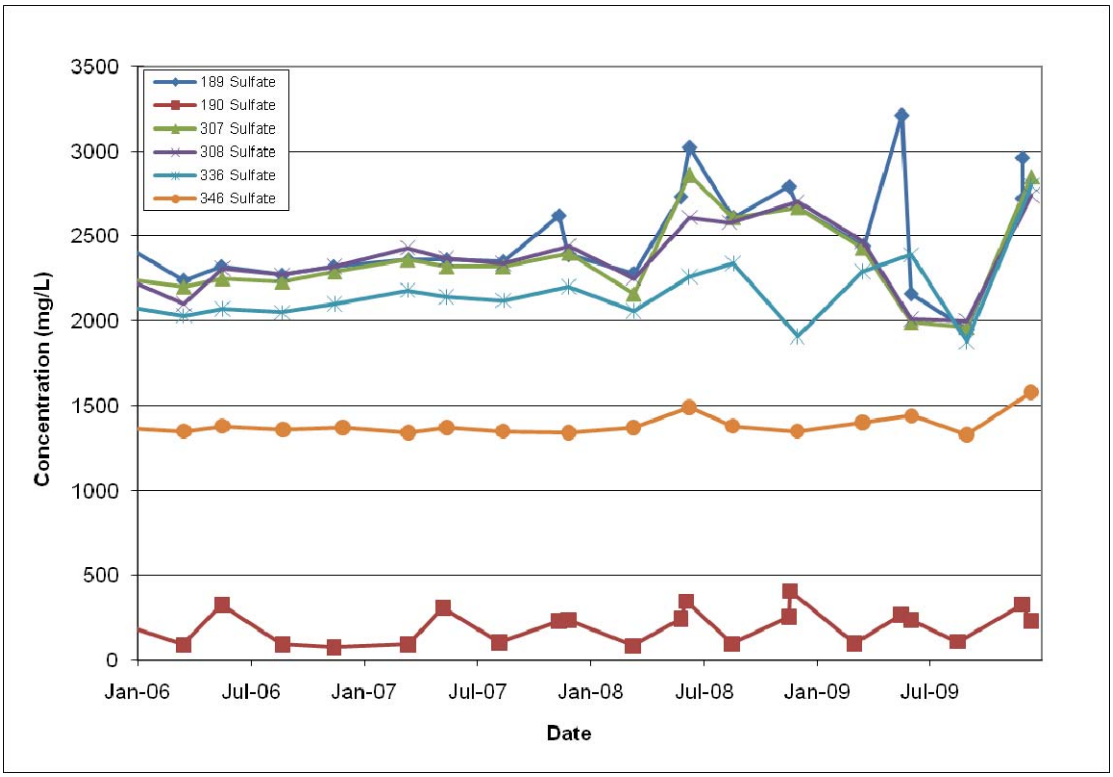


Figure 6-8: Time-series of sulfate concentrations in Fenceline area monitoring wells, south of the target capture zone.

Arsenic concentrations in shallow extraction wells 401 and 402 are consistent at approximately 0.4 mg/L (Figure 6-9). Phosphorus concentrations in these wells have been increasing since early 2008, to levels between 150 and 200 mg/L (Figure 6-10). Sulfate concentrations are approximately 2,500 mg/L in recent years (Figure 6-11).

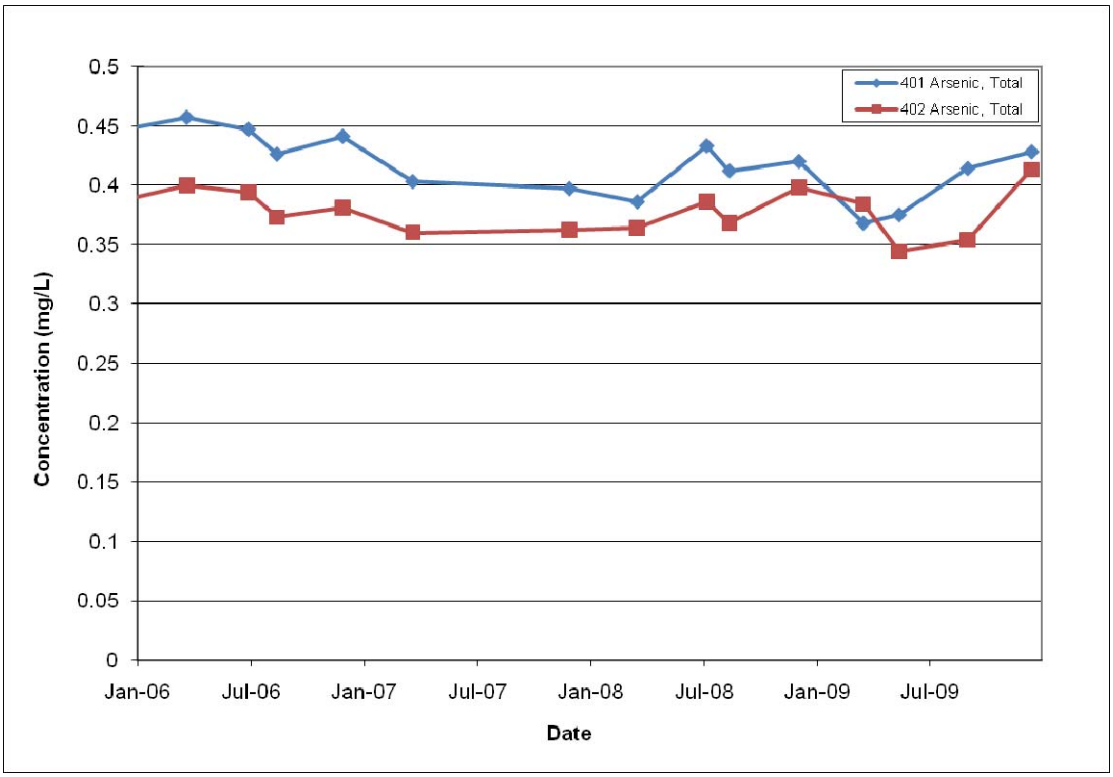


Figure 6-9: Time-series of arsenic concentrations in Fenceline area extraction wells, south of the target capture zone.

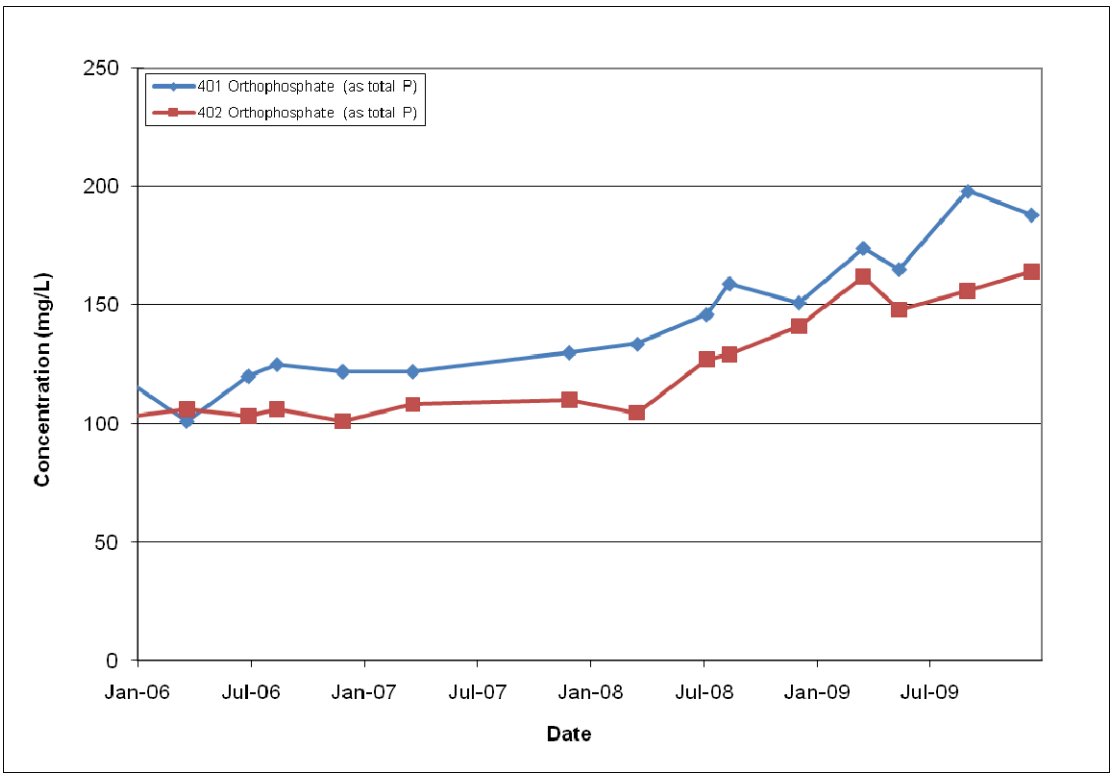


Figure 6-10: Time-series of phosphorus concentrations in Fenceline area extraction wells, south of the target capture zone.

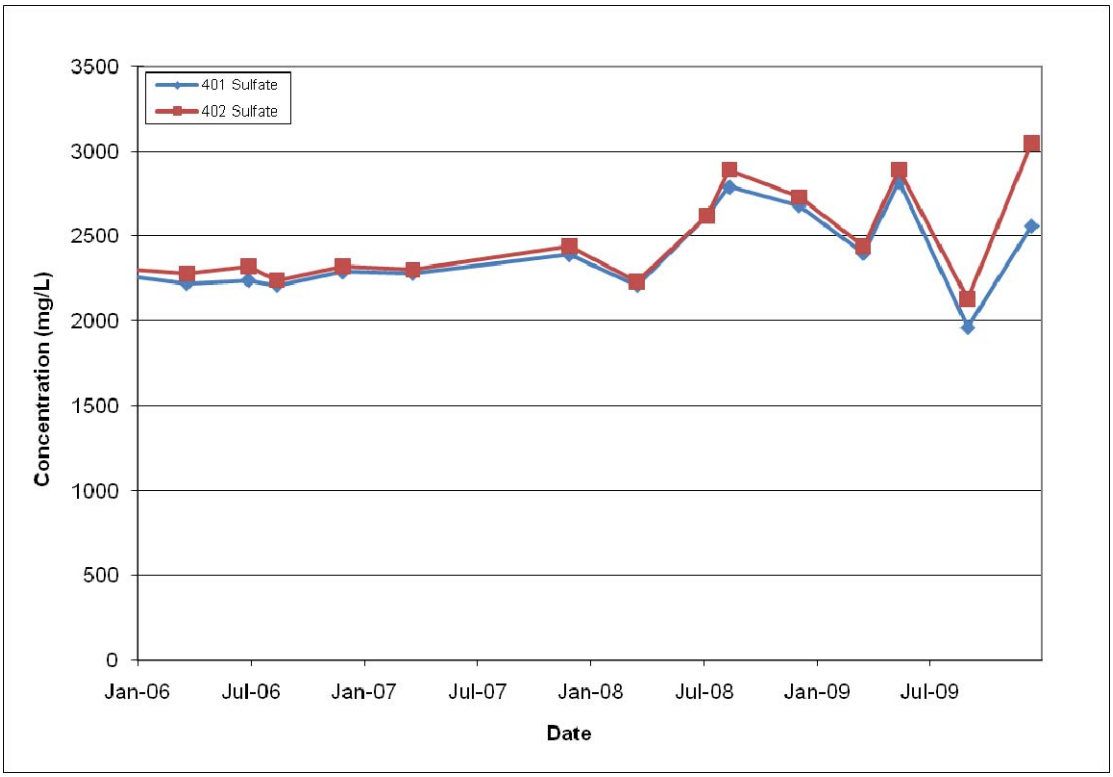


Figure 6-11: Time-series of sulfate concentrations in Fenceline area extraction wells, south of the target capture zone.

In the target capture zone, arsenic, phosphorus, and sulfate concentrations increased in wells 309 and 310 in the middle of 2008, which correlates to when extraction well 415 was turned on (Figures 6-12 through 6-14; Appendix B). In this area, the AFLB is likely present, separating the Upper Zone (well 310) from the Lower Zone (well 309). The increase in concentrations in both wells indicates that extraction from well 415 is effective, and may indicate some degree of connectivity between the Upper and Lower Zones in this area.

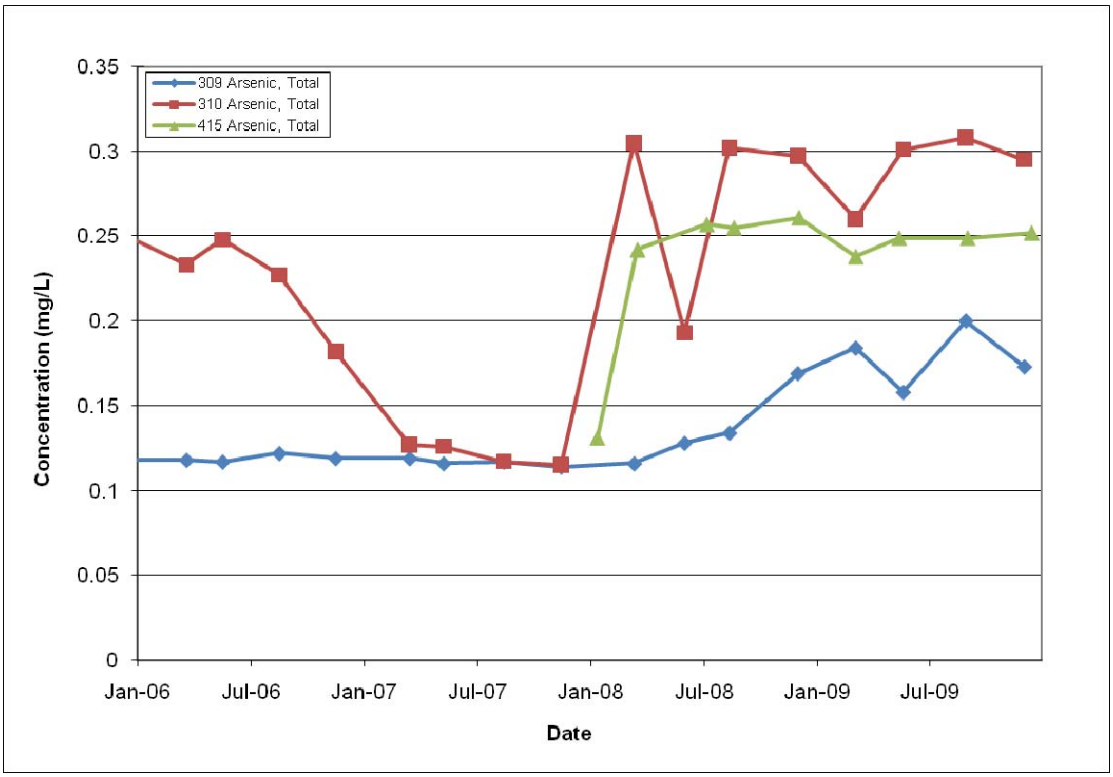


Figure 6-12: Time-series of arsenic concentrations in Fenceline area extraction and monitoring wells in the target capture zone.

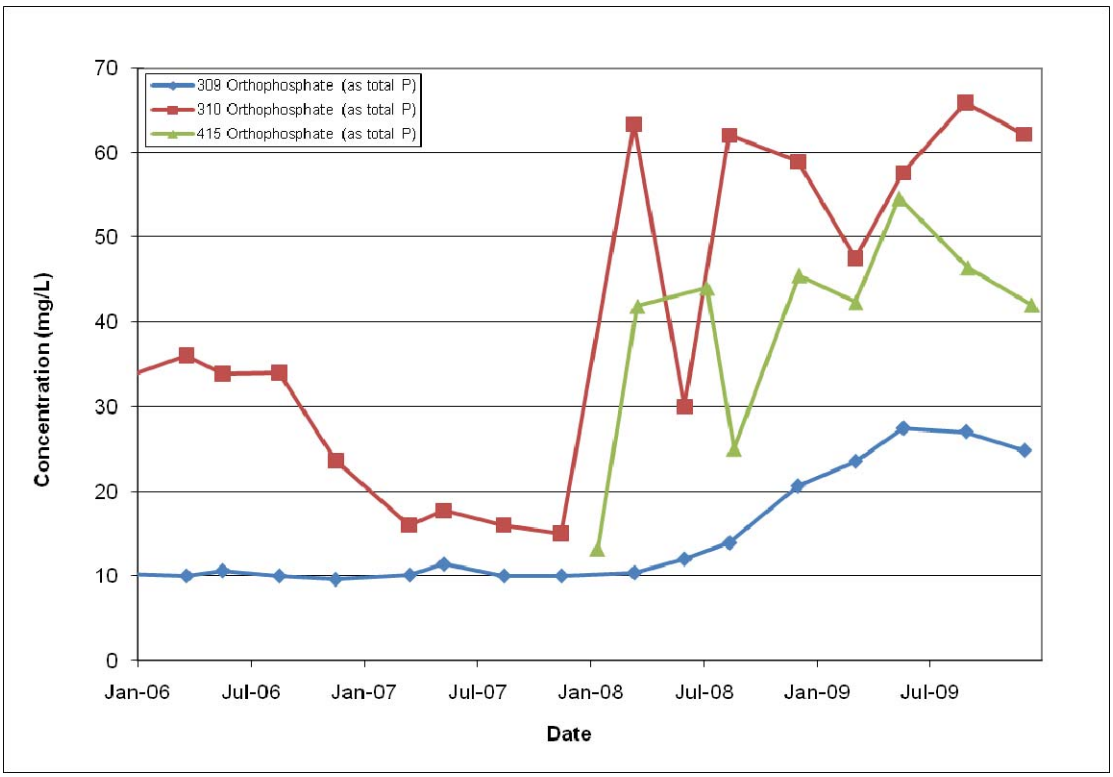


Figure 6-13: Time-series of phosphorus concentrations in Fenceline area extraction and monitoring wells in the target capture zone.

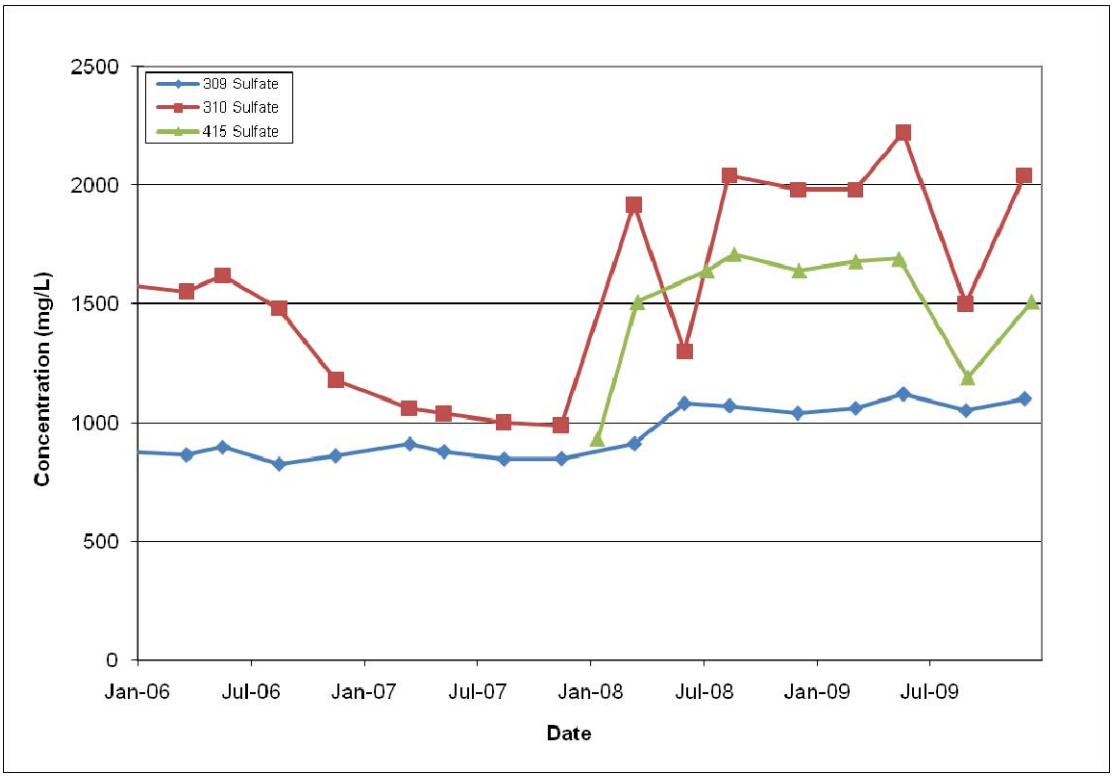


Figure 6-14: Time-series of sulfate concentrations in Fenceline area extraction and monitoring wells in the target capture zone.

The AFLB is present downgradient of the target capture zone in the Fenceline area. Upper Zone monitoring wells downgradient show decreasing concentrations of arsenic and phosphorus over time (Figures 6-15 and 6-16). Concentrations downgradient are less than those observed in the target capture zone (0.1-0.125 mg/L arsenic, 10-20 mg/L phosphorus and 700-1,200 mg/L sulfate [see also Figure 6-17]). Concentrations of arsenic, phosphorus, and sulfate in Lower Zone well 319 are much lower than Upper Zone concentrations.

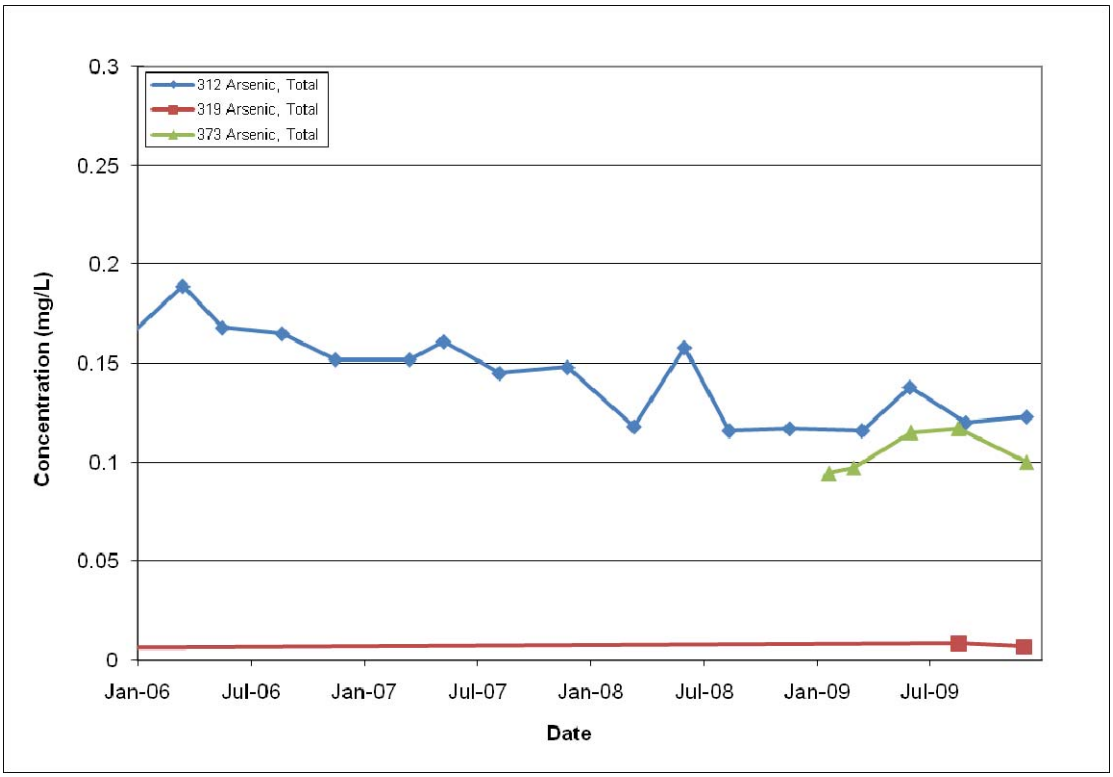


Figure 6-15: Time-series of arsenic concentrations in Fenceline area extraction and monitoring wells downgradient of the target capture zone.

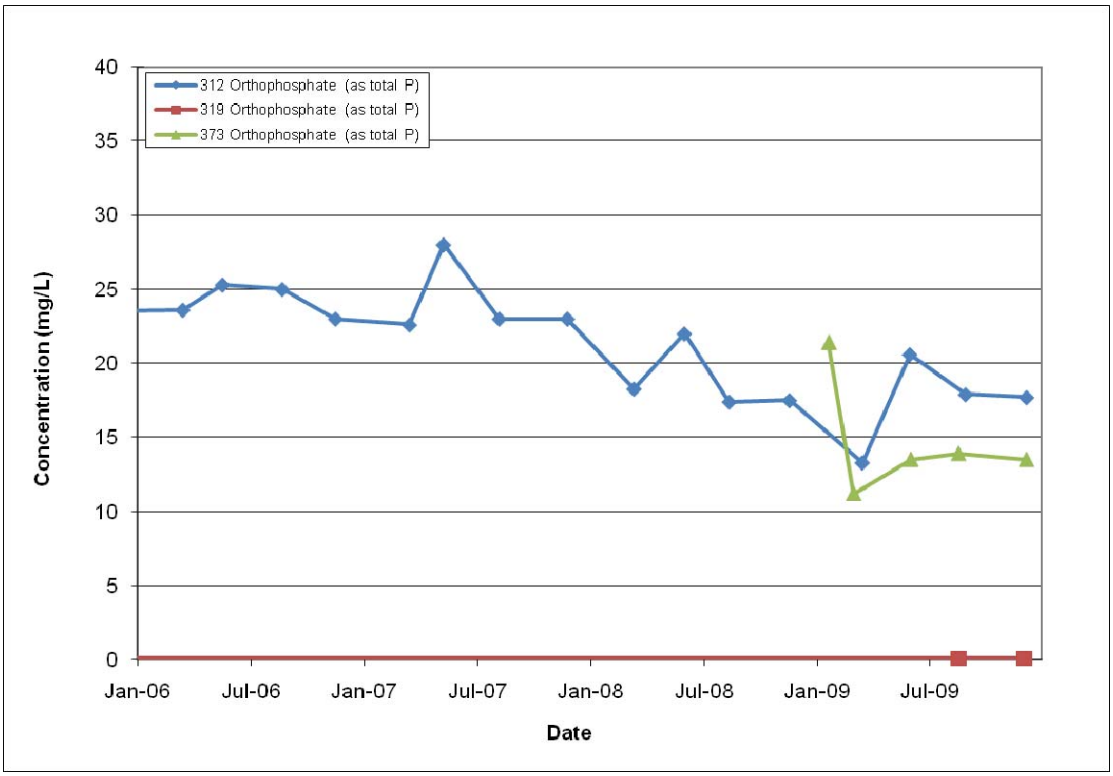


Figure 6-16: Time-series of phosphorus concentrations in Fenceline area extraction and monitoring wells downgradient of the target capture zone.

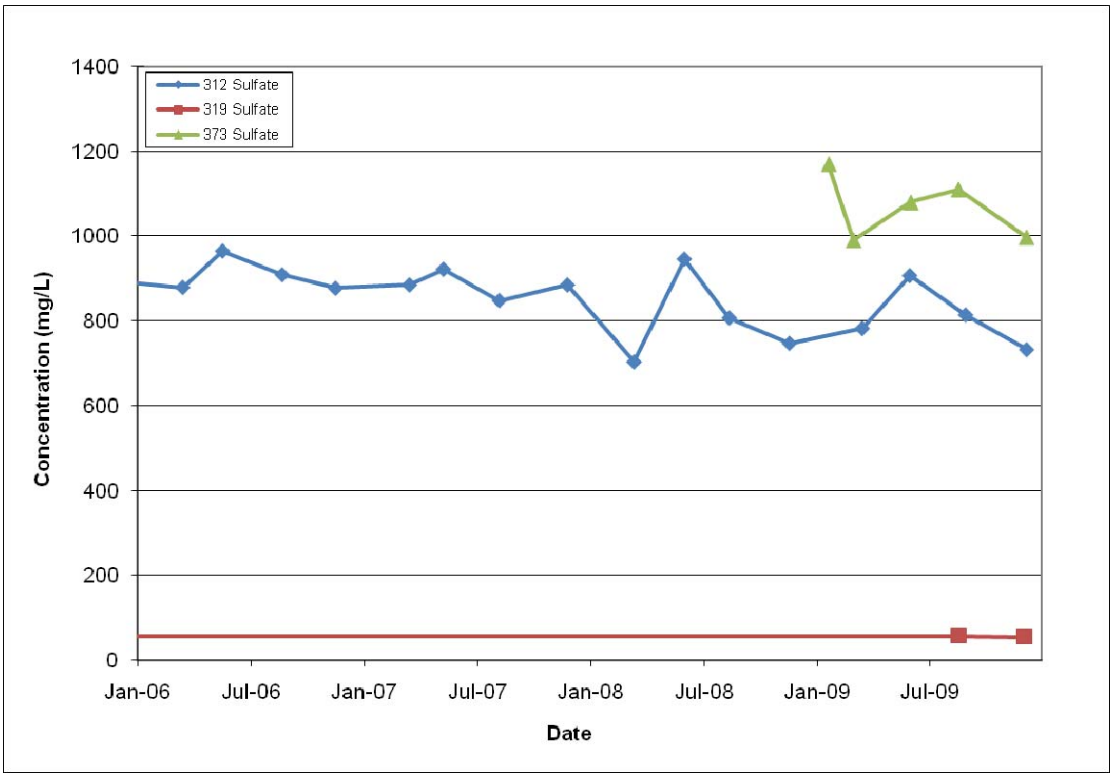


Figure 6-17: Time-series of sulfate concentrations in Fenceline area extraction and monitoring wells downgradient of the target capture zone.

6.1.3.2 Central Plant

Upgradient of the target capture zone in the Central area, monitoring wells are screened in the Upper Zone and in Bedrock. Arsenic concentrations in Upper Zone wells are relatively stable, although bedrock well 351 has been increasing over time, and bedrock well 313 has increased slightly in 2009 (Figure 6-18). Phosphorus in well 334 is higher than other upgradient wells, which are consistently below 50 mg/L (Figure 6-19). Phosphorus in well 334 is variable, but generally shows an increasing trend over time. Sulfate in upgradient wells varies from 1,000 to 2,500 mg/L, with the highest concentrations in well 334, but no temporal trend is apparent (Figure 6-20).

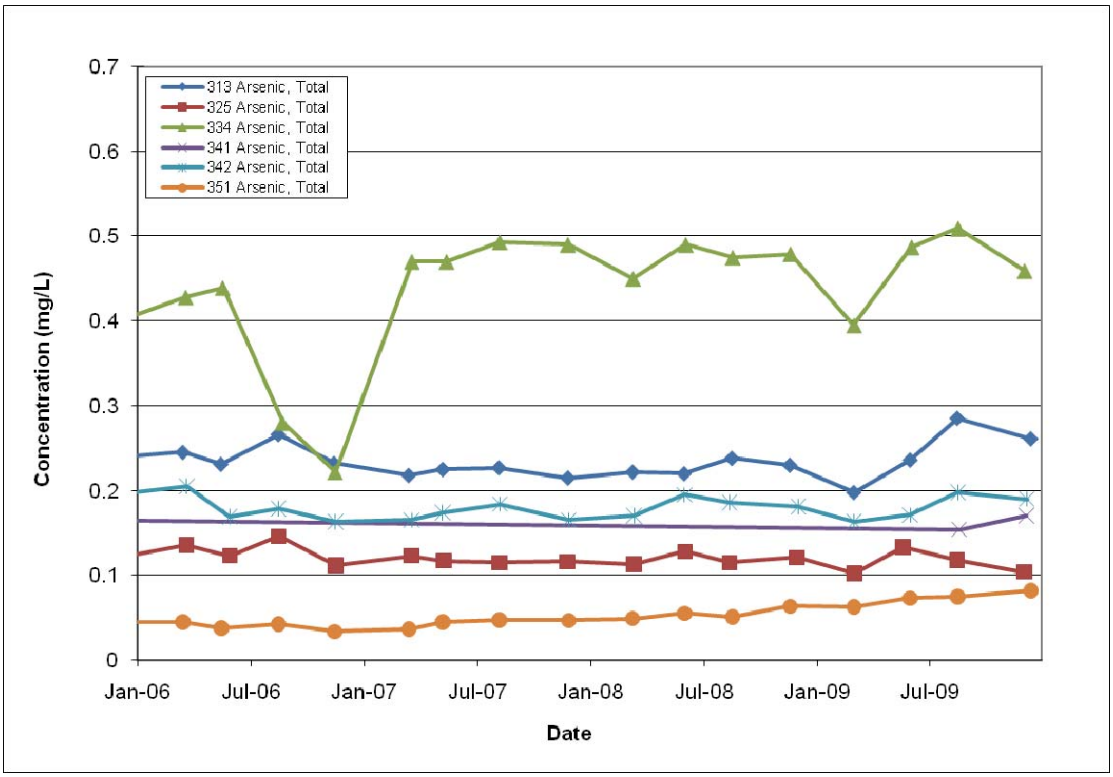


Figure 6-18: Time-series of arsenic concentrations in the Central area monitoring wells upgradient of the target capture zone.

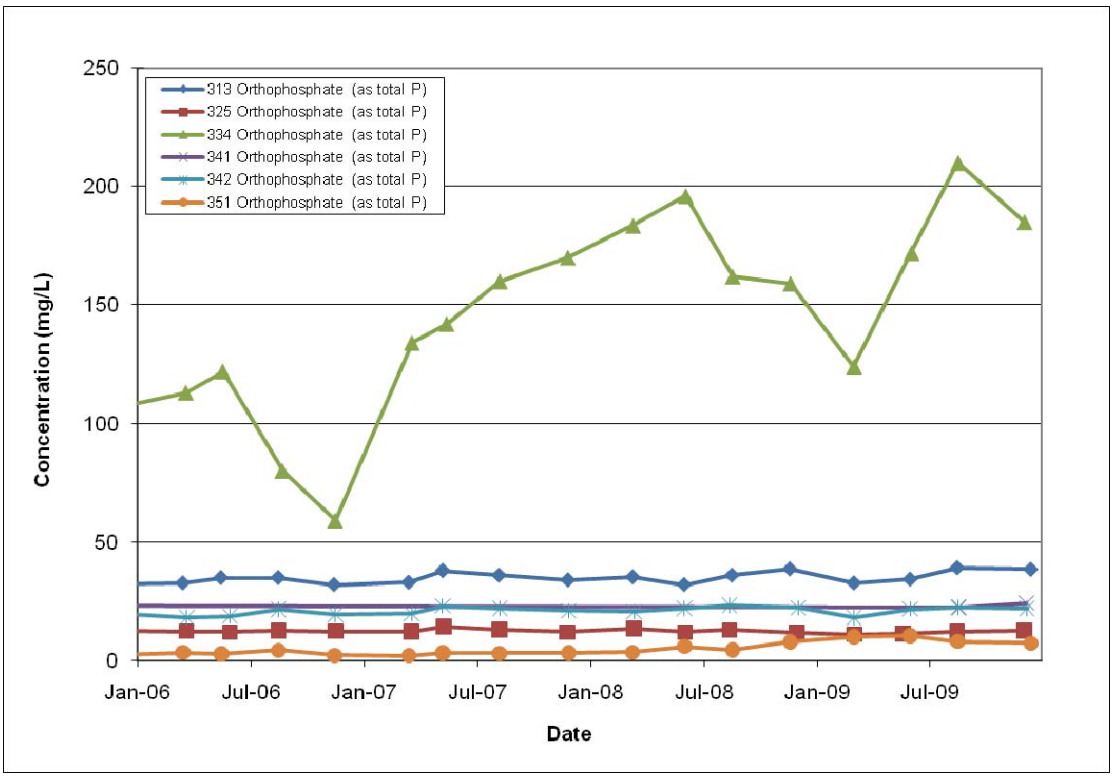


Figure 6-19: Time-series of phosphorus concentrations in the Central area monitoring wells upgradient of the target capture zone.

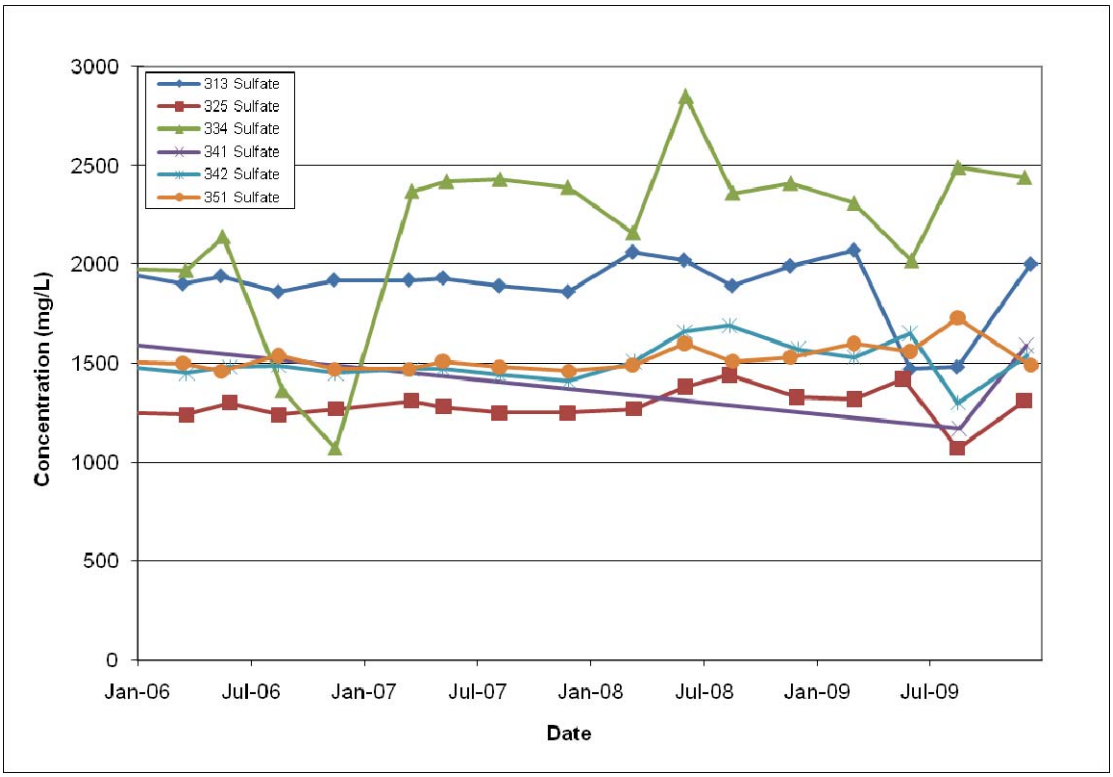


Figure 6-20: Time-series of sulfate concentrations in the Central area monitoring wells upgradient of the target capture zone.

For wells in the target capture zone, most wells have quarterly groundwater quality data. Some wells installed in the phosphoric acid plant area in 2009 (during the Phosphoric Acid Plant Investigation) have weekly data. The most detailed data available for each well is presented below.

In the target capture zone, arsenic in well 340 peaked in 2008, and has been decreasing since throughout 2009 (Figure 6-21). Recently, arsenic concentrations in wells 335S, 414 and 417 have increased slightly. Wells 369 and 370 show decreasing arsenic and wells 367 and 370 show relatively steady concentrations in 2009. Lower Zone well 335D has consistently low concentrations. Phosphorus concentrations were relatively stable in wells 335S, 414, 371, and 335D in 2009, however a slight decrease was observed in well 370 and a slight increase in well 369 (Figure 6-22).

Upper Zone wells in the central area have sulfate concentrations between 1,000 and 2,500 mg/L. Most concentration trends were variable, except for wells 369 and 417 which showed slight increases. Well 335D has consistent sulfate concentrations of approximately 100 mg/L (Figure 6-23).

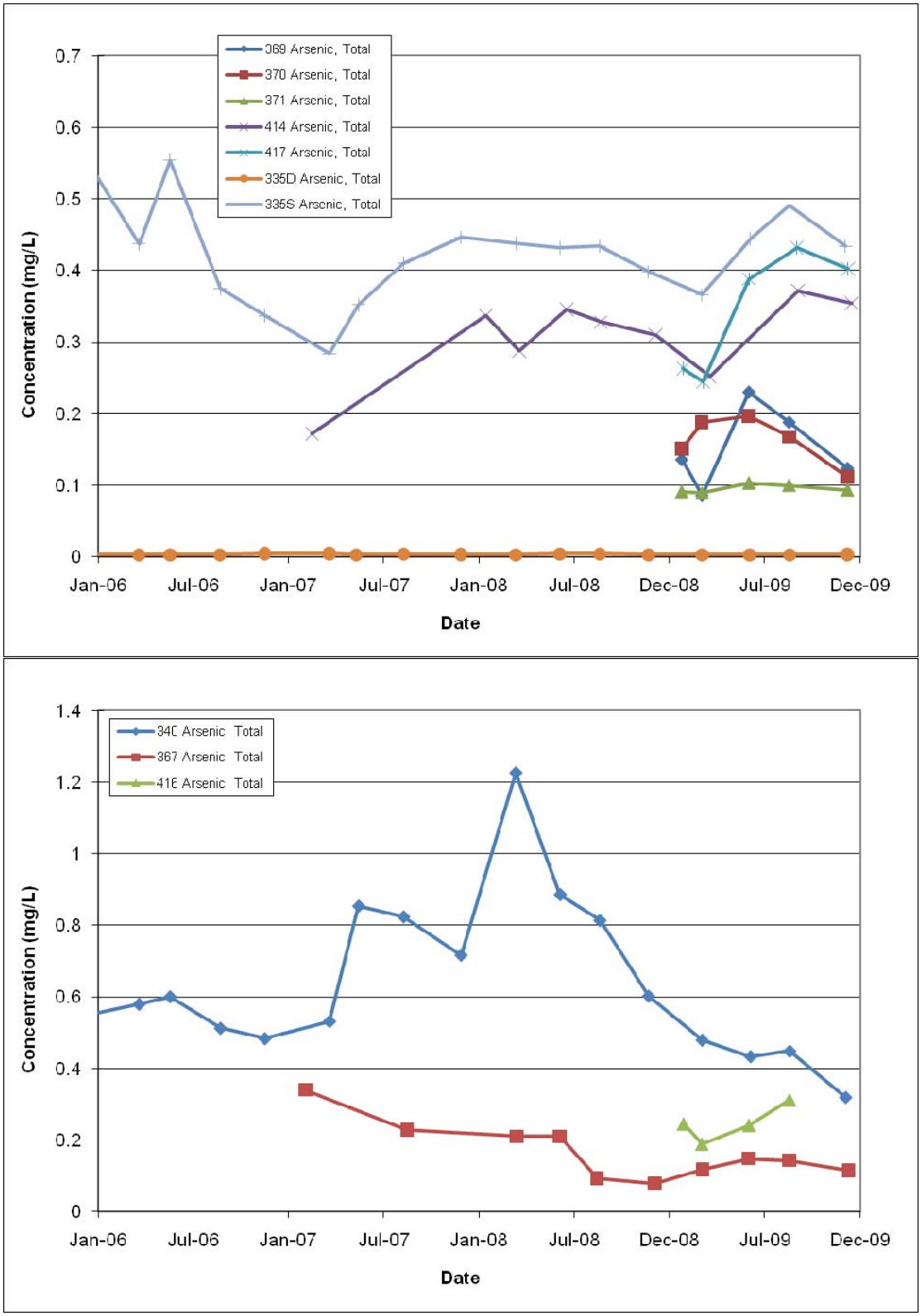


Figure 6-21: Time-series of arsenic concentrations in the Central area monitoring and extraction wells in the target capture zone.

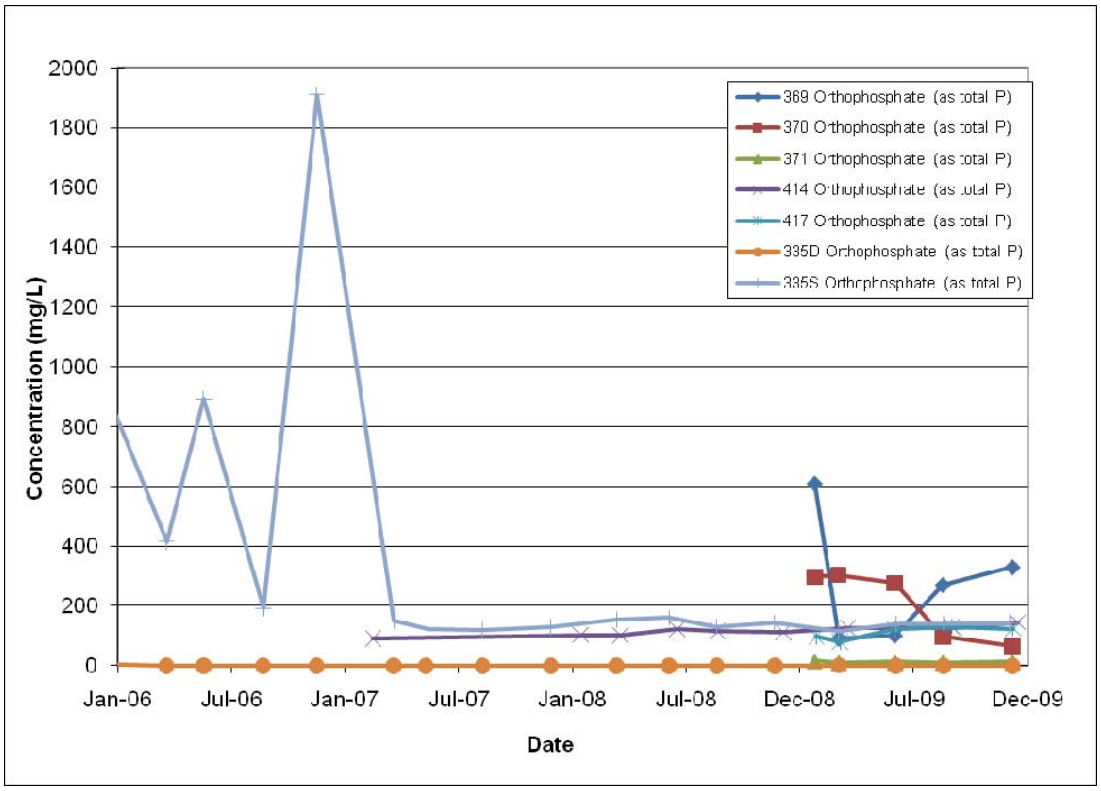


Figure 6-22: Time-series of phosphorus concentrations in the Central area monitoring and extraction wells in the target capture zone.

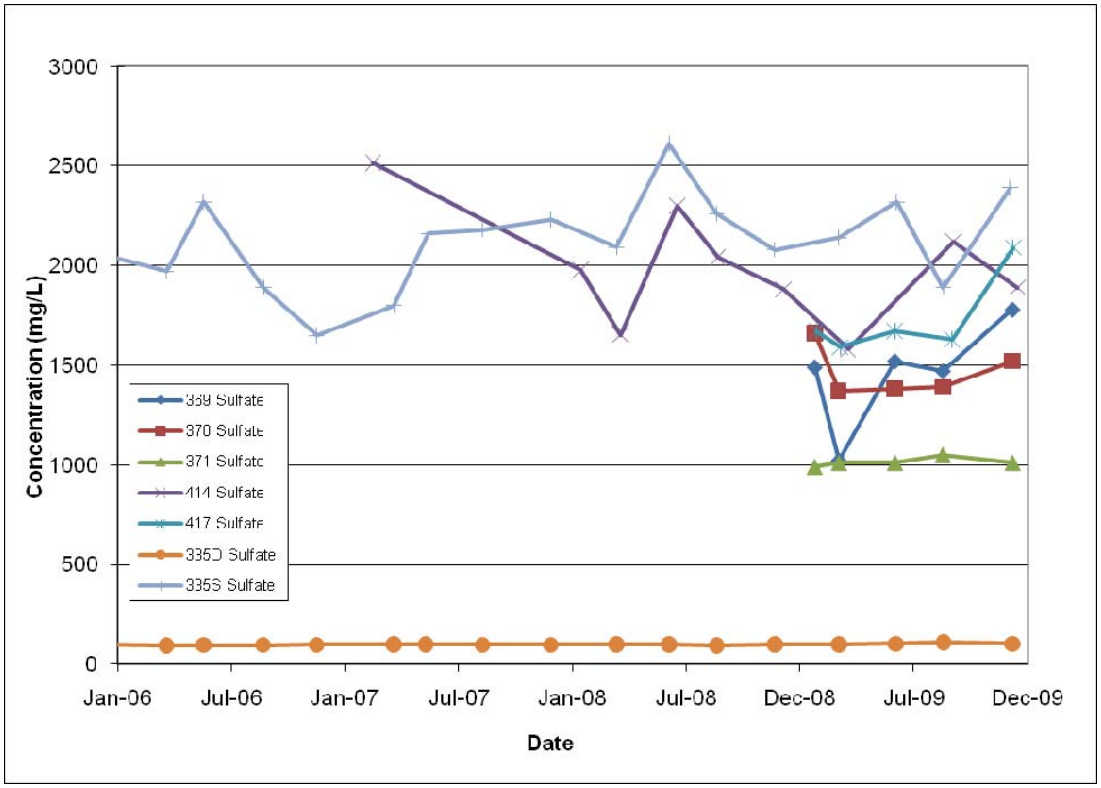


Figure 6-23: Time-series of sulfate concentrations in the Central area monitoring and extraction wells in the target capture zone.

Weekly water quality sampling has been conducted at wells 340 and 367 since May 2007. Weekly sampling was started in these wells after elevated phosphorus was observed in well 340. Well 367 is located just over 100 feet to the west of well 340. Weekly sampling was started in well 419 in January 2009, following installation of this well and the observed elevated phosphorus concentrations greater than 10,000 mg/L. Wells 374 and 416, as well as 340, 367 and 419, were included in the weekly groundwater sampling event from 3/27/2009 to 4/28/2009 when samples were analyzed for a comprehensive list of general chemistry parameters, metals, nutrients and radionuclides. This data was reported in the Phosphoric Acid Plant Supplemental Data Analysis Technical Memorandum (July 24, 2009). Weekly sampling of 340, 367, 374, 416 and 419 continued on 5/7/2009.

Weekly data for arsenic was only collected from well 374 and 419 for a portion of 2009 (Figure 6-24). Arsenic concentration in well 419 were much higher than those in well 374, however, show a strong decreasing trend in 2009. Concentrations in well 374 were near or above 0.1 mg/L in 2009.

Figure 6-25 shows the weekly phosphorus concentrations in wells 367, 374, 416, 340 and 419. Wells 416 and 419 were not sampled during November and the beginning of December since these wells were being converted into extraction wells during that time. Phosphorus concentrations in well 340 have been steadily decreasing in 2009 (Figure 6-25). The phosphorus concentration in well 340 was approximately 750 mg/L at the end of 2009. This is still above the expected impact from the gypsum stack alone. Phosphorus concentrations in well 367 decreased in 2008 and 2009. At the end of 2009, the phosphorus concentration in well 367 was 182 mg/L. This is close to the expected phosphorus concentration from stack-affected groundwater.

Phosphorus concentrations in well 374 show a general decreasing trend to 300 mg/L by the end of 2009 (Figure 6-25). This is slightly above the expected phosphorus concentration from stack-affected groundwater. In well 416, phosphorus concentrations decreased during the initial sampling events in March 2009, and have been at or below 105 mg/L since April 2009. Well 416 could represent stack-affected groundwater that has not been affected additionally by phosphoric acid plant sources.

Phosphorus concentrations in well 419 have been decreasing since an initial high concentration of over 13,000 mg/L measured in January 2009. Concentrations peaked again in March, but have shown a general decreasing trend. The phosphorus concentration in well 419 was 2,319 mg/L at the end of 2009. Well 419 represents a plume of phosphoric acid plant-affected groundwater.

Sulfate concentrations in phosphoric acid plant wells are generally between 1,000 and 2,500 mg/L, except for some inconsistent elevated concentrations observed in well 419 (Figure 6.26). Phosphoric acid plant data is provided in Appendix D.

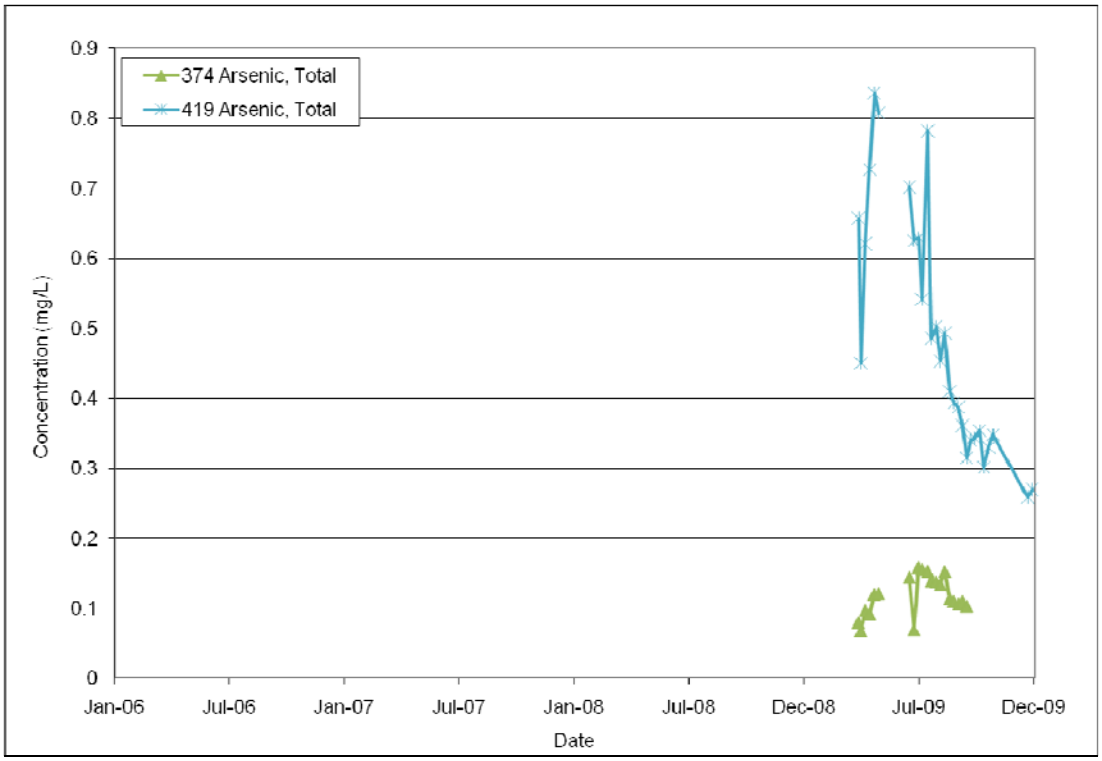


Figure 6-24: Time-series of weekly arsenic concentrations in the phosphoric acid plant area of the central target capture zone.

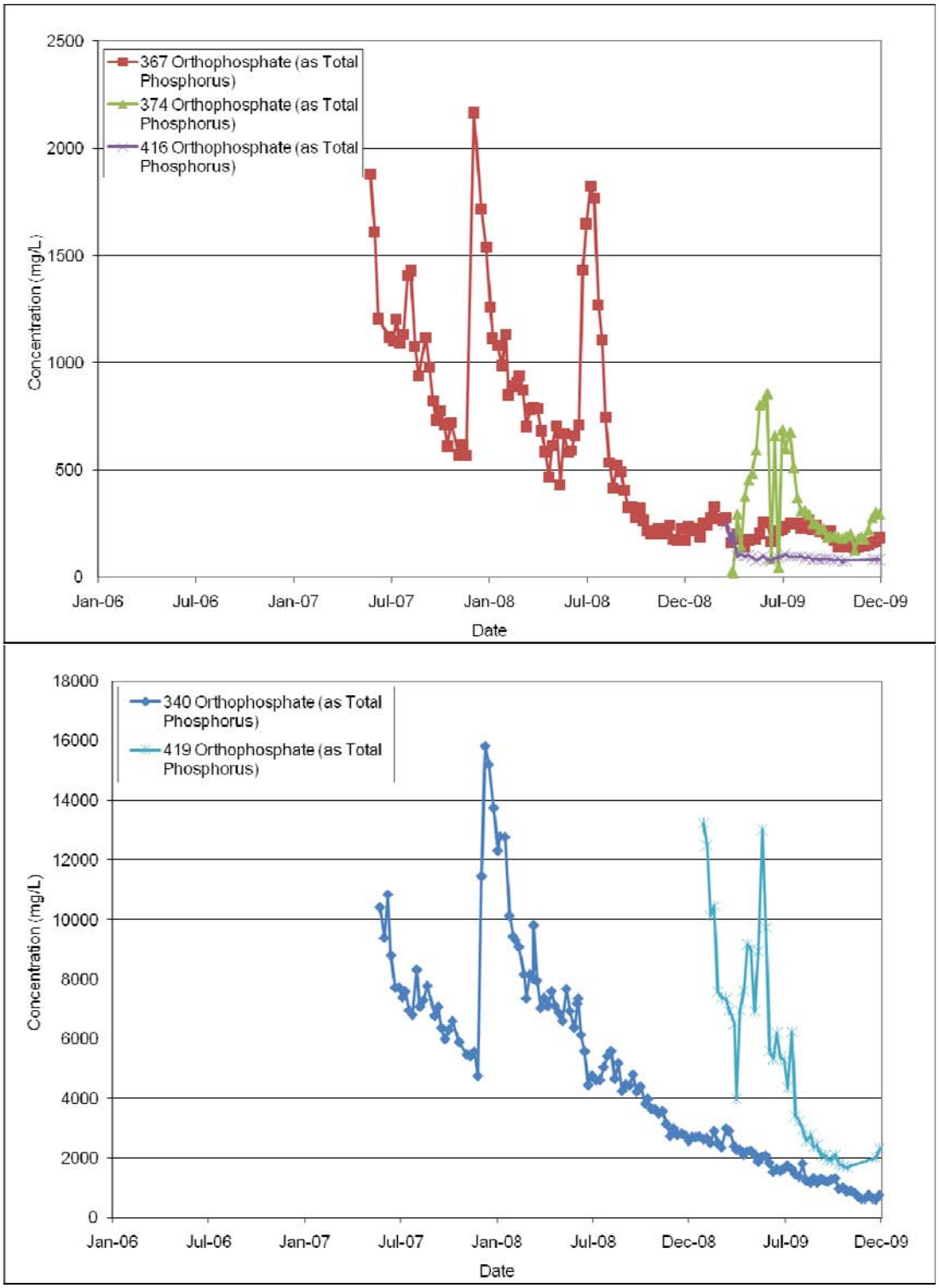


Figure 6-25: Time-series of weekly phosphorus concentrations in the phosphoric acid plant area of the central target capture zone.

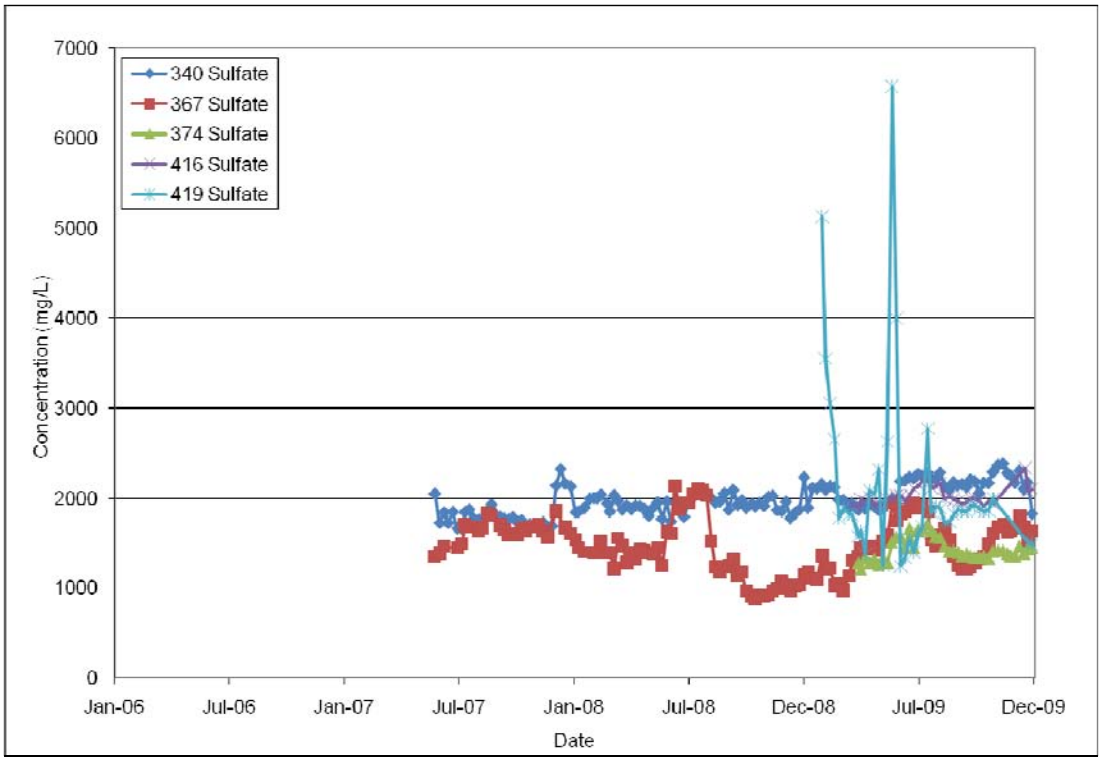


Figure 6-26: Time-series of weekly sulfate concentrations in the phosphoric acid plant area of the central target capture zone.

Upper Zone and Lower Zone wells downgradient of the Central target capture zone show decreasing arsenic, phosphorus and sulfate over time (Figures 6-27 through 6-29; Appendix B). By the end of 2009, arsenic concentrations in the downgradient Upper Zone were less than 0.1 mg/L and less than 0.02 mg/L in the Lower Zone. Phosphorus concentrations were less than 10 mg/L in the Upper Zone and less than 1 mg/L in the Lower Zone. Sulfate concentrations were less than 800 mg/L in the Upper Zone and less than 200 mg/L in the Lower Zone.

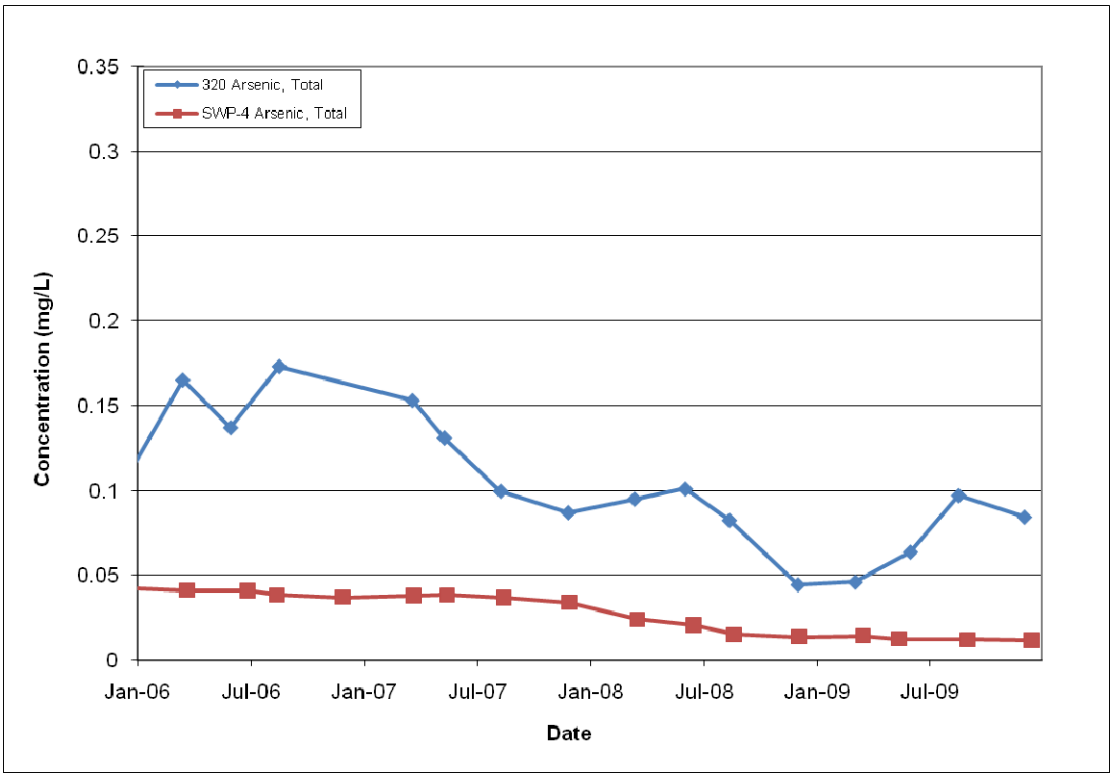


Figure 6-27: Time-series of arsenic concentrations in the Central area monitoring and supply wells downgradient of the target capture zone.

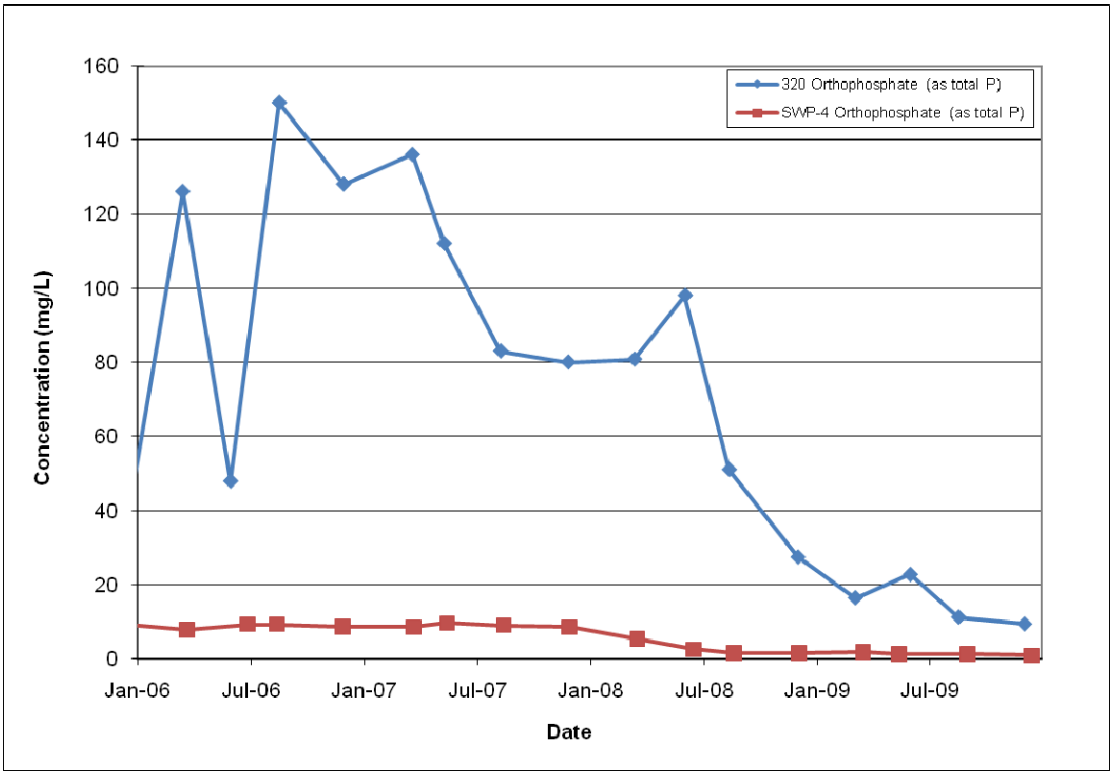


Figure 6-28: Time-series of phosphorus concentrations in the Central area monitoring and supply wells downgradient of the target capture zone.

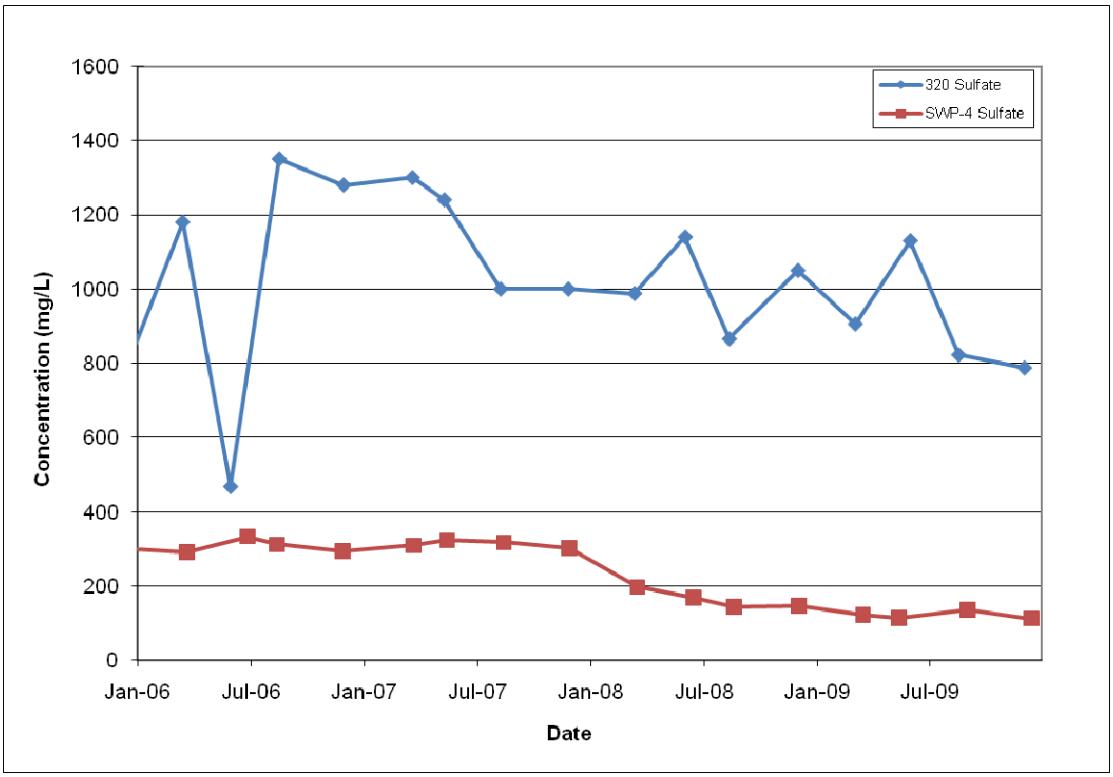


Figure 6-29: Time-series of sulfate concentrations in the Central area monitoring and supply wells downgradient of the target capture zone.

6.1.3.3 East Plant

The East Plant Area consists of multiple target capture zones. Monitoring and extraction wells located upgradient of these capture zones are located at the foot of the lower compartment of the gypsum stack. Extraction wells include Phase I wells 403-409. The AFLB is present in this area.

Upper Zone monitoring wells upgradient of the east area target capture zones show relatively constant arsenic concentrations over time in the range of 0.3 to 0.7 mg/L (Figure 6-30). Phosphorus concentrations in wells 357 and 358 increased in 2009 to between 600 and 800 mg/L (Figure 6-31). Sulfate in these wells is variable between 1,800 and 3,200 mg/L in 2009 and showed a decreasing trend in wells 357 and 348 (Figure 6-32).

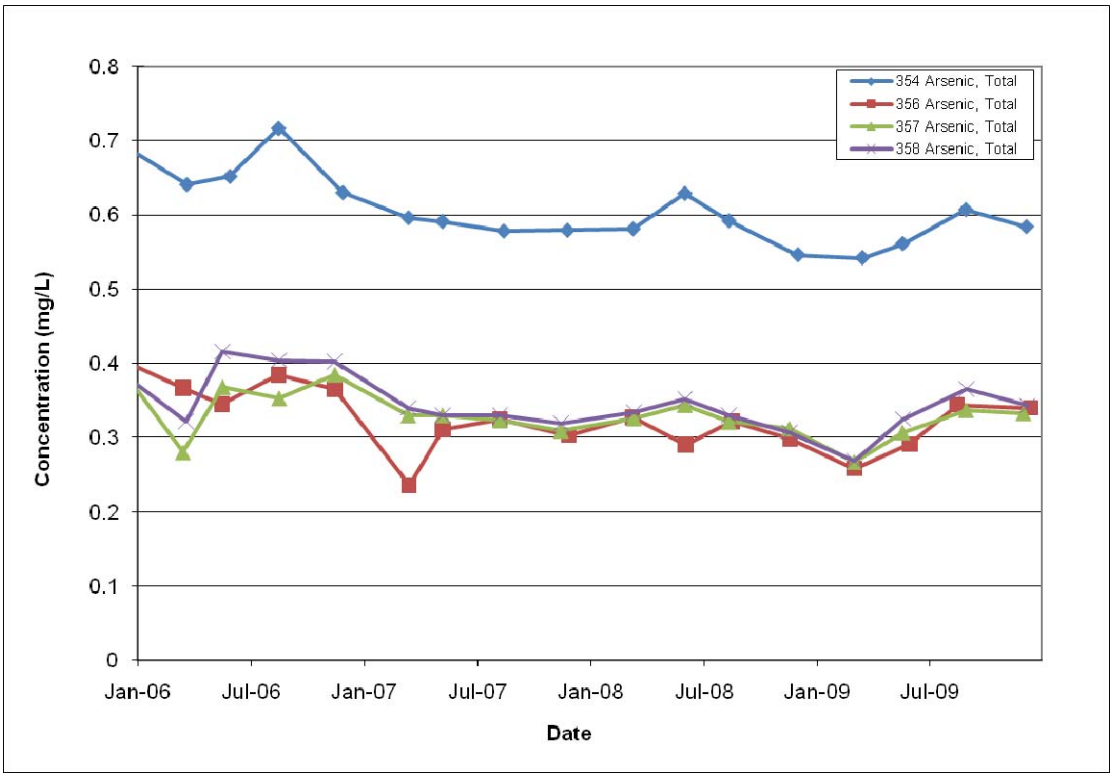


Figure 6-30: Time-series of arsenic concentrations in the East area monitoring wells upgradient of the target capture zones.

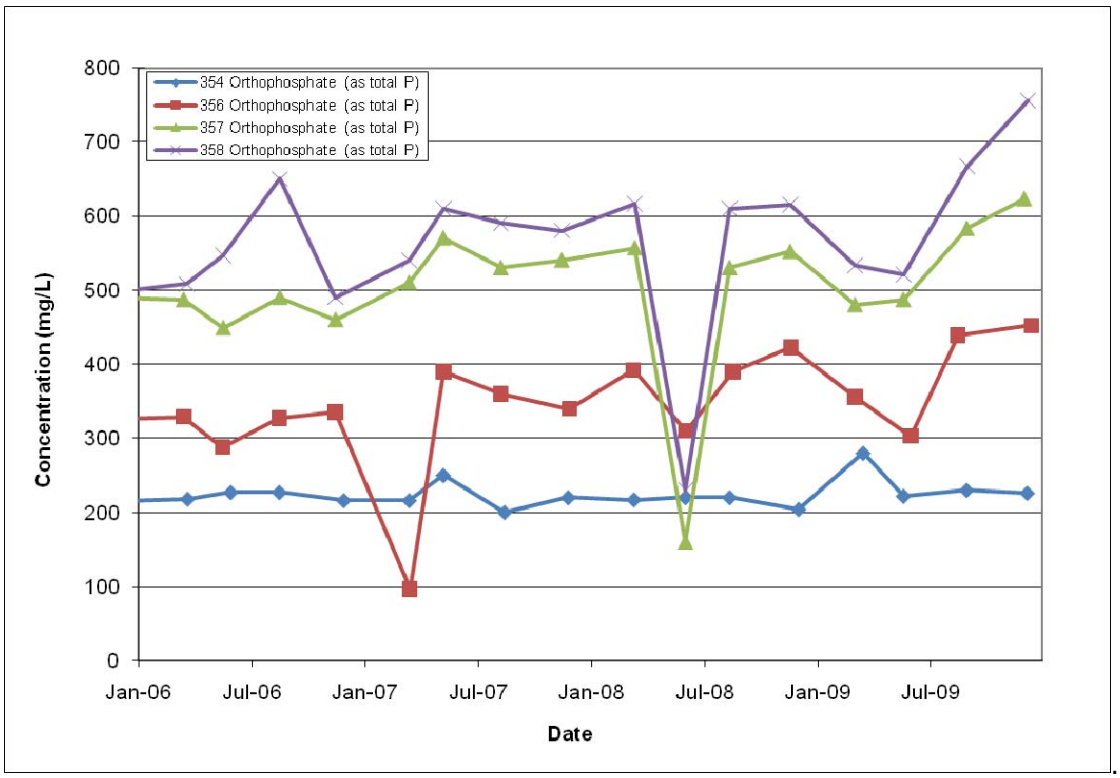


Figure 6-31: Time-series of phosphorus concentrations in the East area monitoring wells upgradient of the target capture zones.

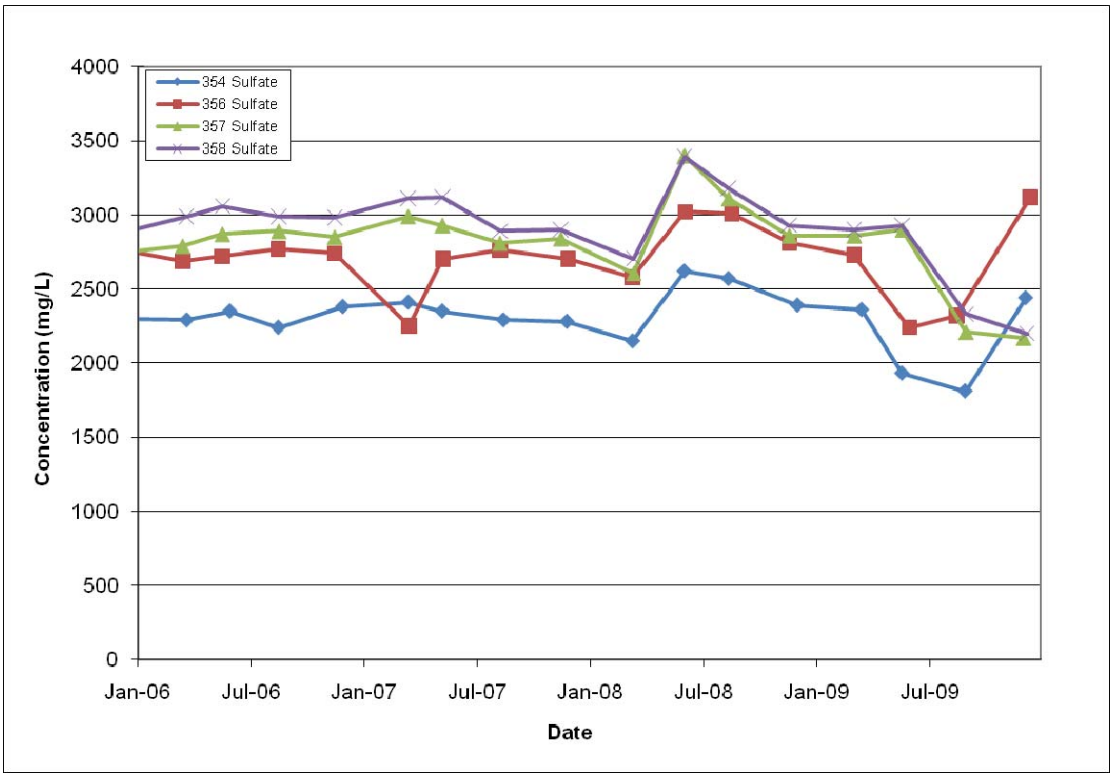


Figure 6-32: Time-series of sulfate concentrations in the East area monitoring wells upgradient of the target capture zones.

Phase I extraction wells in this area show relatively consistent arsenic concentrations between 0.3 and 0.6 mg/L (Figure 6-33). Phosphorus concentrations show a slight drop in the end of 2009 (Figure 6-34). In wells 406 and 407, phosphorus concentrations spiked in the first quarter of 2009, but subsequent samples were consistent with historical values. Sulfate concentrations vary between 2,500 and 3,000 mg/L (Figure 6-35).

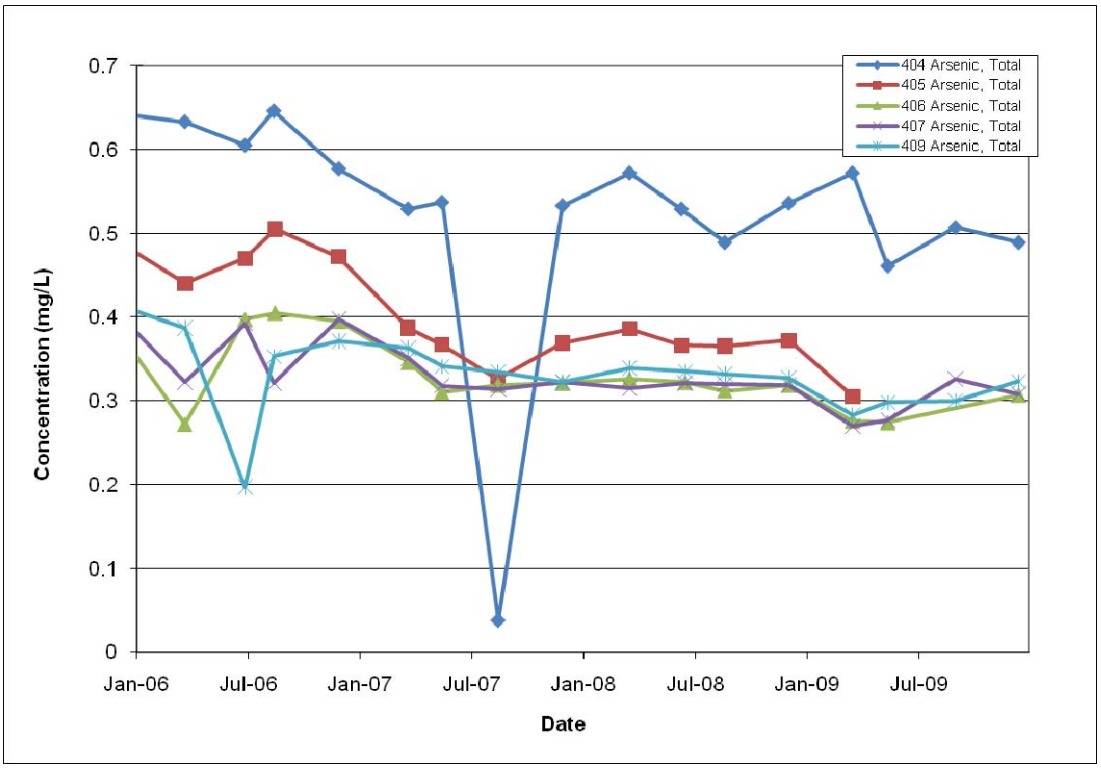


Figure 6-33: Time-series of arsenic concentrations in the East area extraction wells upgradient of the target capture zones. Well 405 was taken off line in mid-2009.

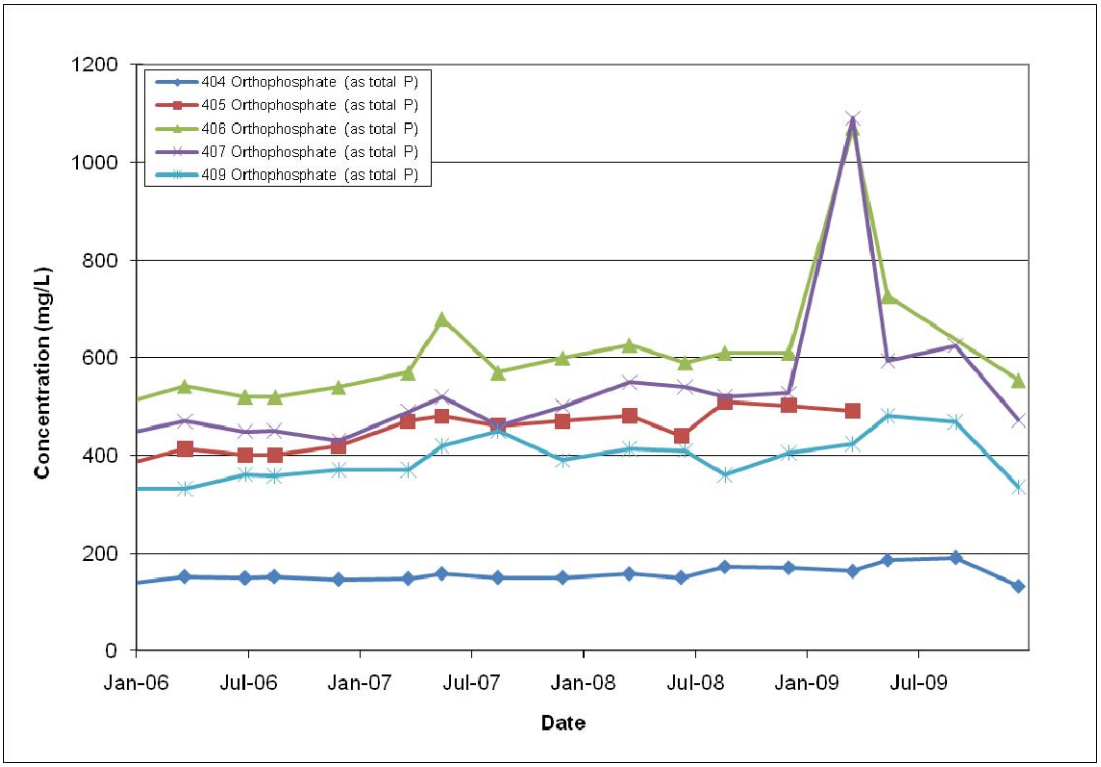


Figure 6-34: Time-series of phosphorus concentrations in the East area extraction wells upgradient of the target capture zones. Well 405 was taken off line in mid-2009.

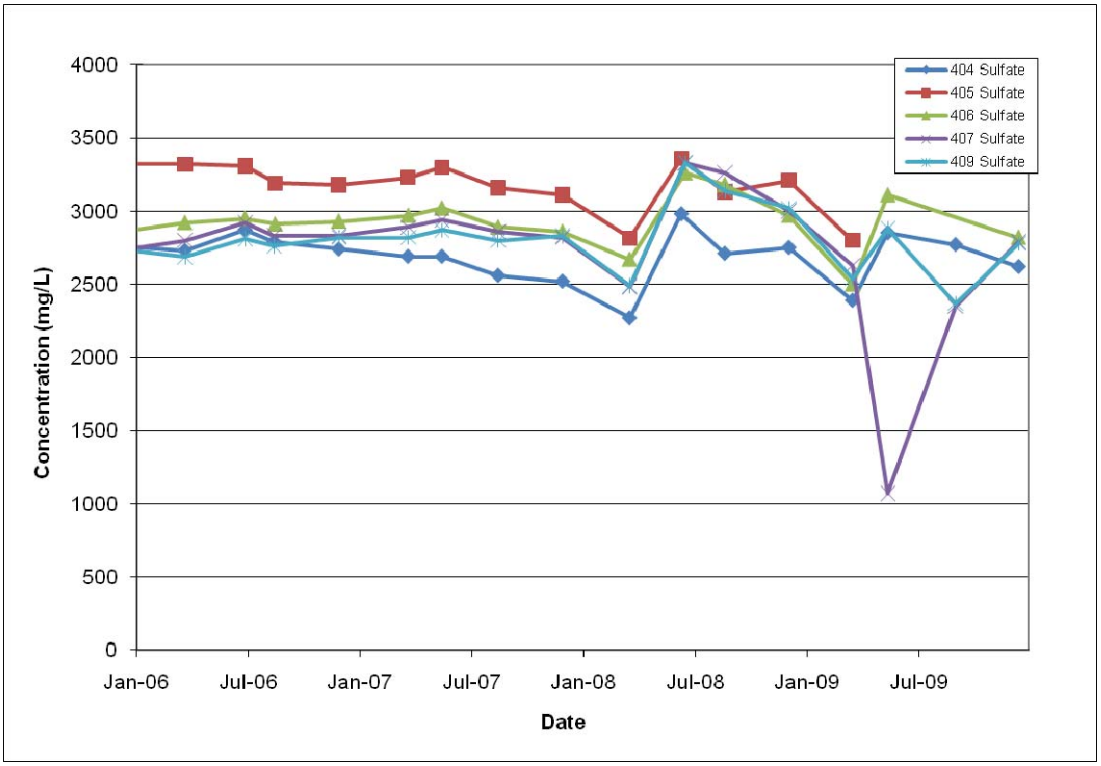


Figure 6-35: Time-series of sulfate concentrations in the East area extraction wells upgradient of the target capture zones. Well 405 was taken off line in mid-2009.

Upper Zone monitoring and extraction wells in the East area target capture zones show a slight increase in arsenic concentrations in 2009 (Figure 6-36). Well 332 also shows a slight increase in phosphorus concentration (Figure 6-37). Arsenic, phosphorus and sulfate concentrations in well 328 are much lower than other Upper Zone wells, confirming that this well marks the eastern edge of stack-affected groundwater. Sulfate concentrations show a decreasing trend in wells 332, 362 and 365 (Figure 6-38).

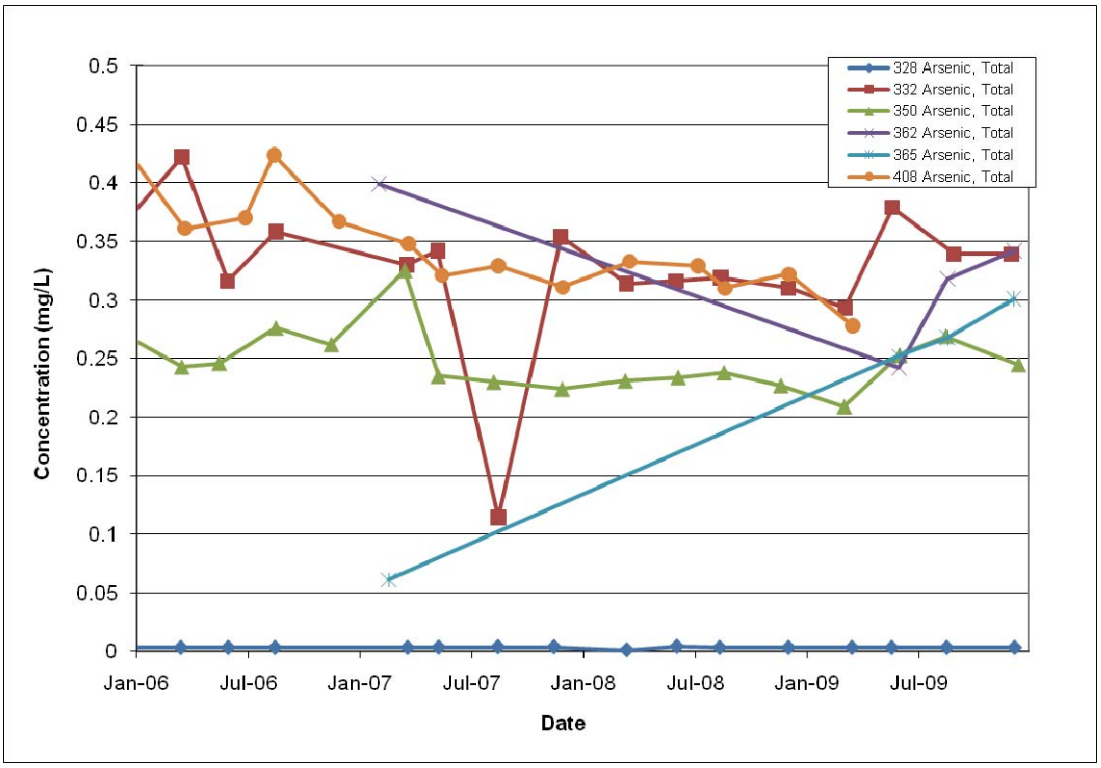


Figure 6-36: Time-series of arsenic concentrations in the East area monitoring and extraction wells in the target capture zones. Well 408 was taken off line in mid-2009.

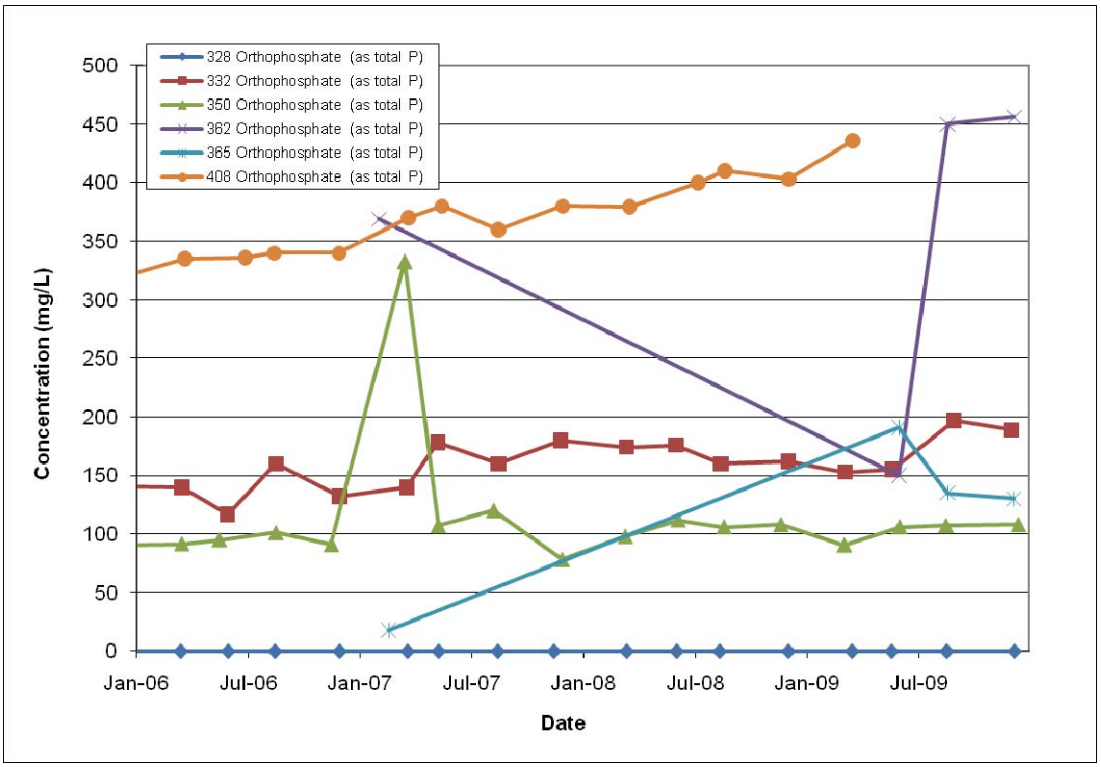


Figure 6-37: Time-series of phosphorus concentrations in the East area monitoring and extraction wells in the target capture zones. Well 408 was taken off line in mid-2009.

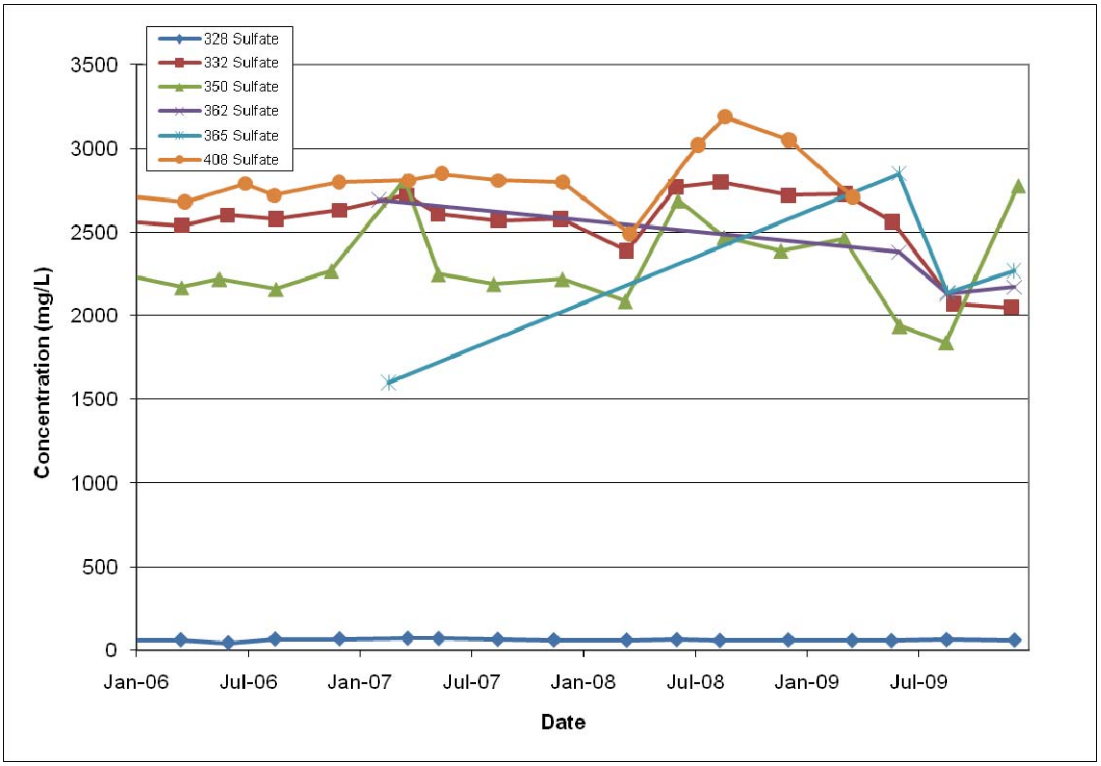


Figure 6-38: Time-series of sulfate concentrations in the East area monitoring and extraction wells in the target capture zones. Well 408 was taken off line in mid-2009.

Lower Zone monitoring wells and multi-level extraction wells in the East area show a slight decrease in arsenic concentrations over time (Figure 6-39). Phosphorus concentrations in wells 326, 410, and 411 are increasing slightly over time (Figure 6-40). Sulfate concentrations have been decreasing since the middle of 2008 and range from 1,500 to 2,600 mg/L (Figure 6-41).

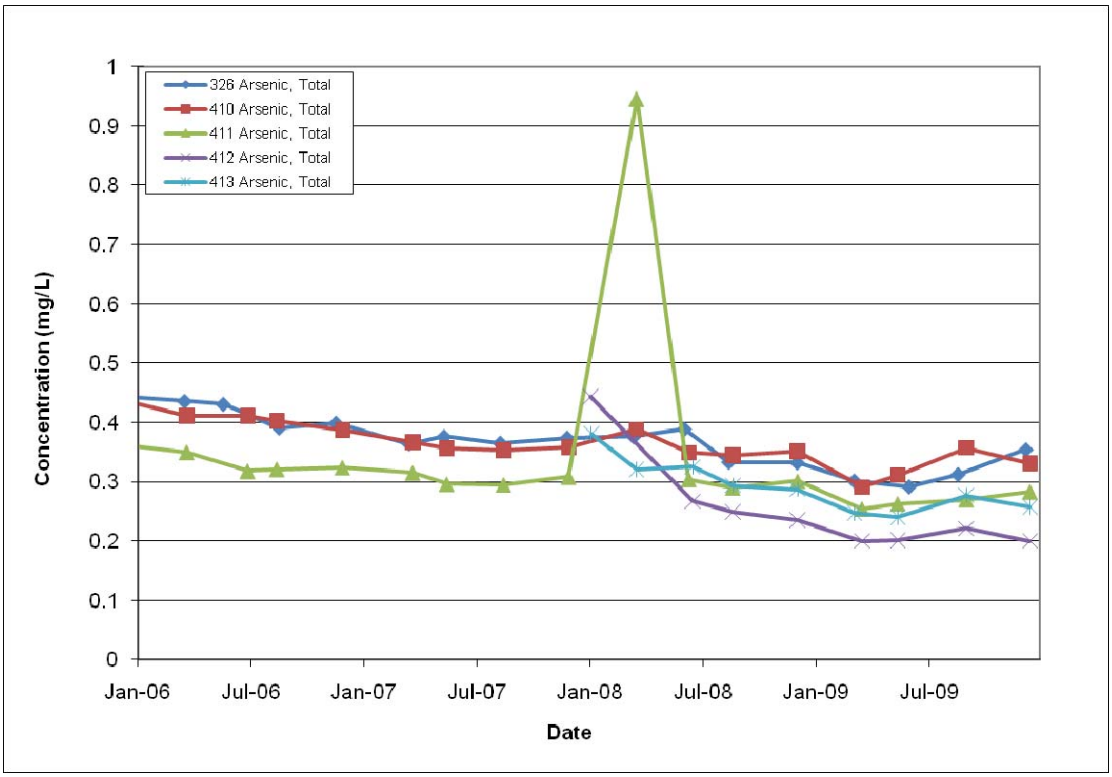


Figure 6-39: Time-series of arsenic concentrations in the East area monitoring and extraction wells in the target capture zones.

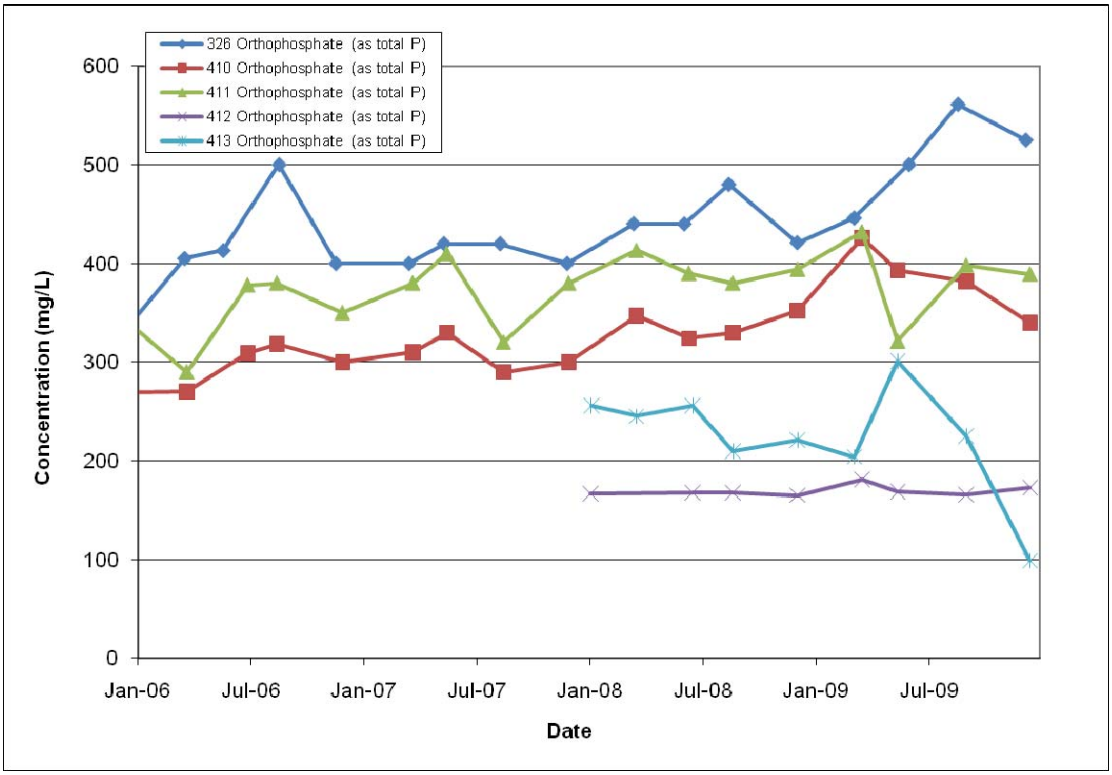


Figure 6-40: Time-series of phosphorus concentrations in the East area monitoring and extraction wells in the target capture zones.

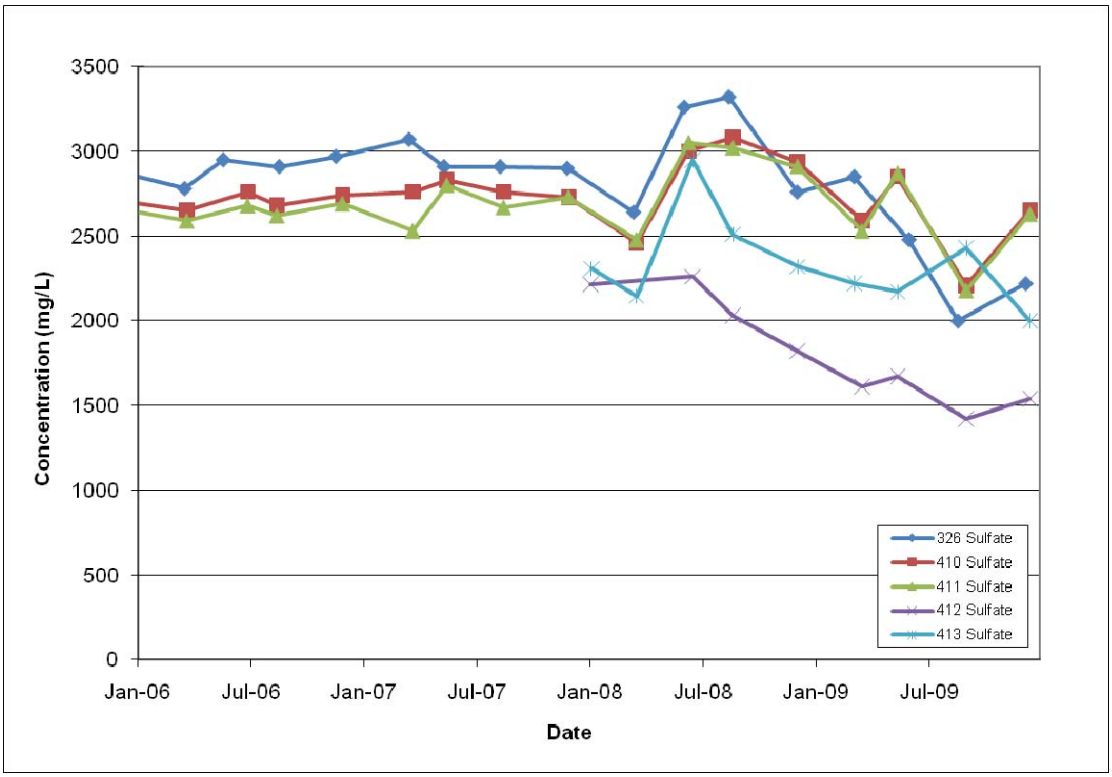


Figure 6-41: Time-series of sulfate concentrations in the East area monitoring and extraction wells in the target capture zones.

Upper Zone and Lower Zone monitoring wells are located downgradient of the target capture zones in the East plant area. Arsenic and phosphorus concentrations in wells 317 and 318 are decreasing over time (Figures 6-42 and 6-43). Wells 372, 418 and 420 were installed in January 2009. The initial sample in these wells is sometimes uncharacteristic of the local groundwater quality. Sulfate in wells 317 has been decreasing since 2007. Sulfate concentrations in wells 318 and 372 range between 2,000 and 2,500 mg/L, and are less than 500 mg/L in wells 327, 347, 348, 418 and 420 (Figure 6-44).

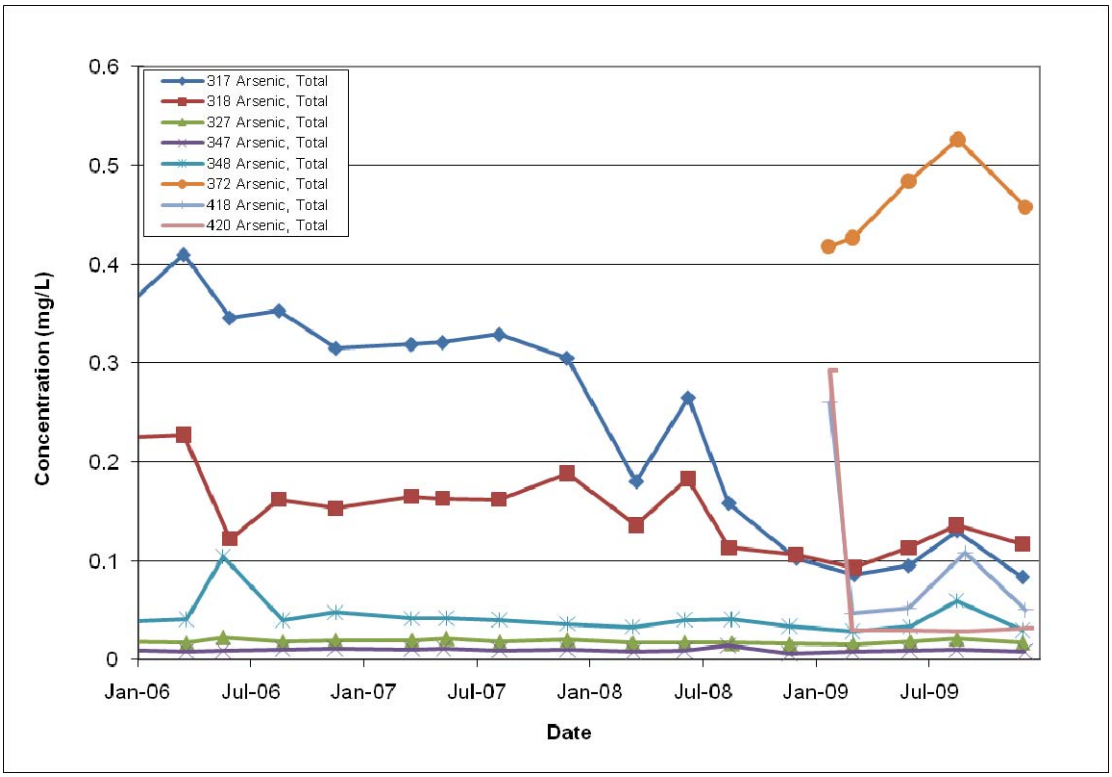


Figure 6-42: Time-series of arsenic concentrations in the East area monitoring wells downgradient of the target capture zones.

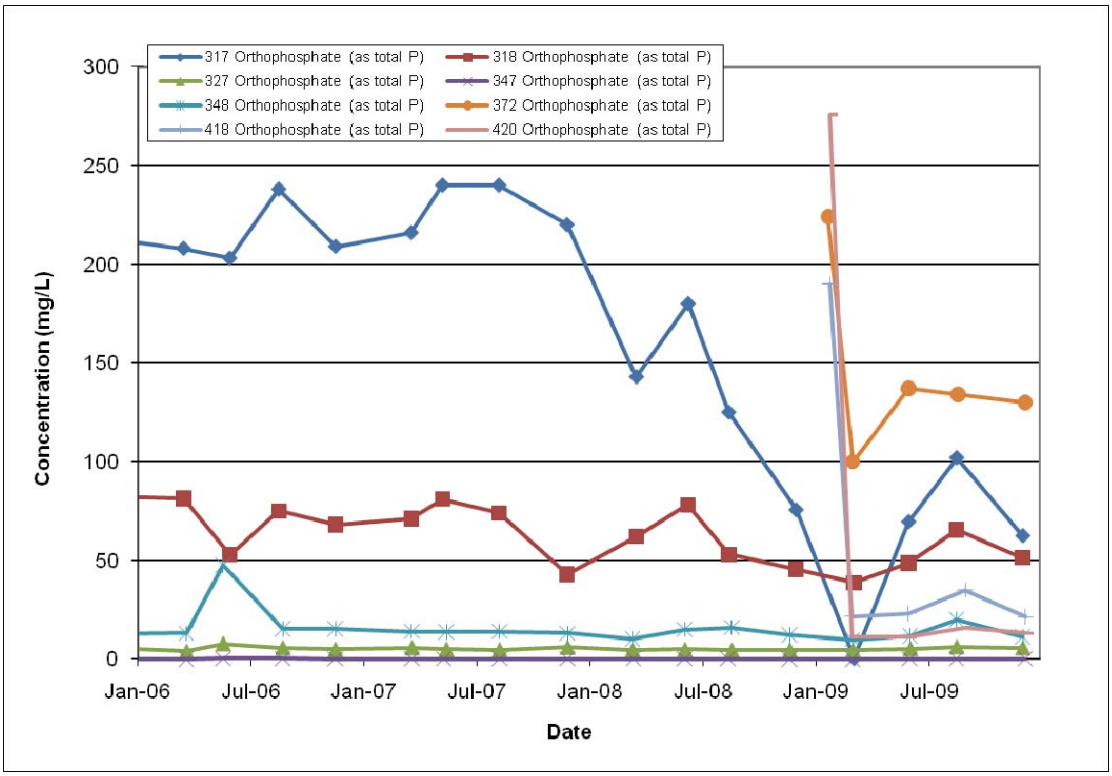


Figure 6-43: Time-series of phosphorus concentrations in the East area monitoring wells downgradient of the target capture zones.

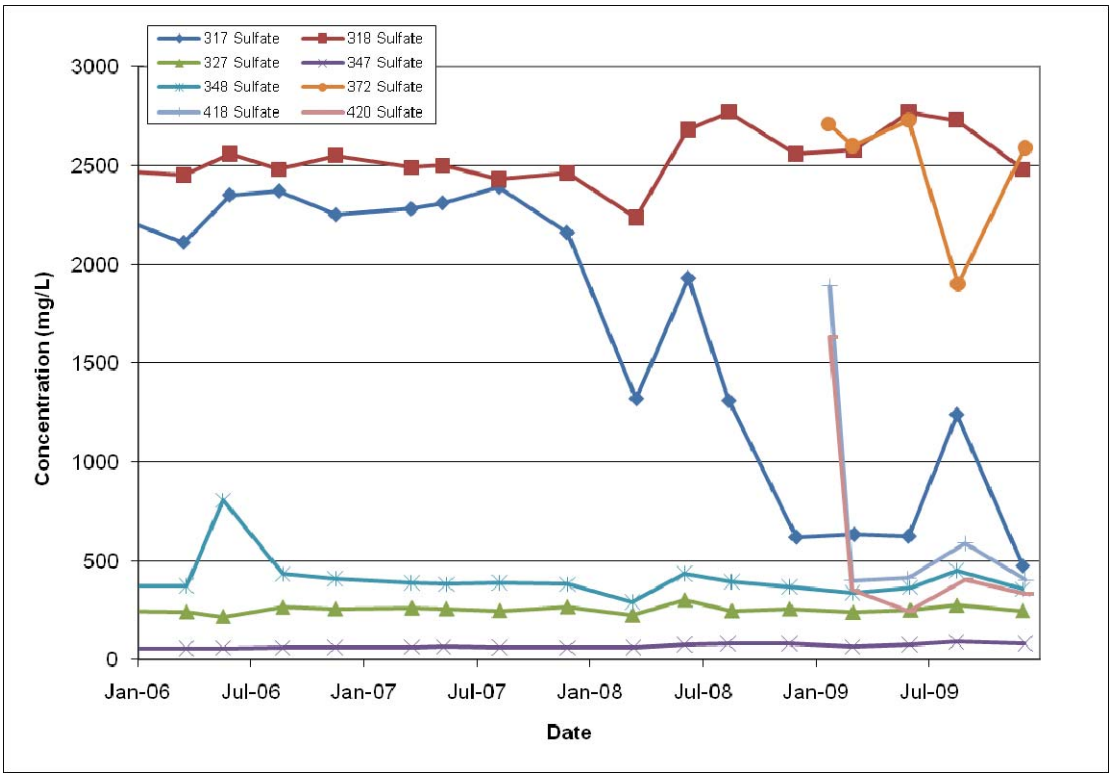


Figure 6-44: Time-series of sulfate concentrations in the East area monitoring wells downgradient of the target capture zones.

6.2 Demonstrating Source Control in the Phosphoric Acid Plant Area

The monitoring goal for the phosphoric acid plant area is evaluating source control effectiveness. Groundwater quality data will be used to assess changes in water quality over time and to help evaluate source control effectiveness in the phosphoric acid plant area.

The proposed data collection program for 2010 in the phosphoric acid plant area includes monthly pH measurements in phosphoric acid plant wells, quarterly groundwater level and sample collection, and more frequent sampling if the pH in any well drops below 5 su. These details are described in the Groundwater and Surface Water Monitoring Plan (Formation 2009a), and will be implemented in the 2010 annual report. The status of the groundwater monitoring effort and results of analyses will be reported monthly in the Phosphoric Acid Plant area Status Report.

The results of groundwater sample analysis will be used to compare groundwater COC concentrations upgradient to concentrations within and downgradient the phosphoric acid plant area and evaluate whether the remedy objective of source control in the Plant Area is being achieved. Statistical tests for comparison were used to compare upgradient and downgradient groundwater COC concentrations (Section 6.2.1). Time-series of phosphorus data is presented in Section 6.1.3.2.

The wells in the phosphoric acid plant area that will be monitored are listed in Table 3-3 of the Groundwater and Surface Water Monitoring Plan, and the monitoring well locations are shown in Figure 6-45. Samples of groundwater were collected and analyzed for the indicator analytes shown in Table 5-1.

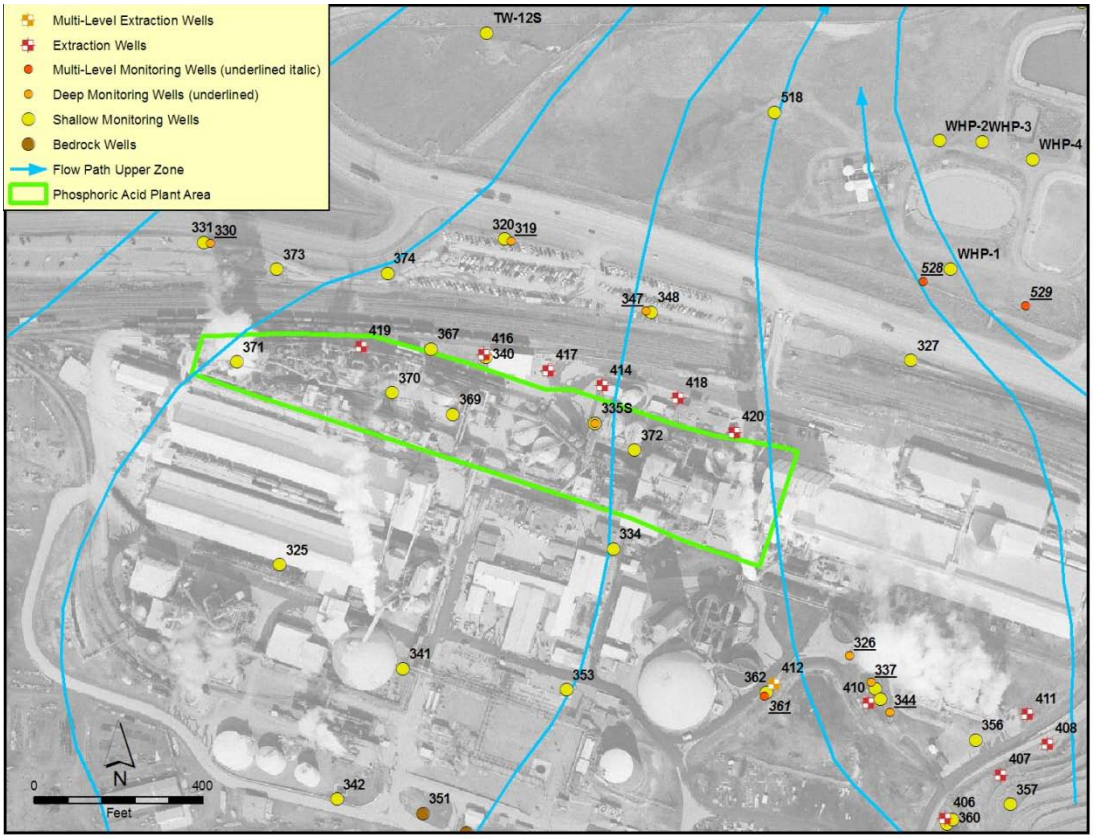


Figure 6-45: Location of wells in and near the phosphoric acid plant area.

6.2.1 Evaluating Source Control

Statistical Tests for Comparison

Statistical tests to compare upgradient and downgradient concentrations were employed for well pairs in the phosphoric acid plant area that had similar phosphorus concentrations. Sets of two wells were selected that were along the same flow path.

The statistical test will help evaluate whether the remedy objective of source control in the Plant Area is being achieved. Upgradient concentrations are defined as the concentration observed in well 325, 334, or 341. Upgradient groundwater concentrations vary, and selection of the appropriate well for a point to point comparison is based on a flow path analysis. When the gypsum stack and phosphoric acid plant

area source controls are operating as intended, the concentration of COCs will be reduced in the phosphoric acid plant area and downgradient. The null and alternate hypotheses for monitoring to demonstrate source control in the phosphoric acid plant area are:

H_0: The concentrations of indicator analytes in groundwater downgradient of the phosphoric acid plant area are greater than those upgradient of the phosphoric acid plant area.

H_A: The concentrations of indicator analytes in groundwater downgradient of the phosphoric acid plant area are less than or equal to than those upgradient of the phosphoric acid plant area.

When conditions result in a decision to reject the null hypothesis, source control in the phosphoric acid plant area will be demonstrated. The decision rule for assessing source control in the phosphoric acid plant area is as follows:

If the concentration of phosphorus in groundwater within or downgradient of the phosphoric acid plant area is less than or equal to the upgradient concentration, then source control is demonstrated.

If conditions dictate acceptance of the null hypothesis, indicator analytes downgradient of the phosphoric acid plant area will be significantly greater than levels representing stack-affected water upgradient of the phosphoric acid plant area. If the investigation indicates that groundwater extraction is necessary, a start-up plan will be prepared and submitted for agency approval, as described in the Operations and Maintenance Plan (Formation 2009e). If conditions return to normal a change of operating status will be requested in a letter to regulatory agencies. Normal conditions are indicated by no significant difference in groundwater quality in the phosphoric acid plant area wells as compared to upgradient water quality. Well pairs selected for analysis were chosen to provide information in specific areas, for instance, the effectiveness of extraction at well 414 can be evaluated by assessing whether or not phosphorus concentrations are greater than upgradient concentration. Well pairs not evaluated were either similar in concentration to other wells evaluated (i.e. 370, 369, 374, 417) or noticeably greater in concentration than upgradient wells (i.e. 419).

<u>Comparison of Concentrations Between Upgradient Well 334 and Downgradient Wells 414, 335S, and 367</u>

Figures 6-46, 6-47 and 6-48 show time-series of recent phosphorus concentrations for these wells. Well 334 is located upgradient of the phosphoric acid plant area by approximately 100 feet. Phosphorus concentrations in well 334 have shown a general increase over the past few years, however a strong trend in 2009 was not evident. Concentrations in well 334 in 2009 ranged from 124 to 210 mg/L. The downgradient well

414 also shows a slight increase in phosphorus over time, but had relatively stable concentrations in 2009 between 125 and 145 mg/L. The downgradient well 335S also shows a slight increase in phosphorus over time, but had relatively stable concentrations in 2009 between 125 and 145 mg/L. Phosphorus concentrations in well 367 were relatively stable in 2009, ranging from 134 to 327 mg/L. Although well 367 is not directly downgradient of well 334, phosphorus concentrations in well 334 are higher than other background wells (i.e. 325 and 341), and since concentrations in well 367 were greater than other downgradient wells, this comparison seemed most appropriate.

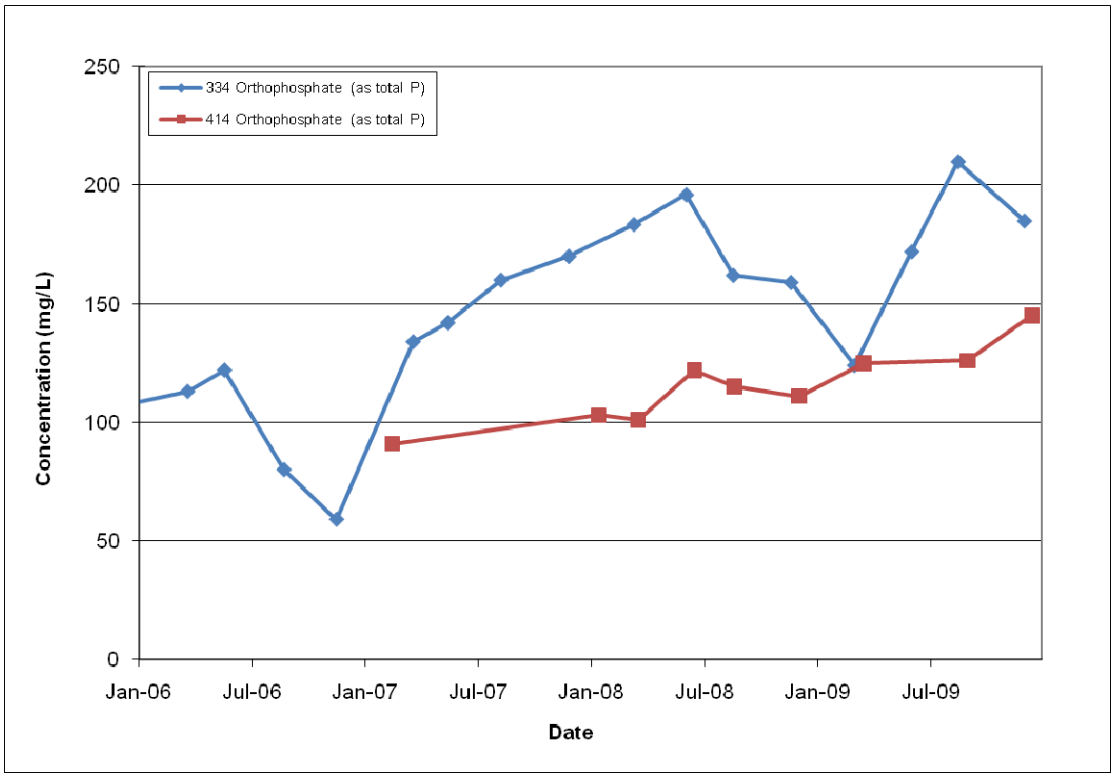


Figure 6-46: Time-series of phosphorus concentrations in wells 334 and 414.

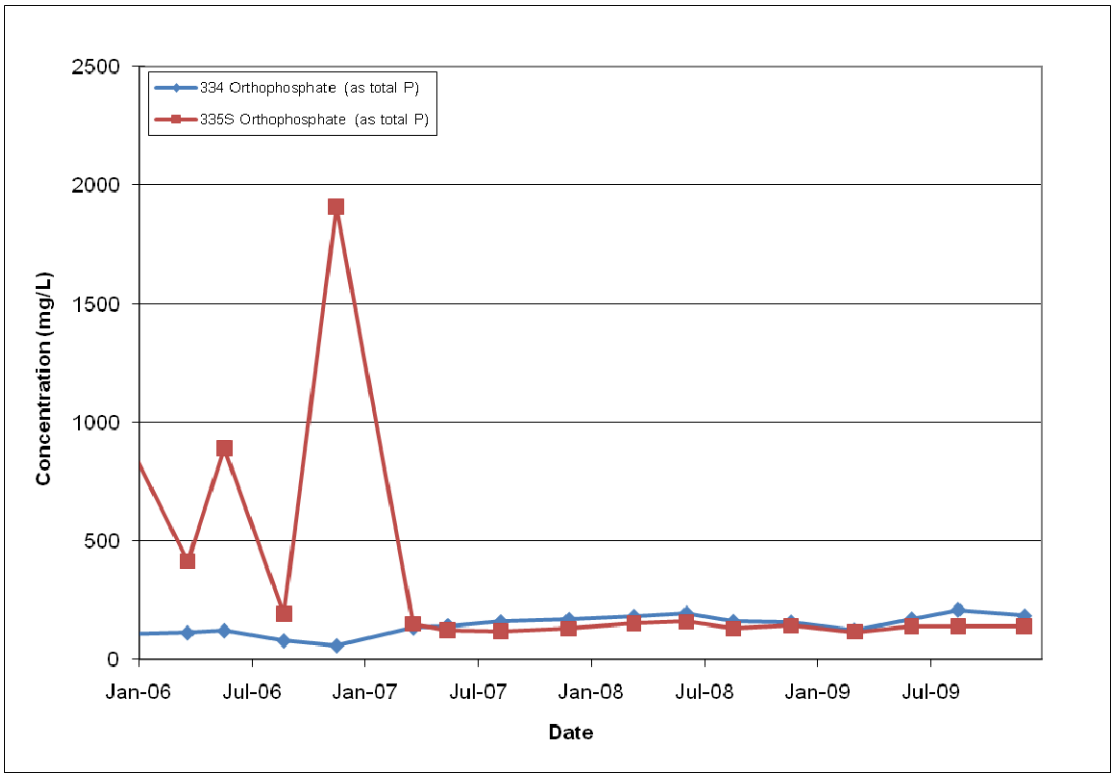


Figure 6-47: Time-series of phosphorus concentrations in wells 334 and 335S.

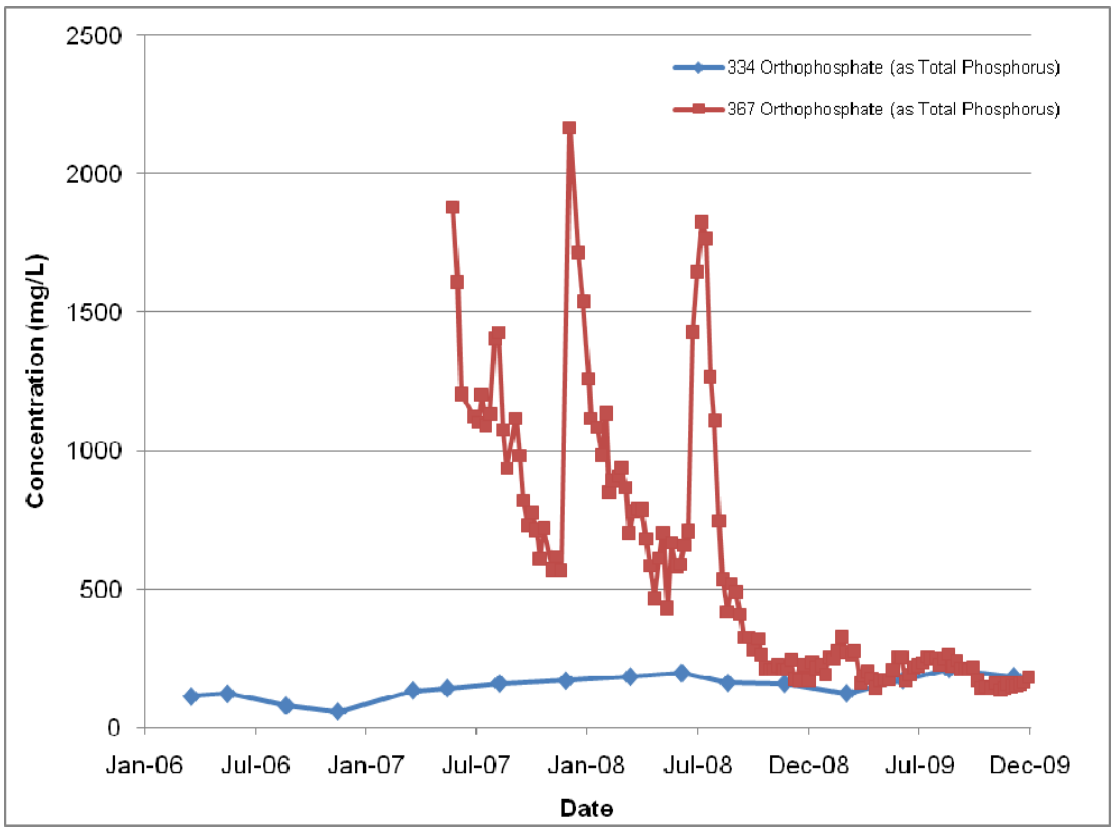
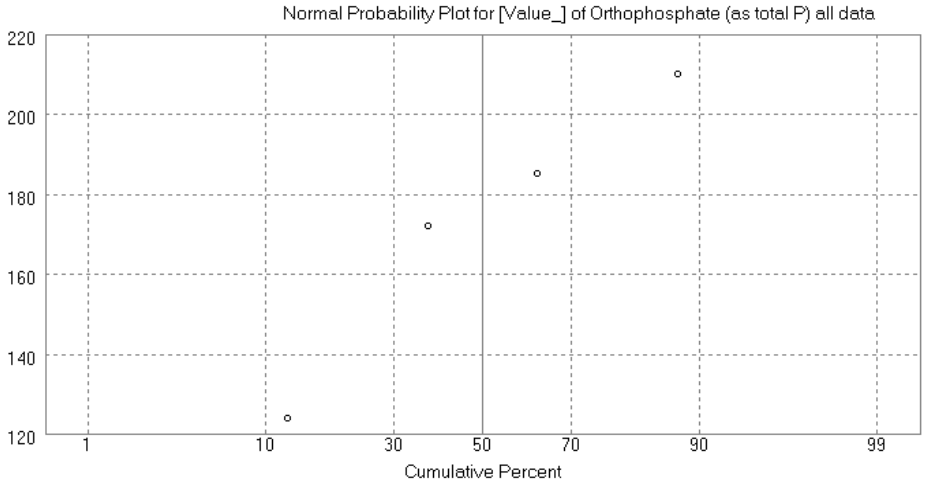


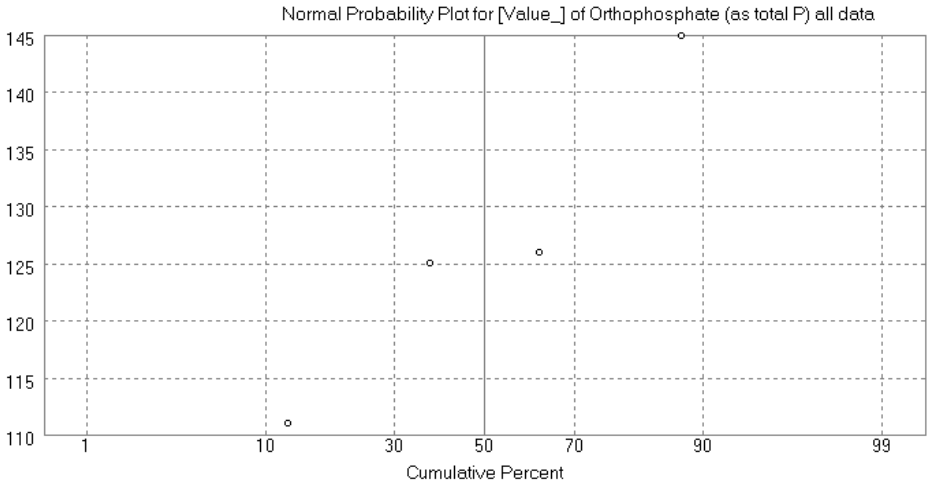
Figure 6-48: Time-series of phosphorus concentrations in wells 334 and 367.

Quarterly water quality samples from 2009 were selected for each well. Well 414 was only sampled three times in 2009, so the fourth quarter 2008 sample was added to this dataset to provide four samples for each well. For well 367, the weekly sampling data was used. Plotting of the data for each well on a normal probability plot shows that each set approximates a normal distribution (Figures 6-49 through 6-52). Normally distributed datasets are compared using the two sample t-test, which is described in the Groundwater and Surface Water Monitoring Plan (Formation 2009a). This test provides robust results even if the data deviate somewhat from a normal distribution (EPA 2009). Since the variances in the 334 data are significantly different than in the well 414, 335S and 367, Welch's T-Test was performed using a confidence interval of 95%.



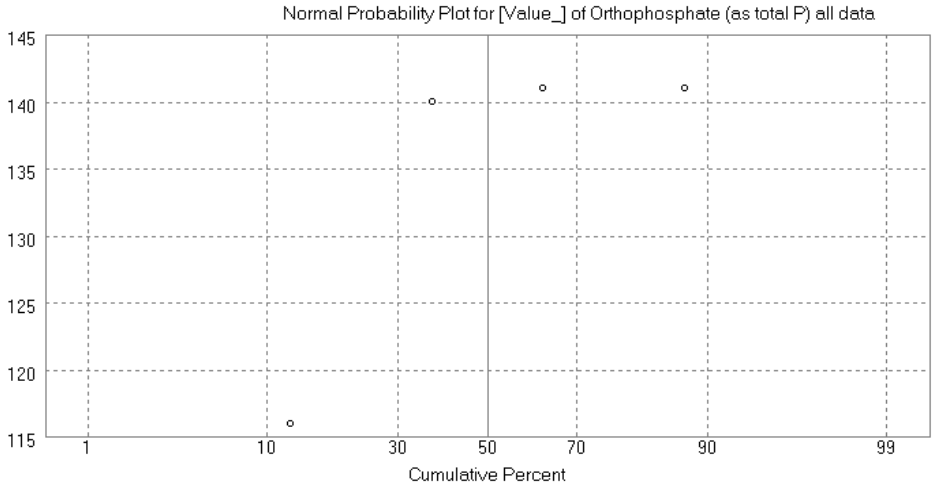
Count	4
Minimum	124.0
Maximum	210.0
Sum	691.0
Mean	172.75
Median	178.5
StdDev	36.12363
Variance	1304.917
Skewness	-0.8815597
Kurtosis	1.369361
95 UCL	215.1953

Figure 6-49: Normal probability plot for recent phosphorus concentrations from well 334.



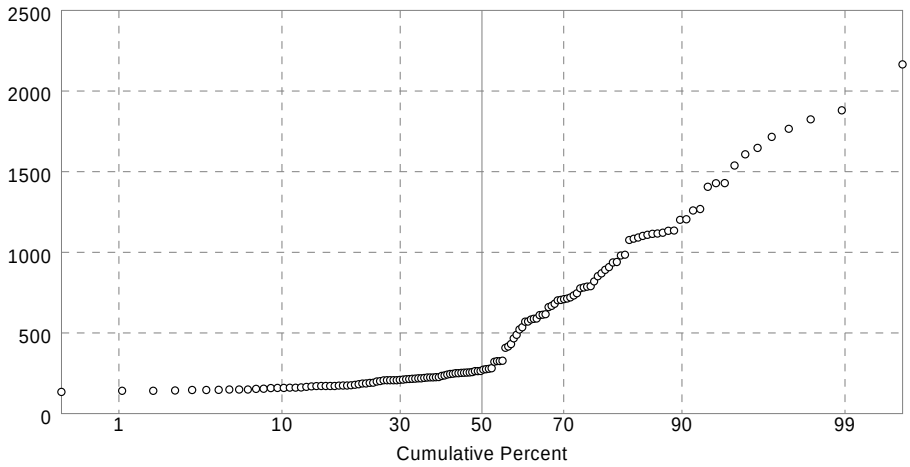
Count	4
Minimum	111.0
Maximum	145.0
Sum	507.0
Mean	126.75
Median	125.5
StdDev	13.96126
Variance	194.9167
Skewness	0.5305405
Kurtosis	1.632399
95 UCL	143.1545

Figure 6-50: Normal probability plot for recent phosphorus concentrations from well 414.



Count	4
Minimum	116.0
Maximum	141.0
Sum	538.0
Mean	134.5
Median	140.5
StdDev	12.34234
Variance	152.3333
Skewness	-1.991331
Kurtosis	3.970074
95 UCL	149.0022

Figure 6-51: Normal probability plot for recent phosphorus concentrations from well 335S.



Count	142
Minimum	134.0
Maximum	2165.0
Sum	77134.0
Mean	543.1972
Median	268.0
StdDev	465.7594
Variance	216931.8
Skewness	1.301167
Kurtosis	0.9810284
95 UCL	607.4931

Figure 6-52: Normal probability plot for recent phosphorus concentrations from well 367.

Results from the calculation using the 334-414 well pair shows that the t-statistic is slightly greater that the critical point (t > tcp) at well 414 indicating that the mean of the upgradient concentration (334) is significantly greater than the mean of the downgradient concentration (414). Results using the 334-335s well pair shows that the t-statistic is slightly less than the critical point (t < tcp) indicating that there is no statistically significant difference between the concentration means. Results from the calculation using the 334-367 well pair shows that the t-statistic is greater that the critical point (t > tcp) at well 334 indicating that the mean of the downgradient concentration (367) is significantly greater than the mean of the upgradient concentration (334).

Table 6-2: Results of the two-sample t-test for wells 334 and 414.

Wells	Method	Degrees of Freedom	t-Test Value (t)	Critical Point (t_{cp}) (0.95)
334 – 414	Welch's T-Test	3.87	2.34	2.13
334 – 335S	Welch's T-Test	3.69	2.00	2.13
334 - 367	Welch's T-Test	66.1	8.60	1.67

<u>Wells 325 and 367</u>

Upgradient well 325 has shown phosphorus concentrations between 11 and 13 mg/L in 2009. This is notably lower than well 367, which has concentrations between 150 and 300 mg/L. Figure 6-53 shows a time-series of phosphorus concentrations in these two wells.

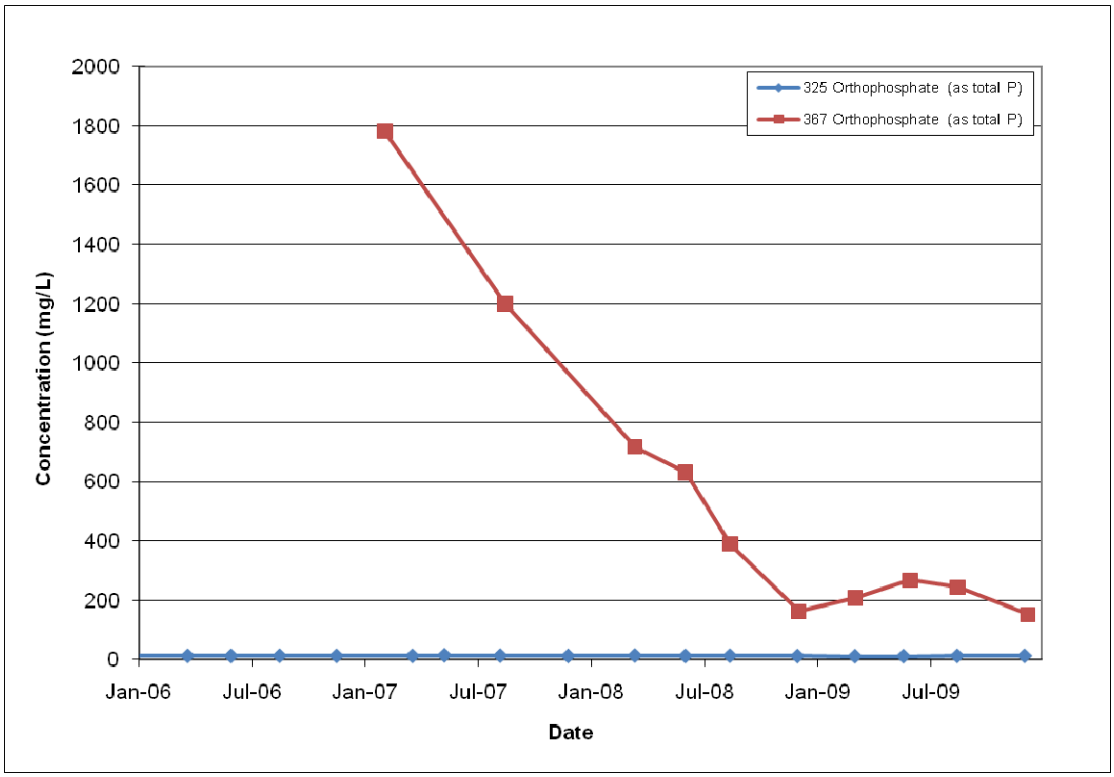


Figure 6-53: Time-series of phosphorus concentrations in wells 325 and 367.

Phosphorus concentrations in well 367 are more similar to those in well 334, however, these two wells are not along the same flow path. Statistical tests are not necessary to conclude that the phosphorus concentration in the downgradient well 367 is significantly higher than the upgradient concentration at well 325.

Wells 341 and 340

Upgradient well 341 has shown phosphorus concentrations between 22 and 25 mg/L in 2009, although it was only sampled twice. This is notably lower than well 340, which has concentrations between 1,000 and 3,300 mg/L. Figure 6-54 shows a time-series of phosphorus concentrations in these two wells.

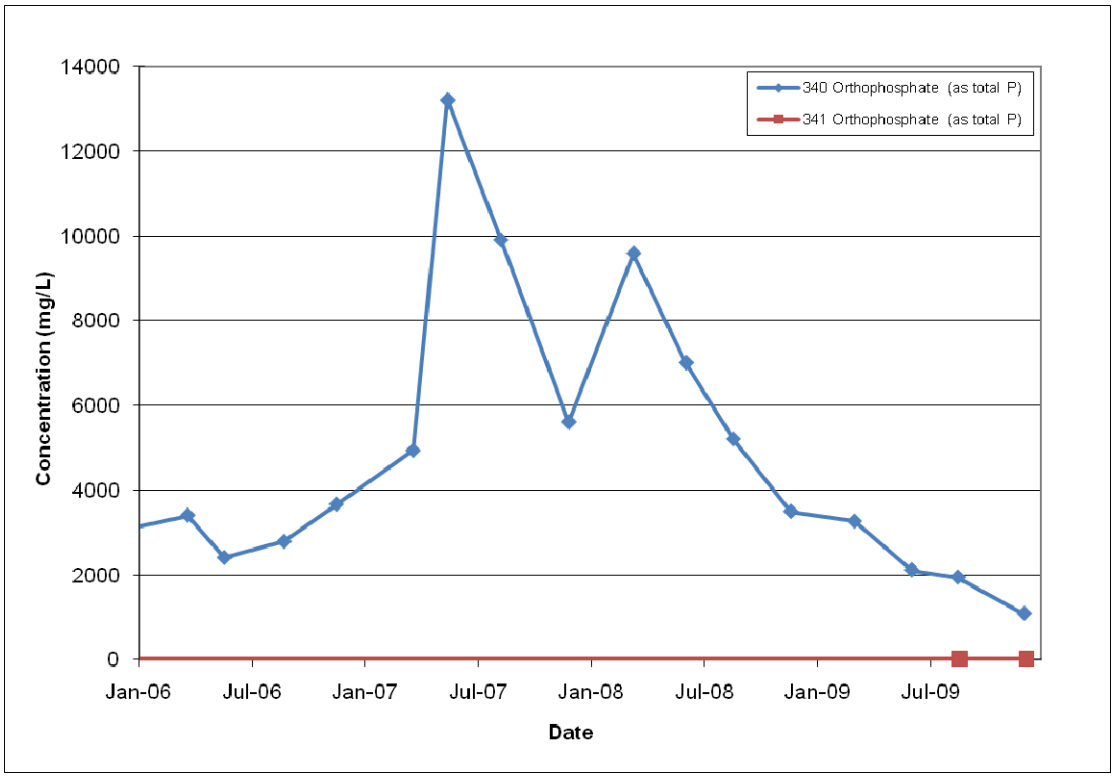


Figure 6-54: Time-series of phosphorus concentrations in wells 341 and 340.

Statistical tests are not necessary to conclude that the phosphorus concentration in the downgradient well 340 is significantly higher than the upgradient concentration at well 341.

<u>Result</u>

Analysis of the well pairs indicates that downgradient phosphorus concentrations are greater than or equal to the upgradient concentrations at the location of wells 340, and 367, and less than upgradient concentrations at well 414. The effects of source control actions taken in 2009 may have yet to be realized due to very low groundwater gradients and slow travel time in this area. Two large diameter monitoring wells (416 and 419) that were installed in the phosphoric acid plant area in January 2009 will be converted to extraction wells to provide further control of phosphorus in groundwater. The details of this plan are outlined in the Groundwater Remedial Design Report (Formation 2009b) and the Well 416 and 419 Startup Plan (Formation 2010c). Source control actions in the phosphoric acid plant area are ongoing, and the planned projects for 2010 are outlined in the Draft Infrastructure Improvement Plan (Simplot 2010).

6.2.2 Phosphoric Acid Plant-Specific Data

The revised Groundwater and Surface Water Monitoring Plan (Formation 2009a) includes a plan for sampling of metals when the pH in any phosphoric acid plant well decreases below

4 su. The provisions of the revised plan will be implemented during 2010. In 2009, three wells had a pH below 4 for any period of time. Well 374 had a pH below 4 su for three weeks during the spring and well 340 had a pH below 4 su for January through March 2009. The pH in well 419 was below 4 su for all of 2009. Results of pH and analyses for metals concentrations were presented in the Technical Report No. 1 (Simplot 2009b) and in the monthly Phosphoric Acid Plant Area Groundwater Summary reports. Time-series of weekly pH measurements are shown in Figure 6-55.

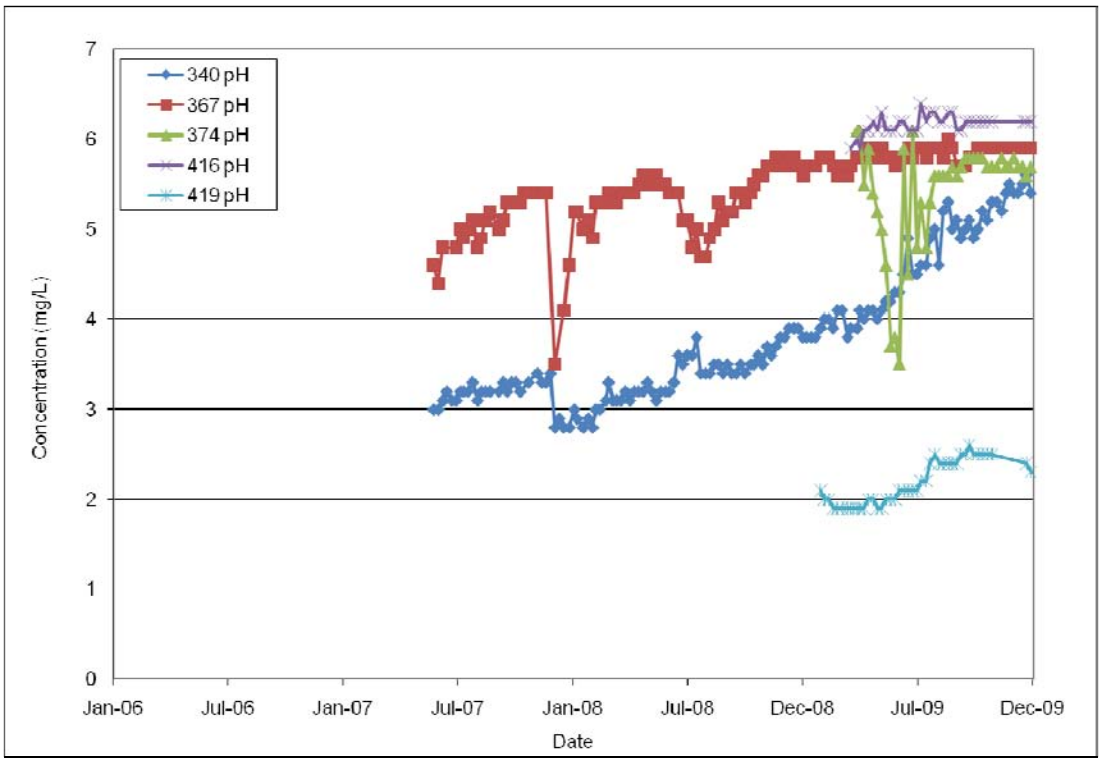


Figure 6-55: Time-series of weekly pH in wells 340, 367, 374, 416 and 419. Note that pH may be field values.

Increasing trends in pH were observed in wells 340, 419, 374, 367 and 416 in 2009. Increasing pH is typically accompanied by decreasing phosphorus concentrations. By the end of 2009, the pH in well 340 had reached 5.5 and the pH in well 419 reached 2.3 su.

6.3 Demonstrating Hydraulic Control in the Target Capture Zones

Demonstrating hydraulic control in the target capture zones is performed according to EPA's *Systematic Approach for Evaluation of Capture Zones at Pump and Treat Systems* (EPA 2008).

The wells in the target capture zones that are monitored and the data that have been collected are listed in Table 5-2, and the monitoring well locations are shown in Figures 5-1, 5-2 and 5-3. Samples of groundwater were collected and analyzed for the indicator analytes shown in Table 5-1.

The EPA approach involves a six-step systematic evaluation of capture zones:

- Step 1 – review site data, site CSM and remedy objectives;
- Step 2 – define the target capture zones;
- Step 3 – interpret water levels;
- Step 4 – perform calculations including flow budget, capture zone width calculation and modeling including particle tracking or transport modeling;
- Step 5 – evaluate concentration trends; and
- Step 6 – interpret actual capture based on steps 1-5, compare the actual capture to the target capture, and assess uncertainties and data gaps.

The information contained in Sections 1 through 3 of the Remedial Design Report constitutes Step 1 in the process (Formation 2009b). Summaries of the evaluations and calculations that were performed as part of Steps 2 through 6 are provided in the following paragraphs.

6.3.1 Review of Site Data, Conceptual Model and Remedy Objectives (Step 1)

A review of remedy objectives, site data and the conceptual model used to design the remedy can be found in Sections 1 through 3 of the Groundwater Remedial Design Report (Formation 2009b).

6.3.2 Delineation of Target Capture Zones (Step 2)

Target capture zones are three-dimensional zones within affected groundwater flow where groundwater extraction will be focused to satisfy the requirements of the remedy. The target capture zones for the Simplot Plant Area were determined based upon multiple hydrogeologic criteria. The zones take into account all known EMF Site data, the CSM, and the remedy objectives (EPA 2008). The target capture zones were delineated during the groundwater

remedial design and a detailed description of this delineation is included in the Remedial Design Report (Formation 2009b). For reference, the lateral delineation of the target capture zones is shown in Figures 6-56 and 6-57.

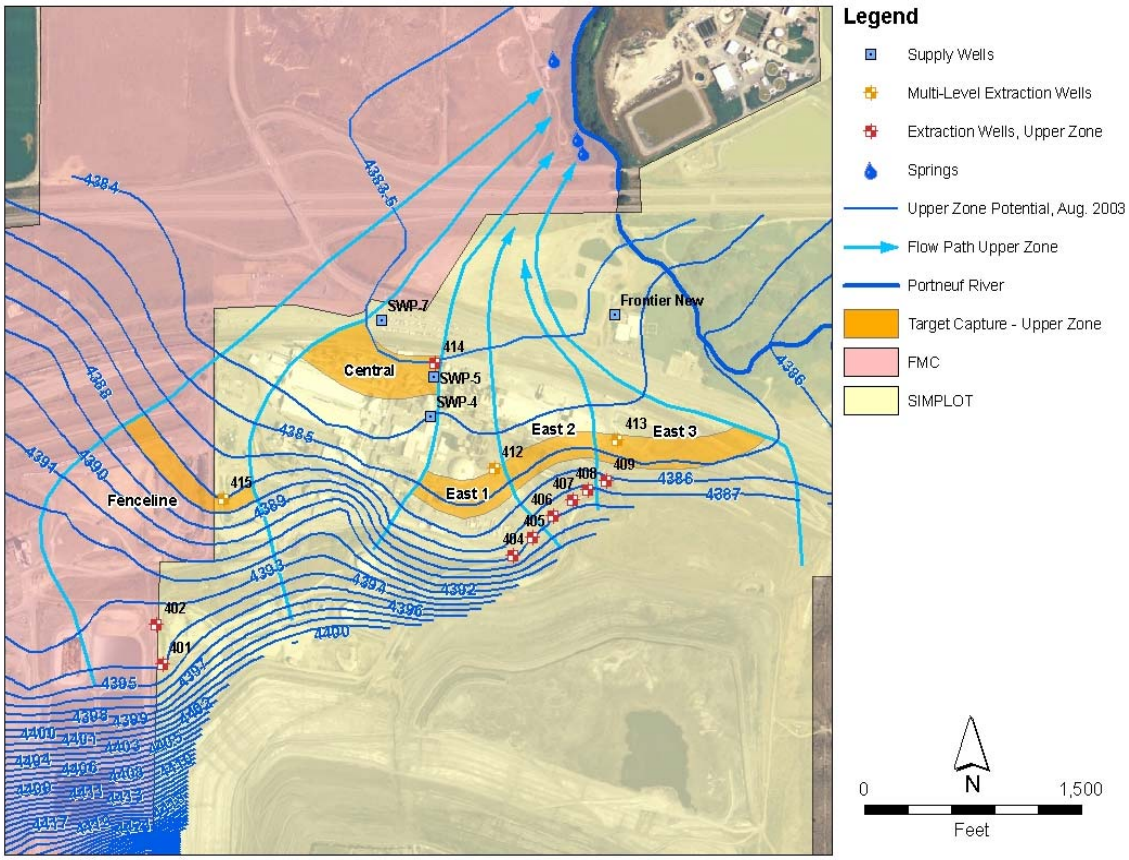


Figure 6-56: Target capture zones for the Upper Zone.

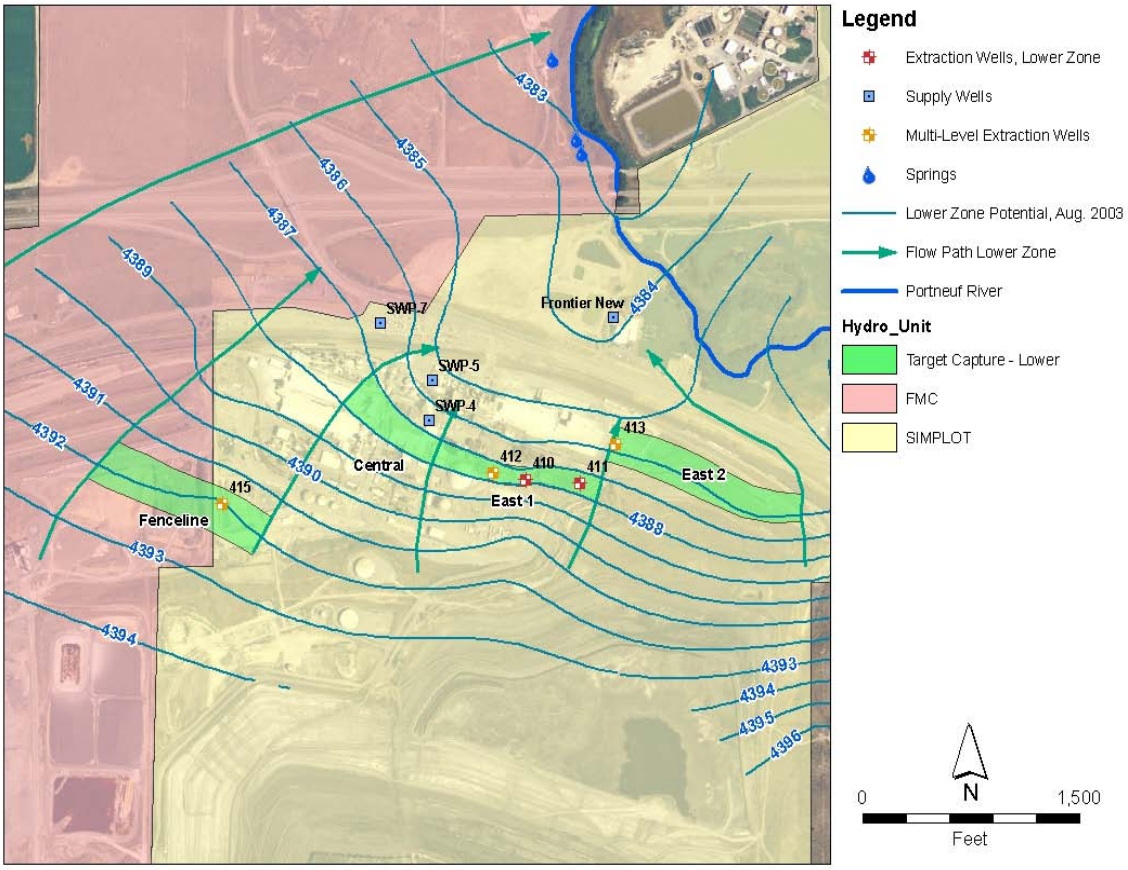


Figure 6-57: Target capture zones for the Lower Zone.

6.3.3 Interpretation of Water Levels (Step 3)

The current extraction system was fully operational when site-wide groundwater levels were measured during all four quarterly groundwater monitoring events in 2009. The large scale groundwater potentiometric surface maps are shown in Figures 5-4 through 5-13.

Pumping Conditions

During the Phase 1 and Phase 2 Investigations (NewFields 2006a and 2008b) well performance tests were conducted on existing extraction wells and aquifer tests were conducted using the new extraction wells 412, 413, 414, and 415. The data obtained were used to estimate aquifer properties and well performance and can now be used to assist in interpreting groundwater level data and develop more representative groundwater potentiometric maps. In general, the hydraulic influence that is obtained from each extraction well is proportional to the pumping rate, the hydraulic conductivity of the zone(s) being pumped, and the thickness of the zone(s) being pumped. In 2009, the smallest amount of hydraulic influence was obtained from Upper Zone extraction wells 404, 405, 407, 408, and 409, which pumped at average rates of less than 5 gpm and the largest amount of hydraulic influence was obtained from the Lower Zone extraction wells 412 and 413 which pumped at average rates of about 400 and 110 gpm respectively (refer to Table 4-1 for average pumping rates).

Since there was little variation in the potentiometric surface between quarterly sampling events in 2009 (Section 5.3), the November 2009 potentiometric surface was used as a representative surface for interpreting capture zones for extraction wells. This potentiometric surface includes the effects of the pumping (see Table 4-1). The interpreted zones are delineated based only on the potentiometric contours and are shown in Figure 6-58.

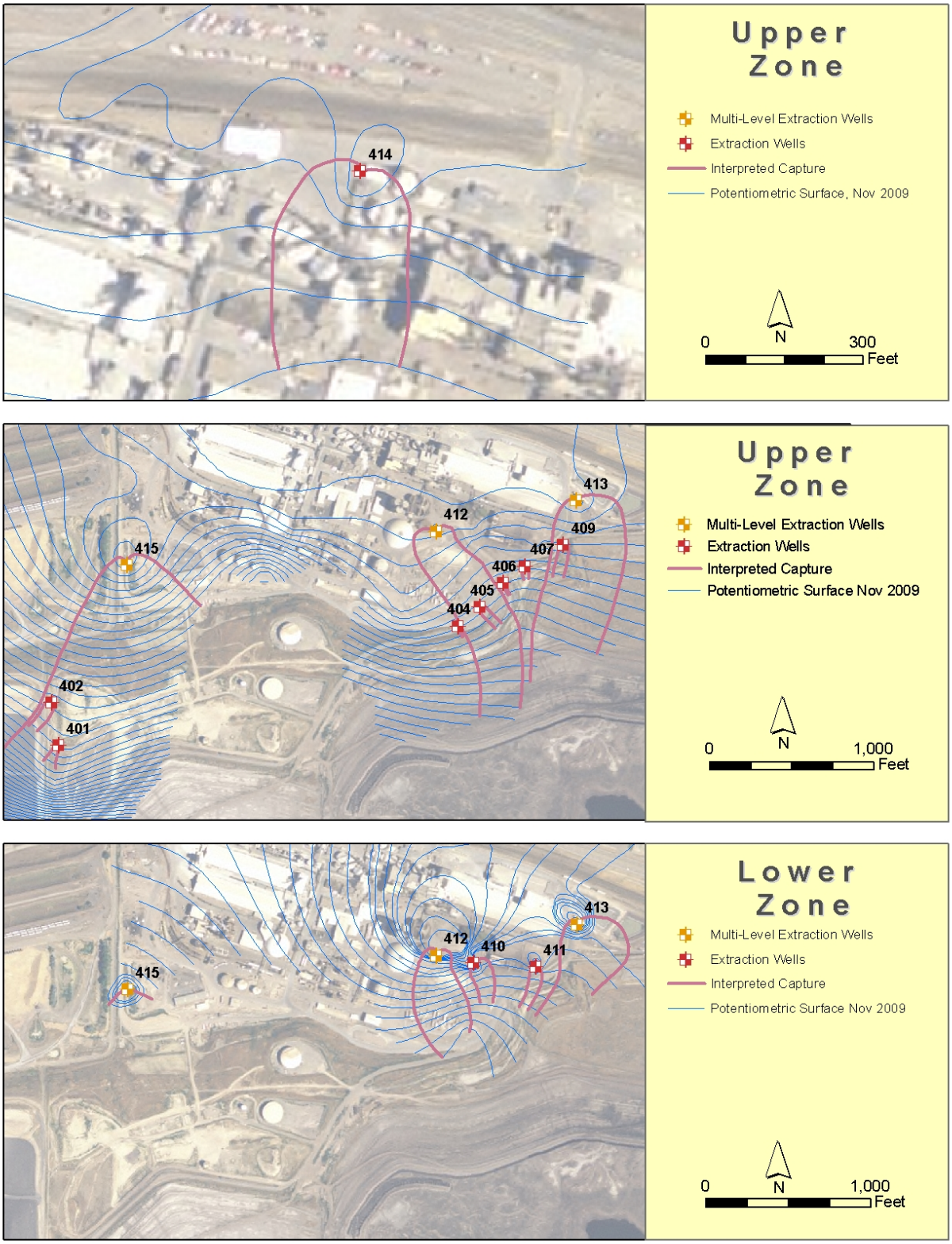


Figure 6-58: Interpreted capture zones.

Vertical Head Differences

Vertical head differences were assessed at well pairs. Well pairs typically have one well screened in the Lower Zone and one well screened in the Upper Zone. Figure 6-59 shows the calculated range of vertical head differences for the 2009 quarterly sampling events.

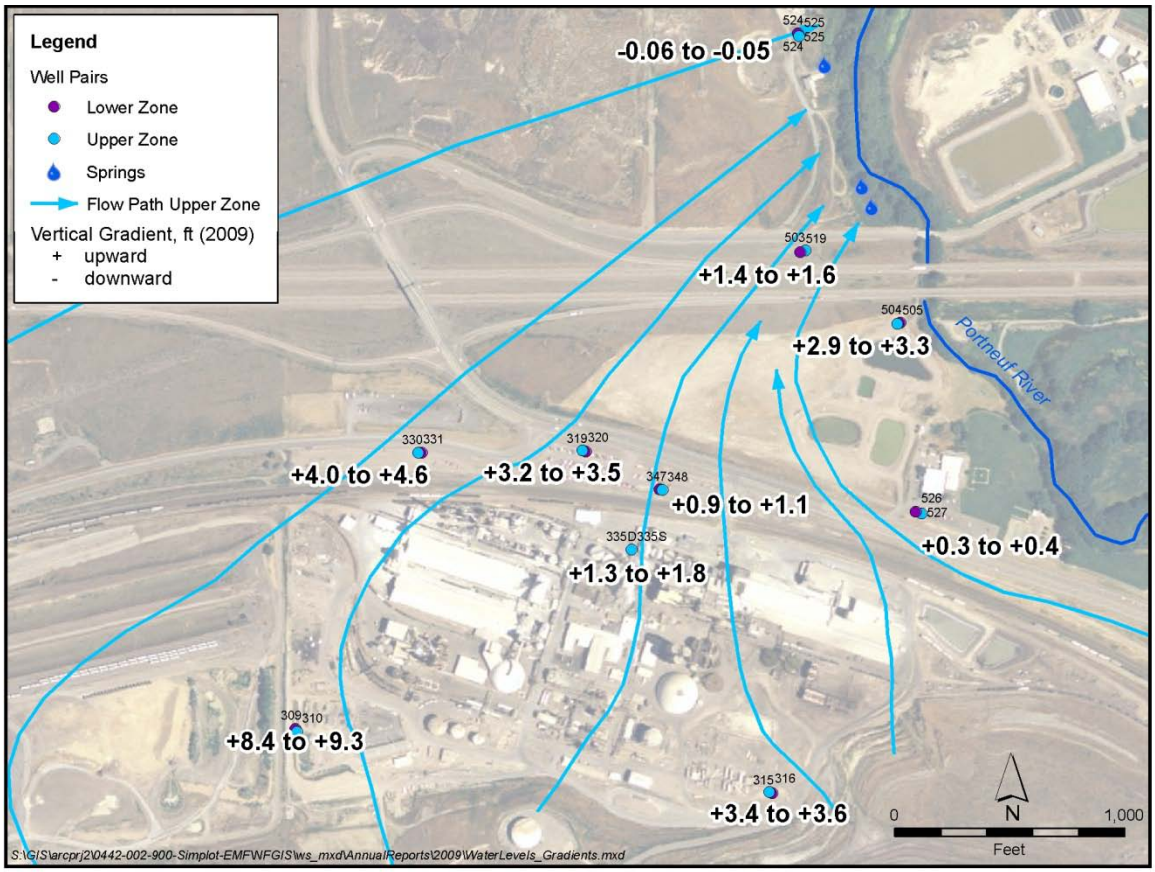


Figure 6-59: Vertical head differences calculated for November 2009 water levels measured at Upper Zone/Lower Zone well pairs.

Significant vertical head differences are observed suggesting upward flow, especially to the south and east of the site. Head differences range from 9.3 ft upward to 0.06 ft downward. Head differences tend to decrease as groundwater moves toward the Portneuf River. Figure 6-60 through 6-69 show time-series of water levels in well pairs. The time-series show that the head differences observed in 2009 have been consistent for the past few years.

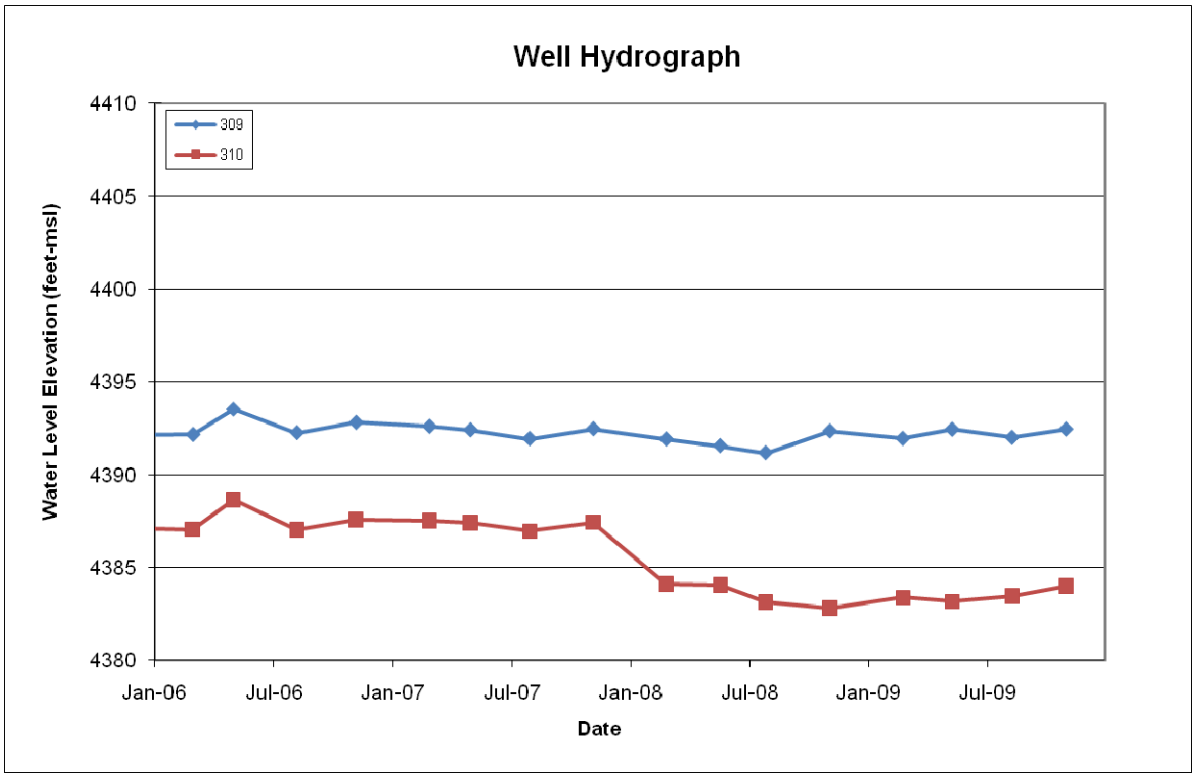


Figure 6-60: Water levels in wells 309 (Lower Zone) and 310 (Upper Zone).

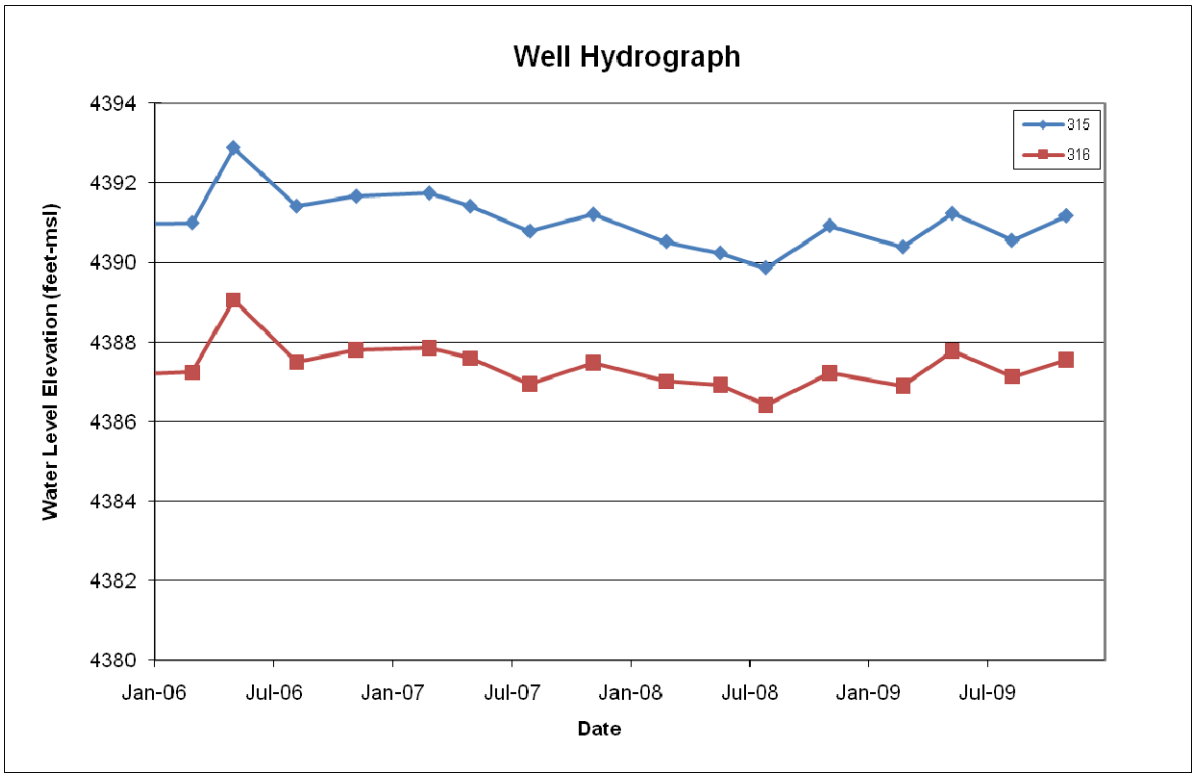


Figure 6-61: Water levels in wells 315 (Lower Zone) and 316 (Upper Zone).

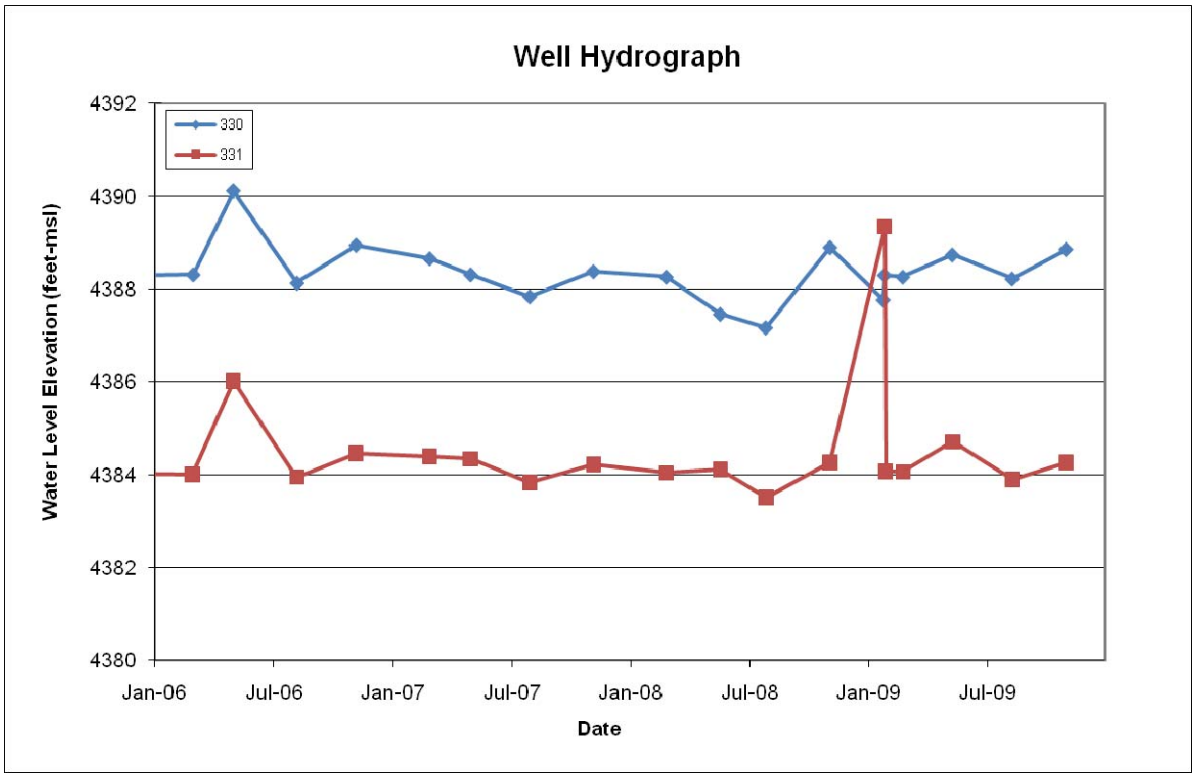


Figure 6-62: Water levels in wells 330 (Lower Zone) and 331 (Upper Zone).

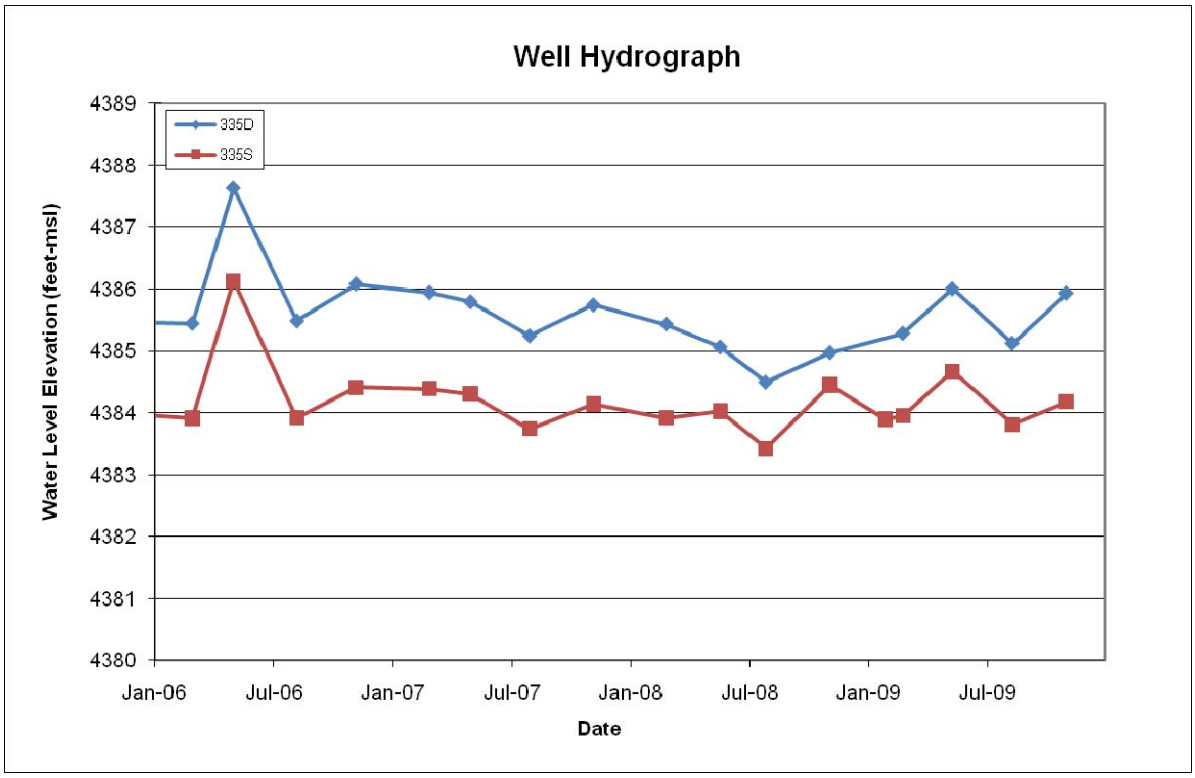


Figure 6-63: Water levels in wells 335D (Lower Zone) and 335S (Upper Zone).

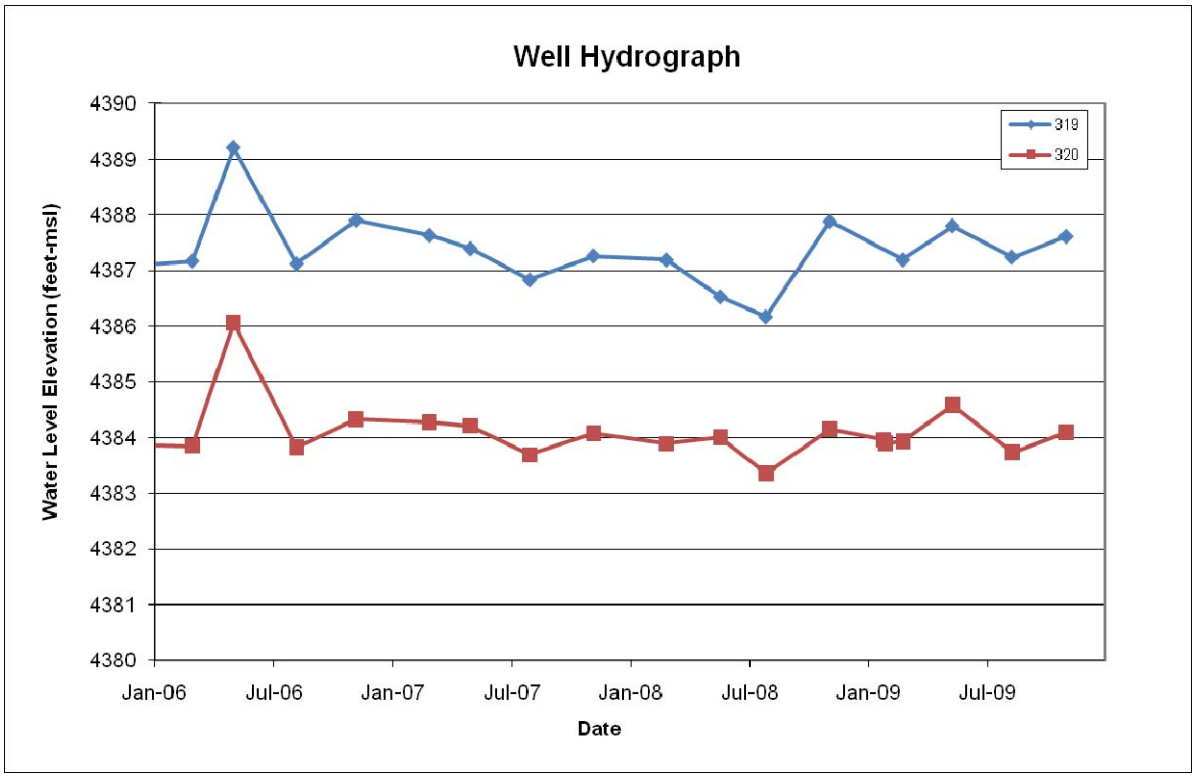


Figure 6-64: Water levels in wells 319 (Lower Zone) and 320 (Upper Zone).

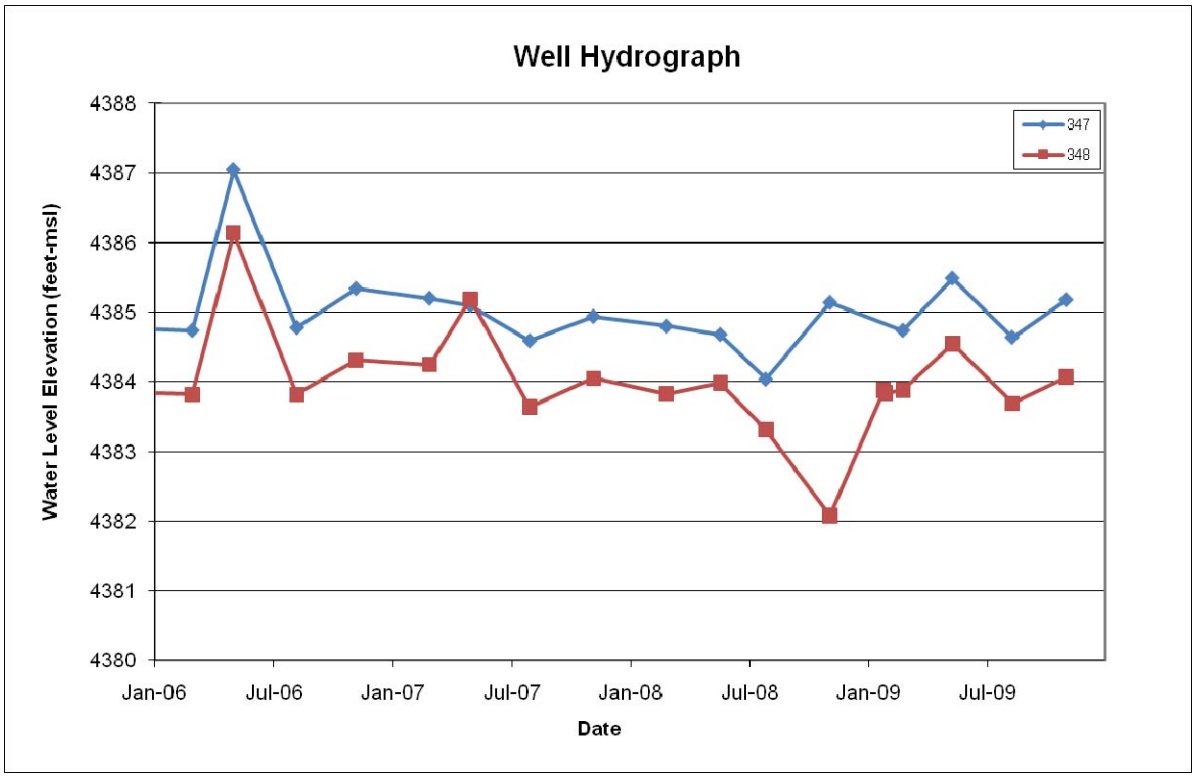


Figure 6-65: Water levels in wells 347 (Lower Zone) and 348 (Upper Zone).

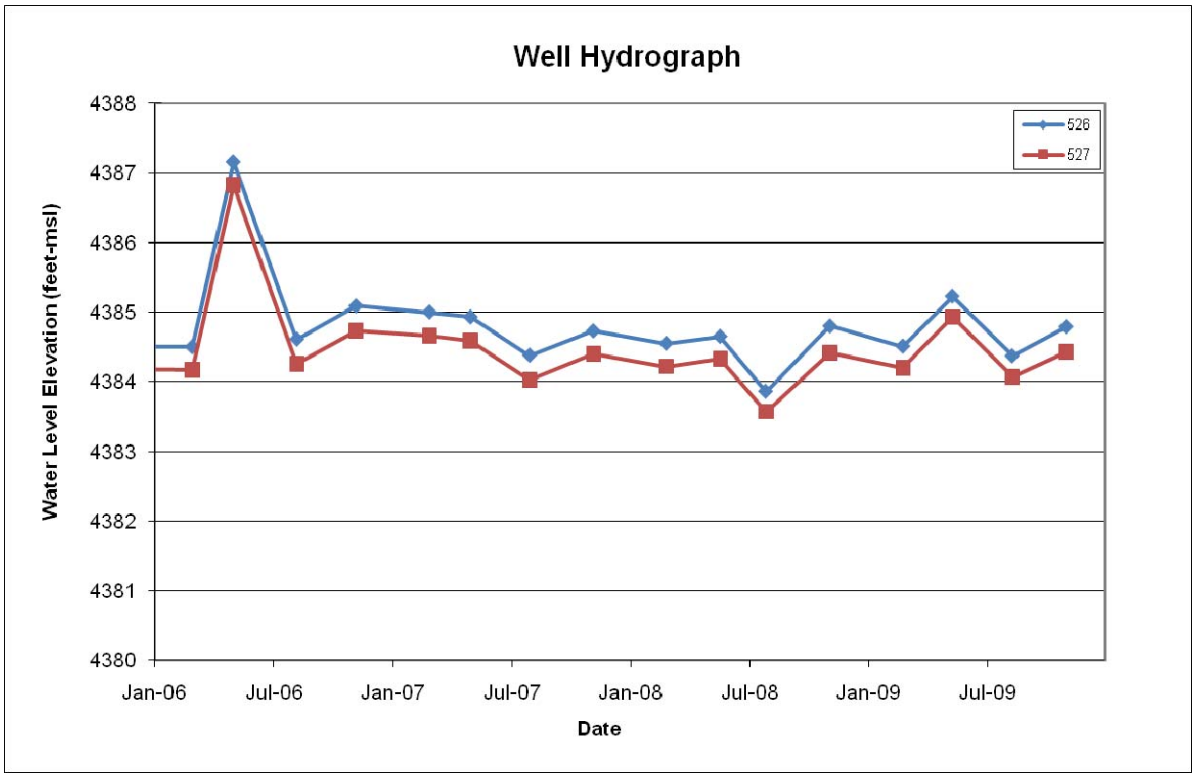


Figure 6-66: Water levels in wells 526 (Lower Zone) and 527 (Upper Zone).

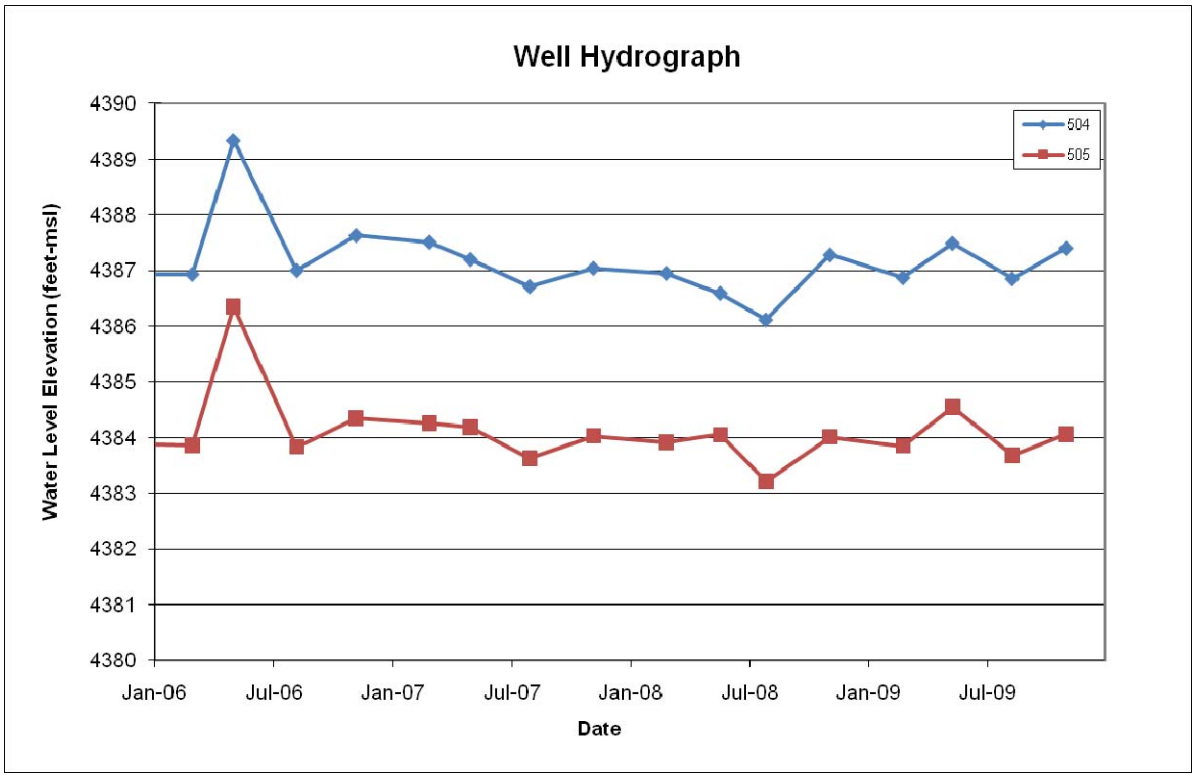


Figure 6-67: Water levels in wells 504 (Lower Zone) and 505 (Upper Zone).

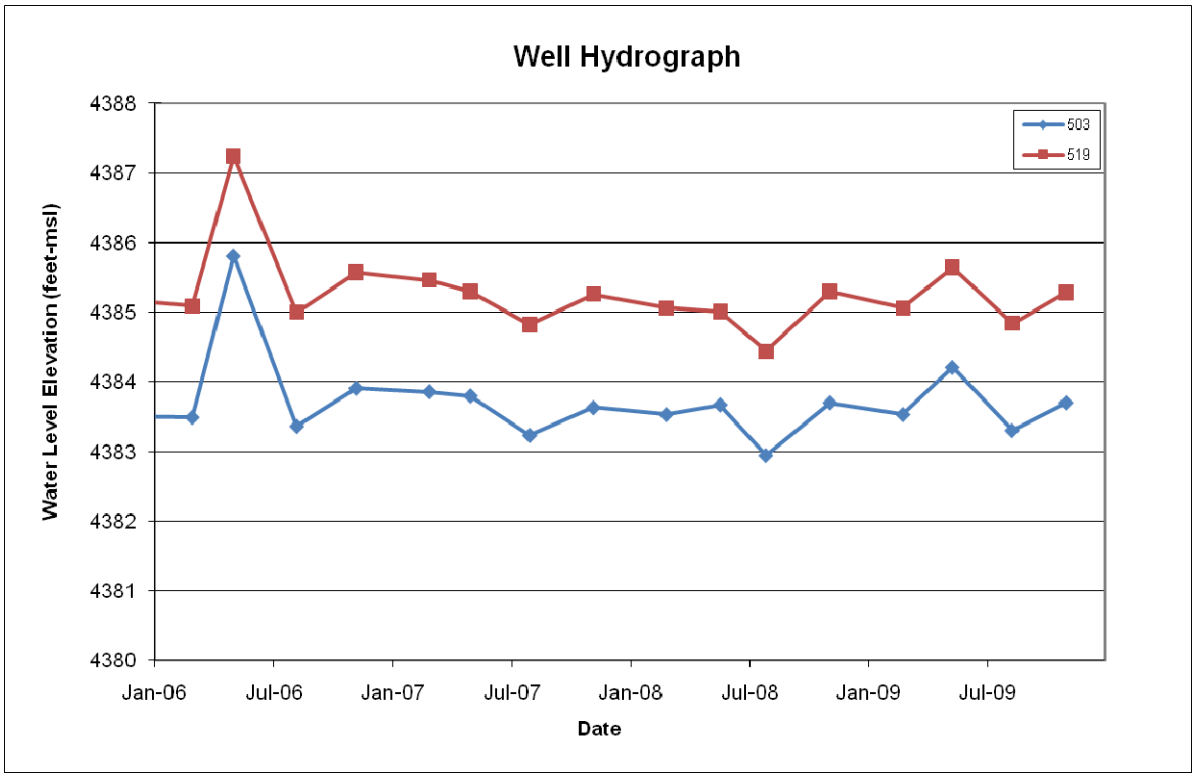


Figure 6-68: Water levels in wells 519 (Lower Zone) and 503 (Upper Zone).

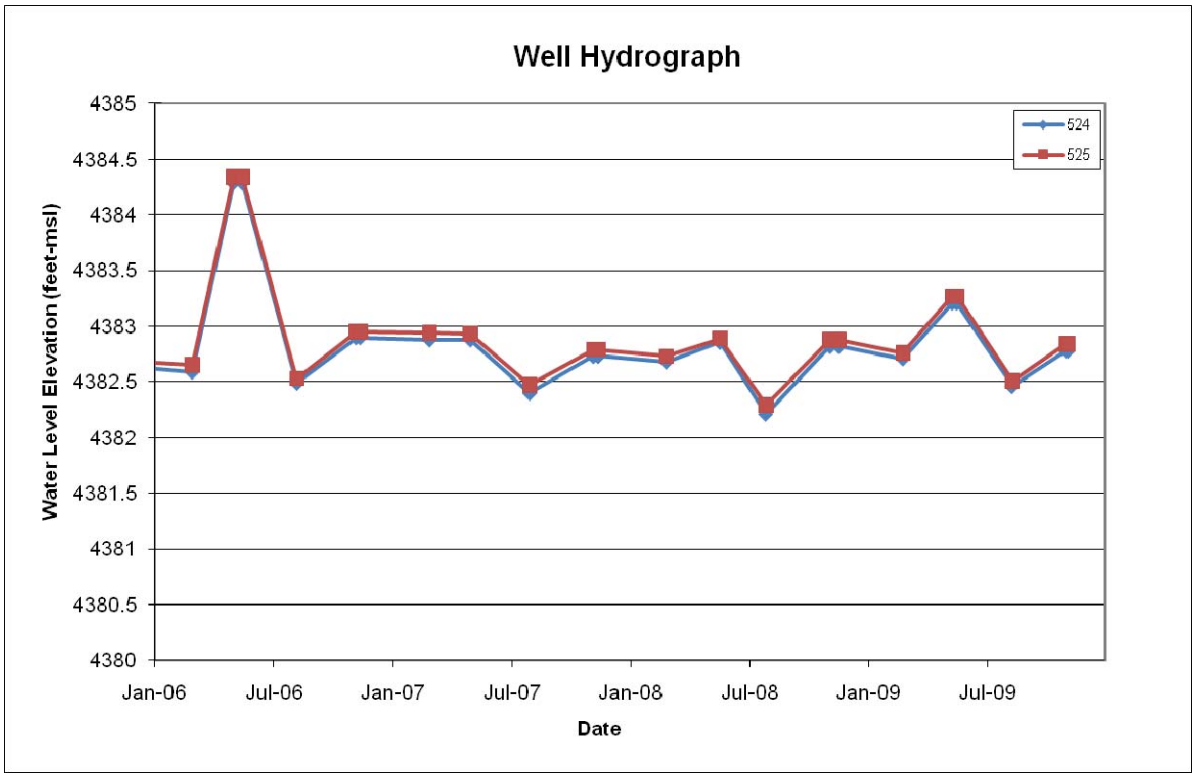


Figure 6-69: Water levels in wells 524 (Lower Zone) and 525 (Upper Zone).

6.3.4 Flow Budget and Capture Zone Calculations (Step 4)

6.3.4.1 Flow Budget Calculations

The effectiveness of the groundwater extraction system operating in 2009 can be assessed in terms of groundwater flow and mass load calculations. Site specific groundwater flow and mass flux calculations were derived to assist with the design of the groundwater extraction system. These calculations are described in Section 3.3.5.1 of the Remedial Design Report (Formation 2009b). The calculations are repeated in this report to provide an assessment of how much mass of the site derived constituents are being removed by the extraction system, how much mass bypasses the extraction system, and to provide an assessment of predicted groundwater concentrations in the compliance area if no further groundwater extraction is provided. The 2009 assessment was made based on observed extraction well discharge rates (average quarterly flow rate), observed constituent concentrations in each target capture zone (based on the quarterly monitoring results), and the mass lost to attenuation based on values calculated for the pre-extraction system. The calculation is included in Appendix E. The results of these calculations are summarized in the following paragraphs.

<u>Groundwater Flow Budget</u>

The groundwater flow budget based on 2009 conditions is the same as that calculated during the design of the extraction system. This budget accounts for the flow of groundwater affected by seepage from the gypsum stack and plant sources and accounts for the flow of unaffected groundwater that discharges to the Portneuf River. A summary of the overall flow budget, is provided in Table 6-3. A summary of the flow of stack-affected and phosphoric acid plant-affected groundwater from the Simplot OU, calculated for each of the target capture zones, is provided in Table 6-4.

Table 6-3: Groundwater flow to the Portneuf River which includes affected groundwater from the Simplot OU.

Groundwater Flow Component	Estimated Flow Rate	
	cfs	gpm
Flow of stack-affected groundwater from the Simplot OU	2.89	1298
Flow of affected groundwater from the FMC OU	0.42	187
Flow of phosphoric acid plant-affected groundwater (low pH)	0.03	14
Flow of stack affected groundwater removed by production wells	0.06	28
Flow of unaffected groundwater discharging to west side of river	30.6	13,750
Total groundwater flow discharging to west side of river	34.0	15,277

Table 6-4: Summary of the flow of affected groundwater from the Simplot OU.

Unit	Zone	Q (gpm)
Upper Zone	East Plant Area 1	50
	East Plant Area 2	77
	East Plant Area 3	29
	Central Plant Area Stack	126
	Central Plant Area Well 340 (PAP)	2
	Central Plant Area Well 419 (PAP)	12
	Fenceline Area	156
	FMC Area	187
Lower Zone	East Plant Area 1	566
	East Plant Area 2	139
	Central Plant Area	121
	Fenceline Area	33
Total Stack Affected Flow		1484
Total PAP Affected Flow		14

Constituent Load in Affected Groundwater

The total constituent load in affected groundwater was evaluated for each target capture zone using the groundwater flow rates for each zone (Table 6-4) and the constituent concentrations present in each zone. Flow rates were assumed to be nearly constant in each zone, since groundwater gradients have not changed significantly. Average groundwater concentrations for each target capture zone were evaluated on a quarterly basis using all available data for the wells in each target capture zone. This analysis is provided in Appendix E and includes estimated constituent loads in groundwater in each of the target capture zones per quarter. A summary of the total estimated constituent load in groundwater at the target capture zones for each quarter in 2009 is provided in Table 6-5.

Table 6-5: Summary of total estimated constituent load in affected groundwater at the target capture zones.

Quarter	Constituent Loads in lbs/day		
	Phosphorus	Sulfate	Arsenic
Q1	5,247	31,893	3.86
Q2	4,675	31,521	3.92
Q3	4,075	27,391	4.36
Q4	3,550	32,012	4.07

Constituent Load Removed by the Groundwater Extraction System

The total constituent load removed by the groundwater extraction system in 2009 is provided in Section 4. The estimated load removal for in each of the target capture zones per quarter is included in Appendix E. A summary of the load removed per quarter is provided in Table 6-6.

Table 6-6: Summary of estimated constituent loads removed by groundwater extraction in the target capture zones.

Quarter	Constituent Loads in lbs/day		
	Phosphorus	Sulfate	Arsenic
Q1	2,258	19,385	2.4
Q2	1,362	13,524	1.6
Q3	1,959	17,154	2.5
Q4	1,912	19,249	2.5

The lower constituent loads removed in the second quarter are the result of turning the groundwater extraction wells off during turnaround.

Effect of Extraction Well Load Removal

The effect of constituent load removal by the groundwater extraction system can be evaluated in terms of predicted groundwater discharge concentrations at the Portneuf River by accounting for the constituent load not extracted, and estimating the effect of the attenuation of this load as the affected groundwater moves toward the Portneuf River. The assessment is provided in

detail for each quarter of 2009 in Appendix E. A summary of the results is provided in Table 6-7.

Table 6-7: Summary of the effect of the constituent removal by groundwater extraction in the target capture zones.

Description	Unit	Q1			Q2			Q3			Q4		
		Phos	Sulfate	Arsenic	Phos	Sulfate	Arsenic	Phos	Sulfate	Arsenic	Phos	Sulfate	Arsenic
Mass Flux in Groundwater Downgradient of Stack	lb/day	3,997	31,692	3.81	3,549	31,372	3.88	3,640	27,216	4.33	3,268	31,782	4.03
Mass Flux in Groundwater Downgradient of PAP	lb/day	1,261	267	0.051	1,108	216	0.045	444	232	0.05	290	297	0.05
Mass flux extracted (see below)	lb/day	2,263	19,426	2.37	1,365	13,552	1.57	1,963	17,190	2.54	1,916	19,289	2.52
Attenuation of Uncaptured PAP-Affected Groundwater	lb/day	1134	241	0	997	194	0	399	209	0	261	267	0
Attenuation of Stack-Affected Groundwater	lb/day	726	2,459	0	895	3,568	0	671	2,010	0	539	2,504	0
Local Unaffected Flow	cfs	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6
Background concentration	mg/L	0.08	57	0.0039	0.08	57	0.0039	0.08	57	0.0039	0.08	57	0.0039
Mass Flux in Background Groundwater	lb/day	13.2	9,419	0.644	13.2	9,419	0.644	13.2	9,419	0.644	13.2	9,419	0.644
Total west side groundwater discharge	cfs	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0
Estimated Constituent Concentrations in the Springs at the River	mg/L	6.3	105	0.011	7.7	129	0.016	5.8	96	0.013	4.7	106	0.012

6.3.4.2 Well Capture Calculations

Although the mass balance calculation takes spatial variability of hydraulic properties into account by dividing the well capture line into multiple target capture zones, a more rigorous understanding of the spatial extent of capture by the 2009 groundwater extraction system is necessary to evaluate the overall effectiveness of the system at mitigating the plume. A detailed description of the calculation is provided in Appendix F.

Analytical Calculations

Well capture zones depend on the groundwater hydraulic gradient in addition to the observed drawdown due to pumping. The width and length of a capture zone can be calculated after accepting some simplifying assumptions (Javandel and Tsang 1986):

- The aquifer is homogeneous, isotropic, confined, and of infinite extent
- The aquifer is of uniform thickness
- Extraction wells are fully penetrating
- The regional hydraulic gradient is uniform and steady-state
- The vertical gradient is negligible
- There is no net recharge
- There are no other sources of water to the aquifer.

The calculation is based on the transmissivity of the aquifer, saturated thickness, regional hydraulic gradient, and extraction rate. Aquifer parameters were estimated to perform the 2009 mass flux calculations, hydraulic gradients from steady-state conditions were used, and extraction rates were based on the average rate for the fourth quarter of 2009, since there was little variation in the potentiometric surface and pumping rates throughout the year. Results of the calculation are summarized in Table 6-8. Y_{max} represents the maximum capture zone width from the central line of the plume (half of total width); Y_{well} is the capture zone width at the location of the well from the central line of the plume (half of total width); and X_o represents the distance from the well to the downgradient end of the capture zone along the central line of flow (Javandel and Tsang 1986). The calculated zones represent hydraulic capture, and not capture of the stack-affected or phosphoric acid plant-affected plume. The calculated extent of the capture zones has been superimposed on the steady-state (August 2003) potentiometric surface map in Figure 6-70.

Table 6-8: Summary of extraction well capture zone dimensions.

	Section	Well	Y_{max} (ft)	Y_{well} (ft)	X_o (ft)
Upper Zone	East 1	Well 412	177	88	56
	East 1	Well 404	16	8	5
	East 1	Well 405	0	0	0
	East 2	Well 406	53	26	17
	East 2	Well 407	13	7	4
	East 2	Well 408	0	0	0
	East 3	Well 409	75	37	24
	East 3	Well 413	494	247	157
	Central	Well 414	169	84	54
	West	Well 401	104	52	33
	West	Well 402	164	82	52
	West	Well 415	89	45	28
Lower Zone	East 1	Well 410	74	37	24
	East 1	Well 411	59	30	19
	East 1	Well 412	383	191	122
	East 2	Well 413	461	230	147
	Central	SWP-4	2384	1192	759
	West	Well 415	214	107	68

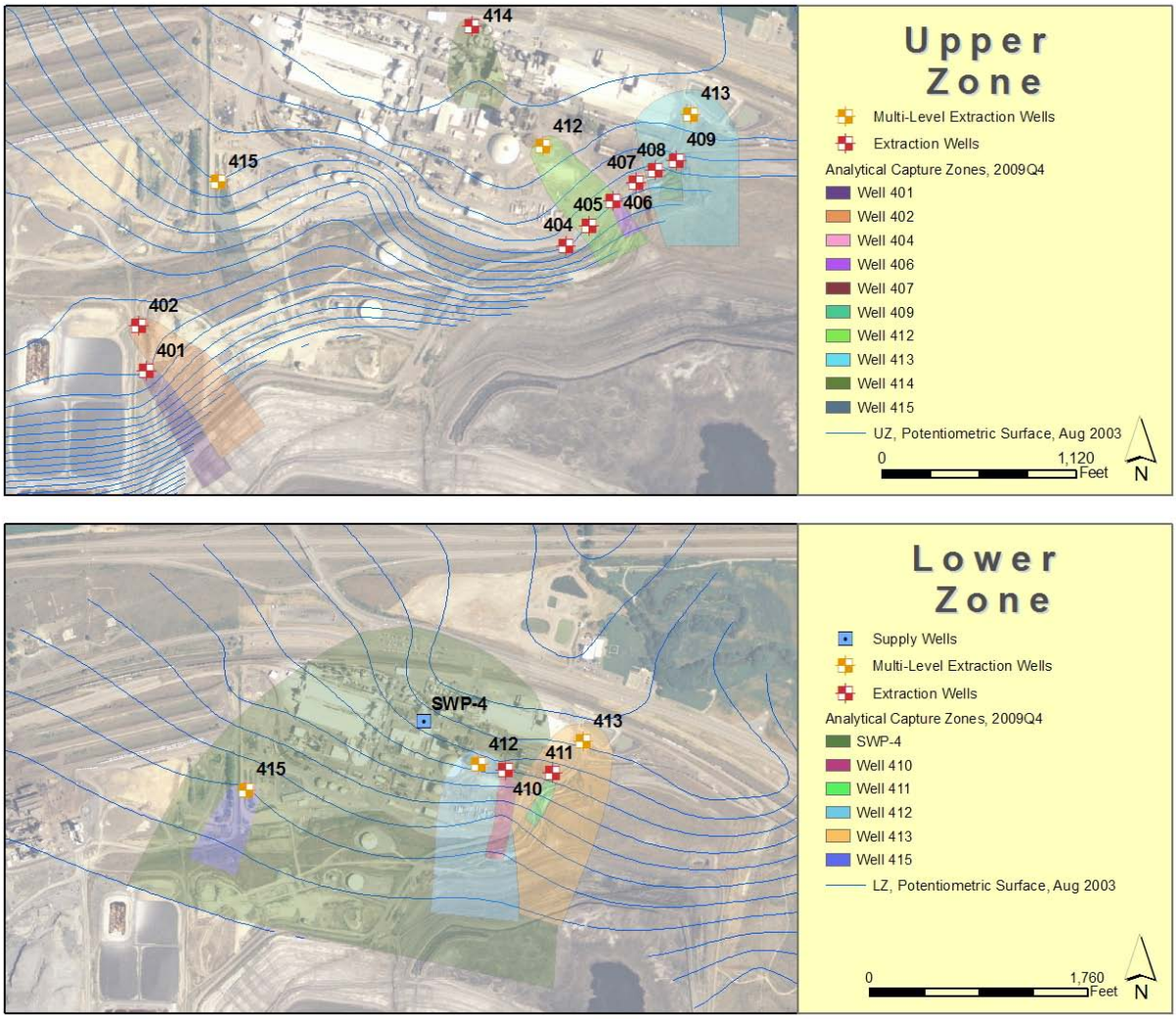


Figure 6-70: Calculated capture zones for Upper and Lower Zone extraction wells.

Numerical Particle Tracking Models

Three numerical groundwater flow and particle tracking models were developed for the Groundwater Remedial Design Report (Formation 2009b) to provide an additional means of quantifying the extent of extraction well capture zones. To examine well capture in 2009, the numerical modeling approach was revised. The flow model area was expanded to include the entire Simplot OU and extended to the Portneuf River. The numerical modeling technique allows for direct representation of the hydrostratigraphy of the site, variations in hydrogeologic properties, and for the simulation of complex boundary conditions. The groundwater flow model Modflow (McDonald and Harbaugh 1988) was used in conjunction with the particle tracking model Modpath (Pollock 1994) inside the pre- and post-processing software Groundwater Vistas (ESI 2007) to provide the simulations.

The model was calibrated to steady-state conditions observed in August 2003 and was then modified to simulate pumping conditions in 2009 by adding extraction wells with steady-state pumping rates allocated to the appropriate screened intervals. A detailed description of the setup of the model is included in Appendix G. A summary of the results of the particle tracking modeling is provided in the following sections.

The site-wide model is comprised of 7 layers, the top layer simulates the Upper Zone, layer 2 simulates the AFLB, layers 3-5 simulate the Lower Zone, and layers 6 and 7 simulate the Tertiary bedrock. Layer elevations are directly input from the site hydrostratigraphic model. The lateral grid spacing is uniform at 50 feet in both the x and y directions. Constant head boundaries are provided at both the upgradient and downgradient limits of the model in the upper and Lower Zones (layers 1, 3, 4, and 5) and throughout the bottom of the model in layer 7 to provide the observed lateral and vertical hydraulic gradients. The Portneuf River was simulated using three river reaches. Hydraulic conductivities vary throughout the model and are based on aquifer testing results. Forward particle tracking is employed to observe the effects of pumping wells. The dense network of particles released upgradient of the pumping wells allows a visualization of well capture zones as well as areas where groundwater is not captured.

Numerical modeling indicates that the 2009 extraction system does not capture all particles in the Upper Zone. A significant amount of particles in the far eastern plant area are not captured and capture in the central Upper Zone is provided by only well 414, which does not provide adequate capture (Figure 6-71).

In the Lower Zone, numerical models show that effective particle capture is provided by wells 410, 411, 412, 413, and SWP-4 (Figure 6-72). Capture zones for the other two production wells, SWP-5 and SWP-7, are not shown since groundwater quality samples from these wells indicate that they to not capture any affected groundwater. In the western area the model indicates that well 415 provides substantial, but not complete particle capture (Figure 6-73).

New extraction wells proposed in the Remedial Design Report (Formation 2009b) were designed to address the gaps in particle capture that are suggested by model results of the 2009 extraction system. For additional information on the design and location of these wells refer to the Remedial Design Report.

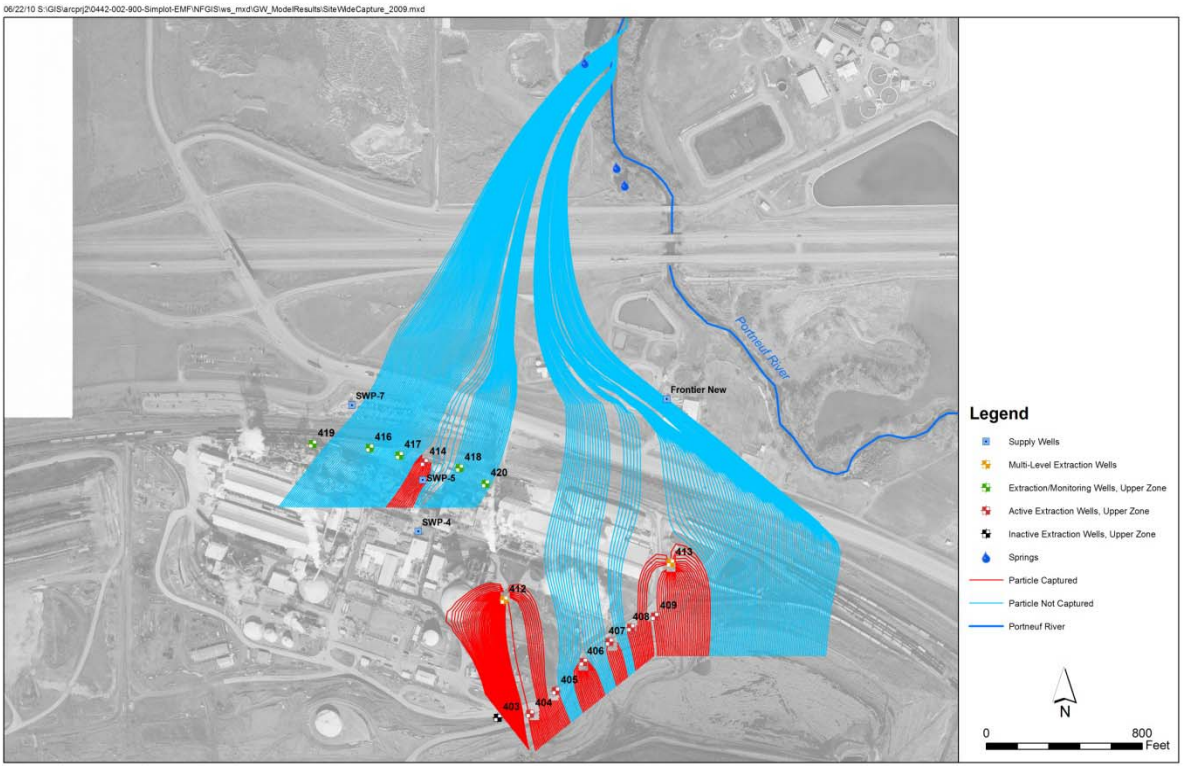


Figure 6-71: Results of particle tracking simulation in the Upper Zones.

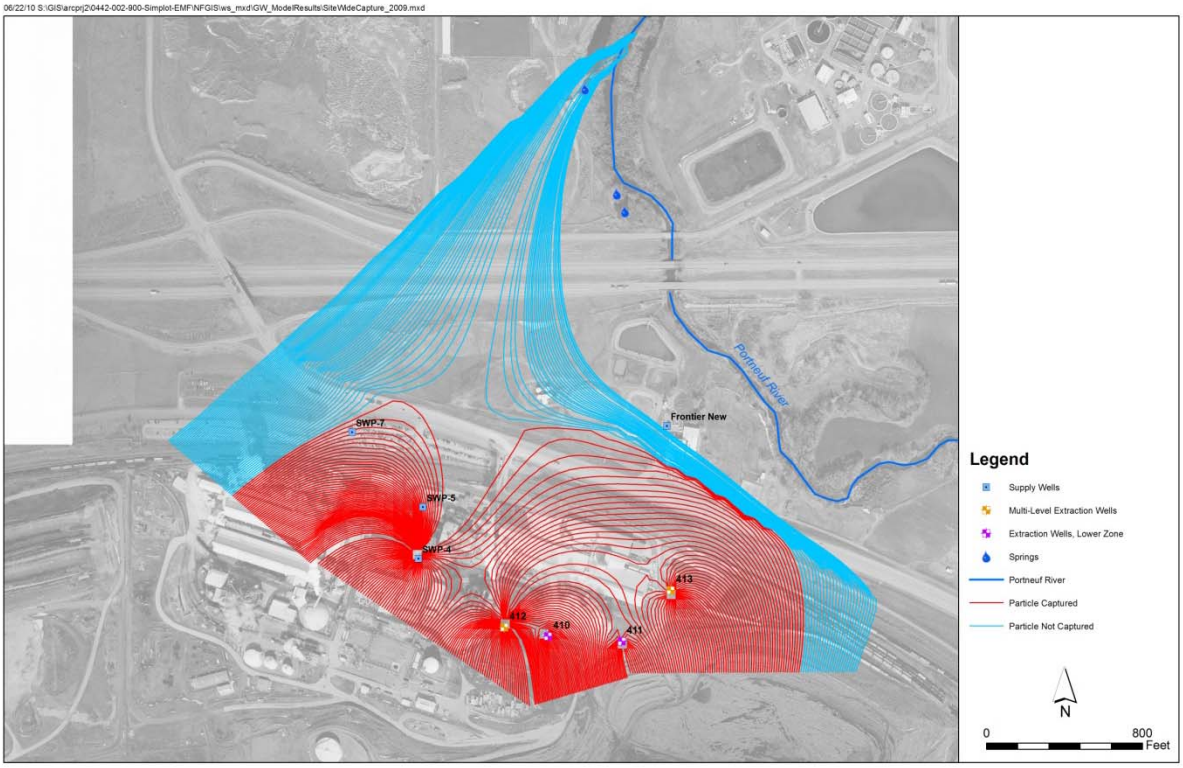


Figure 6-72: Results of particle tracking simulation in the Lower Zones.

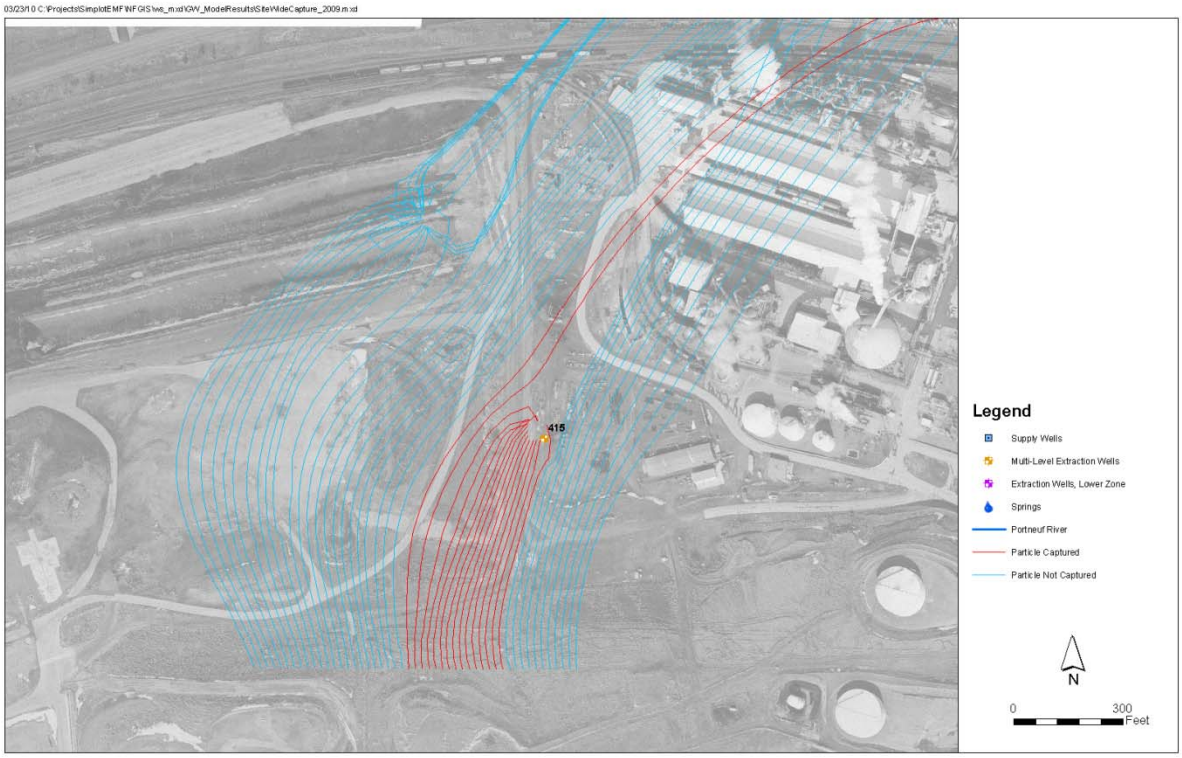


Figure 6-73: Results of particle tracking simulation in the western plant.

6.3.5 Evaluation of Concentration Trends of Indicator Analytes in Groundwater (Step 5)

The concentration trends of site-derived constituents in groundwater samples collected from monitoring wells completed downgradient of the extraction system can be used to assess the impacts of groundwater extraction on migrating plume concentrations. Trend analyses of wells site-wide are included in Section 6.1 of this report and are reported annually (MFG 2005, NewFields 2006a, NewFields 2007, NewFields 2008a). In order to assess the effects of the extraction system on downgradient concentrations, the following factors must be considered:

- Downgradient monitoring wells must be positioned properly with respect to the extraction system to observe an effect.
- Downgradient monitoring wells must have a period of record that can be correlated temporally with periods of extraction.
- Groundwater travel time must be accounted for in the assessment.

The phase 1 extraction system went into operation in June of 2004 and the phase 2 system in January of 2008. The groundwater travel time for 2009 conditions is estimated to be approximately less than 1 to 9 years from the extraction line to the Portneuf River. Assessment

of the extraction system effect must take travel time into account. The effect of the phase 1 extraction system was reviewed in the Groundwater Remedial Design Report (Formation 2009b). The effect of the phase 2 extraction system may be noticeable at some wells in 2009.

Extraction wells installed as part of the phase 2 extraction system include multi-level wells 412, 413, 415, and Upper Zone well 414. Monitoring wells occurring within approximately 1500 feet downgradient of the extraction wells could be affected by the phase 2 extraction system by the end of 2009. However, trends are most apparent in wells located downgradient of but close to extraction wells.

Multi-level well 415 is located southwest of the plant area in the Fenceline flow zone. Wells 309 and 310 are located less than 50 feet downgradient from well 415 (Figures 5-1 and 5-2). Both the Upper Zone and Lower Zone wells (310 and 309 respectively) show an increase in arsenic, phosphorus and sulfate beginning in March 2008 (Figures 6-74 through 6-76). This trend continues through 2009. The increase is sharper and variable in Upper Zone well 310, and more gradual in Lower Zone well 309. Increasing parameter concentrations suggest that the drawdown produced by well 415 is effectively capturing stack-affected water from the surrounding area. A time-series of the water level in well 309 confirms that this well experiences drawdown produced by well 415 (Figure 6-77).

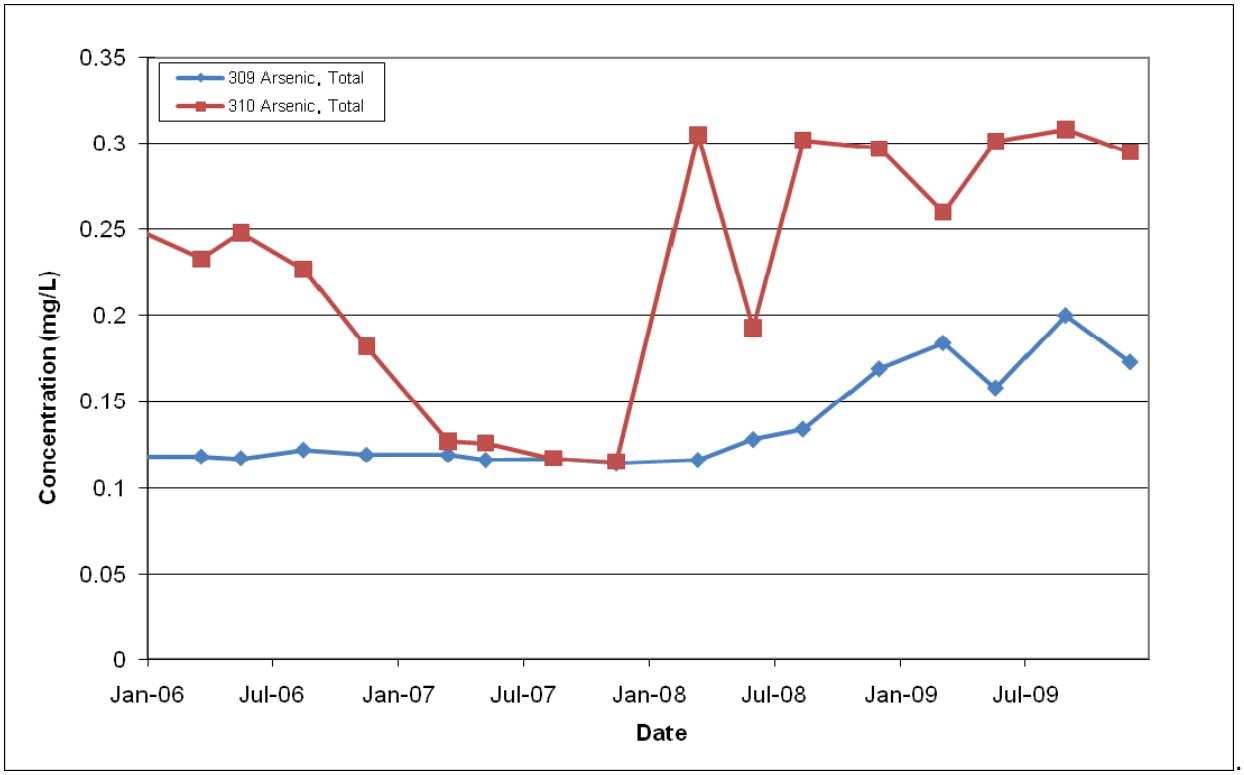


Figure 6-74: Time-series of arsenic in wells 309 and 310, downgradient of well 415.

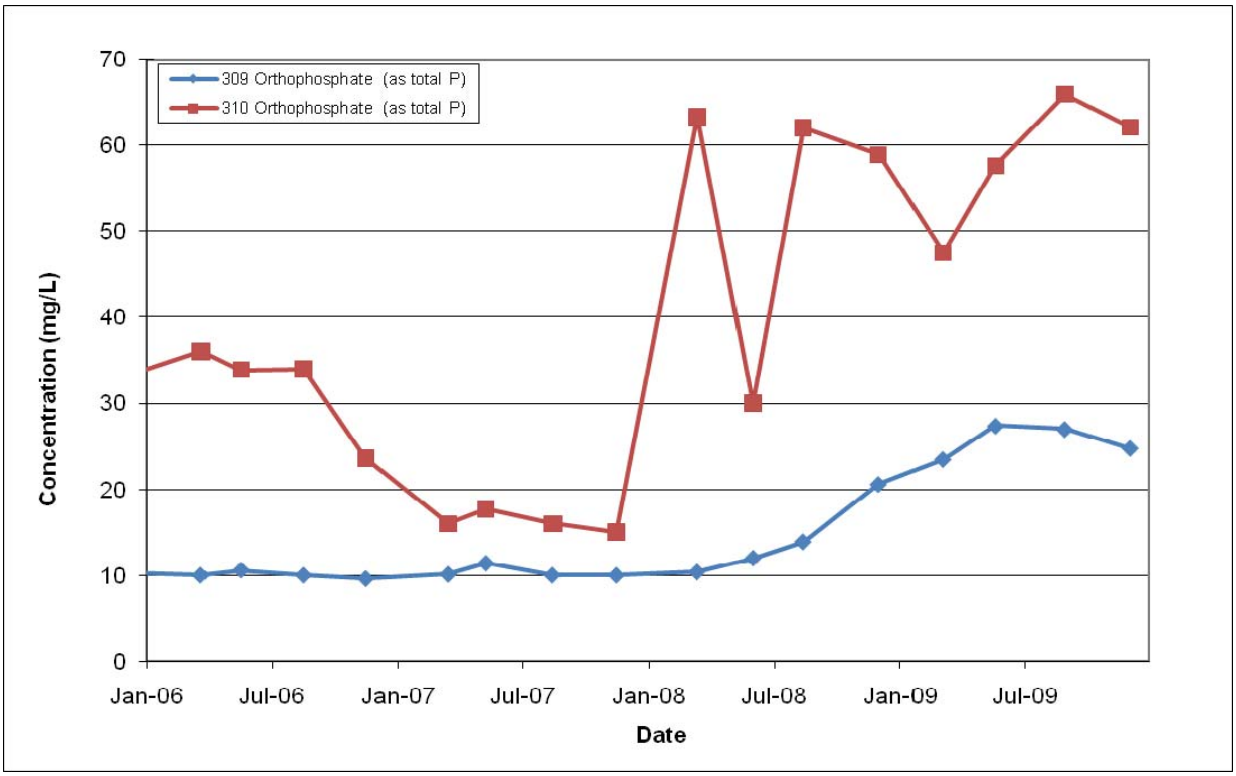


Figure 6-75: Time-series of phosphorus in wells 309 and 310, downgradient of well 415.

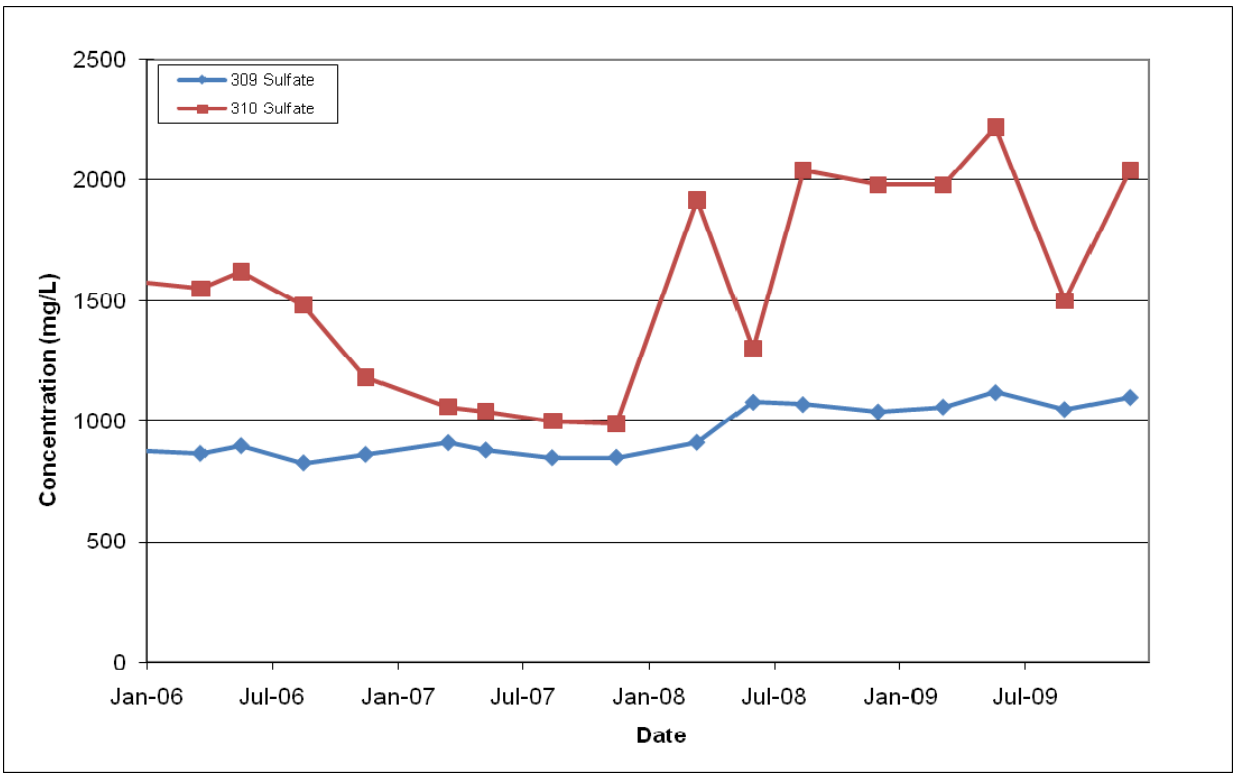


Figure 6-76: Time-series of sulfate in wells 309 and 310, downgradient of well 415.

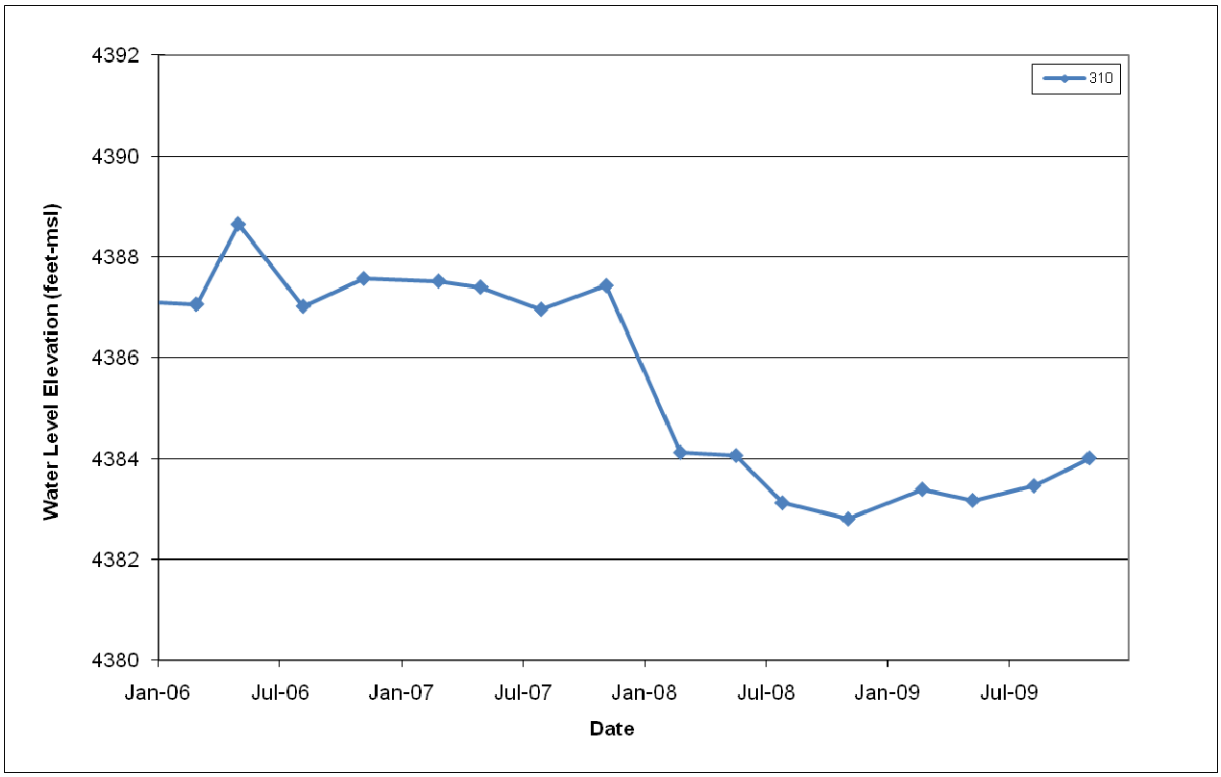


Figure 6-77: Time-series of water levels in well 310, downgradient of well 415.

Lower zone well 317 is located 200 feet approximately downgradient of multi-level extraction well 413 (Figure 5-2). The groundwater travel time for this distance is estimated to be 1 to 3 months. Arsenic, phosphorus, and sulfate began to decrease by March of 2008 (Figures 6-78 through 6-80). This trend continues through 2009. The decreasing trend suggests that the upgradient extraction well 413 is effectively capturing stack-affected groundwater in the East Plant Area.

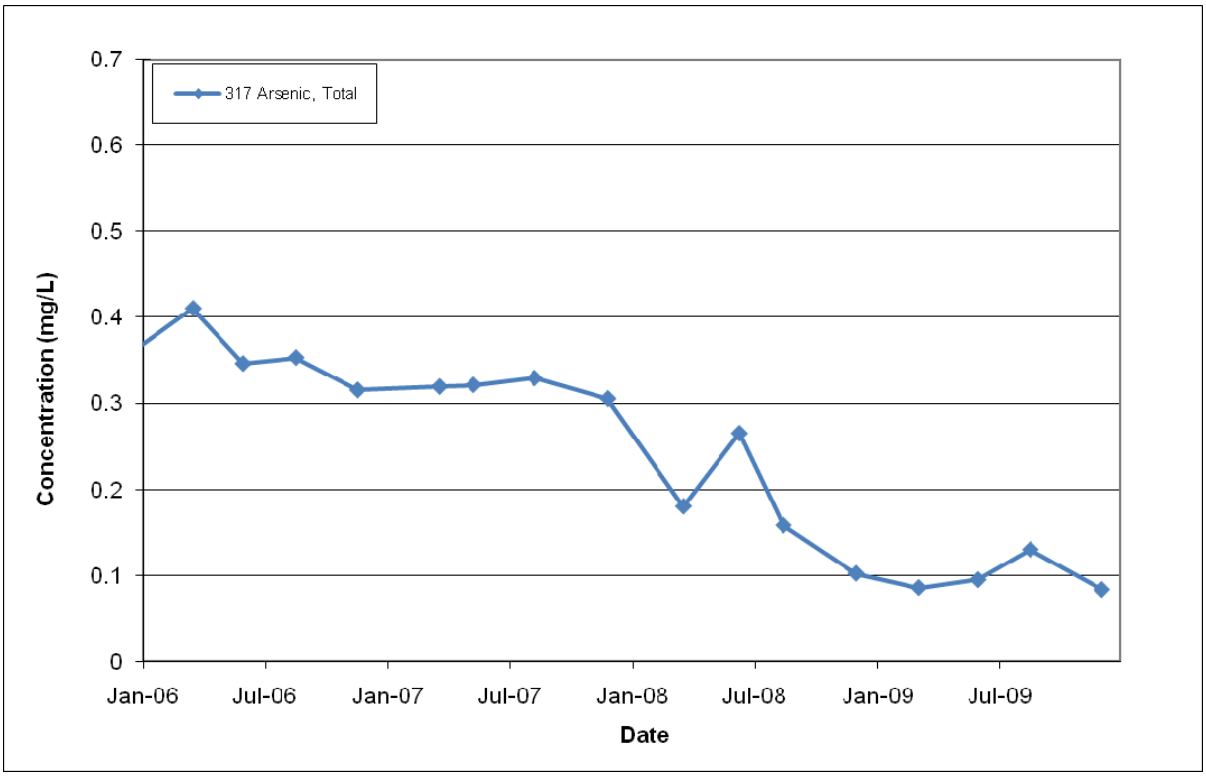


Figure 6-78: Time-series of arsenic in well 317, downgradient of well 413.

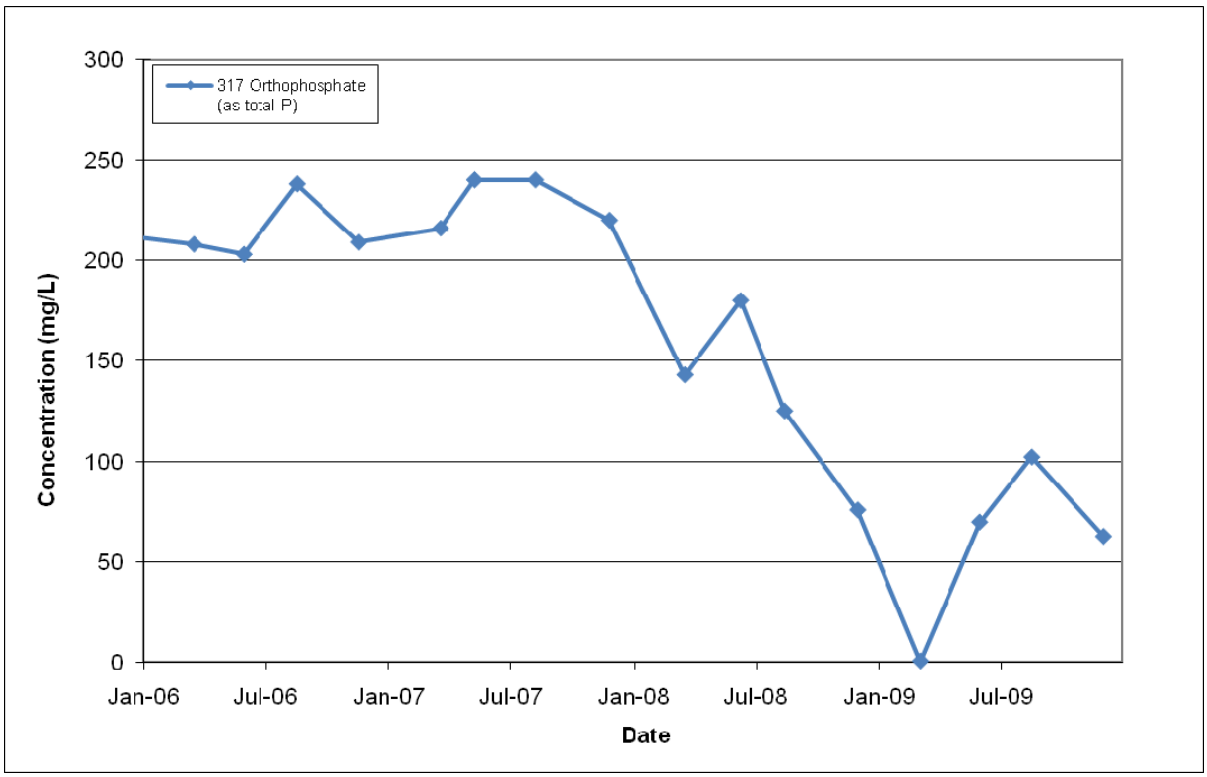


Figure 6-79: Time-series of phosphorus in well 317, downgradient of well 413.

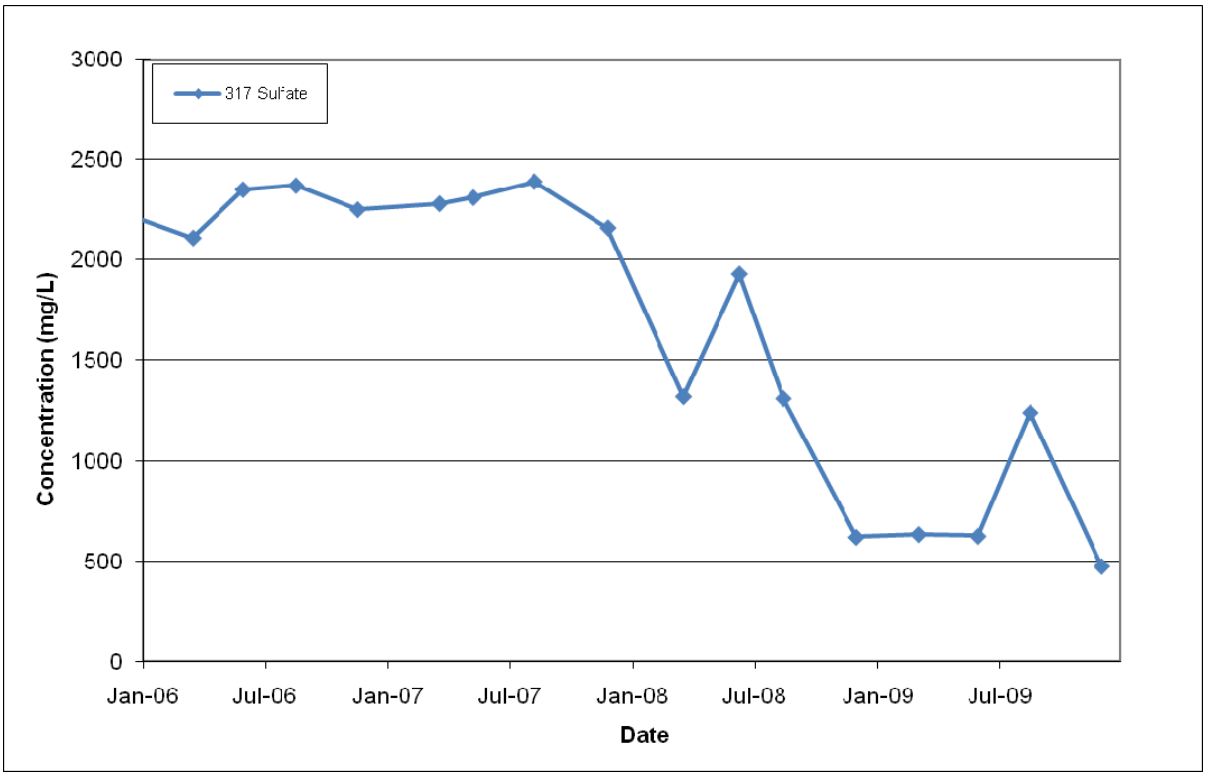


Figure 6-80: Time-series of sulfate in well 317, downgradient of well 413.

6.3.6 Overall Capture Assessment (Step 6)

The results of the analyses provided in the preceding sections can be used collectively to interpret actual capture of the 2009 extraction system and assess the need for additional characterization and/or extraction. This assessment is summarized in the following sections by target capture zone.

<u>Upper Zone in East Plant Area</u>

In 2009, groundwater extraction was provided by wells 404, 405, 406, 407, 408, 409, 412, and 413 in the Upper Zone in the East Plant Area. Analyses indicate that groundwater extraction in 2009 did not capture all of the groundwater in the target capture zones in this area. The Upper Zone is thin in this area which makes groundwater extraction difficult. This issue was investigated during the Phase 1 Data Gap Investigation (NewFields 2006b). Additional extraction from the Upper Zone in the East Plant Area has been achieved by incorporating a shallow screen interval into the design of multi-level extraction wells. Two of these wells, 412 and 413, were installed during the Phase 2 Data Gap Investigation (NewFields 2008b) and provide additional extraction from the Upper Zone in this area. Analytical capture numerical particle tracking calculations suggest that these wells have limited zones of capture in the Upper Zone. Groundwater flow and mass flux calculations indicate that the groundwater flow and mass flux is relatively small from these target capture zones (see Section 6.3.4.1 and Appendix

E) and, as described in the Remedial Design Report (Formation 2009b), remedy goals can be met without extracting this groundwater.

Two additional extraction wells are proposed for this area (Formation 2009b). One well will be a replacement well for well 410 and one well will be placed east of well 413. These wells are primarily Lower Zone extraction wells; however, a screen interval will also be incorporated into the design to collect Upper Zone groundwater. The design of the proposed extraction wells can be found in the.

Upper Zone in Central Plant

In 2009, groundwater extraction was provided by well 414 in the Upper Zone in the Central Plant Area. Analytical capture and numerical particle tracking calculations indicate that well 414 has a relatively large zone of capture in the Upper Zone (see Appendices F and G). Analyses indicate that the location of well 414 is not affected by sources within the phosphoric acid plant area and only stack-affected groundwater is collected. Two areas of phosphoric acid plant-affected groundwater exist in the target capture zone; an area near well 419 and an area near well 340 (see Figure 6-45 for locations). The phosphoric acid plant-affected groundwater at these locations is currently not being extracted. Mass flux calculations indicate that the load removal rate for the zone is not optimal since the extraction well 414 is located to the east of higher concentration groundwater at wells 340 and 419 (see Appendix E). The well performance data and capture zone analysis indicate that adequate capture of groundwater in this target capture zone can be achieved with additional extraction at the location of wells 340 and 419 (see Appendix F).

This area is well characterized and no significant data gaps remain for assessment. As part of the remedial design (Formation 2009b) wells 416 and 419 will be converted to extraction wells and are expected to begin operations in early 2010. Capture calculations for wells 416 and 419 will be included in the 2010 Annual Report, since these wells will go on-line in 2010.

Lower Zones in East Plant

In 2009, groundwater extraction was provided by wells 410, 411, 412, and 413 in the Lower Zone in the East Plant Area. Analytical capture and numerical particle tracking calculations indicate that these wells have nearly complete capture in the Lower Zone. Mass flux calculations indicate that the extraction wells are capturing about two-thirds of the phosphorus load. The well performance data and capture zone analysis indicate that adequate capture of groundwater in this target capture zone can be achieved with additional extraction east of well 411.

This area is well characterized and no significant data gaps remain for assessment. As part of the remedial design (Formation 2009b) two additional extraction wells are proposed for this area. One well will be a replacement well for well 410 and one well will be placed east of well 413.

Upper Zone and Lower Zones in West Plant

In 2009, groundwater extraction was provided by wells 401, 402, and 415 in the West Plant Area. The subsurface geology in this area is complex. These wells were completed within a paleochannel with the intent of intercepting the maximum saturated stratigraphic thickness for groundwater extraction. Analytical capture and numerical particle tracking calculations indicate that the extent of capture at the downgradient extraction well 415 covers a significant portion of the target capture zone since the materials have a low hydraulic conductivity. Mass flux calculations indicate that there is a relatively small load in this area and that current extraction is capturing about 70% of the phosphorus load.

This area is well characterized and no significant data gaps remain for assessment. Current extraction is sufficient to achieve the design goals.

6.4 Evaluating Reduction in Extent and Concentration of COCs in the Assessment Area

The monitoring goal for the Assessment Area is reduction in the extent and concentration of COCs. When the extraction system is operating as intended, the extent and concentration of COCs will be reduced in the Assessment Area.

Data that is collected in the Assessment Area includes quarterly groundwater level measurements, quarterly groundwater sample collection, quarterly surface water level measurements, and quarterly water sample collection from Batiste Springs and Batiste Road Springs. This data will be used to create site-wide potentiometric surfaces (Section 5.3), assess groundwater transport times and COC attenuation (Section 6.4.1 and 6.4.2), and assess the spatial distribution of COCs in the Assessment Area (Section 6.4.3). Surface water data will be used to assess the gaining and losing reaches of the Portneuf River (Section 7.3.1).

The wells in the Assessment Area that will be monitored and the data that will be collected are listed in Table 3-7 of the Groundwater and Surface Water Monitoring Plan. Monitoring well locations are shown in Figures 5-1 through 5-3. Samples of groundwater will be collected and analyzed for the indicator analytes shown in Table 5-1.

6.4.1 Extent of Indicator Analytes

The extent of arsenic, phosphorus, sulfate, and nitrate, in the Assessment Area at the end of 2009 was very similar to that at the end of 2008 (Figures 6-81 through 6-84). Phosphorus was not detected in well 504 in 2008, and in 2009 concentrations were 0.02 mg/L. This well is located directly north of the effluent ponds, north of Highway 30. Phosphorus in well 519 was also not detected in 2008, and detected between 0.01 and 0.04 mg/L in 2009. Well 519 is located in the Assessment Area, along I-86, a few hundred feet from the springs (Figure 5-1). However, phosphorus concentrations in the Batiste Road Spring decreased in 2009, and are

much greater than the detections in well 519 (0.96 mg/L at the end of 2009). Generally, arsenic, phosphorus, and sulfate concentrations decrease to the north in the Assessment Area. Wells TW-11S and 525 show low or non-detect results for phosphorus and arsenic in shallow intervals. Concentrations are typically higher in the shallower intervals in the Assessment Area, as the Lower Zone and Upper Zones merge due to significant upward gradients and the terminus of the AFLB near highway 30. Phosphorus concentrations at the springs were below 2 mg/L in Batiste Road Springs and below 25 mg/L in Batiste Springs in 2009. Shallow well 525 is located less than 200 ft from Batiste Springs, but often shows lower or non-detect phosphorus values, suggesting that this location receives little to no groundwater flow from site-affected areas.

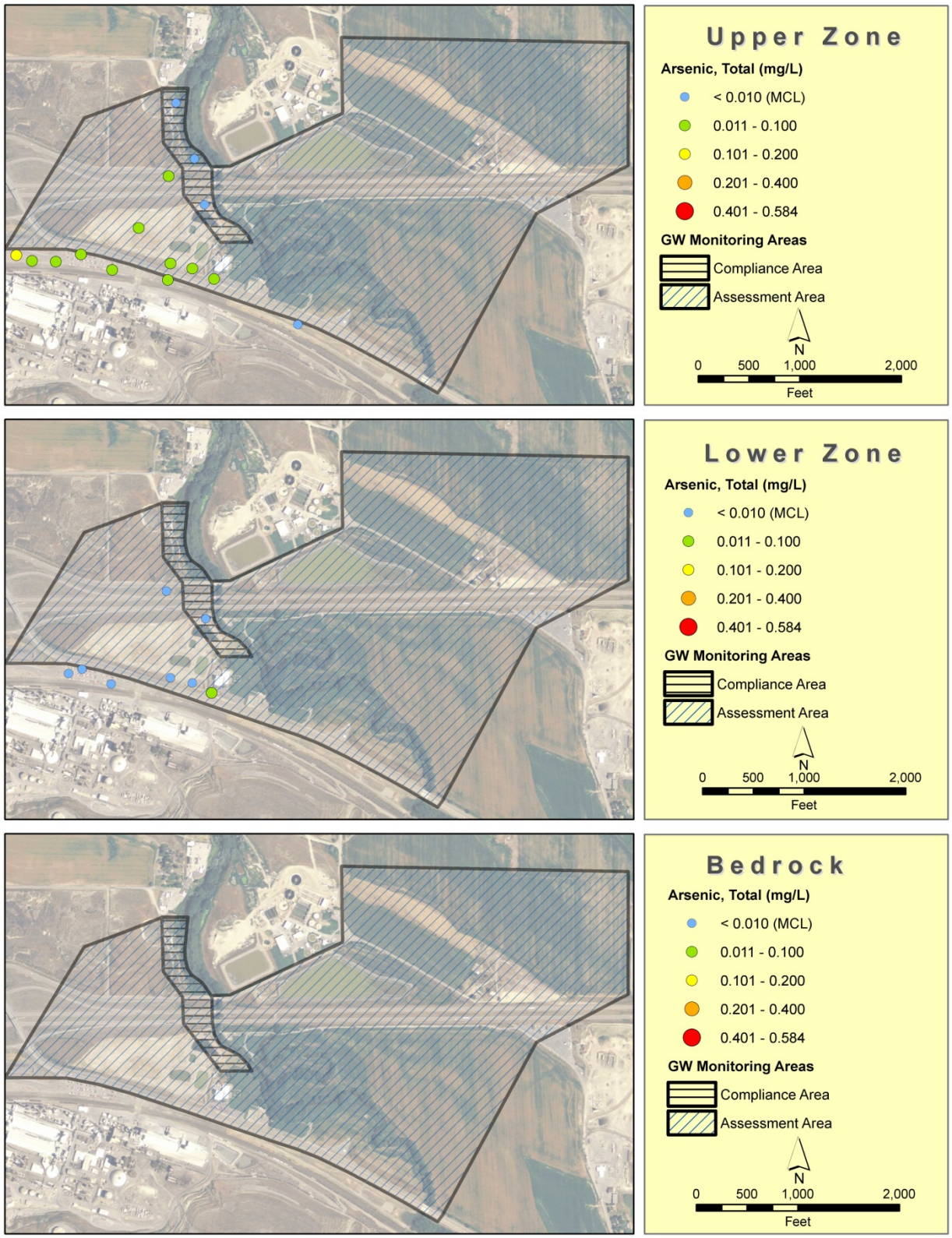


Figure 6-81: Arsenic concentrations at the end of 2009 (fourth quarter) in the Assessment area.

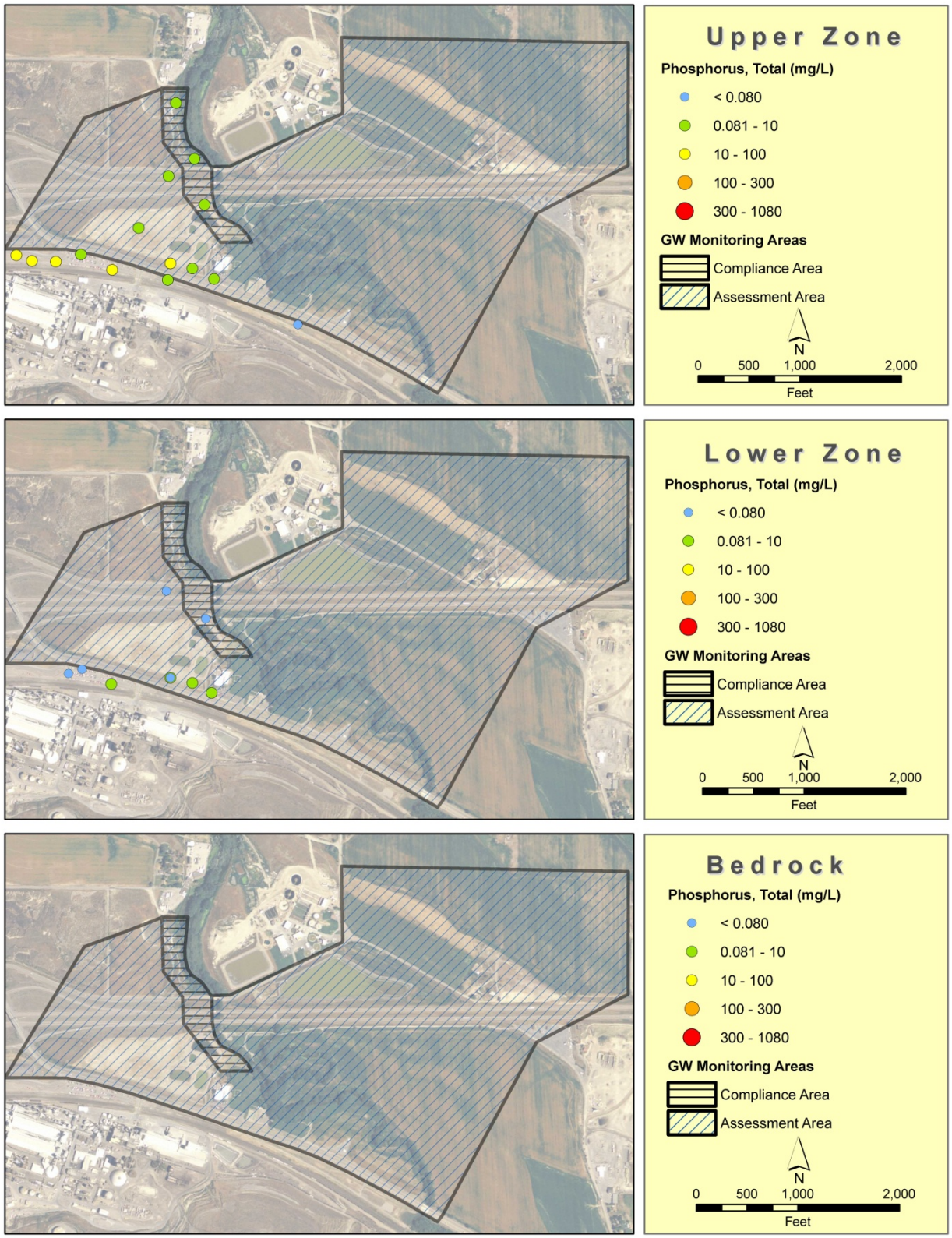


Figure 6-82: Phosphorus concentrations at the end of 2009 (fourth quarter) in the Assessment area.

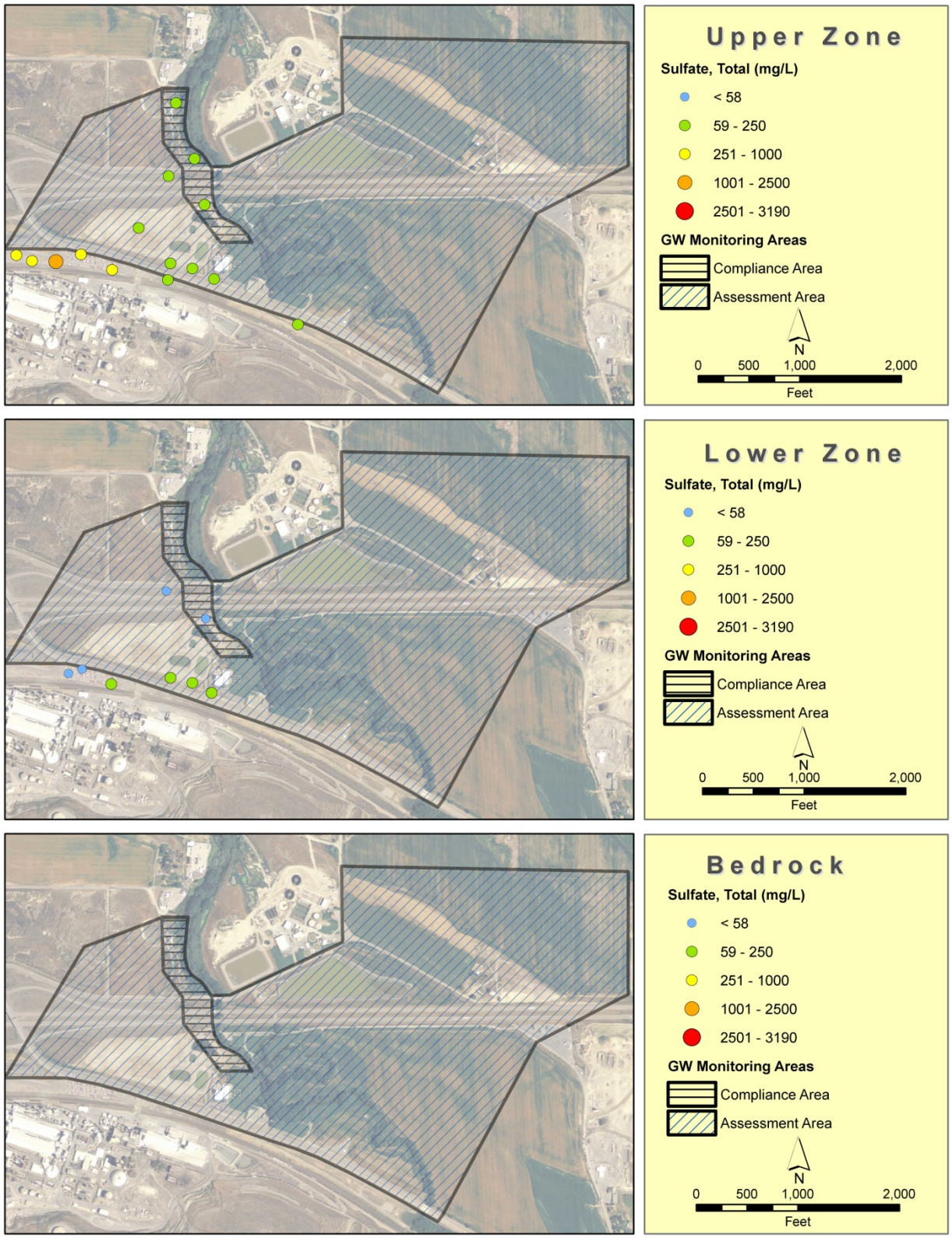


Figure 6-83: Sulfate concentrations at the end of 2009 (fourth quarter) in the Assessment area.

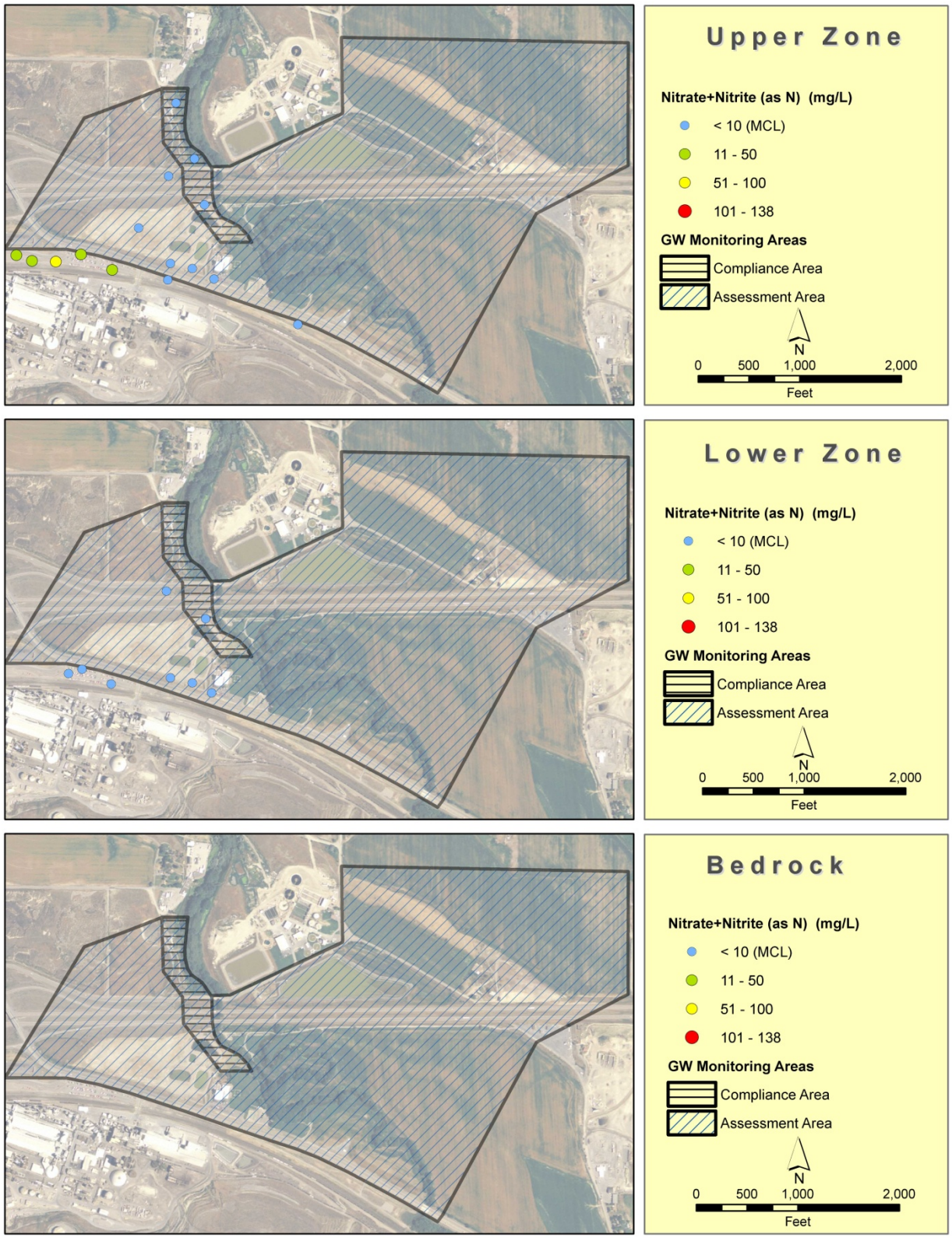


Figure 6-84: Nitrate plus nitrite as N concentrations at the end of 2009 (fourth quarter) in the Assessment area.

6.4.2 Transport Pathways

An estimate of transport time was updated for the 2009 conditions. The methodology was presented in Section 6.1.2. Groundwater travel times in the Assessment Area are represented by the calculation zone from Highway 30 to the Portneuf River.

Table 6-1 presents the estimated groundwater travel times for each area, and for the total flow path from the foot of the stack to the river (travel time from infiltration beneath the stack to the foot of the stack was not included). Groundwater travel times through the Assessment Area are estimated to take between 0.6 and 0.7 years in the Upper Zone and between 3.5 and 4.5 years in the Lower Zone. This calculation is based on limited information. Pump tests to be conducted in 2010 will provide further information to characterize hydrogeologic conditions.

6.4.3 Evaluation of Concentration Trends in Groundwater in the Assessment Area

This section discusses temporal trends in groundwater quality in the Assessment Area. The locations of monitoring and extraction wells in the Assessment Area are shown in Figures 5-1 through 5-3.

6.4.3.1 Wells along Highway 30

Well pairs 526 and 527 and multi-level wells 528 and 529 are located just north of Highway 30 in the Assessment Area (Figure 5-1 and 5-2). Temporal trends observed in 2009 and previous years are described in this section. Long-term trends (over the past three years) were tested using linear regression as described in Section 5 of the Groundwater and Surface Water Monitoring Plan (Formation 2009a). The linear regression lines and correlation coefficients are plotted for each analyte at each well in Appendix B.

Arsenic concentrations were consistent in wells 527 and 529AR, but had decreasing trends in wells 528AR and 529BR (Figure 6-85). A slight increase of phosphorus was exhibited in wells 528AR and 529BR in 2009 following a strong decreasing trend in previous years. Phosphorus was consistent in wells 527 and 529AR (Figure 6-86). Sulfate concentrations were stable in wells 527 and 529AR, but decreased in wells 528AR and 529BR (Figure 6-87). As described in the previous section, concentrations of all three analytes in this area were low compared to site-wide concentrations.

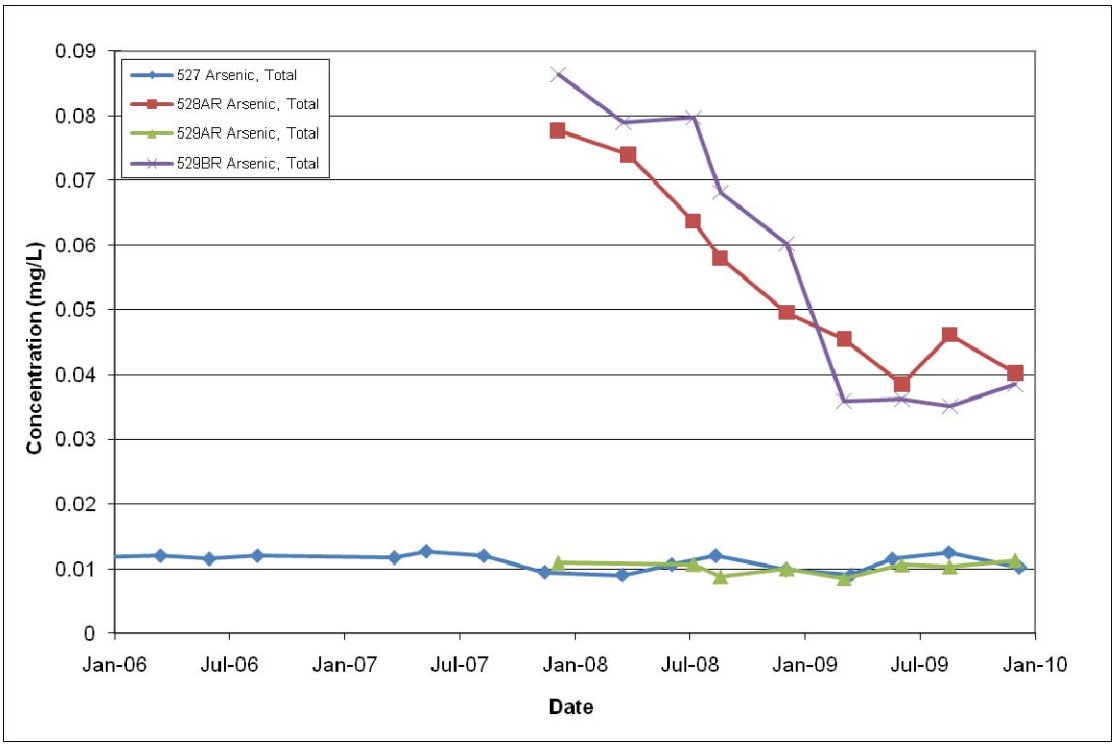


Figure 6-85: Time-series of arsenic concentrations in shallow wells along Highway 30 in the Assessment Area.

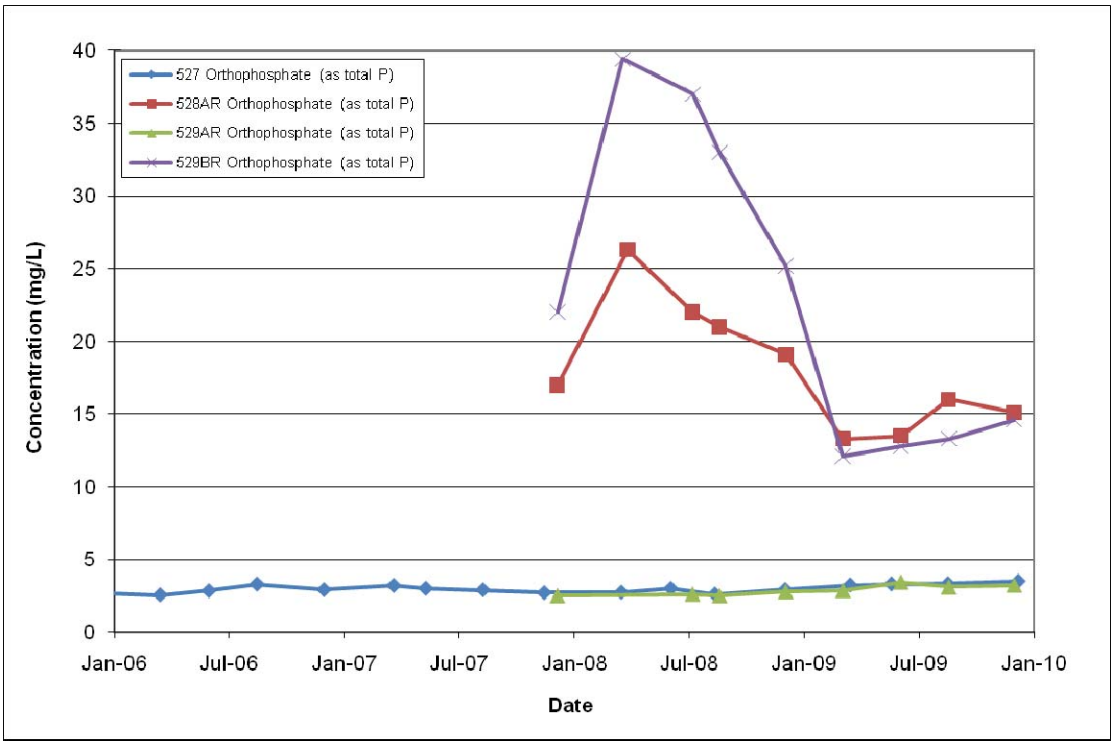


Figure 6-86: Time-series of phosphorus concentrations in shallow wells along Highway 30 in the Assessment Area.

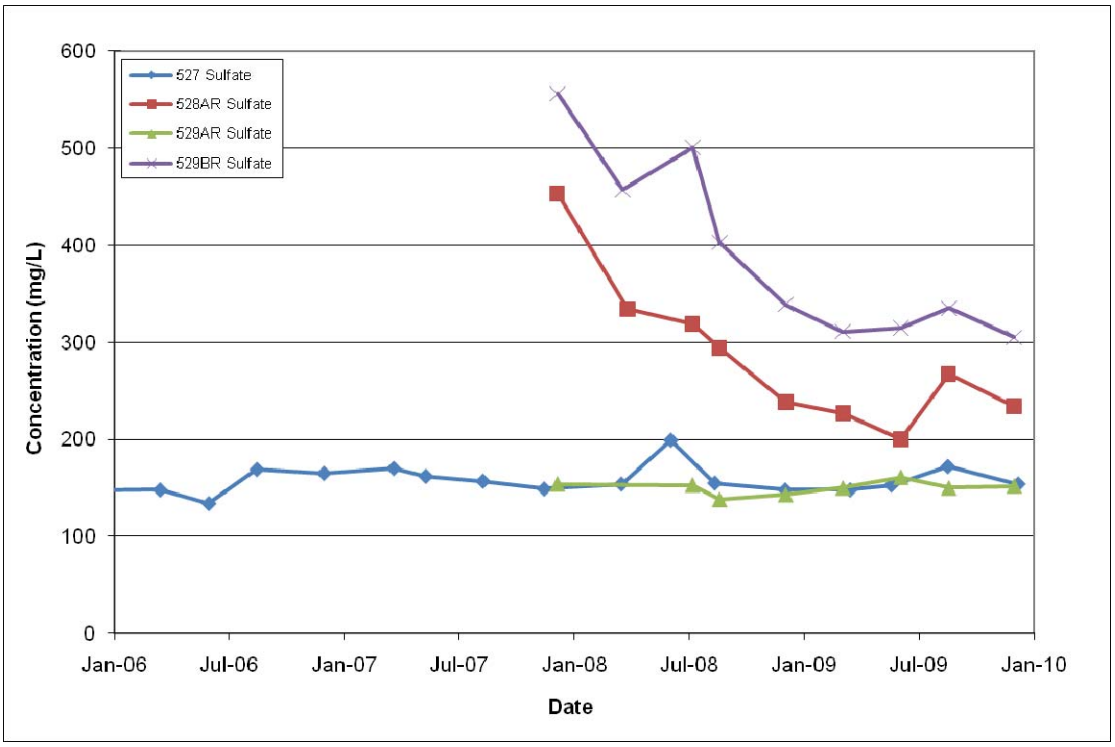


Figure 6-87: Time-series of sulfate concentrations in shallow wells along Highway 30 in the Assessment Area.

Lower screened well intervals along Highway 30 include 527, 528BR, 528 CR, 528DR, 529CR, and 529DR. Apparent temporal trends shown on the figures below were confirmed through statistical testing, specifically linear regression testing as described in Section 5 of the Groundwater and Surface Water Monitoring Plan (Formation 2009a). The linear regression lines and correlation coefficients are plotted for each analyte at each well in Appendix B.

Arsenic concentrations in these intervals were lower than those in the shallower intervals (Figure 6-88). Arsenic showed a general increasing trends in well 526, a slight decrease in well 529CR, and stable concentrations in other wells. Phosphorus concentrations were also lower in the deeper intervals, typically less than 1 mg/L, however well 526 ranged from about 2 to 9 mg/L and showed a general increasing trend in the past few years (Figure 6-89). Well 529CR showed a slight decrease in phosphorus, and wells 529DR showed a slight increase (Figure 6-90). Sulfate concentrations were less than 80 mg/L in all deep intervals except well 526, which ranged from approximately 90 to 130 mg/L in 2009 and showed an increasing trend (Figure 6-91).

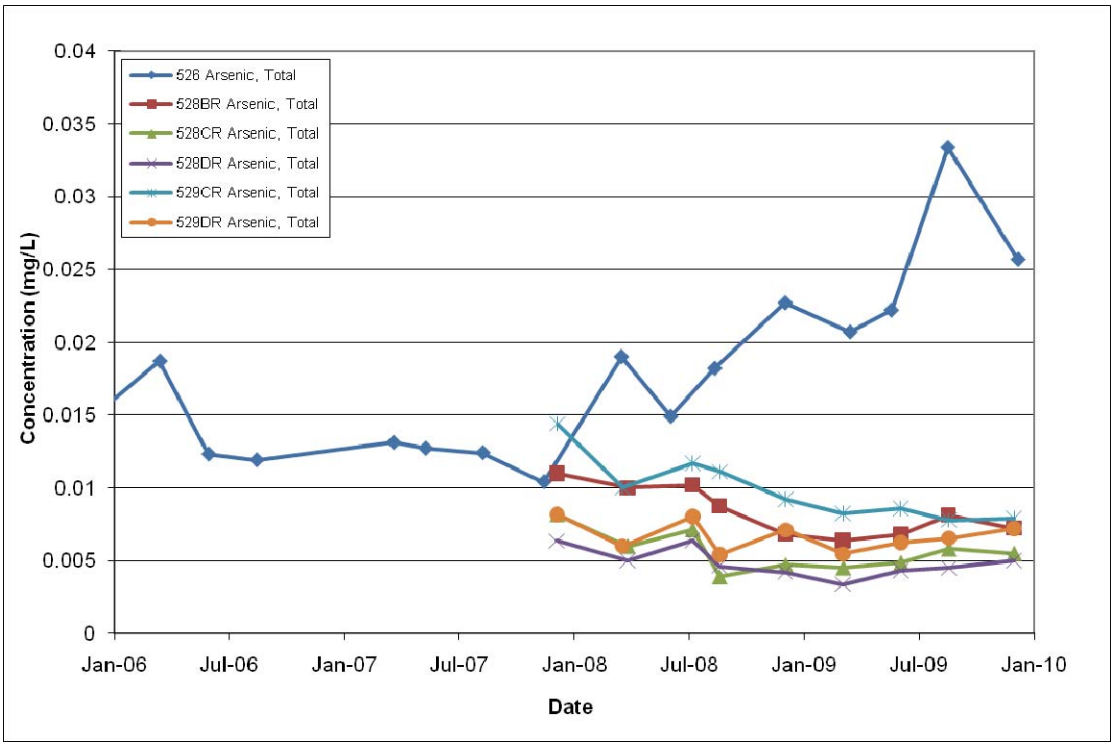


Figure 6-88: Time-series of arsenic concentrations in deep wells along Highway 30 in the Assessment Area.

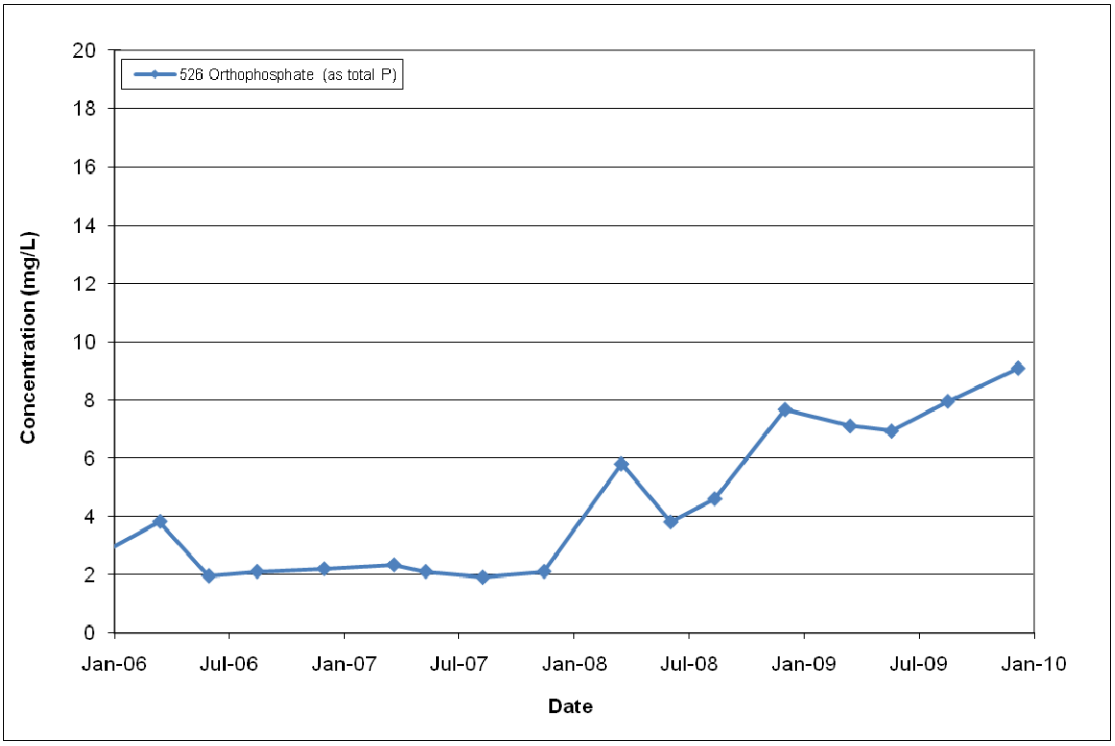


Figure 6-89: Time-series of total phosphorus concentrations in deep wells along Highway 30 in the Assessment Area.

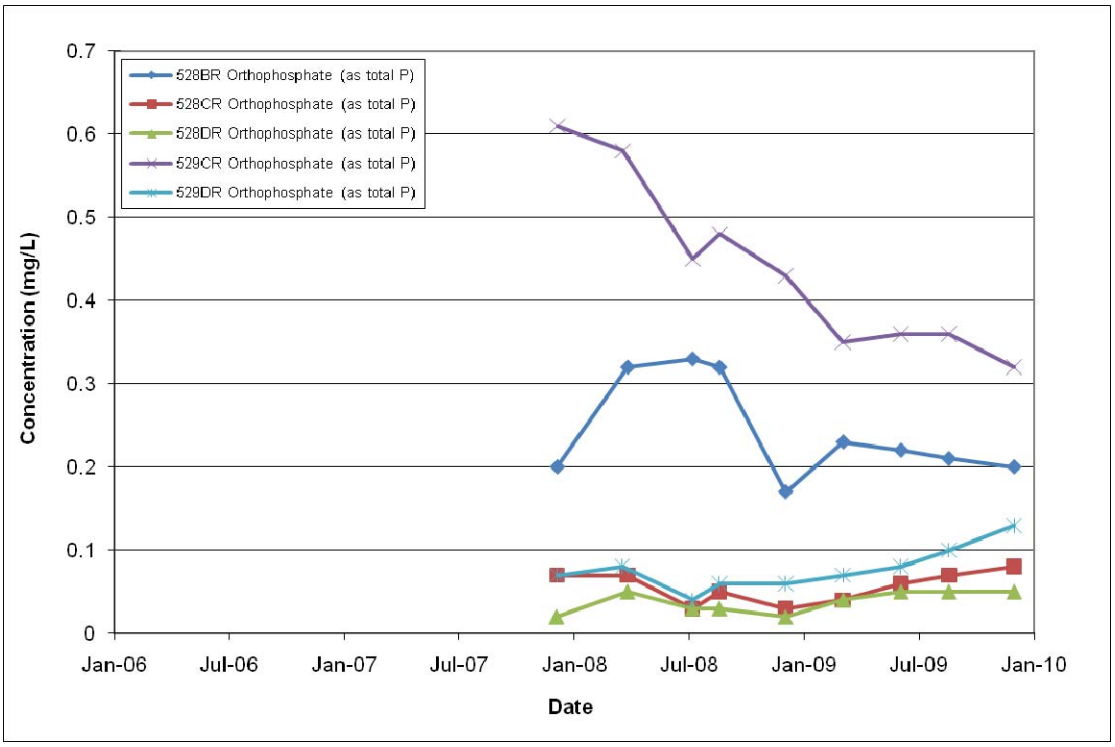


Figure 6-90: Time-series of phosphorus concentrations in deep wells along Highway 30 in the Assessment Area.

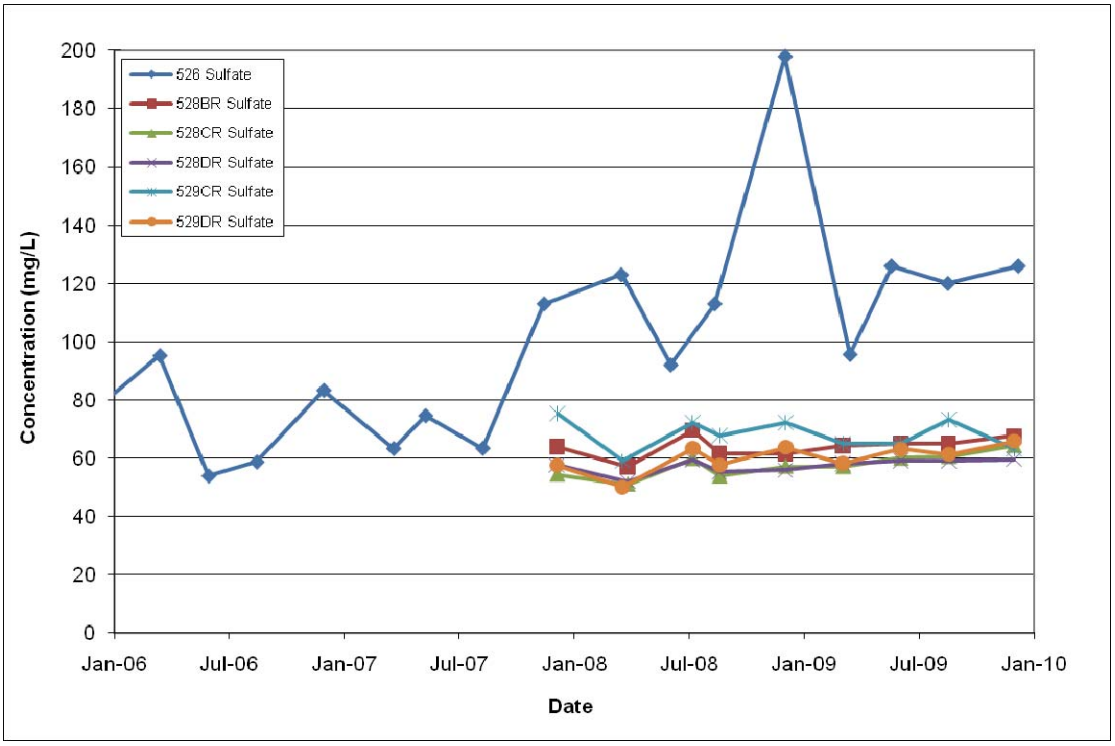


Figure 6-91: Time-series of sulfate concentrations in deep wells along Highway 30 in the Assessment Area.

6.4.3.2 Wells 518, TW-11S and TW-12S

Wells 518, TW-11S and TW-12S are located further north than the wells along Highway 30, and are therefore further along flow paths from the plant area (Figures 5-1 and 5-2). Temporal trends observed in 2009 and previous years are described in this section. Long-term trends (over the past three years) were tested using linear regression as described in Section 5 of the Groundwater and Surface Water Monitoring Plan (Formation 2009a). The linear regression lines and correlation coefficients are plotted for each analyte at each well in Appendix B.

Wells TW-12S showed a decreasing trend in phosphorus concentrations over time (Figures 6-93). Well TW-11S had lower concentrations of arsenic and phosphorus compared to wells 518 and TW-12S, likely due to its location further to the west, where flow paths originate from outside of the Simplot plant area (Figures 6-92 and 6-93). Well TW-12S showed decreasing trends in arsenic and phosphorus. Well 518 showed an increasing trend in phosphorus and sulfate concentrations over time (Figures 6-93 and 6-94).

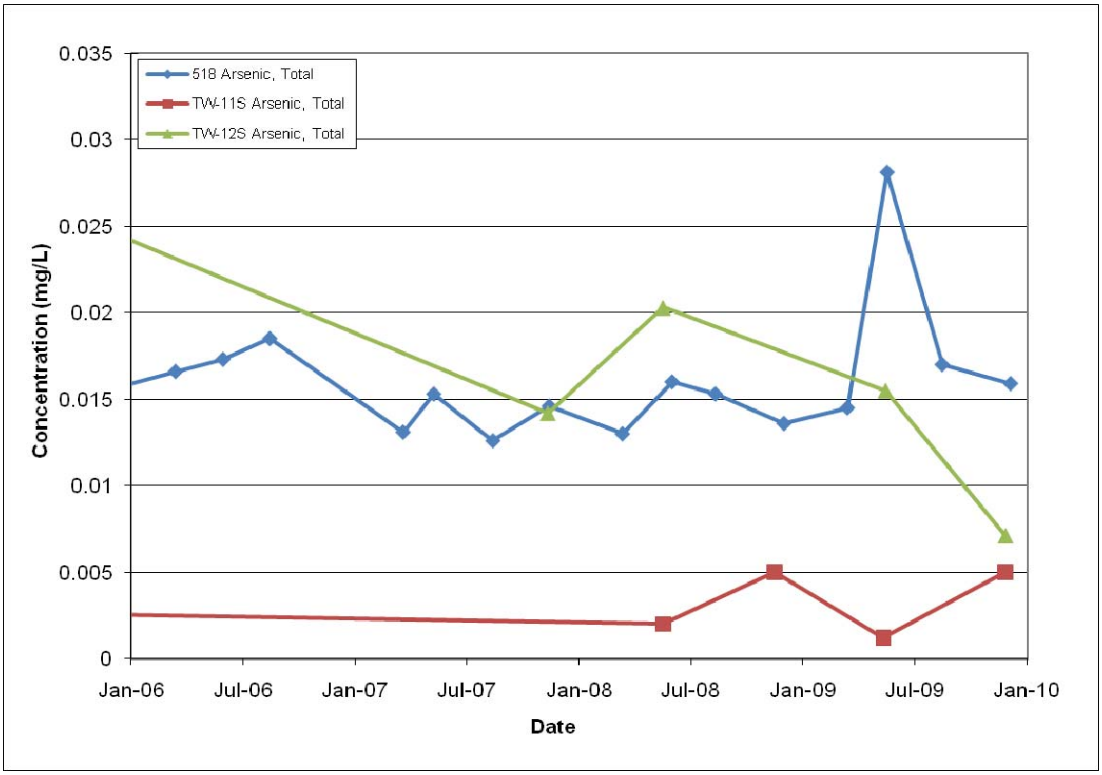


Figure 6-92: Time-series of arsenic concentrations in wells 518, TW-11S, and TW-12S in the Assessment Area.

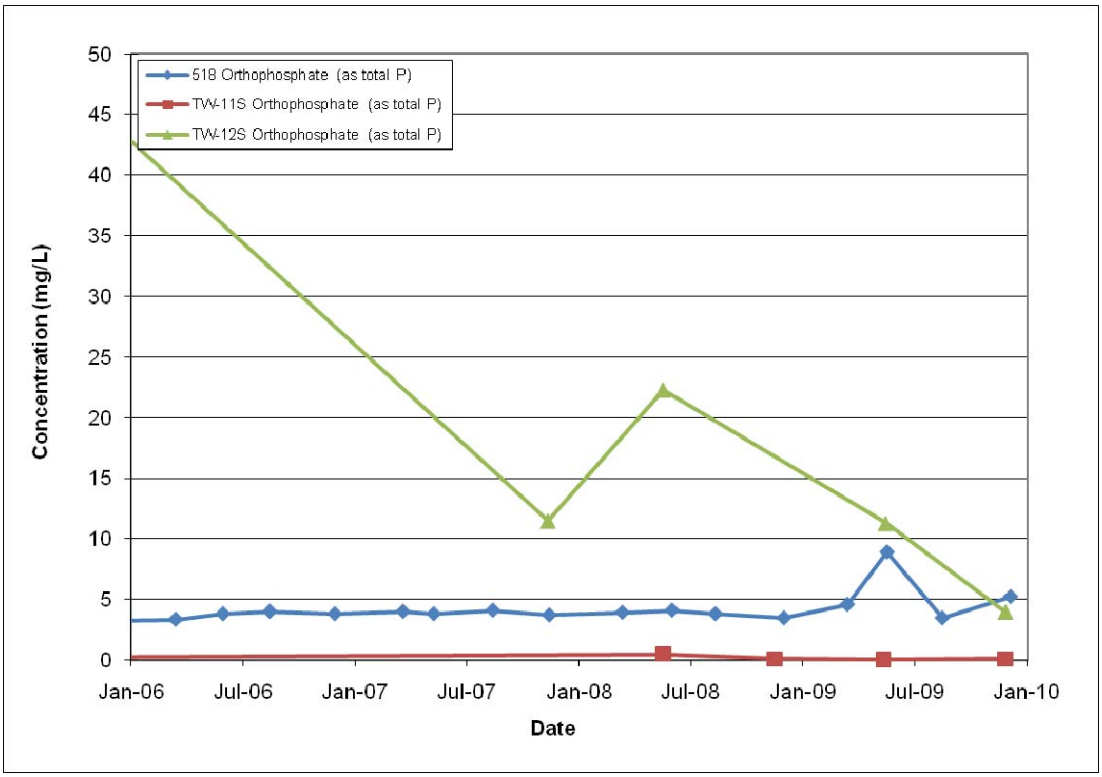


Figure 6-93: Time-series of phosphorus concentrations in wells 518, TW-11S, and TW-12S in the Assessment Area.

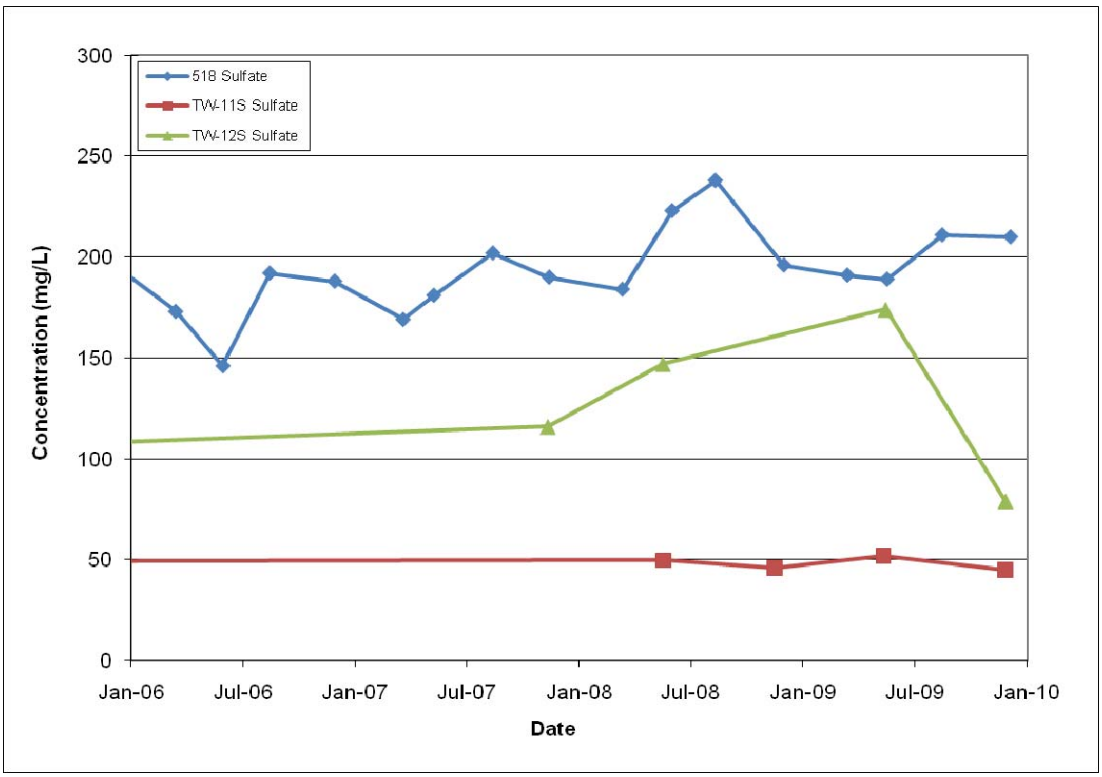


Figure 6-94: Time-series of sulfate concentrations in wells 518, TW-11S, and TW-12S in the Assessment Area.

6.4.3.3 Well pairs in the northern Assessment Area

Well pairs 504/505, 503/519 and 524/525 are located in the Assessment Area and are the monitoring wells closest to the spring locations (Figures 5-1 and 5-2). Temporal trends observed in 2009 and previous years are described in this section. Long-term trends (over the past three years) were tested using linear regression as described in Section 5 of the Groundwater and Surface Water Monitoring Plan (Formation 2009a). The linear regression lines and correlation coefficients are plotted for each analyte at each well in Appendix B.

Arsenic concentrations in these wells have been less than or equal to 0.01 mg/L since 2007 (Figure 6-95), except for well 503, which is typically between 0.01 and 0.015 mg/L with the exception of a spike in the first quarter of 2008 of 1.418 mg/L. Arsenic concentrations in wells 504, 524 and 525 have shown decreasing trends in recent years (Appendix B). Phosphorus concentrations in these wells was typically below 1 mg/L, except well 503 which showed a recent decreasing trend to less than 4 mg/L (Figure 6-96). Well 503 is located in the most direct downgradient pathway for upwelling contaminated groundwater sourced from either the gypsum stack or the phosphoric acid plant area. Linear regression shows increasing trends in phosphorus in Lower Zone wells 505 and 519. Sulfate concentrations were typically less than 50 mg/L, except for well 505 which was less than 100 mg/L and well 503 which generally ranged between 150 and 200 mg/L (Figure 6-97). Increasing sulfate trends were observed in well 519 (Appendix B).

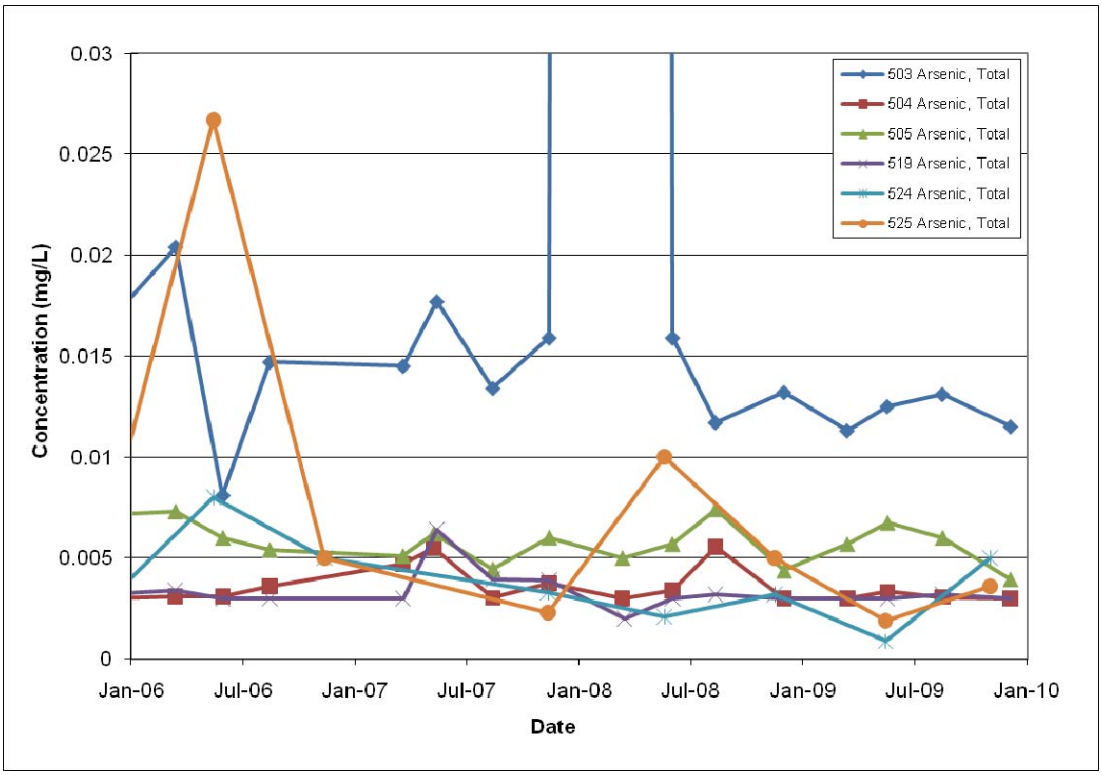


Figure 6-95: Time-series of arsenic concentrations in wells 503, 504, 505, 519, 524, and 525 in the Assessment Area. Well 503 spiked to 1.418 mg/L in March 2008.

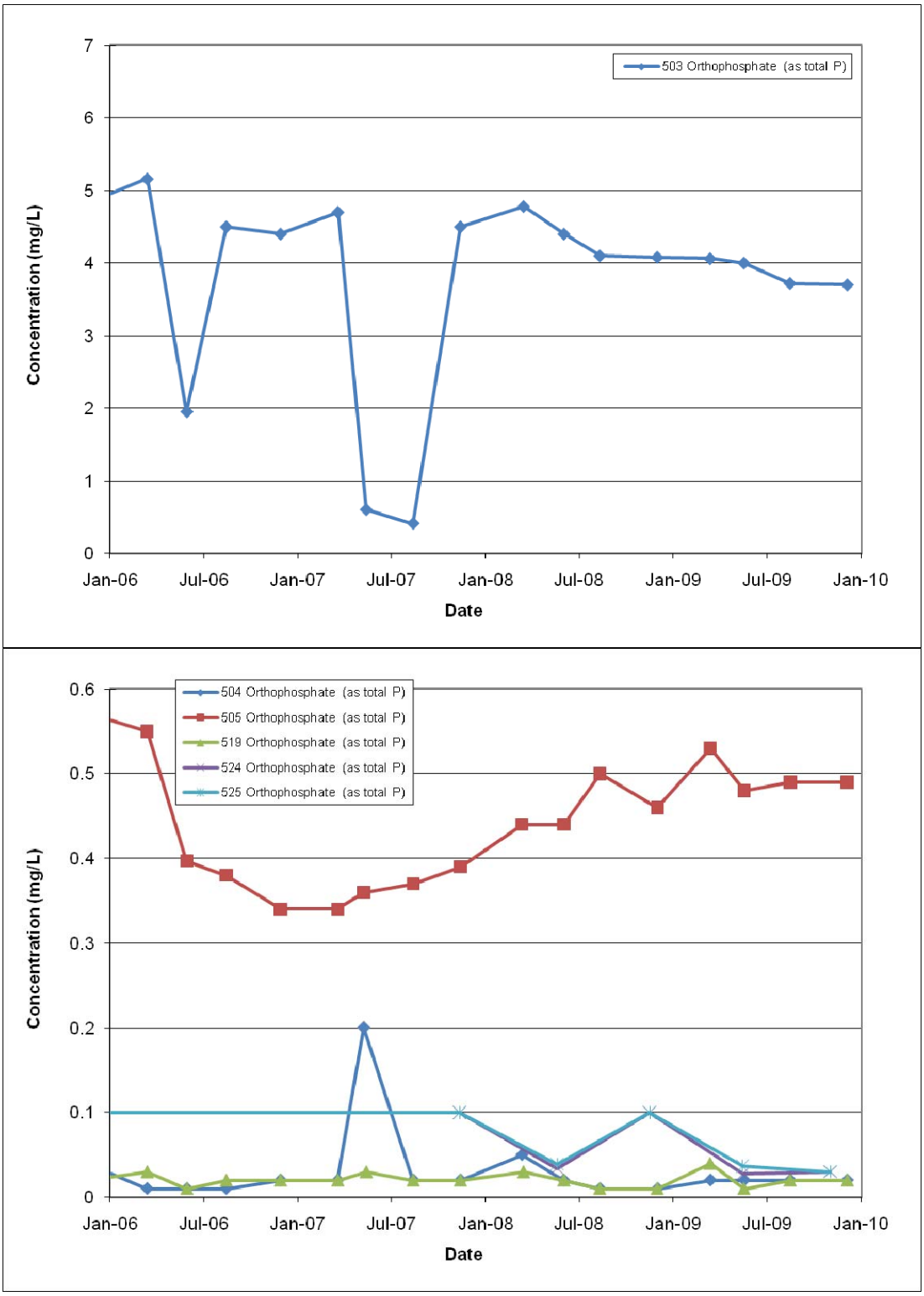


Figure 6-96: Time-series of phosphorus concentrations in wells 503 (top), 504, 505, 519, 524, and 525 (bottom) in the Assessment Area.

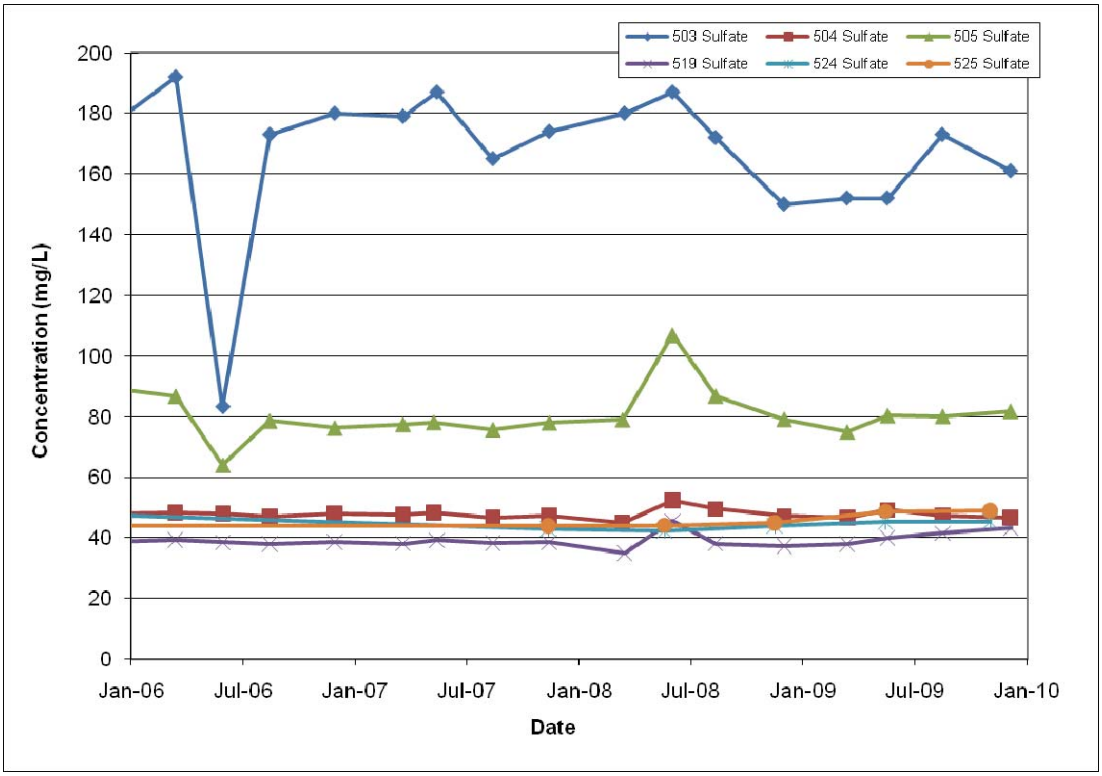


Figure 6-97: Time-series of sulfate concentrations in wells 503, 504, 505, 519, 524, and 525 in the Assessment Area.

6.4.3.4 Springs at the Portneuf River

Batiste Road Springs and Batiste Springs are the major discharge points to the Portneuf River for site-derived groundwater. Temporal trends observed in 2009 and previous years are described in this section. Long-term trends (over the past three years) were tested using linear regression as described in Section 5 of the Groundwater and Surface Water Monitoring Plan (Formation 2009a). The linear regression lines and correlation coefficients are plotted for each analyte at each monitoring point in Appendix B.

Batiste Springs showed a seasonal pattern in arsenic concentrations, with higher concentrations observed in the spring time (Figure 6-98). Batiste Springs arsenic concentrations decreased in 2007 and varied from less than 0.005 to 0.025 mg/L in 2008-9. Batiste Road Springs arsenic levels were lower, having decreased since the end of 2007 to between 0.005 and 0.01 mg/L in 2009. Phosphorus concentrations in Batiste Springs show a decreasing trend over time and in 2009 were generally below 10 mg/L (Figure 6-99). Batiste Road Springs had lower phosphorus concentrations, generally between 1 and 2 mg/L. Sulfate concentrations were decreasing in Batiste Springs over time, and in 2009 ranged from approximately 50 to 150 mg/L (Figure 6-100). In 2009, sulfate in Batiste Road Springs was approximately 100 mg/L. Linear regression confirms that decreasing trends exist for all three analytes in Batiste Springs (Appendix B).

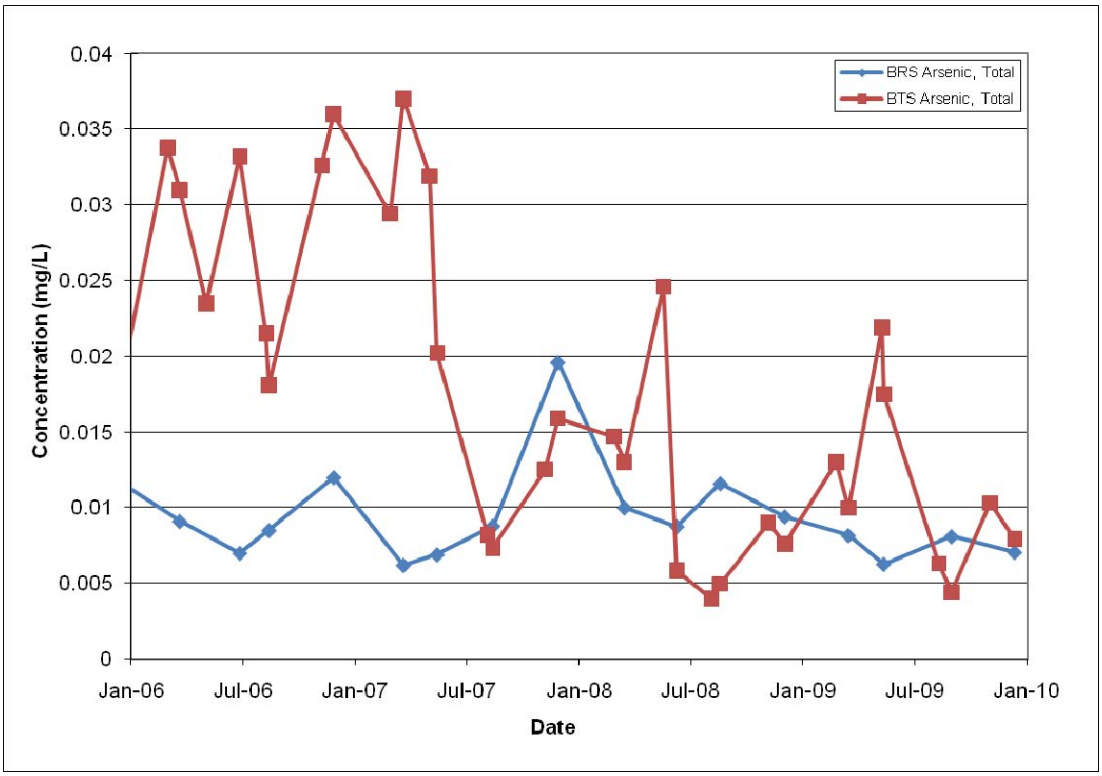


Figure 6-98: Time-series of arsenic concentrations in the springs in the Assessment Area.

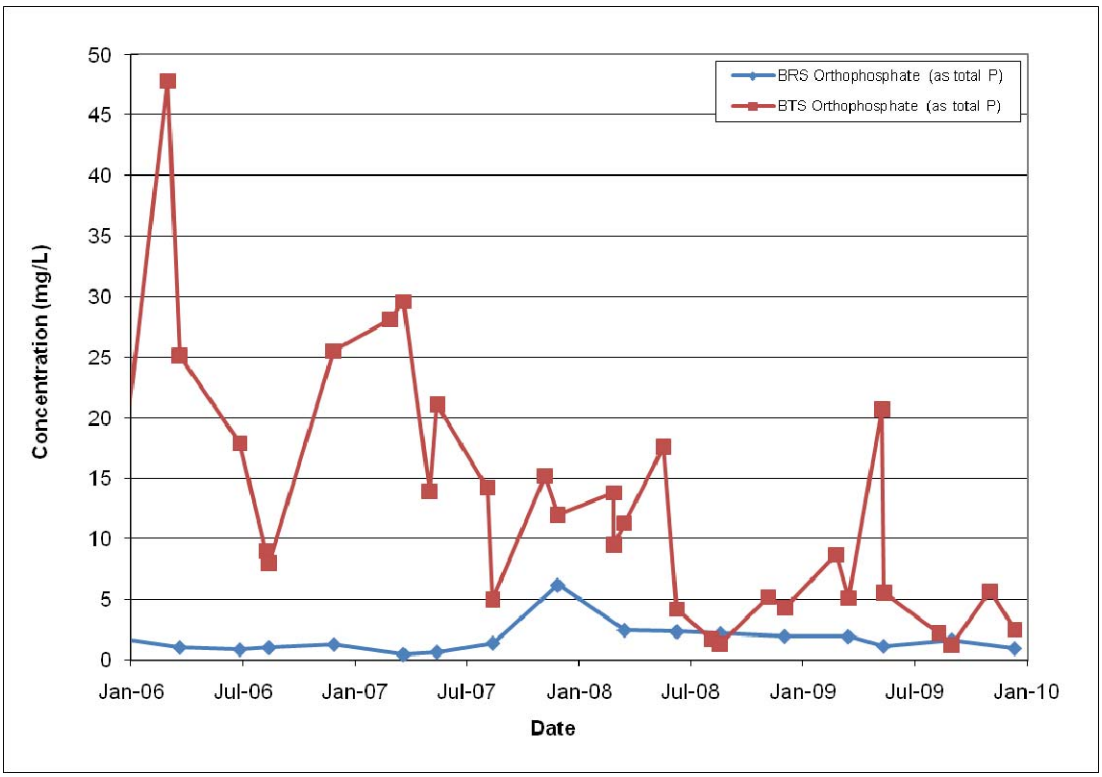


Figure 6-99: Time-series of phosphorus concentrations in the springs in the Assessment Area.

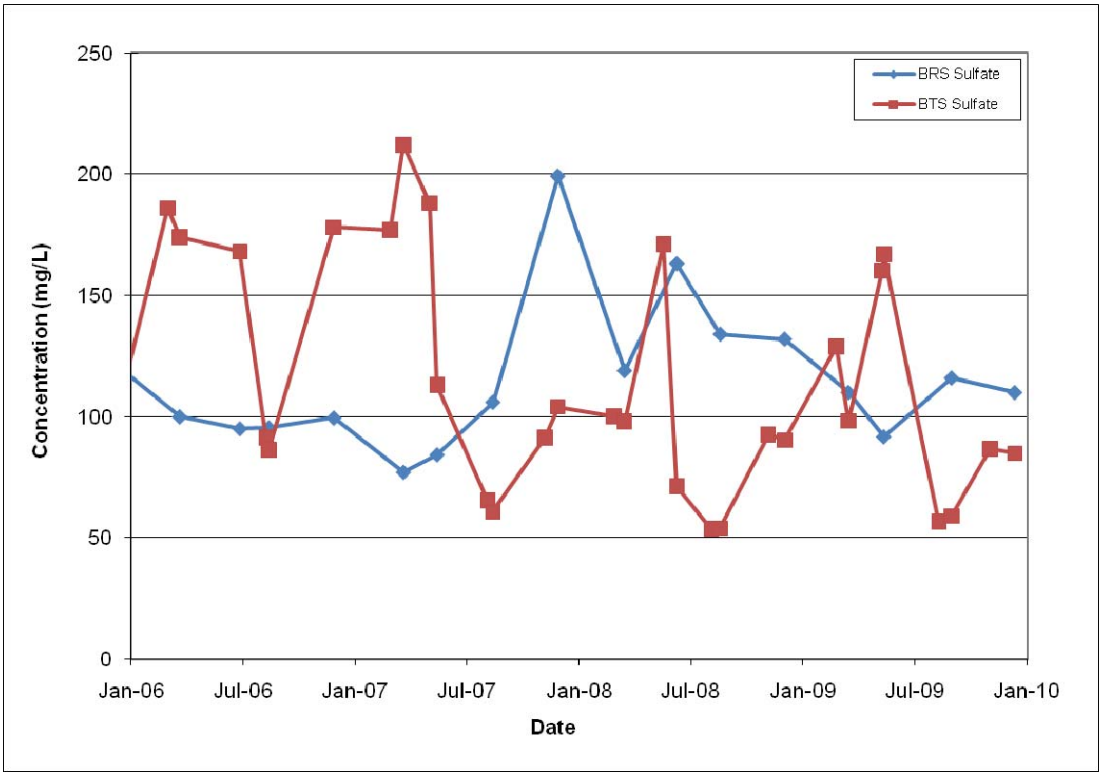


Figure 6-100: Time-series of sulfate concentrations in the springs in the Assessment Area.

6.5 Evaluate Performance Using Interim Target Concentrations in the Assessment Area

Interim target wells were selected from wells within the Assessment Area downgradient of all site sources to provide an additional means for identifying conditions that may result in applicable standards being exceeded at the point of compliance (POC). After source controls have taken effect and groundwater concentrations in the Assessment Area have stabilized, the interim target concentration should be able to provide an early indication of a potential exceedance at the POC. Concepts for the development of the interim target concentration are discussed in the Groundwater and Surface Water Monitoring Plan in Section 3.5.

The groundwater chemistry in wells selected as interim target wells will be compared to an interim target concentration, derived from the estimated relationship between the groundwater concentration in the Assessment Area and the POC. The interim target concentration can only be used as an action level if the concentration at the POC is in compliance and if there is sufficient data available to effectively evaluate the dilution and attenuation factor. The dilution and attenuation factor will be calculated using an average of observed concentrations from plume-affected intervals in the interim target wells and the point of compliance wells.

Attenuation between the two points makes up the difference in concentrations. The interim target concentration is calculated from the compliance concentration as follows:

$C_{IT} = C_{POC} \times DAF$
where:
C_{IT} = interim target concentration
C_{POC}= compliance concentration
DAF= dilution and attenuation factor

Monitoring wells in each area must be able to delineate the lateral and vertical extent of the affected groundwater and provide representative water quality samples of the affected groundwater. These monitoring objectives will be accomplished through groundwater sampling and water level measurement in the Assessment and Compliance Areas. The Assessment area wells include existing well nests 528, 529 and 526/527 and the new nested wells to be installed in 2010 as laid out in the Groundwater and Surface Water Monitoring Plan. This includes wells M-7, M-8, M-9, M-10, M-11. These well installations plans are further described in Section 9.2. The Compliance Area wells include existing well pairs 504/505 and 524/525 and the new nested wells M-1, M-2, M-3 and M-4, also further described in Section 9.2 Since the new monitoring wells have not yet been installed, only existing wells are considered in this report. The concentration CIT and CPOC will be calculated as the average concentration in groundwater samples collected from the screen interval in these wells that is shown to be within the plume of affected groundwater. The DAF can then be calculated as follows:

$DAF = C_{IT} / C_{POC}$

The DAF will be calculated continuously as monitoring data are collected. The DAF is expected to change as the concentrations in the downgradient monitoring wells change due to the implementation of the extraction system. Since the groundwater travel time from the upgradient assessment wells to the point of compliance is currently estimated around 2 to 3 years, a differential effect on groundwater concentrations in the two areas is likely to be observed – initial effects in the assessment wells may be observed at the assessment wells within the first year of the initiation of extraction but not for over 3 years at the point of compliance.

Since the monitoring wells M-1 through M-4 and M-7 through M-11 needed for this analysis have not yet been installed, the assessment cannot be completed for 2009. These monitoring wells are planned for installation in 2010.

6.6 Evaluating COC Concentrations in the Compliance Area

The monitoring goal for the Compliance Area is to demonstrate that groundwater migration into the Off-Plant Area is not occurring at concentrations above an applicable groundwater protection standard (GWPS) such as a MCL. The mean concentration in groundwater will be calculated and compared to the standard on an interval by interval basis for each well in the

compliance area. A confidence interval on the mean will be used to evaluate whether the mean is above or below the GWPS.

To make a comparison to groundwater goals that are based on surface water quality criteria such as TMDL goals, the discharge load of the constituent from the groundwater system to the Portneuf River is the primary consideration. The load value can be converted to an average concentration of affected groundwater in the compliance area by considering the discharge rates of both the groundwater and the river. The discharge rate of affected groundwater in the Compliance Area is a function of the hydraulic conductivity, hydraulic gradient, and cross-sectional flow area of the zone of affected groundwater.

Monitoring wells in the compliance area must be able to delineate the lateral and vertical extent of the affected groundwater and provide representative water quality samples of the affected groundwater. These monitoring objectives will be accomplished through groundwater sampling and water level measurement in the compliance area at the new nested wells M-1, M-2, M-3, and M-4 and at existing well pairs 504/505 and 524/525. In addition, water quality data from Batiste Spring and the Batiste Road Spring are also available. Since the new monitoring wells have not yet been installed, only existing wells will be analyzed in this report.

Quarterly groundwater levels and water quality samples will be taken at Compliance Area wells. These data will be used to create a site-wide potentiometric surface (Section 5.3), assess the spatial distribution of COCs in the Assessment Area (Section 6.6.1 and 6.6.2), and perform statistical tests for comparison with performance standards (Section 6.6.3).

The wells and springs in the Compliance Area that will be monitored and the data that will be collected are listed in Table 3-9 of the Groundwater and Surface Water Monitoring Report. Monitoring well locations are shown in Figures 5-1 and 5-2. Samples of groundwater will be collected and analyzed for the analytes shown in Table 5-1.

6.6.1 Transport Pathways

In the compliance area, site-affected groundwater discharges to the Portneuf River through groundwater springs. Significant vertical head differences are observed in the Assessment Area south of the Compliance Area, as groundwater moves upward toward the surface discharge point. In 2009, vertical head differences at well pair 503/519 ranged from 1.4 to 1.6 ft. Strong vertical gradients are no longer observed as far north as wells 524/525. As groundwater approaches the discharge point at the springs, it appears to be hydraulically connected with the Portneuf River, as shown by similar trends in water levels at wells 503, 519, and surface water station PBATR (at Batiste Road) (Figure 6-101). Installation of four additional monitoring wells in the Compliance Area, as proposed in the Groundwater Remedial Design Report (Formation 2009b), will help understand the plume dimensions in this area. Monitoring wells M-1, M-2, and M-3 will be used to confirm plume position and provide water quality data to demonstrate compliance. Monitoring well M-4 will be used to confirm the southern limit of the plume prior to

discharge to the Portneuf River in a similar manner that the well nest 524/525 confirms the northern limit of the plume.

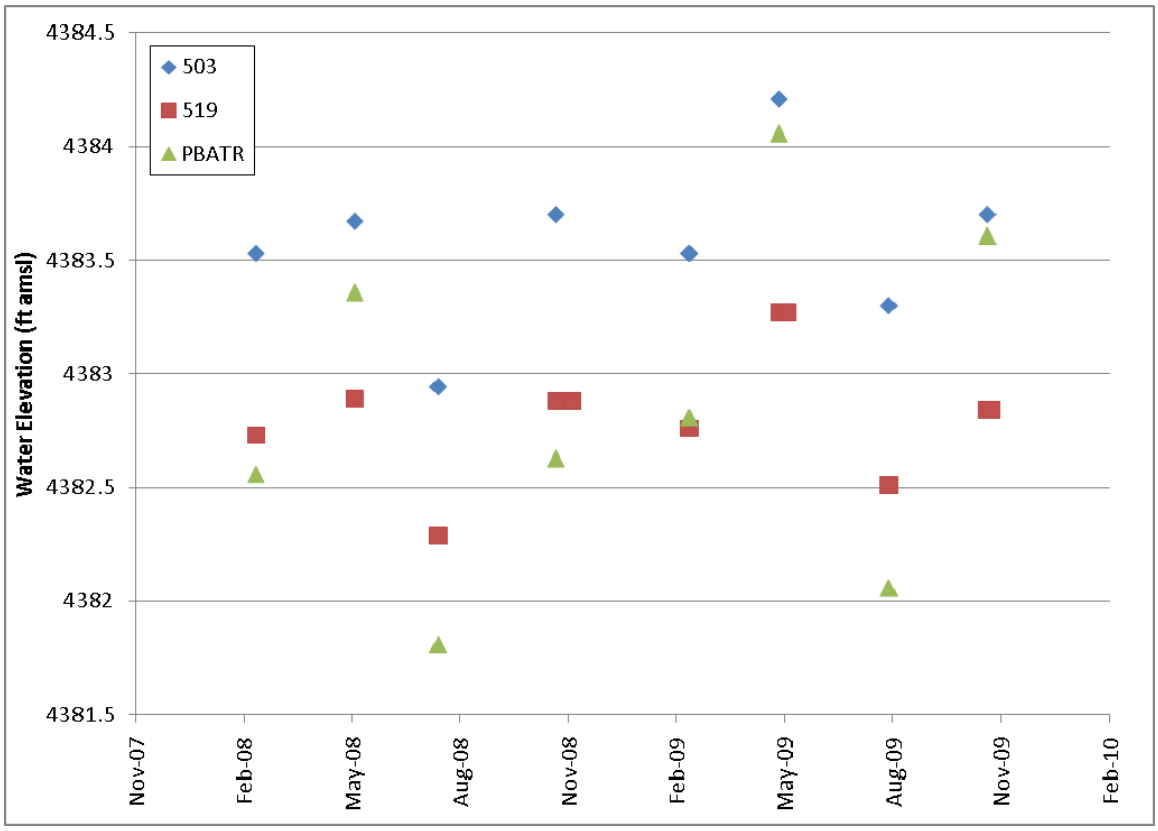


Figure 6-101: Time-series of water elevations in Assessment Area wells 503, 519 and surface water station PBATR (at Batiste Road).

6.6.2 Temporal Trends

Trends of concentrations in groundwater and groundwater levels in Compliance Area wells were covered in Sections 6.4.3.3 and 6.4.3.4.

6.6.3 Statistical Comparison to Groundwater Protection Standards

The method for comparing observed groundwater concentrations to groundwater protection standards is described in Section 5.2.2 of the Groundwater and Surface Water Monitoring Plan (Formation 2009a). Comparisons are conducted for each well independently (EPA 2009). Monitoring locations in the Compliance Area are listed in Table 6-9. Monitoring wells M-1 through M-4 have not yet been installed, so analysis cannot be conducted for these locations.

Table 6-9: Groundwater Monitoring Locations, Compliance Area.

Monitoring Location	Zone	Analyses	TOC Elev. (ft)	Depth to Top of Screen (ft bgs)	Depth to Bottom of Screen (ft bgs)
504	Deep	GWL, WQ	4394.99	153.8	163.4
505	Shallow	GWL, WQ	4395.71	30.3	39.9
524	Deep	GWL, WQ	4399.92	48.5	58.5
525	Shallow	GWL, WQ	4399.61	17.8	27.8
Batiste Spring (BTS)	Shallow	GWL, WQ	Surface Water Location		
Spring at Batiste Road (BRS)	Shallow	GWL, WQ	Surface Water Location		
M-1	Multi-level	GWL, WQ	Proposed Location		
M-2	Multi-level	GWL, WQ	Proposed Location		
M-3	Multi-level	GWL, WQ	Proposed Location		
M-4	Multi-level	GWL, WQ	Proposed Location		

Notes:
GWL = Groundwater level
WL = Water level
WQ = Water quality sample

As described in the EPA Groundwater Monitoring Statistical Guidance (EPA 2009), at least 4 samples from each well are required, but 8 samples are preferred. Eight samples were selected from each well, which typically represents the past two years. Dixon's test was applied for each dataset to identify potential outliers. One outlier above the 99% significance level was removed for well 504. All other data were retained. The upper confidence limit of the mean (UCL) was calculated using the EPA software Pro-UCL. The datasets were first tested for normality. In order to reduce the false positive rate, a small α was used (0.05), giving a confidence level of 1-α (0.95 or 95%). For datasets with all detected values, the Student's t UCL was chosen at the 95% confidence level. For datasets with non-detects, the KM (t) UCL was chosen at the 95% confidence level. The KM (t) UCL incorporates the Kaplan-Meier (KM) method for datasets with non-detect values. Although phosphorus datasets contained a high percentage of non-detects, distributions were normal at a 5% significance level, for the KM method was used. Table 6-10 summarizes the UCL values for arsenic and phosphorus in Compliance Area wells.

For monitoring intervals in affected groundwater in the Compliance Area the null and alternate hypotheses are set up to be consistent with corrective action monitoring (EPA 2009). The following is to demonstrate that the concentration of groundwater is in compliance:

H_0: C_W > applicable MCL

H_A: C_W ≤ applicable MCL

where:

C_W = the 95% UCL on the mean for any one monitoring interval

When conditions result in a decision to reject the null hypothesis, prevention in the migration of COCs into the Off-Plant Area above the MCL or RBC is demonstrated. The null hypothesis can be rejected for arsenic in wells 504, 505, 524, and the Spring at Batiste Road (BRS). According to the decision rule in the Groundwater and Surface Water Monitoring Plan, in order to determine that the groundwater remedy is effective in achieving the remedial action objectives, a majority of the wells tested must reject the null hypothesis. Four of the six monitoring points tested reject the null hypothesis, indicating concentrations less than the arsenic MCL, however a better evaluation of this statistical test will be possible after the proposed additional monitoring wells have been installed in the Compliance Area and included in the evaluation. It should be noted that while remedial actions are being carried out, there may be exceedances of the GWPS, and this test is conducted as a way to monitor the relative efficacy of the remedial actions. Formal corrective action monitoring evaluation is appropriate at the conclusion of remediation activities (EPA 2009).

A groundwater protection standard for phosphorus has not yet been developed for the Compliance Area wells. The TMDL for phosphorus in the Portneuf River applies to the sampling point at Siphon Road. Ultimately, the site-derived load of phosphorus to the river that would correspond to achieving the TMDL at Siphon Road should be calculated. In order to isolate the site-derived load from the total load to the Portneuf River from the west side (which includes background sources) the vertical and horizontal extent of the plume needs to be estimated. The proposed additional monitoring wells that will be installed in the Compliance and Assessment Areas in 2010 will help determine the plume dimensions in this area.

Table 6-10: UCL of the means of datasets for arsenic and phosphorus at Compliance Area monitoring locations.

Arsenic

Well	Date Range	No. Outliers Removed	No. Data Points Used	Percent ND	Distribution	95% UCL (mg/L)	Type	Arsenic MCL (mg/L)	Greater than MCL?
504	2008-2009	1	7	42.86%	Normal	0.00324	95% KM (t) UCL	0.01	N
505	2008-2009	0	8	0%	Normal	0.00638	95% Student's-t UCL	0.01	N
524[1]	2004-2009	0	8	50.00%	Normal	0.00487	95% KM (t) UCL	0.01	N
525[1]	2005-2009	0	8	37.50%	Normal	0.0135	95% KM (t) UCL	0.01	Y
BRS	2008-2009	0	8	0%	Normal	0.0098	95% Student's-t UCL	0.01	N
BTS	2008-2009	0	8	0%	Normal	0.0119	95% Student's-t UCL	0.01	Y

Orthophosphate

Well	Date Range	No. Outliers Removed	No. Data Points Used	Percent ND	Distribution	95% UCL (mg/L)	Type		
504[2]	2008-2009	1	7	42.86%					
505	2008-2009	0	8	0%	Normal	0.499	95% Student's-t UCL		
524[1]	2004-2009	1	7	57.14%	Normal	0.0747	95% KM (t) UCL		
525[1]	2004-2009	0	8	62.50%	Normal	0.115	95% KM (t) UCL		
BRS	2008-2009	0	8	0%	Normal	2.203	95% Student's-t UCL		
BTS	2008-2009	0	8	0%	Normal	6.603	95% Student's-t UCL		

[1] *Available values span an extended temporal record and may not represent current conditions.*

[2] *Only one distinct detected value. A data distribution could not be estimated.*

7.0 SURFACE WATER MONITORING

As specified in the VCO/CA, the objective of the surface water monitoring program is to collect sufficient data of adequate quality to verify that remedial actions successfully limit Don Plant impacts to surface water in the Portneuf River per the concentration-based requirements set out in Section 2.1 of the Groundwater and Surface Water Monitoring Plan. The monitoring strategy will also provide a mechanism to identify when additional contingency actions are required, and shall measure progress toward achieving final surface water RBCs as measured at the locations approved by EPA.

The VCO/CA sets out the required monitoring locations, as follows:

- IDEQ (accompanied by a Simplot representative when possible) will collect samples at the point of compliance (Siphon Road) to determine the concentration of phosphorus in the Portneuf River on a monthly basis. The calculation basis for compliance shall be the annual median of monthly values.

Simplot or DEQ will perform monthly sampling at the following two locations:

- Batiste Road; located on the downstream side of Batiste Road Bridge crossing, 50 ft west of the City of Pocatello Wastewater Treatment Facility and 50 ft north of Interstate 15 West. This location is used for background values for comparison to Siphon Road and T2B.

- A location approximately 300-400 meters north of Batiste Road at site T2B (as defined in IDEQ 2004).

The sampling locations are shown in Figure 7-1.

Figure 7-1: Portneuf River sampling locations.

7.1 Surface Water Sampling Activities

Three main sampling methods take place at the three monitoring stations. Physical and chemical conditions are monitored monthly, water quality parameters are measured continuously at Batiste and Siphon Roads, and river discharge is measured both continuously and monthly through water level recorders. The Portneuf River Quality Assurance Project Plan (IDEQ 2009) provides details of sampling procedures and protocols.

<u>Monthly Physical and Chemical Monitoring</u>

Surface water samples have been analyzed monthly for the parameters shown in Table 7-1.

Table 7-1: Analyte list for monthly surface water samples.

	Method	Reporting Limit (RL) or Sensitivity	Units
Turbidity	A2130; E180.1	0.01	NTU
Chloride	300.0	0.02	mg/L
Sulfate	300.0	0.3	mg/L
Nitrate + Nitrite (as N)	353.2	0.02	mg/L
Phosphorus, Total	SM 4500-P-E	0.01	mg/L
Dissolved Phosphorus	EPA 365.2	0.004	mg/L

Continuous Water Quality Monitoring

In addition to the monthly sampling events, continuous water quality monitoring takes place at Batiste and Siphon Roads. The equipment consists of YSI 5920 multiparameter water quality sondes with records of temperature, specific conductance, pH, dissolved oxygen, and turbidity. Measurements are recorded every 10 minutes during ice free conditions.

Discharge Monitoring

The discharge at Batiste Road and T2B is measured monthly as part of the monthly monitoring program. For Siphon Road, the discharge is calculated using data from the USGS station number 13075910, Portneuf River at Tyhee gage, with irrigation records from the Fort Hall Pump station measured by the Idaho Department of Water Resources (IDWR). The amount of water pumped out of the Portneuf River at the Fort Hall Pump station is added into the discharge measured at the Tyhee gage to calculate the estimated discharge at Siphon Road.

7.2 Data Review and Quality

Data review and quality is described in detail in the Portneuf River Quality Assurance Project Plan (IDEQ 2009). The plan summarizes quality control for field sampling, the continuous monitoring system, and laboratory analysis as well as the procedures to follow for exceedance of a quality control limit. Surface water data is provided in Appendix H.

7.3 Results

The goals of the data analysis are to:

- Assess the discharge at each monitoring location for seasonal variations and groundwater inflow.
- Validate Batiste Road as an effective background sampling location.
- Compare the surface water chemistry and water quality of Siphon Road and T2B to Batiste Road and evaluate goals for:
    - Phosphorus Concentration
    - Phosphorus Loads
    - Dissolved Oxygen
    - Turbidity
    - Total Suspended Solids
    - pH
    - Temperature

7.3.1 River Discharge

River discharge is measured along the Lower Portneuf River and at point source locations (i.e. the Pocatello Waste Water Treatment Plant (POTW)) in order to evaluate the loads of contaminants entering the river, analyze seasonal variations, and also to evaluate the influx of regional and EMF groundwater.

A simple conceptual model of sources and monitoring locations for the Lower Portneuf River is presented in Figure 7-2.

Figure 7-2: Conceptual model of inputs for the lower Portneuf River.

This model indicates where point source inputs are located with respect to other sources and the estimated influx locations for non-point sources. Table 7-2 shows the average monthly discharge for 2009 measured along the Lower Portneuf River (Batiste Road, T2B, Siphon Road, and Tyhee) as well as point source flows added (POTW) and removed (Fort Hall).

Table 7-2: The monthly average measured discharge along the lower Portneuf River for 2009.

Discharge Analysis (cfs)	Batiste Road	T2B	POTW	Siphon Road	Fort Hall Pump	Tyhee Gage
January	228	294	10.2	427	0	427
February	174	241	10.8	403	0	403
March	251	327	10.5	474	0	474
April	567	605	10.5	769	0	769
May	347	397	10.2	560	-178	382
June	640	720	10.7	876	-85	791
July	114	189	10.8	348	-105	243
August	91	164	11.0	320	-129	191
September	100	182	10.8	381	-120	261
October	188	273	10.9	510	0	510
November	187	261	10.6	455	0	455
December	202	265	10.6	428	0	428
Annual Average	257	327	10.6	496	-51	445

Note: Siphon Road flows calculated.

Discharge at Batiste Road, T2B, Siphon Road, and Tyhee is highest during spring runoff and much lower by August, with Batiste Road having the largest difference between spring flows and late summer flows (decrease of 86% at Batiste Road and 49% at Siphon Road for 2005 – 2009, and 77% at T2B for 2009). This shows that the groundwater influx at T2B and Siphon Road helps reduce spring and summer variations. The influx from the POTW is steady, with an average of 10.6 cfs. The Fort Hall Pump is only used during the growing season.

To evaluate the influx of groundwater between Batiste Road and T2B, the discharge measured at Batiste Road is subtracted from the discharge at T2B. For the influx between Batiste Road and Siphon Road, the discharge measured at Batiste Road and the discharge from the POTW is subtracted from the discharge estimated at Siphon Road. The flow at Siphon Road is estimated by adding in the removed river water from the Fort Hall pump to the discharge measured at the Tyhee gage. Figure 7-3 shows these flow differences.

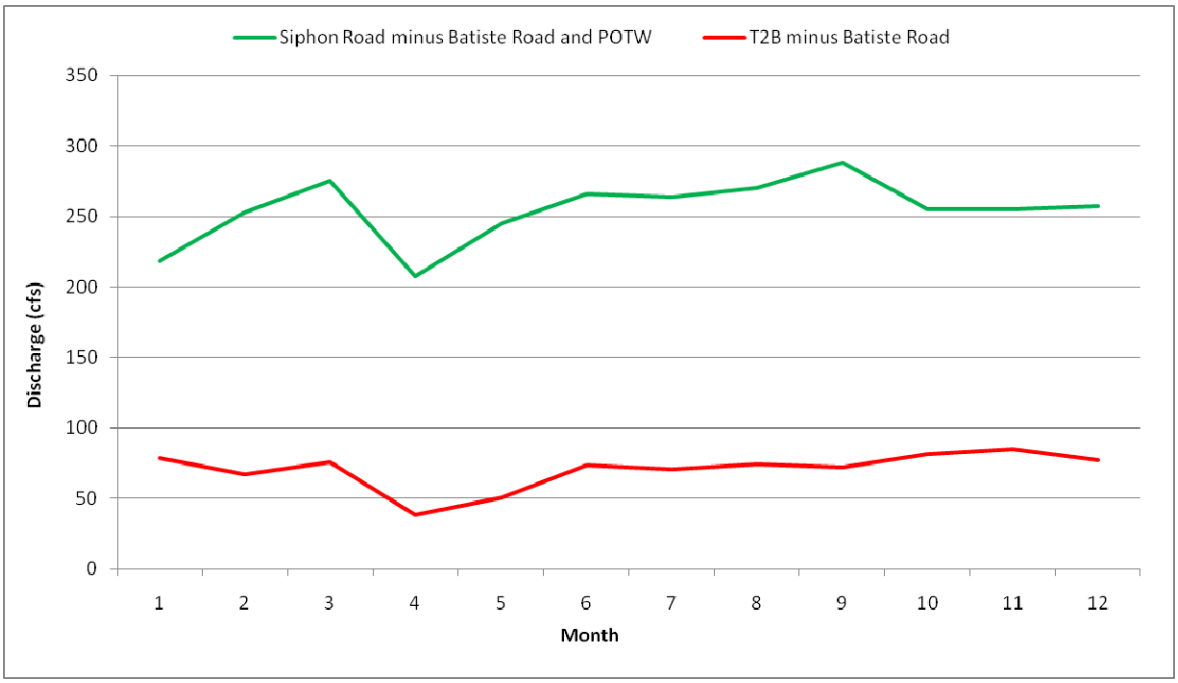


Figure 7-3: The average monthly difference in discharge between Batiste Road and T2B (2008 – 2009) and Batiste Road, POTW, and Siphon Road (2003 – 2009).

The yearly average groundwater influx is approximately 70 cfs by station T2B and 250 cfs by Siphon Road This influx is relatively steady throughout the year.

To show the seasonal variations in discharge at each location, the monthly discharge was averaged for the years of measurement at Batiste Road, Siphon Road, and T2B (Figure 7-4).

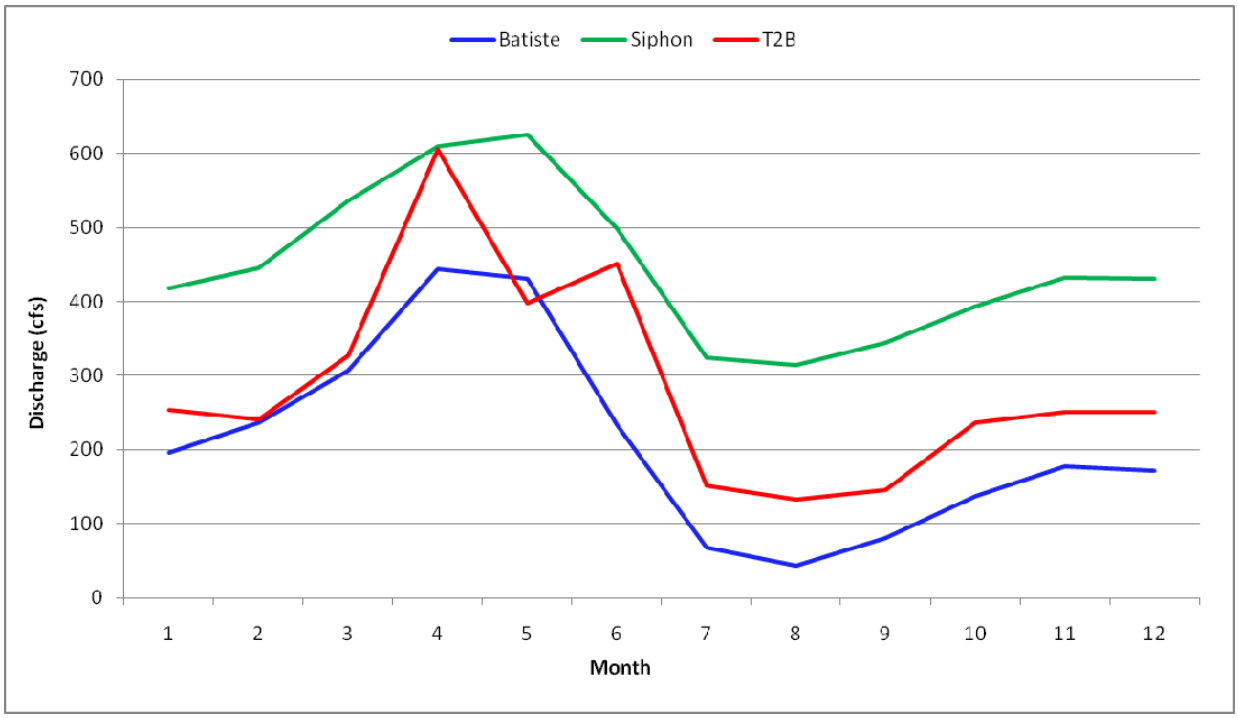


Figure 7-4: The average monthly discharge for Batiste and Siphon Roads (2003 – 2009), and T2B (2008 – 2009).

The annual variations at the stations demonstrate highest flows during spring runoff and lowest flows in late summer. Station T2B has only been monitored since January of 2008, with the months of February through May 2008 missing discharge data, which is why the T2B monthly average for these months is not steady. To further show the discharge at Siphon Road, the yearly average, minimum, and maximum estimated discharges are shown in Table 7-3.

Table 7-3: Siphon Road discharge (cfs).

Year	Average Flow	Minimum	Maximum
2003	356	205	539
2004	368	221	652
2005	487	304	968
2006	594	296	1620
2007	405	252	1020
2008	418	225	752
2009	498	307	939
Average	446	258	927

This also indicates that the discharge at Siphon Road has been fairly steady throughout the last 6 years, except for 2006, which demonstrated higher spring runoff flows. Year 2009 was a typical flow year, with only a slightly higher late summer discharge compared to previous years.

In summary:

- Groundwater influx downstream of Batiste Road helps reduce the spring to summer flow variations.
- The yearly average groundwater influx is approximately 70 cfs between Batiste Road and T2B and 250 cfs between Batiste Road and Siphon Road.
- Groundwater influx is relatively steady throughout the year.
- 2009 discharge at Siphon Road was typical when compared to previous years, with only slightly higher late summer flows.

7.3.2 Batiste Road Evaluation

Phosphorus concentrations at Batiste Road were compared to the Highway 30 sampling site between March 2005 and February 2008 (data range for Highway 30) in order to evaluate whether Batiste Road is being affected by EMF groundwater (Figure 7-5).

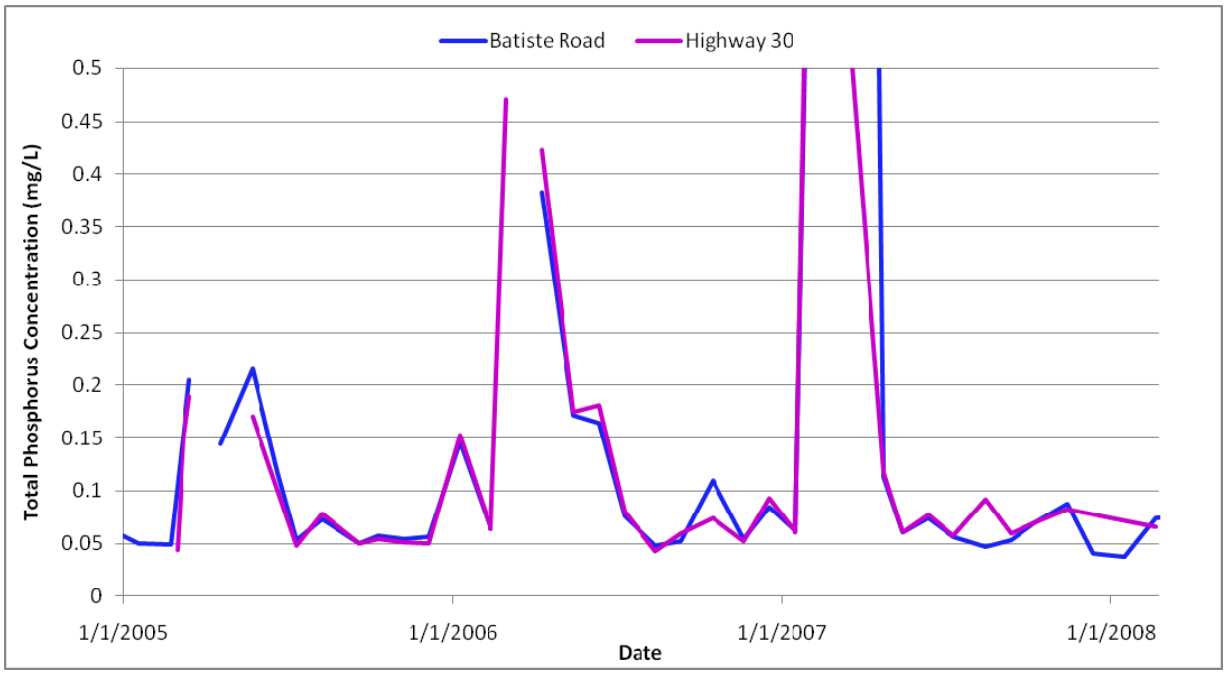


Figure 7-5: Comparison of Highway 30 and Batiste Road monitoring sites on the Portneuf River.

This indicates that Batiste Road is essentially identical in phosphorus concentration to Highway 30, which is farther upstream and out of the influence of regional groundwater influx. Using the concentration comparison of these two locations, it is clearly shown that Batiste Road is not affected by contaminated groundwater and can be used as a background monitoring location for the EMF Site.

7.3.3 Surface Water Chemistry and Water Quality

This section describes the water chemistry and quality of the Lower Portneuf River. The chemistry evaluated includes phosphorus and sulfate, and the quality measurements include dissolved oxygen, turbidity, total suspended solids, pH, and temperature.

Phosphorus Concentration

In order to evaluate the phosphorus concentration trends in the river for meeting the VCO and TMDL requirements, the monthly phosphorus concentrations at Siphon Road, T2B, and Batiste Road are examined. This includes graphically comparing Siphon Road and T2B to Batiste Road from 2004 through 2009 (Figure 7-6).

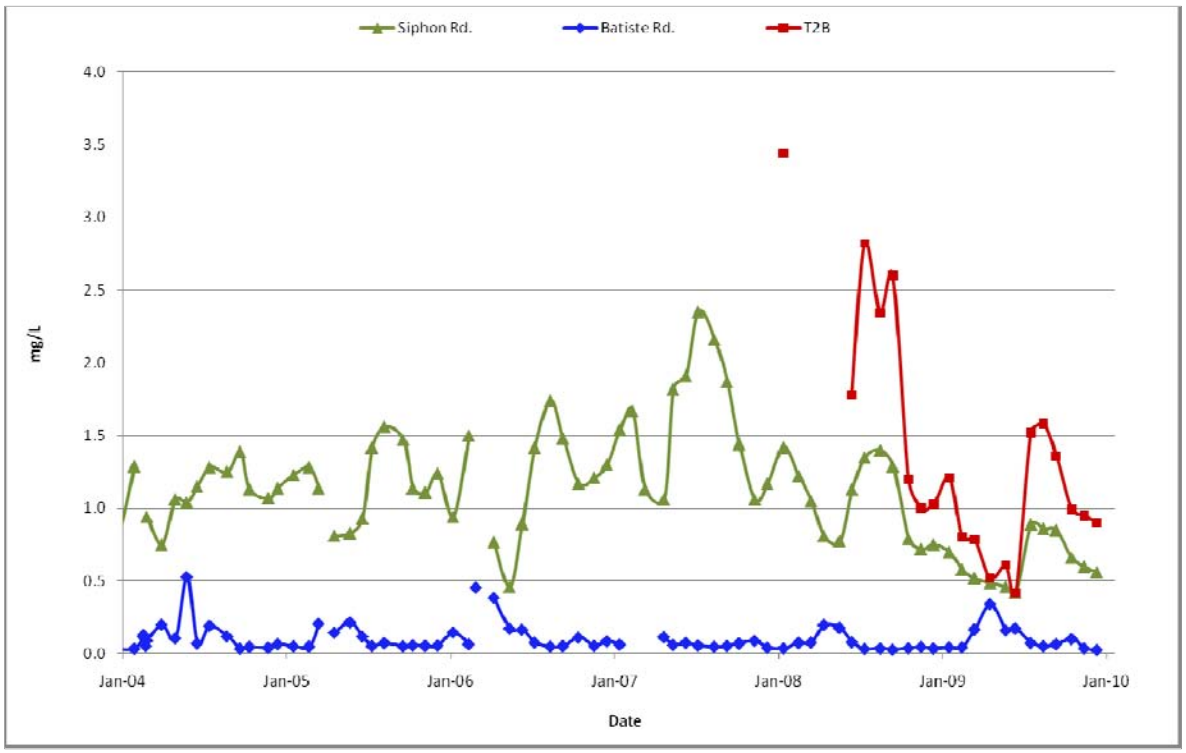


Figure 7-6: The phosphorus concentrations for the last 6 years at each monitoring site.

As shown, the concentrations at Siphon Road have decreased starting in 2007. T2B shows higher concentration levels and was selected as the location of highest impact from EMF groundwater. This site needs more years of monitoring before a trend can be stated for certain, but with the little data that is available, the concentration is generally reducing at this site as well.

Note that the high concentrations in February and March of 2007 have been omitted from the charts. The high amounts of phosphorus have been attributed to extremely high turbidity during spring runoff throughout the Portneuf River. To show that this trend was

also evident upstream from Batiste Road, the turbidity and phosphorus concentrations of March 2007 were tabulated and graphed with data from March 2008 and 2009. Table 7-4 shows the high phosphorus and turbidity levels in March of 2007 for 4 stations upstream from Batiste Road compared with March 2008 and 2009 and Figure 7-7 shows this trend graphically.

Table 7-4: The high phosphorus and turbidity levels of March 2007 compared to March 2008 and 2009.

Analyte	Year	Batiste Road	Fichter Park	Marsh Creek at Triplett's	Guthrie's	Topaz
Miles Upstream from Batiste Road		-	9.1	20.1	20.1	35.5
Turbidity (NTU)	Mar-07	212	127	81	120	122
	Mar-08	25.2	19.2	28.5	6.94	5.48
	Mar-09	26	30.6	32.7	2.93	6.1
TP (mg/L)	Mar-07	3.44	0.39	0.28	0.43	0.50
	Mar-08	0.08	0.07	0.11	0.04	0.06
	Mar-09	0.17	0.18	0.30	0.05	0.09

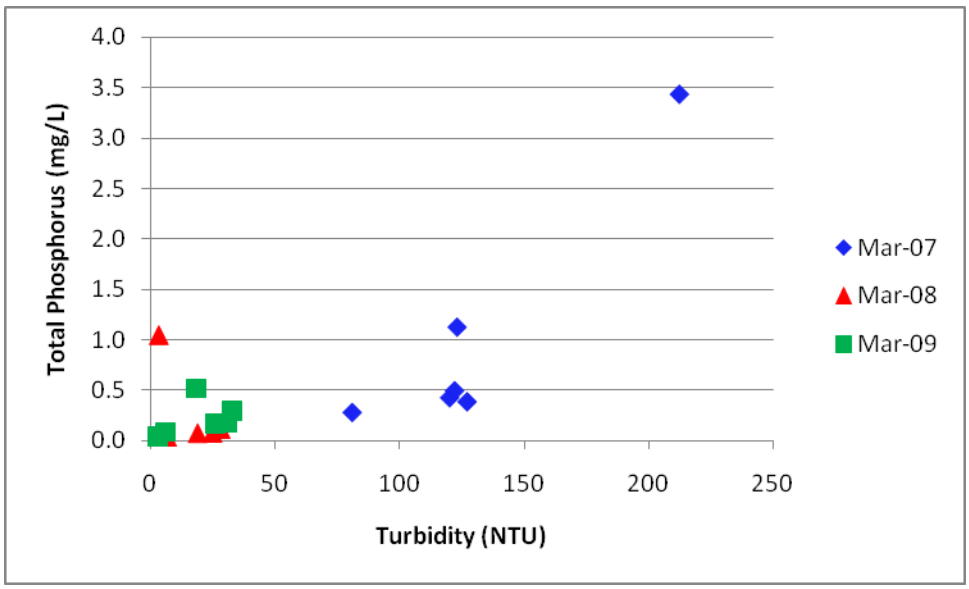


Figure 7-7: The high phosphorus and turbidity levels in the lower Portneuf River during March of 2007 compared to March of 2008 and 2009.

Table 7-4 and Figure 7-7 show that the high phosphorus concentration in the river at Batiste Road was not unusual for that year when compared to upstream sites. This trend of high turbidity leading to high phosphorus concentrations does occur, and when it does, it occurs all along the Lower Portneuf River.

To show the yearly concentration trend changes at Siphon Road, the monthly data were averaged since 2003 and graphed with the average monthly flow data (Figure 7-8).

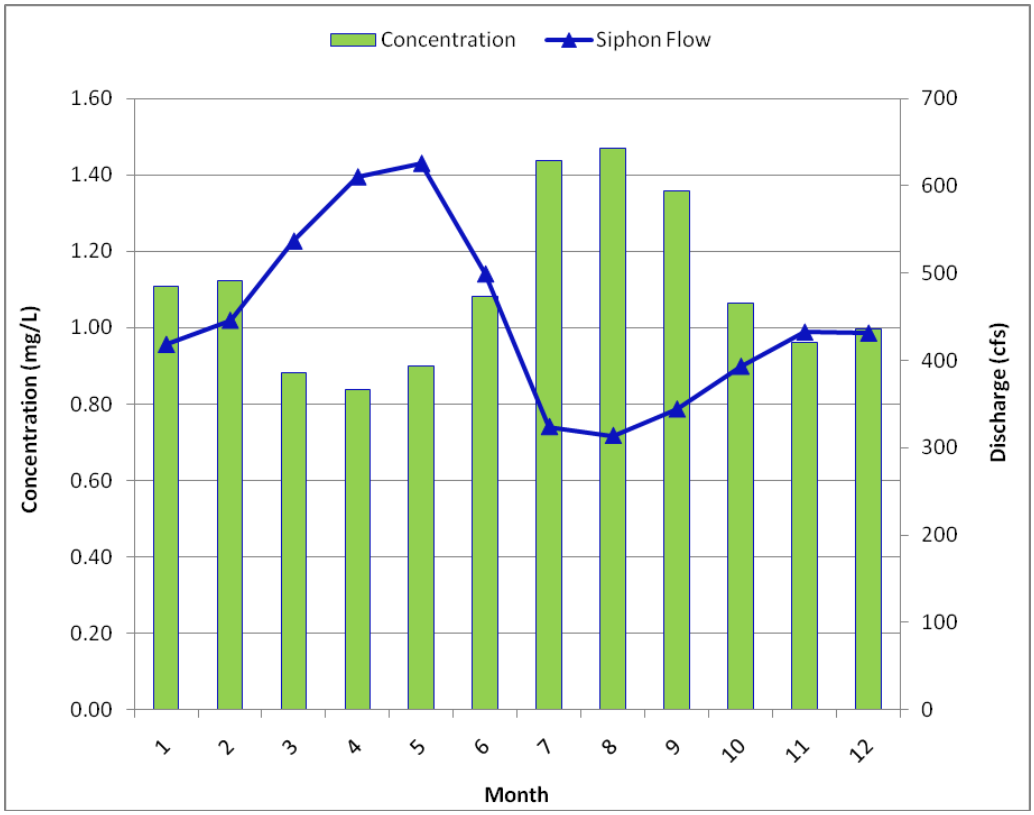


Figure 7-8: The monthly average concentration and discharge at Siphon Road (2003 – 2009).

This shows that the varying yearly concentrations were related to the changes in discharge amounts, with lower concentrations and high flows during spring runoff and higher concentrations and low flows in late summer.

To compare the phosphorus concentrations with the TMDL goal at Siphon Road of 0.07 mg/L (low flow) and 0.125 mg/L (high flow) (IDEQ 2009), the monthly phosphorus concentrations measured by IDEQ for the calendar year were tabulated and the median of the results calculated for direct comparison to the concentration targets. Figure 7-9 shows the phosphorus concentrations measured at Siphon Road and the median concentration for the current and previous 11 concentration points. The median and average concentration for each year since 2003 is summarized in Table 7-5.

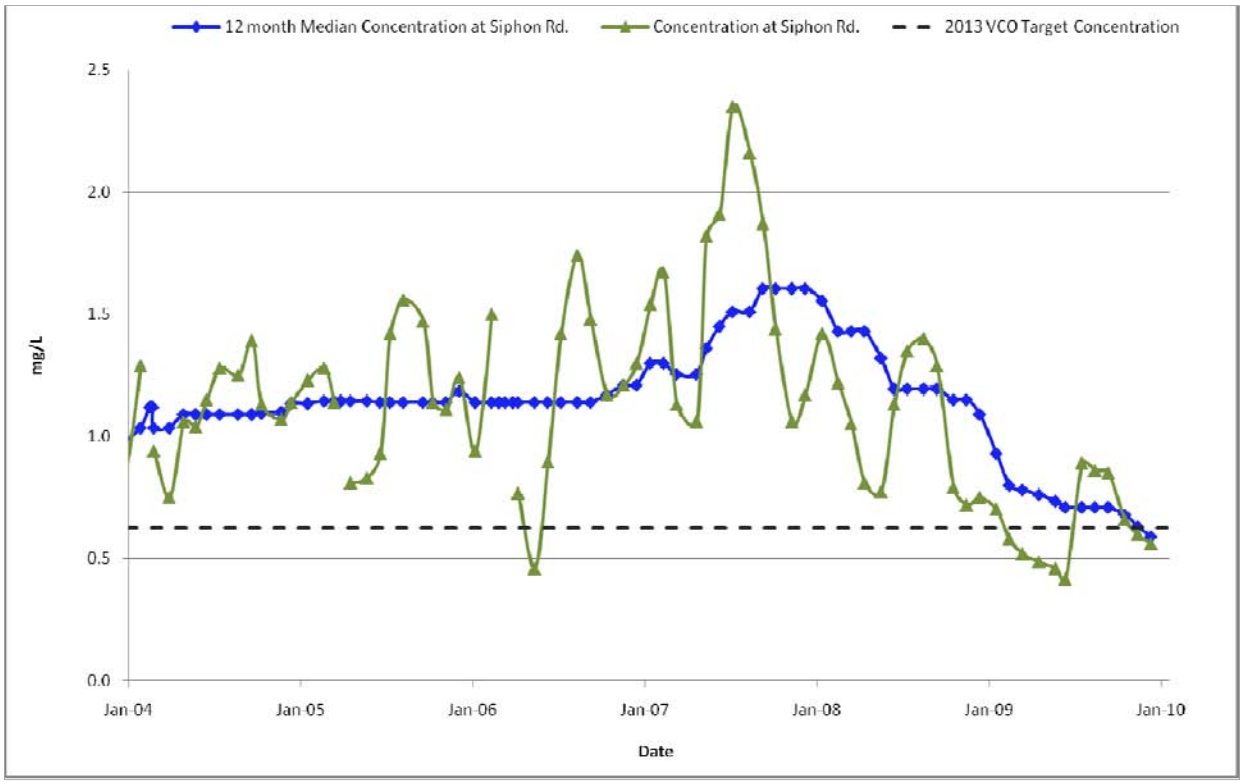


Figure 7-9: Phosphorus concentration and rolling annual median concentration for Siphon Road with the December 31st, 2013 VCO Target Concentration.

Table 7-5: Siphon Road yearly median and average phosphorus concentrations.

Year	Median	Average
2003	0.94	0.97
2004	1.14	1.12
2005	1.19	1.18
2006	1.17	0.99
2007	1.61	1.60
2008	1.09	1.06
2009	0.59	0.63
2013 Target	0.625	-

As shown, as of December 2009, the 12-month median concentration was 0.59 mg/L. This represents a 53% reduction from the IDEQ baseline of 1.25 mg/L and meets the December 31st, 2013 VCO/CA target concentration of 0.625 mg/L.

An outline of conclusions for concentration trends is provided below:

- Concentrations at Siphon Road have significantly decreased since 2007
- Varying seasonal concentrations can be attributed to changes in discharge

- The reduction in concentrations at Siphon Road in 2009 was due to reduced loading, not higher flow volumes
- The 12-month median phosphorus concentration for 2009 was 0.59 mg/L.

Phosphorus Loads

Since the concentrations measured in the river vary seasonally due to the changes in discharge amounts, the phosphorus loads in the Portneuf River were analyzed at Siphon Road, T2B, and Batiste Road to evaluate the effectiveness of remedial actions at the EMF Site. The phosphorus load amounts in pounds per day were calculated at each monitoring location by multiplying the concentration (lb/ft^3) and the discharge (ft^3/day). Figure 7-10 shows the load trends for each station from 2004 through 2009.

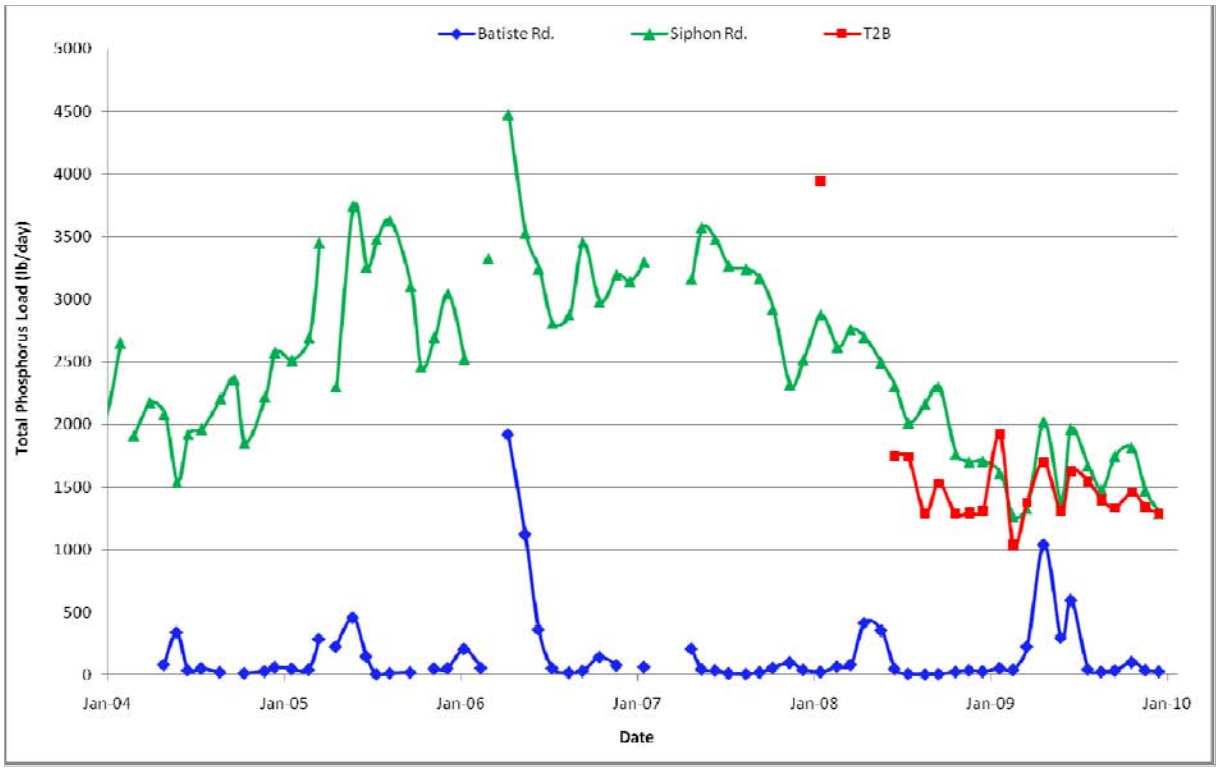


Figure 7-10: The phosphorus loads, in pounds per day, at Batiste Road, T2B, and Siphon Road.

The decrease in load amounts at Siphon Road is clearly evident. Batiste Road remained relatively steady since 2004, indicating that the reduced load at Siphon Road is a reflection of the reduced load amount from EMF groundwater.

To evaluate the estimated load of phosphorus from EMF groundwater, the calculated loads at Batiste Road and the estimated loads from the POTW and unaffected groundwater were subtracted from the calculated load at Siphon Road. Estimated load

amounts of 76 and 10 pounds per day were used for the POTW and regional groundwater, respectively (IDEQ 2004).

To demonstrate the seasonal trends of phosphorus loading from EMF compared to discharge at Siphon Road, field measurements were tabulated by month and averaged for the last 6 years (Figure 7-11).

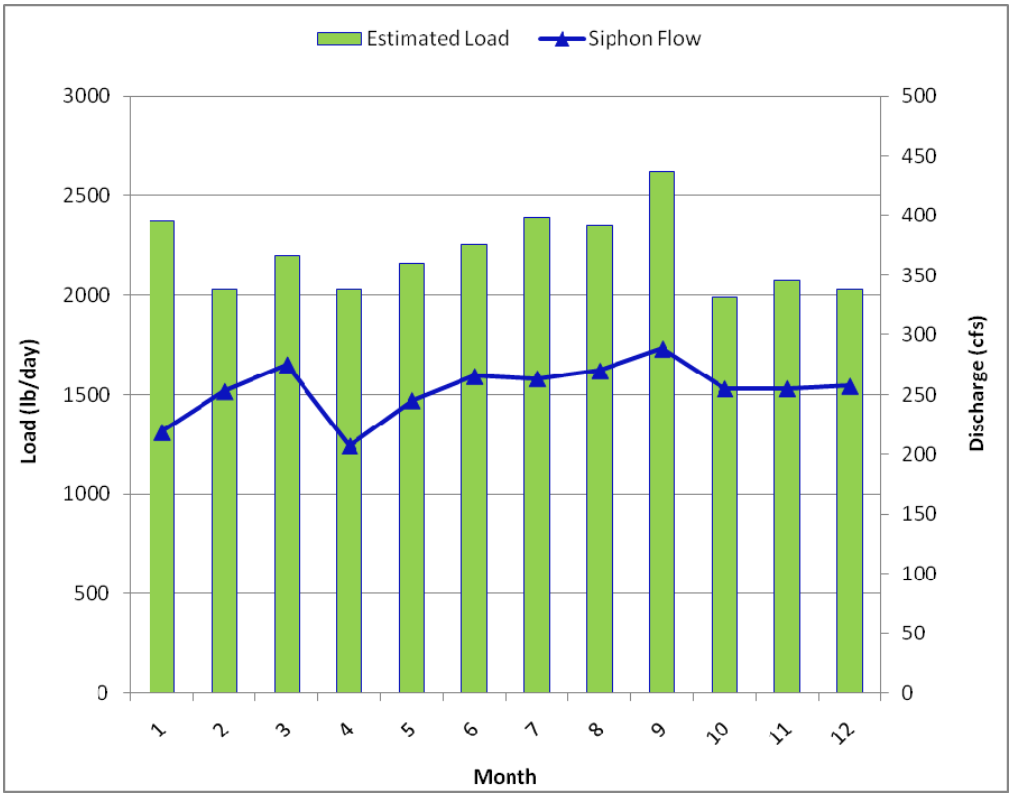


Figure 7-11: The average monthly estimated EMF phosphorus load at Siphon Road and the discharge difference between Batiste Road and Siphon Road (2003 – 2009).

The estimated phosphorus load amounts from EMF groundwater have been relatively constant with season, between 2,000 and 2,600 pounds per day. The discharge difference between Batiste Road and Siphon Road also remains fairly constant.

Detailed seasonal data are shown in Figure 7-12. The data further illustrates that phosphorus loads from EMF groundwater has not varied significantly with season. This figure also shows that phosphorus loads in 2009 were lower for every month compared to previous years.

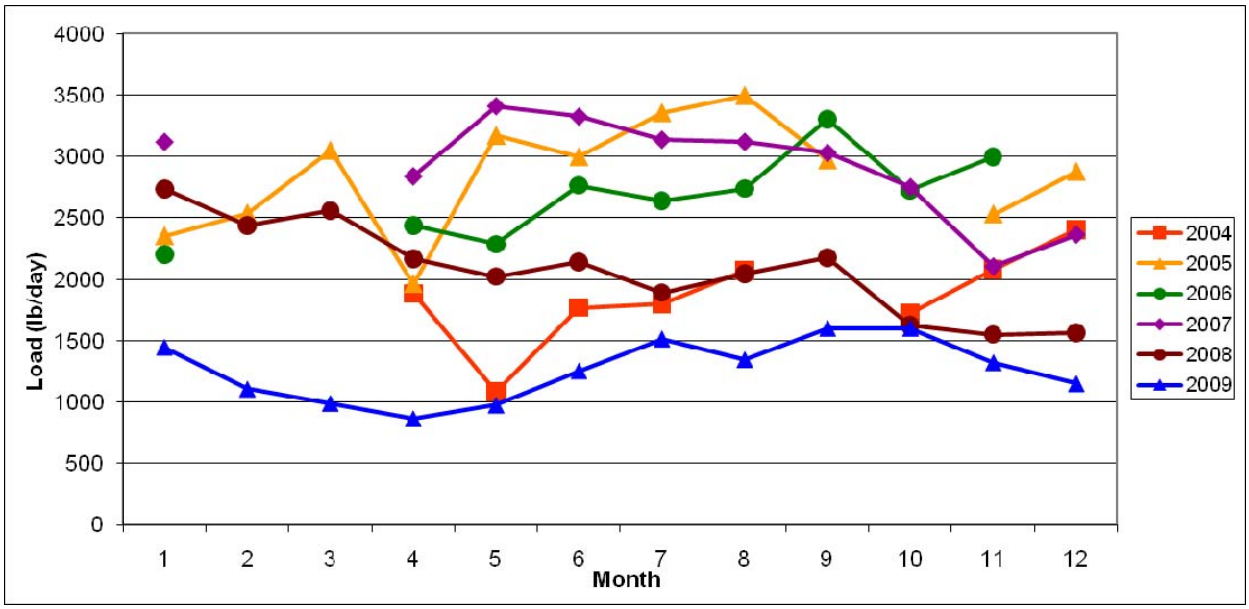


Figure 7-12: Estimated phosphorus loads from EMF groundwater at Siphon Road by year.

Table 7-6: The estimated yearly average load at Siphon Road from EMF groundwater.

Year	Average Load (lb/day)
2003	1690
2004	1851
2005	2844
2006	2678
2007	2920
2008	2076
2009	1263

The estimated phosphorus loads from EMF groundwater at Siphon Road have reduced to a yearly average of 1260 lb/day in 2009. This is the lowest average over the last 6 years and represents a 57% reduction from the 2007 average (Table 7-6).

The difference in EMF phosphorus loads between T2B and Siphon Road was evaluated in order to determine the amount of EMF groundwater entering the Portneuf River above T2B, and the potential capture by the Batiste Springs side channel (Figure 7-13).

Table 7-7 indicates the differences in load amounts between Siphon Road and T2B from estimated EMF groundwater.

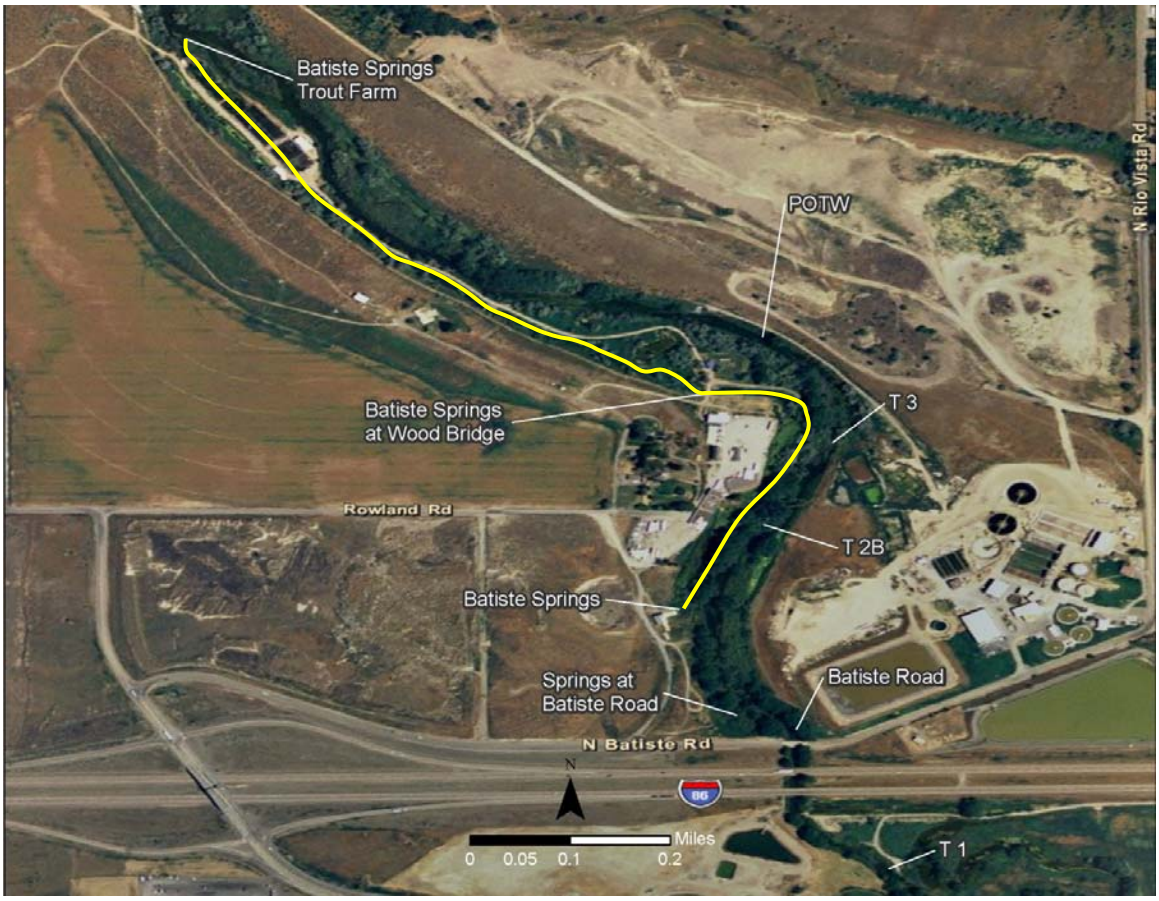


Figure 7-13: The location of the Batiste Springs channel (yellow) and monitoring stations.

Table 7-7: The difference between loads from EMF groundwater at Siphon Road and T2B (negative indicates higher loading at T2B over Siphon Road).

Date	Estimated EMF input at Siphon Road	Estimated EMF input at T2B	Difference
Jun-08	2142	1660	482
Jul-08	1891	1695	197
Aug-08	2047	1243	803
Sep-08	2176	1483	693
Oct-08	1625	1225	400
Nov-08	1550	1220	331
Dec-08	1564	1248	316
Jan-09	1444	1827	-383
Feb-09	1106	959	147
Mar-09	990	1112	-122
Apr-09	866	619	247
May-09	976	970	6
Jun-09	1253	992	261
Jul-09	1513	1466	47
Aug-09	1344	1335	9
Sep-09	1598	1262	337
Oct-09	1598	1315	283
Nov-09	1320	1263	57
Dec-09	1150	1221	-72

Monitoring station T2B usually demonstrates lower loads than Siphon Road. This indicates that station T2B, while affected from EMF groundwater, may not completely capture the total input amounts from EMF affected groundwater and that some EMF groundwater may be intercepted by the Batiste Springs channel before entering the Portneuf River further downstream. Further future monitoring of the Batiste Springs channel is planned (Batiste Springs at Wood Bridge, Figure 7-13).

In summary:

- The reduced load at Siphon Road is a reflection of the reduced load amount from EMF contaminated groundwater.
- The estimated phosphorus load amounts from EMF groundwater have been relatively constant with season, between 2,000 and 2,600 pounds per day.
- The estimated phosphorus loads from EMF groundwater at Siphon Road have reduced to a yearly average of 1260 lb/day in 2009. This is the lowest average over the last 6 years and represents a 57% reduction from the 2007 average.
- Monitoring station T2B does not completely show the total input load amounts from EMF affected groundwater and the groundwater may be intercepted by the Batiste Springs channel before entering the Portneuf River.

Sulfate

Sulfate data was analyzed as another contaminant in order to evaluate the effects of remedial actions at EMF. The concentration and loading data was monitored, compiled, and calculated the same as the phosphorus data. To show sulfate trends, concentrations and loads were graphed over the last 6 years for Batiste Road, T2B, and Siphon Road (Figure 7-14 and Figure 7-15).

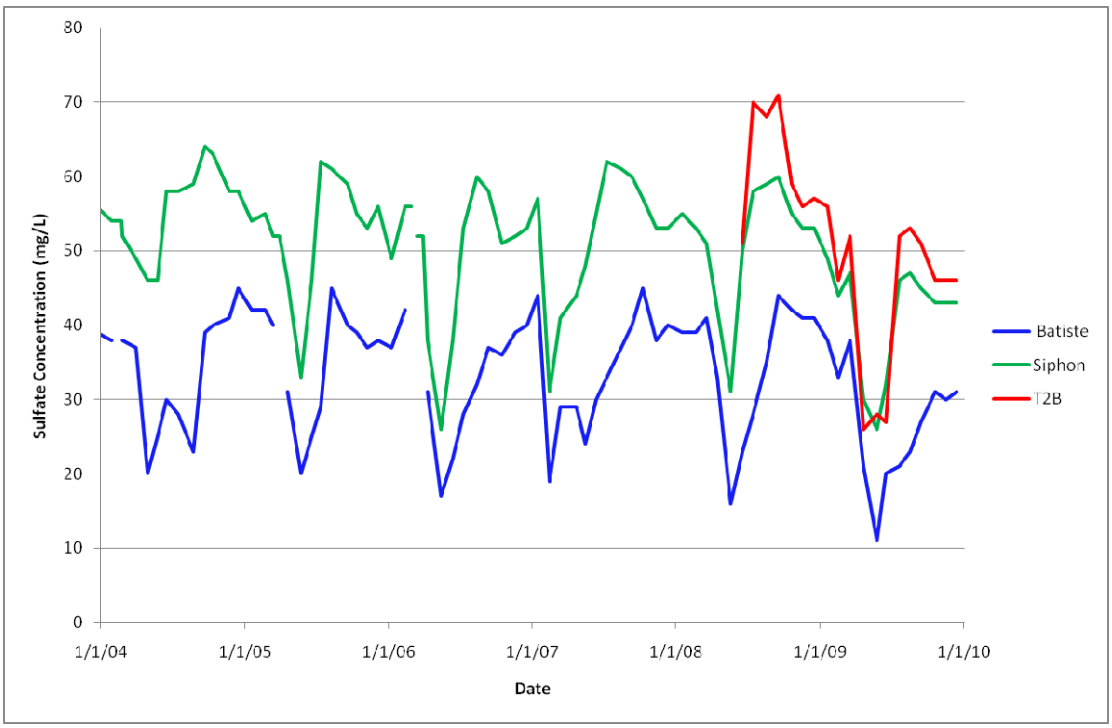


Figure 7-14: Sulfate concentrations at Batiste Road, Siphon Road, and T2B.

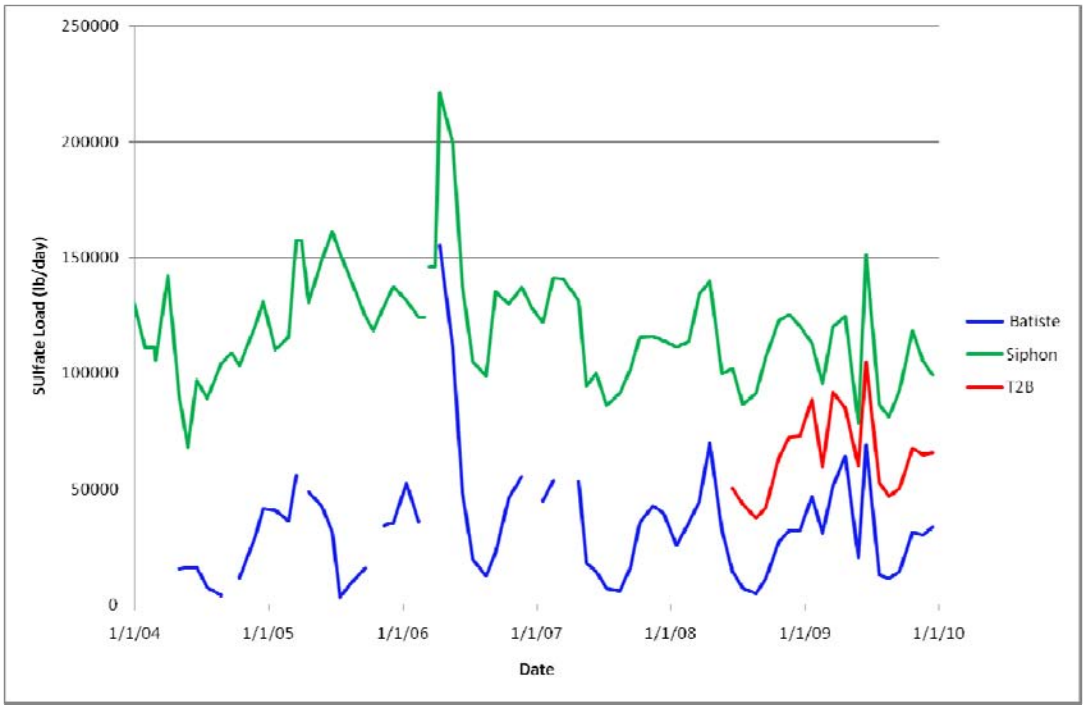


Figure 7-15: Sulfate loading at Batiste Road, Siphon Road, and T2B.

Figure 7-14 and Figure 7-15 show that the difference between Batiste Road and Siphon Road is small. Regional groundwater contains sulfate in the range of 58 mg/L and EMF groundwater near the river (measured at Batiste Springs) contains sulfate concentrations in the range of 53.7 to 425 mg/L, up to approximately 7.3 times background. Conversely, phosphorus concentrations are in the range of 0.4 to 47.8 mg/L, approximately 5 to 600 times the mean concentration of unaffected groundwater in the vicinity (0.08 mg/L). This indicates that sulfate is not a useful tracer for use in modeling the reduction in loads to groundwater from the EMF site.

Dissolved Oxygen

The dissolved oxygen (DO) in the lower Portneuf River is a concern due to the effects it can have on biological activity in the river system. DO is affected by many different factors, one of which is high algae activity, which tends to reduce DO at night and increase DO during the day. Large-scale diel swings in DO are indicative of excessive plant and algae growth and potential nutrient impacts. High algae activity may increase due to high nutrient loading (i.e. phosphorus). Figure 7-16 shows a plot of average daily minimum DO and log average summer TP levels for 2003 through 2009 for Batiste and Siphon Roads.

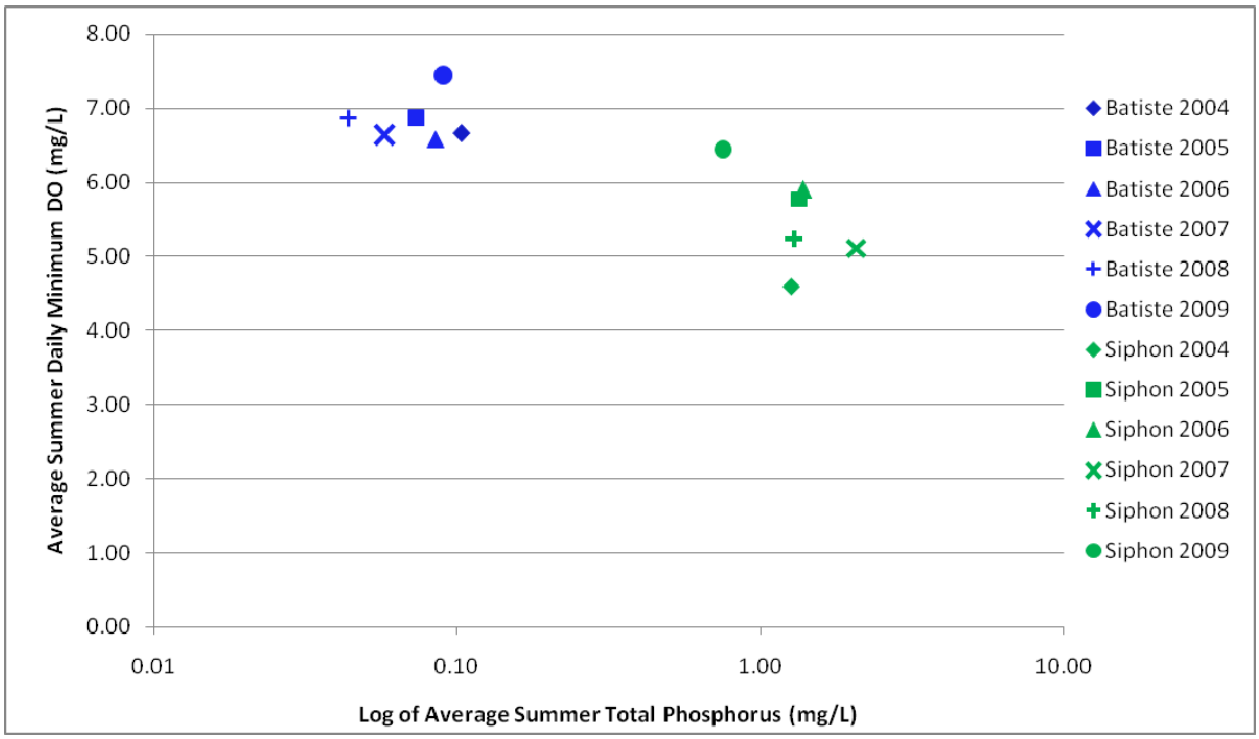


Figure 7-16: The correlation between dissolved oxygen and phosphorus.

The data show that the minimum DO values are reduced from Batiste Road to Siphon Road and that the nutrient concentration ranges are substantially different. Thus, a clear causative link to nitrogen and/or phosphorus is difficult to establish from these data. Figure 7-17 and Figure 7-18 show data collected in 2009 as an example and a summary of average observed data at both sites is presented in Table 7-8. Figure 7-19 shows the yearly average trend for both sites from 2004 through 2009.

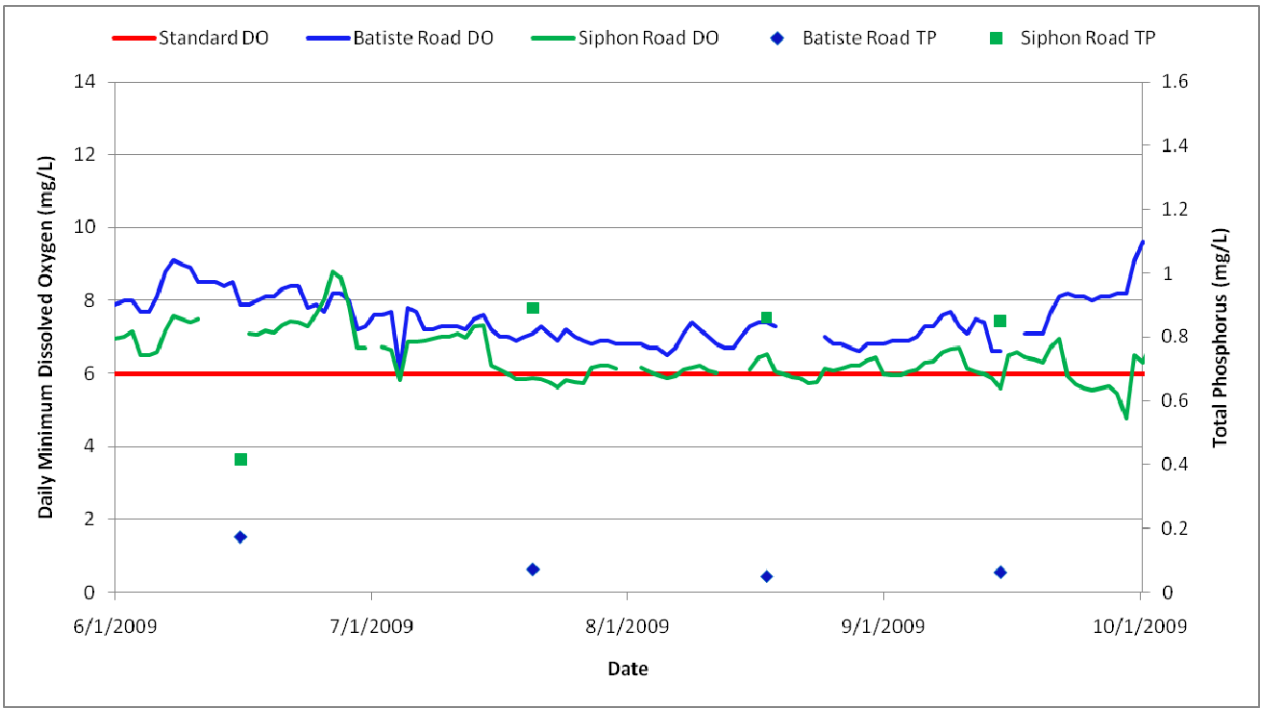


Figure 7-17: Summary of DO and TP monitoring at Batiste Road v. Siphon Road (Summer 2009).

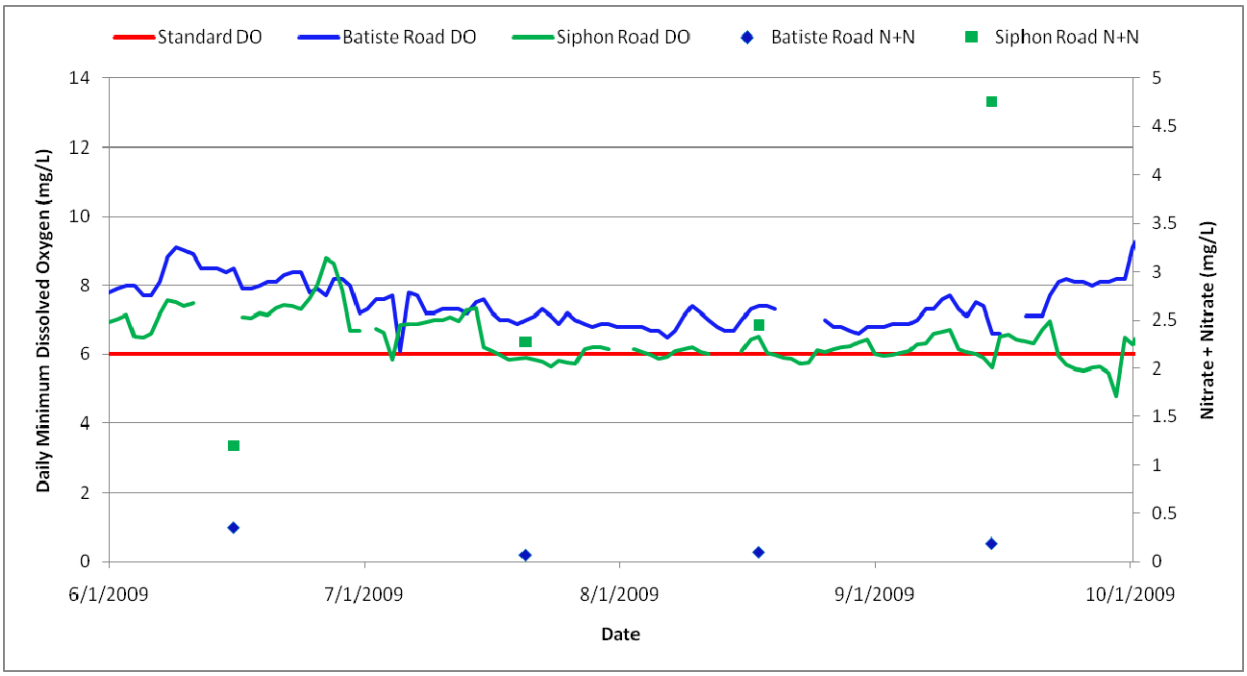


Figure 7-18: Summary of DO and Nitrogen monitoring at Batiste Road v. Siphon Road (Summer 2009).

Table 7-8: Summary of summer average data at Batiste Road verse Siphon Road (2003 - 2009).

		Batiste	Siphon
2003	Avg Daily Min DO	5.25	5.76
	Avg Daily Min pH	7.95	7.13
	Avg Daily Max pH	8.52	7.62
	Avg P	0.05	1.24
	Avg N	0.24	2.91
	Veg (%)	-	-
2005	Avg Daily Min DO	6.92	5.73
	Avg Daily Min pH	8.39	7.47
	Avg Daily Max pH	8.53	7.77
	Avg P	0.07	1.35
	Avg N	0.18	2.42
	Veg (%)	70	96.3
2006	Avg Daily Min DO	6.41	5.87
	Avg Daily Min pH	8.34	7.46
	Avg Daily Max pH	8.47	7.62
	Avg P	0.09	1.38
	Avg N	0.39	2.53
	Veg (%)	14.3	74.1
2007	Avg Daily Min DO	6.44	5.06
	Avg Daily Min pH	8.32	7.33
	Avg Daily Max pH	8.41	7.62
	Avg P	0.06	2.07
	Avg N	0.23	2.86
	Veg (%)	-	-
2008	Avg Daily Min DO	6.78	5.24
	Avg Daily Min pH	8.31	7.44
	Avg Daily Max pH	8.49	7.76
	Avg P	0.04	1.29
	Avg N	0.18	2.72
	Veg (%)	-	-
2009	Avg Daily Min DO	7.45	6.44
	Avg Daily Min pH	8.28	7.52
	Avg Daily Max pH	8.42	7.74
	Avg P	0.09	0.75
	Avg N	0.22	2.02
	Veg (%)	-	-
Combined	Avg Daily Min DO	6.54	5.68
	Avg Daily Min pH	8.27	7.39
	Avg Daily Max pH	8.47	7.69
	Avg P	0.07	1.34
	Avg N	0.24	2.61
	Veg (%)	40.13	81.9

Note: DO and pH averages come from continuous datasets. P and N averages come from discrete datasets where samples were collected approximately once per month. DO, pH, P, and N measurements were averaged over the summer season (June - September), Vegetative cover percentages come from a single summer measurement.

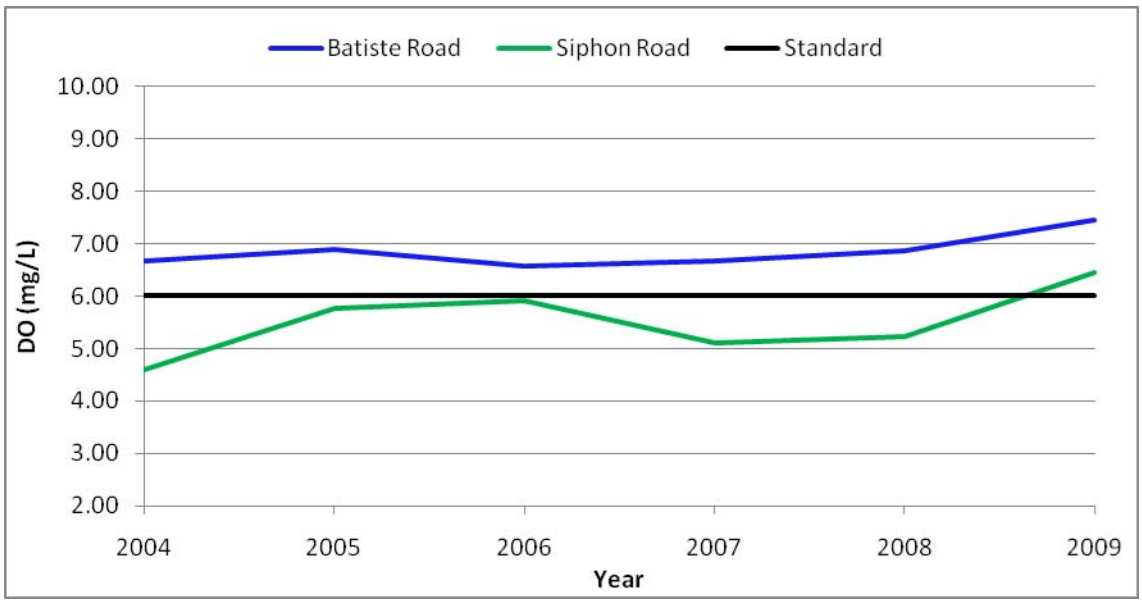


Figure 7-19: The yearly average dissolved oxygen trend for Batiste Road and Siphon Road.

Table 7-9: The number of days at Siphon Road with dissolved oxygen levels under 6.0 mg/L.

Date	Days under 6.0 mg/L
2004	71
2005	80
2006	79
2007	113
2008	102
2009	33

As shown in Table 7-8, Table 7-9, and Figure 7-19, 2009 has demonstrated considerable improvement with regards to dissolved oxygen levels.

There are other sources of pollutants and other activities that occur between Batiste Road and Siphon Road that could explain, at least in part, some of the differences observed between these sites. These include regional groundwater inflow, discharge from the Pocatello Wastewater Treatment Plant, septic tanks, fish hatchery operations, runoff from agricultural and urban areas, and changing flow volumes. DO concentrations are affected by multiple processes, including sediment oxygen demand, re-aeration, flow, and oxygen-demanding materials; in addition to nutrient-related eutrophication effects. The relative importance of these various processes on the DO regime requires further analysis.

In summary:

- DO concentrations are affected by multiple processes other than nutrient loading that require further analysis.
- 2009 DO levels are higher at Siphon Road compared to past years with only 33 days under 6.0 mg/L.

Turbidity

Turbidity is monitored continuously at both Batiste and Siphon Roads. To further analyse the potential differences between Batiste and Siphon Roads and compare levels to the TMDL goals, , the maximum daily turbidity level was determined. The water quality standards for turbidity "shall not exceed background by more than 50 NTU instantaneously or more than 25 NTU for more than 10 consecutive days" (IAC 2009 [58.01.02.250]). Background levels were calculated using a 20 day rolling median value.

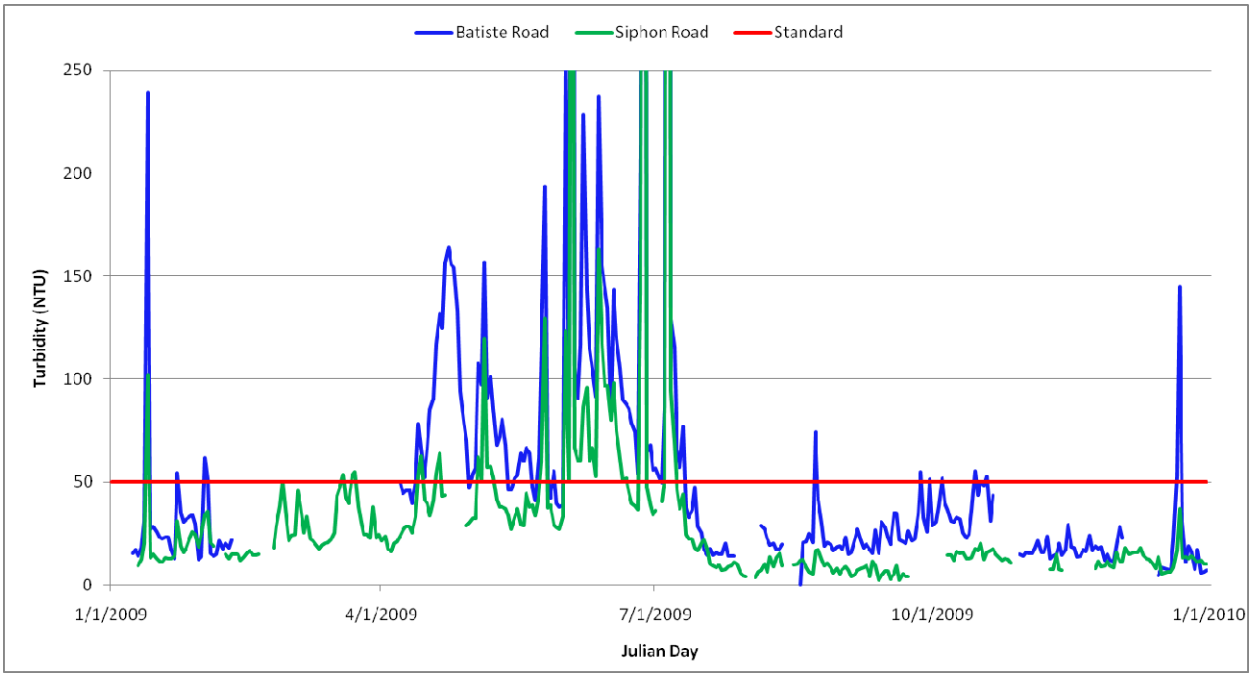


Figure 7-20: The daily maximum turbidity minus background levels for Batiste and Siphon Roads with the 50 NTU standard.

Figure 7-20 shows that Batiste Road demonstrated 93 days with greater than 50 NTU over background levels while Siphon Road measured 34 days with greater than 50 NTU over background levels. The lower turbidity levels at Siphon Road are most likely due to the large groundwater influx in-between the two sites including EMF groundwater which has low turbidity levels. The extremely high readings in the beginning of July are due to a large storm that contributed significant sediment amounts to the river through runoff. To show the trends for turbidity at each site, the number of days over 50 NTU were

divided by the days of measurement to estimate a percentage of days exceeding the turbidity standard.

Table 7-10: The estimated percentage of days over 50 NTU above background turbidity for Batiste and Siphon Roads.

Location	2004	2005	2006	2007	2008	2009
Batiste	20.5%	33.6%	38.3%	23.9%	9.2%	33.6%
Siphon	8.4%	15.9%	18.9%	10.1%	3.2%	10.9%

Table 7-10 shows that Siphon Road has less days above 50 NTU consistently for the last 6 years compared to Batiste Road. Overall the water quality for turbidity is better at Siphon Road than upstream.

The daily maximum turbidity was then compared to phosphorus in order to assess the correlations between these data quality parameters (Figure 7-21 and Figure 7-22).

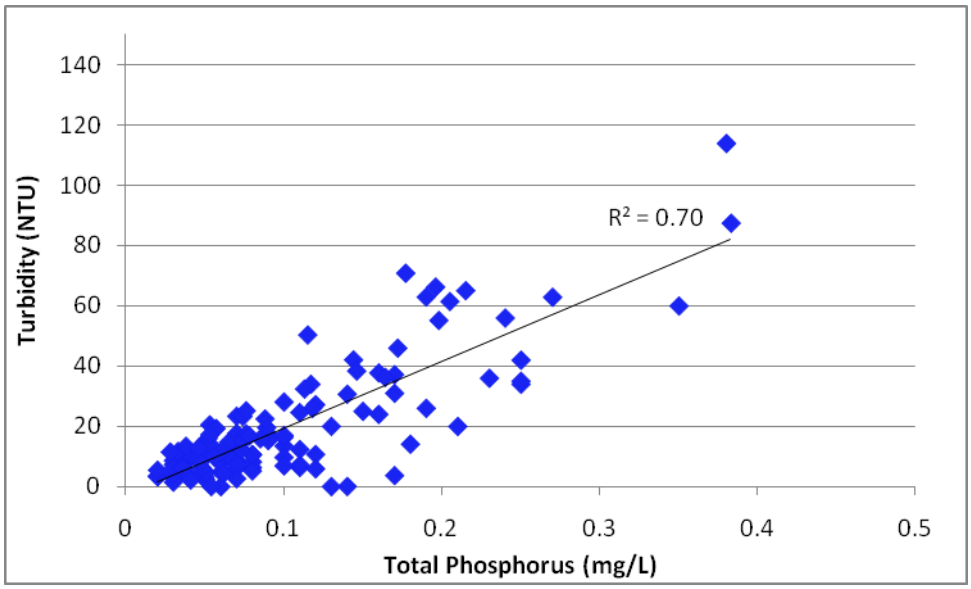


Figure 7-21: The turbidity and phosphorus relationship at Batiste Road (1998 – 2009).

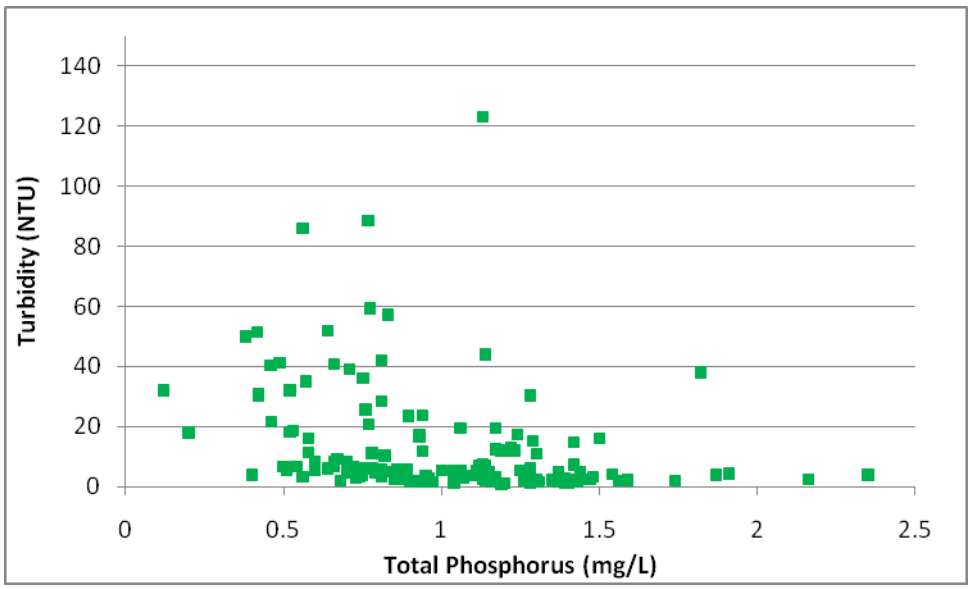


Figure 7-22: The turbidity and phosphorus relationship at Siphon Road (1998 – 2009).

The correlation between turbidity and phosphorus at Batiste Road is high (R^2=0.7) while there is no trend evident at Siphon Road. This is likely due to the high groundwater influx, including EMF groundwater, before Siphon Road.

In summary:

- Water quality for turbidity is higher at Siphon Road compared to Batiste Road.
- The trend between phosphorus concentration and turbidity is strong at Batiste Road while no trend exists at Siphon Road.

Total Suspended Solids

Total suspended solids (TSS) are measured in order to assess the TMDL goals for the lower Portneuf River. The TMDL goal for TSS is 35 mg/L for low flow conditions and 80 mg/L for high flow (IDEQ 2009). The TSS concentration for Batiste and Siphon Roads are shown graphically to compare the two sites to the TMDL goals (Figure 7-23).

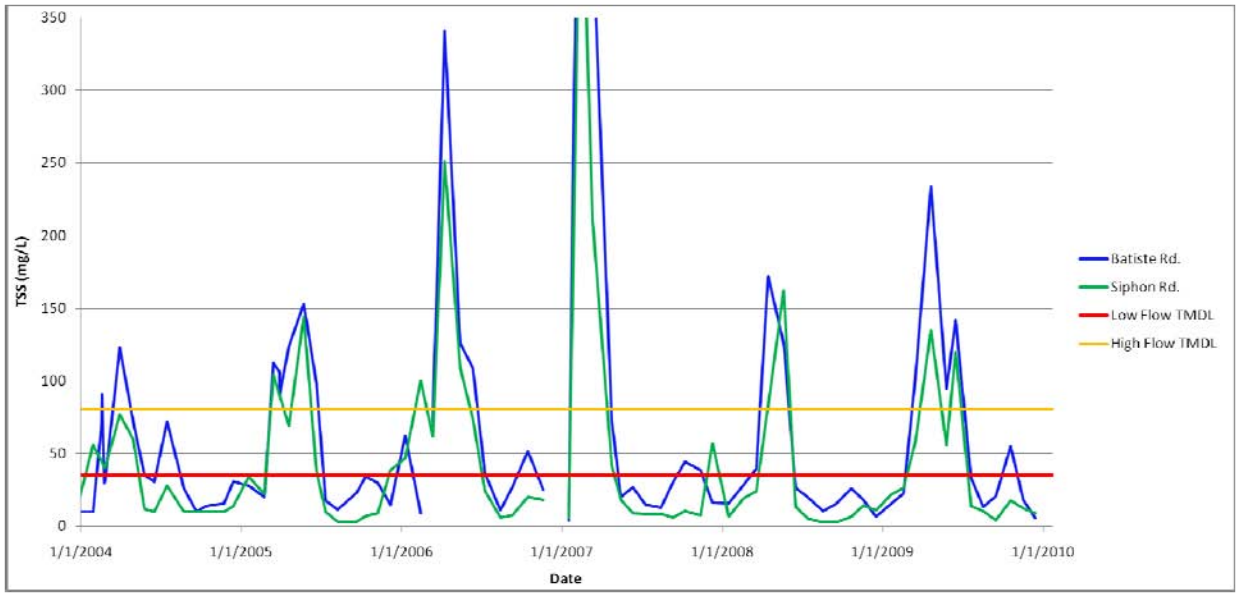


Figure 7-23: The TSS concentration at Batiste and Siphon Roads with low and high flow TMDL target concentrations.

Both sites have shown concentrations above the TMDL during spring runoff periods for the last 6 years. During low flow periods, however, Batiste Road demonstrates slightly higher TSS concentrations than Siphon Road, with Batiste Road occasionally reading greater than 35 mg/L. Siphon Road maintains the TSS TMDL during low flow. EMF and regional groundwater are not sources of TSS to the Portneuf River, as evident at Siphon Road.

Total suspended solid levels were then compared to phosphorus in order to assess the correlations between these data quality parameters (Figure 7-24 and Figure 7-25).

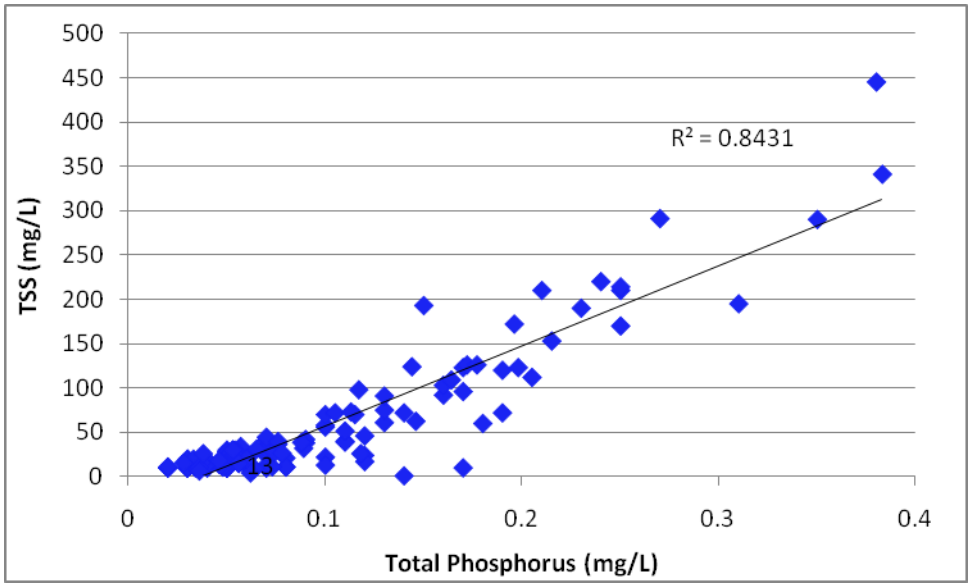


Figure 7-24: Batiste Road phosphorus compared to total suspended solids (TP<0.4 mg/L).

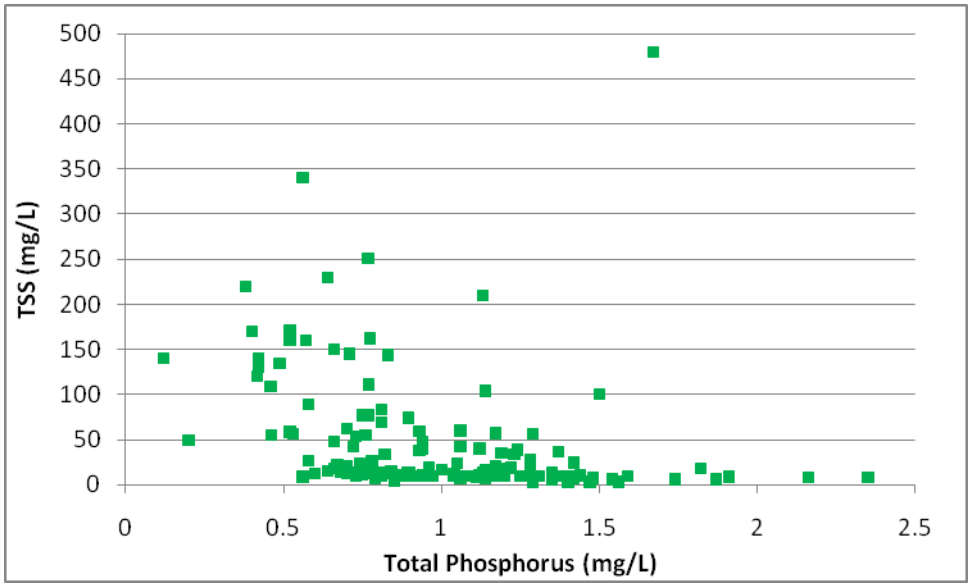


Figure 7-25: Siphon Road phosphorus compared to total suspended solids.

TSS is closely related to phosphorus concentrations at Batiste Road with an R^2=0.8 (TP< 0.4 mg/L). Phosphorus at Batiste Road is primarily in suspended form, giving the relationship between TSS and phosphorus. The TSS concentration at Siphon Road, however, is not statistically comparable to phosphorus concentrations. This is due to the phosphorus entering the river in dissolved form through groundwater inputs.

In summary

- Both Batiste and Siphon Road have shown concentrations above the high flow TMDL of 85 mg/L during spring runoff periods for the last 6 years.
- Siphon Road maintains the TSS TMDL of 35 mg/L during low flow.
- The trend between phosphorus and total suspended solids is strong at Batiste Road while no trend exists at Siphon Road.

<u>Temperature and pH</u>

Temperature and pH are further water quality standards that have an influence on a river system and these parameters are measured continuously at both Batiste and Siphon Roads. pH data were tabulated as the daily minimum for comparison to water quality while the temperature was averaged daily (Figure 7-26 and Figure 7-27).

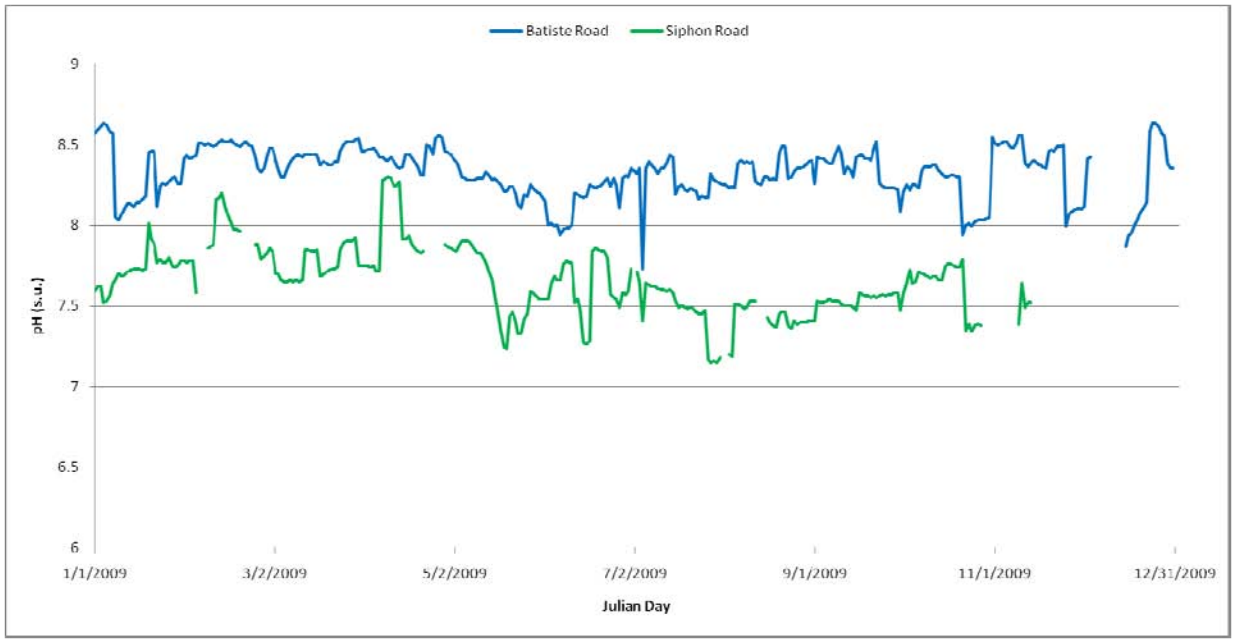


Figure 7-26: The daily minimum pH for Batiste Road and Siphon Road (2009).

The water quality standard for pH is to be in the range of 6.5 to 9.0 units (IAC 2009 [58.01.02.250]). pH upstream of the EMF Site at Batiste Road is higher (approaching the maximum end of the allowable range) than at Siphon Road.

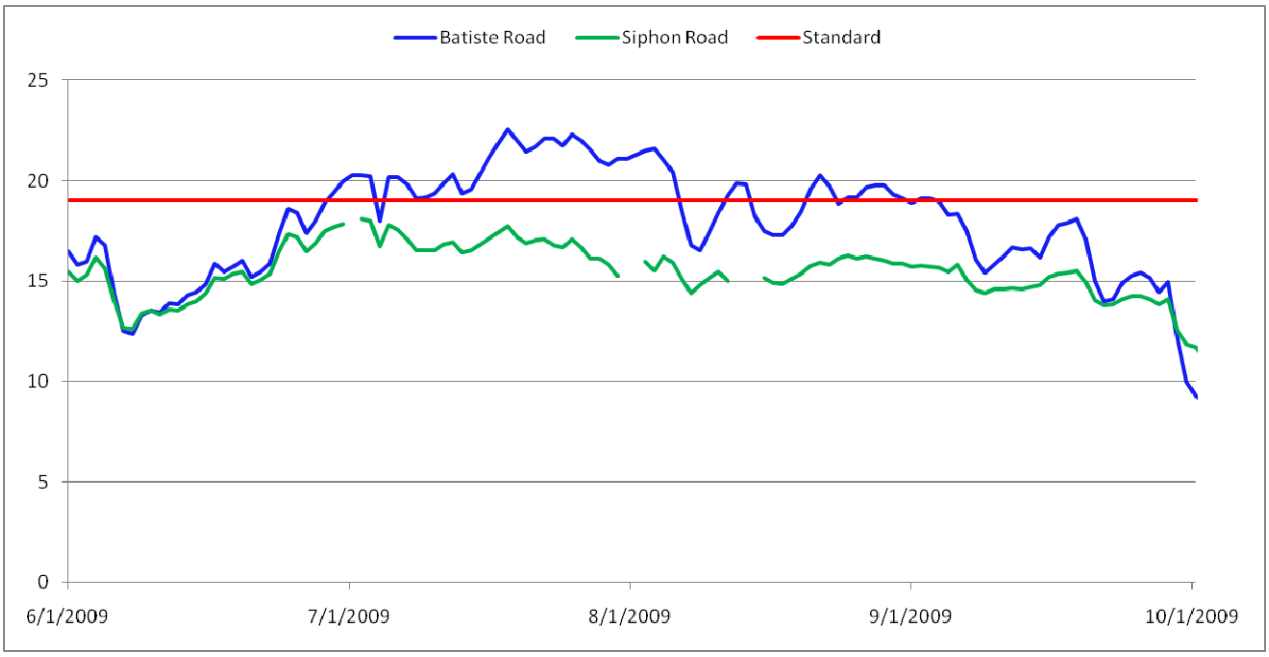


Figure 7-27: Daily temperature comparison - Batiste Road v. Siphon Road (Summer 2009).

The corresponding temperature standard for the Portneuf River on a daily average basis is 19 degrees C for protection of cold water biota (note: 22 degrees C is the instantaneous standard) (IAC 2009 [58.01.02.250]). Average daily temperature values frequently exceed the temperature standard at Batiste Road, while the standard is

always met at Siphon Road, due to the large influx of regional groundwater with temperature typically in the range of 12 to 13 degrees C.

For water temperature and maximum pH (which is also related to increased algal activity), the general trend is substantial improvement in quality at Siphon Road compared to Batiste Road. The substantially cooler water temperatures at Siphon Road are presumably related to groundwater that enters the river downstream of Batiste Road. Regional groundwater in the valley just north of the EMF facilities has a relatively constant temperature year-round, typically between 12 and 13 degrees C and relative constant pH, typically 7.4 to 7.6 su (EMF wells 524 and 525, data record from 2000 to present). Approximately 30 cfs of this groundwater originates from the EMF Site and has a pH ranging from 6.5 to 7.5 su (Batiste Spring and the Spring at Batiste, quarterly data since 2000, Figure 7-13) and is not elevated in temperature. Thus, regional groundwater tends to reduce the pH and cool the river downstream of Batiste Road and is believed to have a significant influence on river conditions at Siphon Road.

In summary:

- pH upstream of the EMF Site at Batiste Road is substantially higher than at Siphon Road.
- Average daily temperature values frequently exceed the temperature standard at Batiste Road, while the standard is always met at Siphon Road.
- The general trend for temperature and pH is substantial improvement in quality at Siphon Road compared to Batiste Road due to regional and EMF groundwater inputs between sites.

Conclusions

The results of the surface water monitoring program for the lower Portneuf River through 2009 are summarized below.

- The yearly average groundwater influx is approximately 70 cfs between Batiste Road and T2B and 250 cfs between Batiste Road and Siphon Road and is relatively steady throughout the year.
- Discharge at Siphon Road in 2009 showied no significant deviation from previous years, indicating that reduced concentrations in phosphorus at Siphon Road are not due to higher discharges, but due to reduced loads from EMF groundwater.
- Batiste Road is not affected by EMF groundwater and can be used as a background monitoring location.
- Concentrations at Siphon Road have significantly decreased starting in 2007 with the 12-month median phosphorus concentration for 2009 equal to 0.59 mg/L. This meets the December 31st, 2013 VCO goal.
- The reduced load at Siphon Road is a reflection of the reduced load amount from EMF groundwater with the estimated phosphorus loads from EMF groundwater at Siphon Road having reduced to a yearly average of 1260 lb/day in 2009. This

is the lowest average over the last 6 years and represents a 57% reduction from the 2007 average.

- Monitoring station T2B may not completely show the total input load amounts from EMF affected groundwater and the groundwater may be intercepted by the Batiste Springs channel before entering the Portneuf River further downstream.
- Dissolved oxygen levels at Siphon Road showed considerable improvement with the average daily minimum concentration equal to 6.44 mg/L for 2009.
- The pH upstream of the EMF Site at Batiste Road is substantially higher than at Siphon Road.
- The general trend for turbidity, TSS, temperature, and pH is improvement in quality at Siphon Road compared to Batiste Road.

There continues to be uncertainties related to the question of how much of the observed impairment in the lower Portneuf is due to excess nutrients and how much is due to other factors such as elevated temperatures, low water levels/flow regulation, groundwater influences, oxygen-demanding materials or land uses. Additional monitoring of key parameters is expected and may result in information that helps reduce these uncertainties. However, as the phosphorus loads decrease, future monitoring should focus on whether the river is responding to these improvements. Monitoring should evolve from defining the problem (that is, assessing the current chemical and biological status of the river) to measuring improvements related to TMDL implementation.

8.0 REMEDY PERFORMANCE

This section provides a summary of the overall performance of the remedy in 2009. The performance of the remedy components, source control, and groundwater extraction, are examined in terms of effectiveness near the point of implementation. The overall performance is assessed in terms of influence on groundwater and surface water quality at the point of compliance for groundwater in the Portneuf River.

8.1 Direct Effects of Remedy Implementation

8.1.1 Gypsum Stack Source Control

The gypsum stack lining project will take place in four major stages: decant pond construction, lower compartment lining, upper west compartment lining, and upper east compartment lining. Decant pond construction was completed in 2009. The lining project for the lower compartment commenced in October 2009 when the lower stack was taken out of service. The stack lining project will be completed in the next 5 years. After each phase of lining, seepage through the gypsum to groundwater will be significantly reduced. Predicted seepage reduction from the gypsum stack is shown in Figure 8-1 (Simplot 2009b). Since no stack lining was completed in 2009, the effects of seepage reduction have not yet been observed.

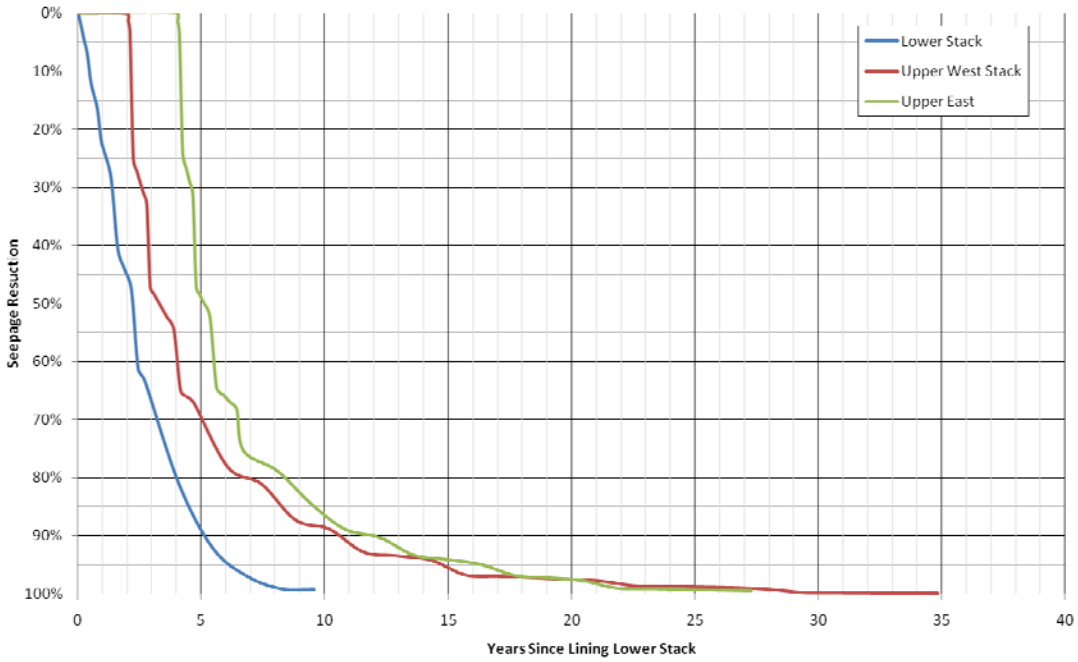


Figure 8-1: Estimated seepage reduction at each of the gypsum stack compartments.

8.1.2 Phosphoric Acid Plant Area Source Control

The total phosphorus load attributable to the phosphoric acid plant area can be evaluated by calculating the phosphorus mass flux in groundwater upgradient and downgradient of the phosphoric acid plant area. A detailed description of the calculation methodology is provided in Technical Report No. 1 (Simplot 2009b). Calculations of the estimated phosphorus load gained in the phosphoric acid plant area are summarized in Tables 8-1 through 8-5. Detailed calculations are provided in Appendix I.

The concentration of phosphorus in groundwater upgradient of the phosphoric acid plant area is represented by the Upper Zone wells 325, 334, and 341, which are monitored quarterly. The mean phosphorus concentration was 11.9 mg/L in well 325, 173 mg/L in well 334 for 2009 and 23.4 mg/L for well 341 for the third and fourth quarter of 2009. A trend of increasing concentrations in the eastern upgradient well 334 has been observed (Section 6) in recent years and appears to be related to increasing concentrations in the East Plant Area.

In 2009, constituent concentrations in groundwater downgradient of the phosphoric acid plant area were elevated at the locations of wells 340 and 419. Concentrations in groundwater samples from both of these wells have consistently decreased as the result of infrastructure improvements in the phosphoric acid plant area in 2009. Resulting mass flux rates in the phosphoric acid plant area have decreased from 1,459 lb/day in the first quarter of 2009 to 358 lb/day by fourth quarter 2009. This corresponds to a 75% reduction in 2009.

Table 8-1: The calculated mass flux of phosphorus for the upgradient and downgradient lines of assessment in the phosphoric acid plant area, First Quarter, 2009.

RESULTS:		*2009*	**Q1**		
ORTHOPHOPHATE					
		Q (gpm)	*Mean P (mg/L)*	*P Load (kg/day)*	*Fraction of Total Load*
	Upper Zone Central Upgradient				
	Total upgradient	140	68	51	*7.2%*
	Upper Zone Central Downgradient				
	Stack	126	206	142	
	340	2	2626	28	
	419	12	8604	544	
	Total downgradient			713	
	LOAD GAINED:			*662*	*100.0%*
				1459	*lb/day*

Table 8-2: The calculated mass flux of phosphorus for the upgradient and downgradient lines of assessment in the phosphoric acid plant area, Second Quarter, 2009.

RESULTS:			**Q2**		
ORTHOPHOPHATE					
		Q (gpm)	*Mean P (mg/L)*	*P Load (kg/day)*	*Fraction of Total Load*
	Upper Zone Central Upgradient				
	Total upgradient	140	92	70	*11.6%*
	Upper Zone Central Downgradient				
	Stack	126	146	100	
	340	2	1935	20	
	419	12	7623	482	
	Total downgradient			603	
	LOAD GAINED:			*533*	*100.0%*
				1175	*lb/day*

Table 8-3: The calculated mass flux of phosphorus for the upgradient and downgradient lines of assessment in the phosphoric acid plant area, Third Quarter, 2009.

RESULTS:			**Q3**		
ORTHOPHOPHATE					
		Q (gpm)	*Mean P (mg/L)*	*P Load (kg/day)*	*Fraction of Total Load*
	Upper Zone Central Upgradient				
	Total upgradient	140	82	62	*20.1%*
	Upper Zone Central Downgradient				
	Stack	126	158	109	
	340	2	1378	15	
	419	12	2953	187	
	Total downgradient			310	
	LOAD GAINED:			*248*	*100.0%*
				546	*lb/day*

Table 8-4: The calculated mass flux of phosphorus for the upgradient and downgradient lines of assessment in the phosphoric acid plant area, Fourth Quarter, 2009.

RESULTS:			**Q4**		
ORTHOPHOPHATE					
		Q (gpm)	*Mean P (mg/L)*	*P Load (kg/day)*	*Fraction of Total Load*
	Upper Zone Central Upgradient				
	Total upgradient	140	74	56	*25.8%*
	Upper Zone Central Downgradient				
	Stack	126	127	87	
	340	2	816	9	
	419	12	1943	123	
	Total downgradient			219	
	LOAD GAINED:			*162*	*100.0%*
				358	*lb/day*

Comparing the estimated phosphorus load from the phosphoric acid plant area in 2009 to the loading rate from the fourth quarter of 2008, it is estimated that conditions in 2009 reflect a reduction in phosphorus releases of approximately 200,000 lbs on an annual basis (Table 8-5).

Table 8-5: Estimated pounds of phosphorus released.

	lb/day	Days	Pounds	Difference between 2009 and 2008 Q4 (lbs)
2008 Q4	1,484	91.25	135,397	-
2009 Q1	1,459	91.25	133,136	2,261
2009 Q2	1,175	91.25	107,226	28,171
2009 Q3	546	91.25	49,844	85,553
2009 Q4	358	91.25	32,631	102,766
		Total difference 2009:		218,751

8.1.3 Groundwater Extraction System

A comprehensive assessment of the performance of the groundwater extraction system for 2009 is provided in Section 6. This assessment indicates that additional groundwater extraction is necessary to meet the arsenic MCL in the Compliance Area. A quantitative summary of the effectiveness of the groundwater extraction system is shown in Tables 8-6 through 8-8, using mass flux and mass removal calculations for the target capture zones. By the end of 2009 it is estimated that the groundwater extraction system is removing approximately 39% of the phosphorus load, 59% of the sulfate load, and 63% of the arsenic load that passes through the target capture zones. The total mass

removed for 2009 was approximately 700,000 lbs of phosphorus. This amount is greater than previous years with 2008 having removed 650,000 pounds and 2007 seeing only 350,000 pounds removed.

Table 8-6: The phosphorus load estimated from the gypsum stack,the phosphoric acid plant, and the load removed by the extraction system.

Quarter	Estimated Gypsum Stack Loads (lb/day)	Estimated PAP Load (lb/day)	Load Removed from extraction (lb/day)	Load Passed (lb/day)	Mass Reduction (Load Removed/Total Load)(%)
Q1	3,996	1,261	2,262	2,567	47%
Q2	3,576	1,108	1,365	3,464	28%
Q3	3,639	444	1,963	2,866	41%
Q4	3,267	290	1,915	2,914	40%
Average 2009	3,620	884	1,876	2,953	39%

Table 8-7: The sulfate load estimated from the gypsum stack,the phosphoric acid plant, and the load removed by the extraction system.

Quarter	Estimated Gypsum Stack Loads (lb/day)	Estimated PAP Load (lb/day)	Load Removed from extraction (lb/day)	Load Passed (lb/day)	Mass Reduction (Load Passed/Load Removed)(%)
Q1	31,684	267	19,420	9,800	66%
Q2	31,363	216	13,548	15,672	46%
Q3	27,209	232	17,186	12,034	59%
Q4	31,773	267	19,284	9,936	66%
Average 2009	30,507	253	17,360	11,860	59%

Table 8-8: The arsenic load estimated from the gypsum stack, the phosphoric acid plant area, and the load removed by the extraction system.

Quarter	Estimated Gypsum Stack Load (lb/day)	Estimated PAP Load (lb/day)	Load Removed from extraction (lb/day)	Load Passed (lb/day)	Mass Reduction (Load Passed/Load Removed)(%)
Q1	3.81	0.05	2.37	1.20	66%
Q2	3.88	0.05	1.57	2.00	44%
Q3	4.32	0.04	2.54	1.04	71%
Q4	4.03	0.05	2.52	1.06	70%
Average 2009	4.01	0.048	2.25	1.33	63%

8.2 Remedy Performance in the Groundwater Compliance Area and at the Portneuf River

8.2.1 Comparison of COC Concentrations with MCLs in the Compliance Area

Comparison of COC concentrations in the Compliance Area to GWPS/MCLs is performed annually, as noted in the Groundwater and Surface Water Monitoring Plan (Formation 2009a) and is presented here in Section 6. The method for comparison is described in Section 5.2.2 of the Groundwater and Surface Water Monitoring Plan (Formation 2009a).

Wells in the Compliance Area currently include wells 504, 505, 524, and 525. Four additional monitoring wells are proposed for installation during 2010. Statistical comparisons were conducted for each existing well independently (EPA 2009). For arsenic, the majority of wells tested showed that COC migration above the MCL to the Off-Plant Area is prevented. The 95% UCL of arsenic for existing wells ranged from 0.003 to 0.014 mg/L. The 95% UCL of total phosphorus ranged from 0.075 to 0.499 mg/L, however, the RBC for phosphorus has not yet been determined.

The proposed additional monitoring wells in the Compliance and Assessment Areas will aid in assessing the migration of COCs above GWPS in the Off-Plant area.

8.2.2 Phosphorus Load to the Portneuf River

The loads measured in the Portneuf River at Siphon Road, as discussed in Section 7, have decreased since 2007. Figure 8-2 shows this decreasing trend, along with the steady loads from upstream measuring at Batiste Road, indicating that the reduced load at Siphon Road is a reflection of the reduced load amount from EMF groundwater.

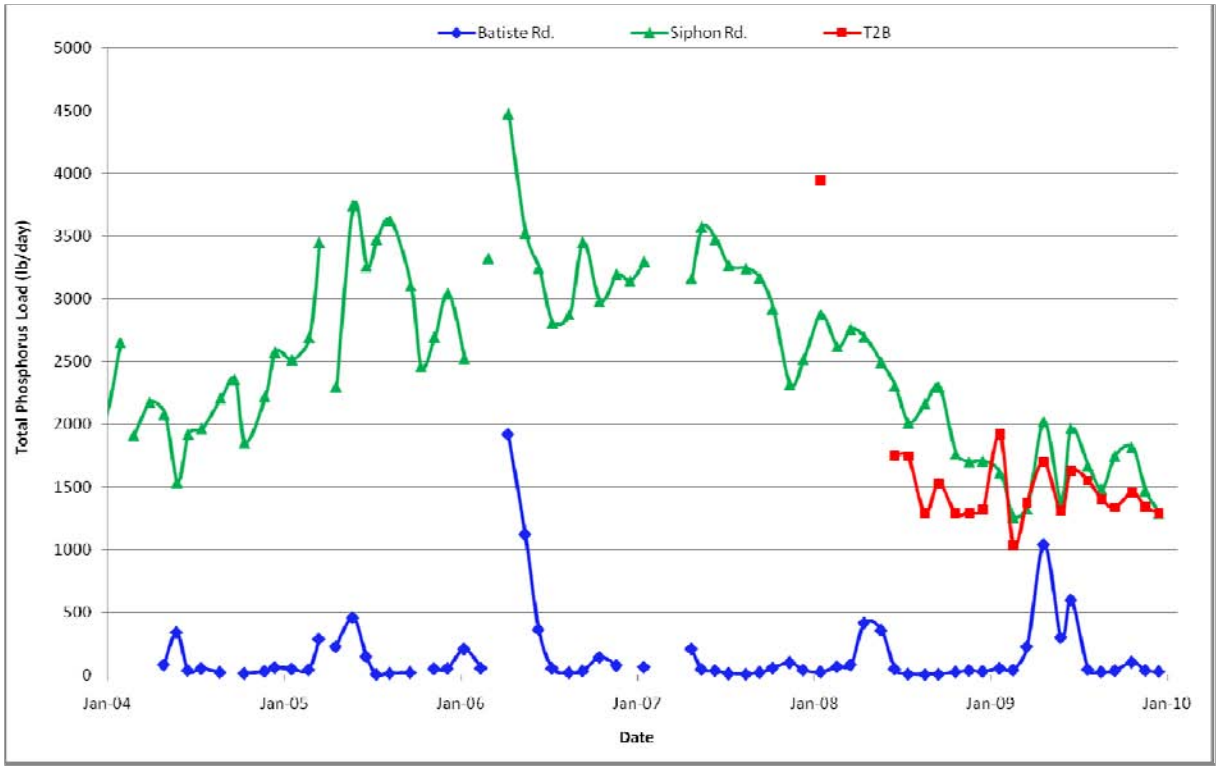


Figure 8-2: The total phosphorus loads, in pounds per day, at Batiste Road, T2B, and Siphon Road.

Table 8-9 provides the average loads of total phosphorus and sulfate measured at Siphon Road for 2008 and quarterly for 2009. The decrease in load amounts is substantial, with 1,020 pounds per day reduction for total phosphorus. Further river monitoring is needed to fully assess the relationship between the reduction in loads in the river and remedial actions at the EMF site.

Table 8-9: The loads measured in 2009 at Siphon Road in pounds per day.

Quarter	Total Phosphorus	Sulfate
Average 2008	2,283	112,861
2009 Q1	1,179	109,565
2009 Q2	1,031	119,056
2009 Q3	1,484	86,681
2009 Q4	1,356	107,706
Average 2009	1,263	105,502

8.3 Phosphorus Concentrations in the Portneuf River

Figure 8-3 was calculated in order to show the effectiveness of the extraction system on groundwater concentrations with respect to target concentrations in the river. The calculations use an attenuation factor of 35% for the area between the target capture zones and the Portneuf River and a final extraction load reduction of 90% (This is the load reduction expected after the final phase of extraction well installation is completed, which is described in the Remedial Design Report [Formation 2009b]).

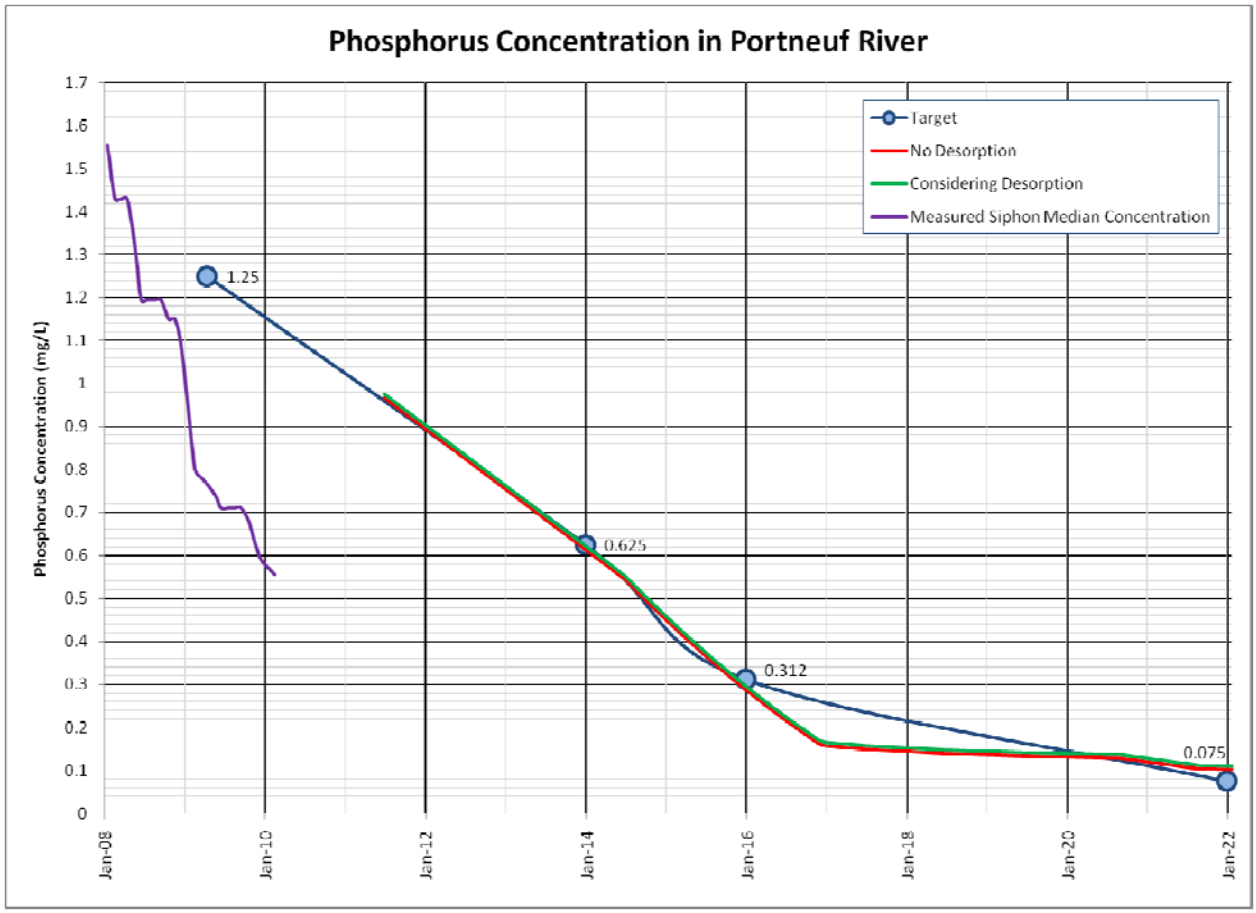


Figure 8-3: The VCO Target Concentration with estimated and measured Phosphorus concentrations in the Portneuf River. Details of the projected concentration calculation can be found in Appendix C of the Technical Report No.1 (Simplot 2009b).

This shows that the calculated concentration in the Portneuf River at Siphon Road is greater than the measured concentration. This demonstrates that either source controls (which are not taken into account in the calculations for the estimated concentrations above), higher attenuation rates, longer groundwater travel times, or less mass loading the system to begin with are contributing to the reduced concentration at the point of compliance. The concentrations are already much lower than the target concentrations, and continue to decrease.

9.0 REMEDY COMPONENTS PLANNED FOR FY2010

Remedy components planned for FY2010 are described in the Remedial Action Plan (Simplot 2009a), the Remedial Action Work Plan (Formation 2010d), and the Draft Infrastructure Improvement Plan (Simplot 2010). The tasks planned for FY2010 are summarized in the following sections.

9.1 Groundwater Extraction System

The design of the groundwater extraction and monitoring systems is presented in detail in the Groundwater Extraction and Monitoring System Remedial Design Report (Formation 2009b). A summary of the design of the systems is provided in the following paragraphs.

Extraction of groundwater will be performed as an interim action to reduce the amount of phosphorus contaminated groundwater entering the Portneuf River while source control actions are implemented and become effective. The extraction system will consist of the existing extraction system that has been installed in previous investigation phases, along with additional proposed extraction wells that meet CERCLA and VCO/CA objectives.

The groundwater extraction system currently consists of 14 extraction wells that were installed in two prior phases of work; phase 1 in 2003-2004 and phase 2 in 2007-2008. In the remedial design report a third phase of extraction well installation is proposed for 2010. In the third phase well 410 will be replaced with a new multi-level extraction well (E-1), two of the wells installed during the phosphoric acid plant subsurface investigation will be converted to extraction wells (wells 416 and 419), and an additional extraction well is proposed east of the existing well 413 (E-2). The locations of the extraction wells are shown in Figure 9-1.

Newly installed wells 416 and 419 in the phosphoric acid plant area were converted to extraction wells and the startup plan was submitted to IDEQ and EPA in January 2010. It is planned to have wells E-1 and E-2 on line in 2010. The expected performance of the groundwater extraction system is presented in Technical Report No. 1 along with the Groundwater and Surface Water Monitoring Plans (Simplot 2009b; Formation 2009a).

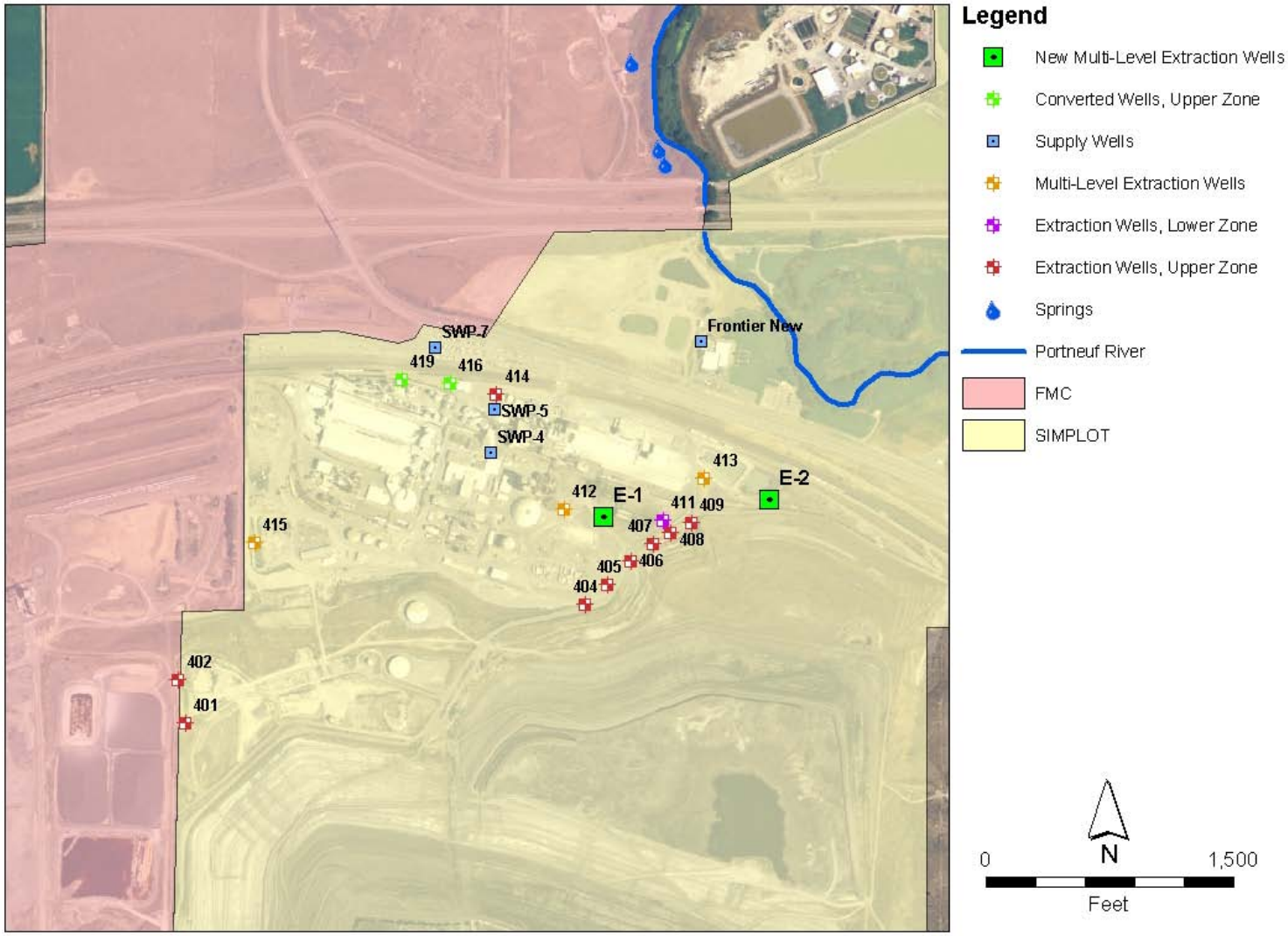


Figure 9-1: Location of existing extraction wells, monitoring wells 416 and 419 to be converted to extraction, and new multi-level wells, E-1, and E-2.

9.2 Groundwater Monitoring System

The groundwater monitoring system in the Simplot OU has been divided into four sub-areas based on monitoring objectives and performance criteria, as described in the Groundwater and Surface Water Monitoring Plan (Formation 2009a). The sub-areas are shown in Figure 9-2 and listed below with their respective objectives.

- Don Plant Area
- Target Capture Overlay (in Don Plant Area)
- Assessment Area
- Compliance Area

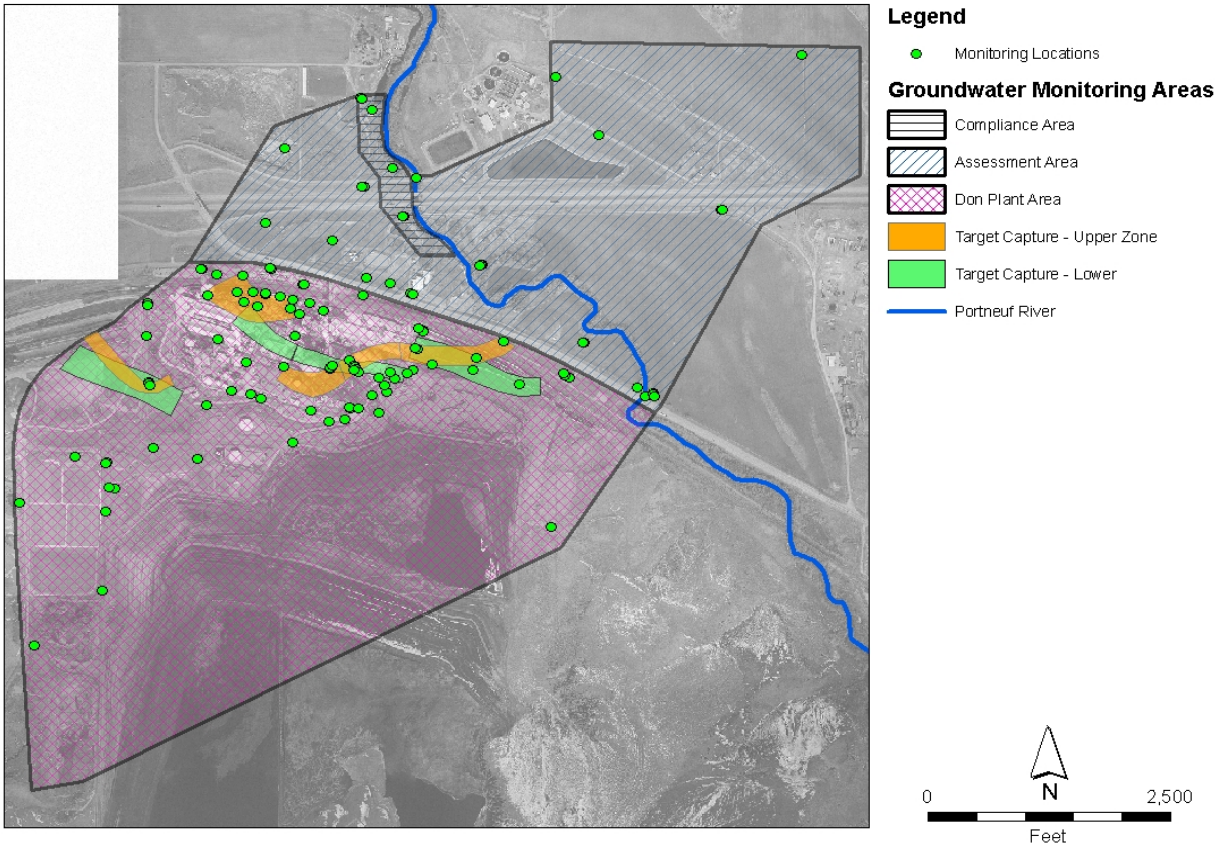


Figure 9-2: Location of monitoring areas within the Simplot Area

In the Groundwater RDR, thirteen additional monitoring well nests are proposed for installation. The locations of the additional wells are shown in Figure 9-3.

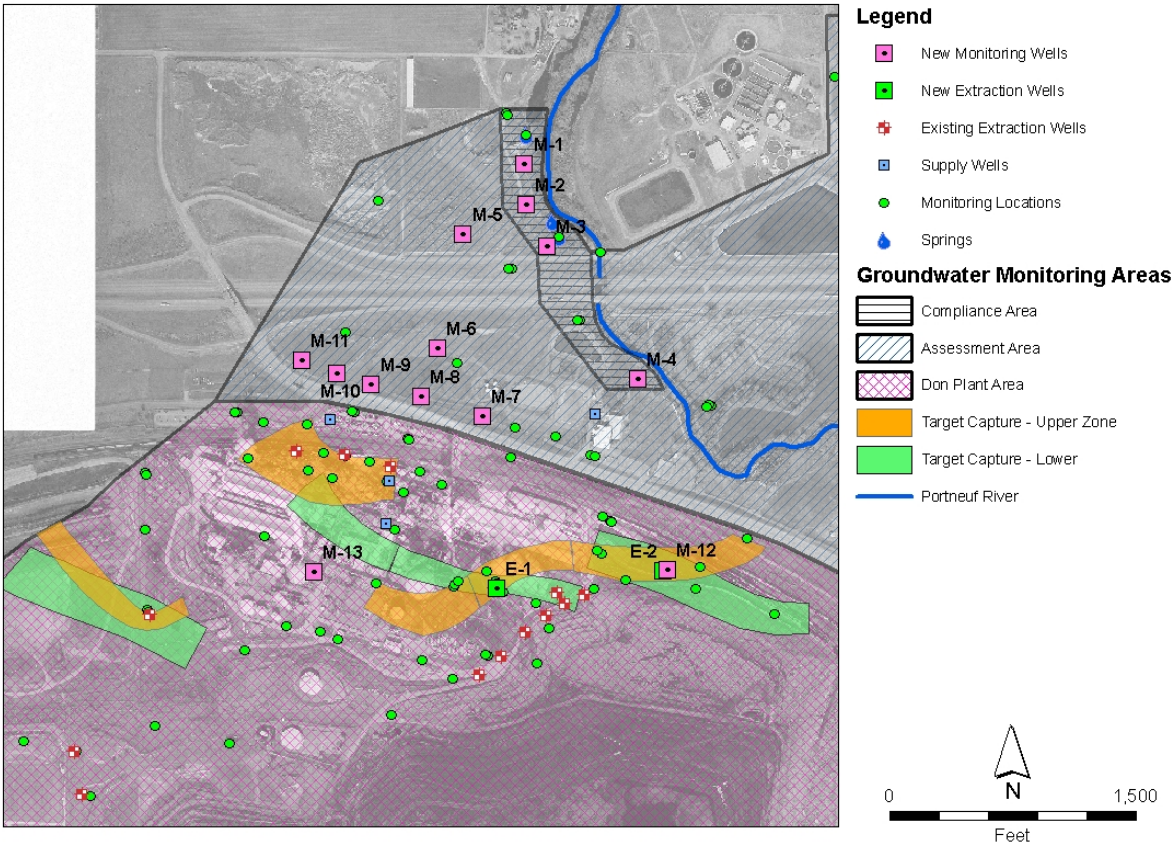


Figure 9-3: Proposed locations of additional monitoring wells.

9.3 Lining of the Gypsum Stack

Lining of the existing gypsum stack will be performed as a source control action to reduce seepage and loading of phosphorus to groundwater beneath the stack. As a result, the stack lining is expected to eventually reduce concentrations of phosphorus in the plant area below levels of concern. This will allow the groundwater extraction system to be phased out of operation when verified by the groundwater monitoring system.

A preliminary schedule was presented in Section 2 of this report. Elements that are scheduled for completion in 2010 include:

<u>Decant Pond</u>:

- Seepage testing — April 2010
- Begin using Decant Pond — May 2010

<u>Lower Stack</u>:

- Start of supplemental dike building may begin in 2009 and may need to continue for a full year.

- In March 2010, construction will start.
- Use of the lower stack will occur in November 2010.

Upper West Stack:

- Build the final upper road late 2010 or early in 2011

9.4 Phosphoric Acid Plant Area Source Control

Source control in the phosphoric acid plant area will be achieved though infrastructure improvements and changes in plant activities such as improvements to tank cleanout procedures and efforts to increase employee awareness. The Don Plant has a number of projects planned to further improve the infrastructure associated with tanks, sumps, pads, and sewers, especially in the production area (liquid and phosphoric acid plant areas). These projects are listed in Table 9-1 and explained in detail in the Draft Infrastructure Improvement Plan FY2010 (Simplot 2010).

Table 9-1: Planned Phosphoric Acid Plant Projects

Year	Project
2010	Evaporator Wash Can Project SPA West Aging Pad Repairs and SPA Aging Sump Removal Project SPA Aging Pumps Relocation Project SPA Loading/Car Wash Lead Track Replacement Project Evaluation of Options to Reduce Continuous Flows Into Sumps On-going Tank, Pad and Sump Inspections

This list and schedule may change based on recommendations from the Don Plant Sump and Pad Team and other plant management. These recommendations will be based on the current sump/pad/tank design, equipment inspections, analytical data and other pertinent information. Simplot plans to have a list of potential projects to be completed during the upcoming calendar year to provide to DEQ and EPA for discussion by the end September. During the annual meeting prescribed in the VCO/CA, the list of projects will be discussed and a priority agreed to among the agencies and Simplot. Simplot would then provide a scope and schedule for the agreed upon projects as an updated Draft Infrastructure Improvement Plan in January of the next calendar year.

10.0 SUMMARY AND CONCLUSIONS

This report provides a description of the groundwater/surface water remedy implementation and performance in 2009 in the Simplot Operable Unit of the Eastern Michaud Flats Superfund Site near Pocatello Idaho.

A groundwater/surface water remedy has been designed to meet the requirements of a Record of Decision issued by EPA in 1998 and an Interim Record of Decision Amendment for the Simplot Operable Unit issued by EPA in February 2010. The remedy and monitoring also meets the requirements of a Voluntary Consent Order/Compliance Agreement (VCO/CA) between the Idaho Department of Environmental Quality and the J.R. Simplot Company intended to fulfill Simplot's obligations for the Portneuf River Total Maximum Daily Load (TMDL). The two projects are intertwined because groundwater affected by Simplot sources discharges to the Portneuf River, resulting in phosphorus concentrations above TMDL targets.

The remedy contemplated under Superfund and the VCO/CA has the same basic elements:

- Extraction of groundwater downgradient of the gypsum stack and phosphoric acid plant area;
- Installation of a high density polyethylene liner on top of the existing gypsum stack with continued placement of gypsum on the liner;
- Control of sources of phosphorus to groundwater in the phosphoric acid plant area; and
- Groundwater and surface water monitoring to assess the performance of the remedial actions.

Overall, Simplot implemented significant source control actions in the phosphoric acid plant area and successfully operated the groundwater extraction system in 2009. Groundwater data indicate significant reduction in phosphoric acid plant sources, but that some sources may still continue. Identifying and addressing these is the focus of 2010 work. Mass flux modeling does not predict that the current groundwater extraction system will meet arsenic MCLs in groundwater near the Portneuf River, however, additional extraction wells to be installed in 2010 are expected to provide for meeting this remedy goal. Preparatory work for lining the gypsum stack was performed in 2009 and lining of the lower cell is scheduled to occur in 2010. As a result of extraction system operation and source control activities, the phosphorus load from Simplot groundwater to the Portneuf River was significantly reduced in 2009. This resulted in a significant reduction in phosphorus concentrations in the river and improvement in dissolved oxygen levels. In fact, in 2009 the median monthly average phosphorus concentration in the river at Siphon Road was already below the target set out in the VCO/CA for 2013. This

indicates that remedial actions are resulting in greater and faster water quality improvements than previously predicted. Because of the travel time from remedial actions to the river (from one year and possibly up to 10 years), the effect in the river is likely due to previous source control in the phosphoric acid plant area and expansion of the extraction system in 2008 (in particular wells 412 and 413 which came on line in January 2008 and pump over 530 gpm combined). The effects of 2009 activities have likely not yet been observed in the river and additional reductions in phosphorus concentrations are anticipated as additional remedial action components are implemented.

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APPENDIX A: 2009 Groundwater Data
APPENDIX B: Groundwater Chemistry Time-Series
APPENDIX C: Hydraulic Gradient Calculation
APPENDIX D: Phosphoric Acid Plant Specific Data
APPENDIX E: Mass Flux Analysis
APPENDIX F: Analytical Capture Zone Calculations
APPENDIX G: Groundwater Modeling and Particle Tracking
APPENDIX H: Surface Water Data
APPENDIX I: PAP Area Load Analysis

Included on Disc