FMC Idaho LLC, Pocatello, Idaho
Groundwater Current Conditiions
Report for the
FMC Plant Operable Unit

June 2009
FINAL

MWH

FMC

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TABLE OF CONTENTS

Section		Page
1	**INTRODUCTION**	**1-1**
1.1	Scope and Objectives	1-1
1.2	Background	1-2
1.2.1	Land and Groundwater Use During the EMF Remedial Investigation	1-4
1.3	Current Status	1-6
1.3.1	Plant Decommissioning	1-6
1.3.2	RCRA Waste Management Unit (WMU) Closures	1-7
1.3.3	Calciner Pond Closures	1-7
1.3.4	Current and Future Land and Groundwater Use	1-8
1.4	Report Organization	1-12
2	**GEOLOGY AND HYDROGEOLOGY**	**2-1**
2.1	Geology	2-1
2.2	Hydrogeology	2-3
2.2.1	Regional Hydrogeologic Setting	2-4
2.2.2	Site Hydrogeology	2-5
2.2.3	EMF RI Conceptual Groundwater Flow Model	2-11
2.2.4	EMF RI Groundwater Numerical Modeling Results	2-11
2.2.5	EMF Site Hydrogeology Summary	2-13
3	**GROUNDWATER INVESTIGATIONS**	**3-1**
3.1	Summary of Remedial Investigation – Geologic and Hydrogeologic Investigations	3-1
3.1.1	Summary of RI Field Activities	3-1
3.1.2	RI Boring and Well Location Selection Process	3-2
3.1.3	RI Groundwater Sampling	3-3
3.1.4	RI Chemical and Radiological Groundwater Analyses	3-3
3.1.5	RI Hydrogeologic Testing	3-3
3.1.6	RI Water-Level Monitoring	3-4
3.2	Post-RI Groundwater Special Studies and Routing Monitoring	3-4
3.2.1	Groundwater Special Studies	3-4
3.2.2	Routing (“On-Going”) Groundwater Monitoring Programs	3-18
3.3	2008 EMF Geophysical Study	3-21
4	**RESULTS AND FINDINGS**	**4-1**
4.1	Summary of the EMF Remedial Investigation – Groundwater	4-1
4.1.1	Assessment Methodology and Background Information	4-2
4.1.2	Overview of Findings	4-3

TABLE OF CONTENTS (continued)

Section			Page
	4.1.3	Representative Groundwater Chemistry	4-6
	4.1.4	Nature and Extent of EMF-Related Constituents in Groundwater at FMC	4-10
	4.1.5	Nature and Extent of EMF-Related Constituents in Groundwater In the Joint Fenceline Area	4-17
	4.1.6	Nature and Extent of EMF-Related Constituents in Groundwater Within the Northern FMC/Simplot Properties	4-21
	4.1.7	Nature and Extent of EMF-Related Constituents in Groundwater North of I-86	4-25
	4.1.8	Radiological Speciation Routine Results	4-26
4.2		Results of the Post-RI Groundwater Studies and Monitoring	4-45
	4.2.1	Results and Findings of Groundwater Studies	4-45
	4.2.2	Results and Findings of Routine Groundwater Monitoring	4-77
4.3		Reevaluation of Groundwater Representative Arsenic Concentrations	4-83
	4.3.1	Representative Groundwater Wells	4-83
	4.3.2	Data for Calculation of Groundwater Arsenic Representative Levels	4-89
	4.3.3	Statistical Evaluation and Calculation of Representative Arsenic Concentration using ProUCL	4-91
	4.3.4	EPA Review Comments on the Reevalution of Groundwater Representative Arsenic Concentrations	4-95
	4.3.5	Calculation of 95% Upper Confidence Limit for Representative Arsenic Concentrations using ProUCL	4-100
	4.3.6	Summary of Recalculation of Groundwater Representative Arsenic Concentrations	4-102
5		**ASSESSMENT OF GROUNDWATER QUALITY AND SOURCE AREAS**	**5-1**
5.1		Groundwater Quality Assessment and Trends	5-1
	5.1.1	Western Ponds Area	5-2
	5.1.2	Central Plant Area	5-8
	5.1.3	Joint Fenceline/Canciner Ponds Area	5-15
	5.1.4	Area North of Highway 30 and Interstate 86	5-20
5.2		Source Area Evaluation	5-27
	5.2.1	Western Ponds Area	5-28
	5.2.2	Central Plant Area	5-35
	5.2.3	Joint Fenceline/Calciner Ponds Area	5-44
	5.2.4	Area North of Highway 30 and Interstate 86	5-50
	5.2.5	Summary	5-50

TABLE OF CONTENTS (continued)

Section			Page
6	**FATE AND TRANSPORT**		**6-1**
	6.1	Principal Factors Affecting Migration in the Vadose Zone	6-1
	6.2	Principal Factors Affecting Migration in the Saturated Zone	6-6
	6.3	Groundwater Migration and Discharge to the Portneuf River	6-9
		6.3.1 Summary of EMF RI Findings	6-9
		6.3.2 IDEQ Evaluation of Water Quality Impacts	6-10
		6.3.3 EMF Geophysical Study	6-11
	6.4	Summary	6-12
7	**UPDATE TO THE BASELINE HUMAN HEALTH RISK ASSESSMENT**		**7-1**
	7.1	Introduction	7-1
	7.2	Baseline HHRA Evaluation of Exposure to Groundwater	7-2
		7.2.1 Baseline HHRA Findings for Potential Future Residents in the FMC Plant OU Area North of Highway 30 and Interstate 86	7-3
		7.2.2 Baseline HHRA Findings for Potential Future Workers at the FMC Plant OU	
		7.2.3 Consequences of Baseline HHRA Findings	7-4
	7.3	Updated Groundwater Conceptual Site Model (CSM)	7-5
	7.4	Evaluation of COPCs/ROPCs	7-6
		7.4.1 Analytical Data	7-7
		7.4.2 Data Treatment	7-7
		7.4.3 Comparison of Groundwater Concentrations to Representative (Background) Levels and Risk-Based Concentrations	7-8
		7.4.4 COC Exposure Point Concentrations	7-9
	7.5	Exposure Assessment	7-9
		7.5.1 COC Intake (Dose) Rates	7-9
	7.6	Toxicity Assessment	7-11
		7.6.1 Toxicity Values for COCs	7-12
		7.6.2 Selection of Chronic Noncarcinogenic and Carcinogenic Toxicity Values	7-13
	7.7	Risk Characterization	7-15
		7.7.1 Risk Characterization: Methods and Assumptions	7-15
		7.7.2 Risk Estimates by Groundwater Area	7-17
8	**CONCLUSIONS AND RECOMMENDATIONS**		**8-1**
	8.1	Conclusions	8-1
	8.2	Recommendations	8-6
9	**REFERENCES**		**9-1**

TABLE OF CONTENTS (continued)

LIST OF APPENDICES

APPENDIX A	Hydrographs for FMC Plant OU Monitoring Wells
APPENDIX B	Groundwater Contour Maps: EMF RI Figures and Quarterly from 1995 through May 2008
APPENDIX C	FMC and EPA Correspondence Related to the Reductions to the CERCLA and RCRA Groundwater Monitoring Programs
APPENDIX D	EPA and FMC Correspondence Related to Installation of Additional Groundwater Wells at the FMC Plant Site
APPENDIX E	Geologic Drilling Logs and Well Construction Diagrams for TW-series Wells, 1995 Wells, 1997 Wells, 1998 Wells and (Simplot) 2003 Wells
APPENDIX F	Data Validation Report for the May 2008 Groundwater Monitoring Event
APPENDIX G	FMC and EPA Documents Related to the Groundwater Representative Concentrations
APPENDIX H	EPA August 18, 2008 Memorandum (Review Comments on Representative Arsenic Concentration) and Undated/Untitled EPA/SAIC Paper with 95UCL Calculation
APPENDIX I	Boring Logs for EMF RI Boring F027B and Well (Dry Hole) 138
APPENDIX J	Concentration Trend Plots for Selected FMC Plant OU Wells
APPENDIX K	Tables and Figures from the 1996 EPA Baseline Human Health Risk Assessment
APPENDIX L	Original and Annotated copy of Letter from FMC to EPA dated May 24, 1999 – Revised Interim Stormwater Management at Western Ponds Area, FMC Corporation

TABLE OF CONTENTS (continued)

LIST OF TABLES

THE FOLLOWING TABLES ARE LOCATED WITHIN THE TEXT SECTIONS

		Page
Table 3.2-1	Summary of Modifications to FMC's RCRA Groundwater Monitoring Network Based on EPA Review and Recommendations During 1995	3-6
Table 3.2-2	Summary of Modifications to FMC's RCRA Groundwater Monitoring Network Based on EPA Review and Recommendations During 1998	3-11
Table 5.2-3	Summary of Identified Sources and Associated Groundwater Constituents at the FMC Plant OU	5-48

THE FOLLOWING TABLES FOLLOW THEIR RESPECTIVE SECTIONS

Table 1.3-1	RCRA Waste Management Unit (WMU) Closure Timeline and Status
Table 2.2-1	Vertical Head Differentials in Shallow/Deep Well Pairs, May 2008
Table 3.2-3	FMC's Routine Groundwater Monitoring and Additional Wells for the 2Q2008 "Special" Groundwater Monitoring Event
Table 3.2-4	Summary of the FMC Routine Groundwater Monitoring Programs (as of 3rd Quarter of 2008)
Table 4.2-1	Groundwater Representative Concentrations and Comparative Values
Table 4.2-2	Comparison of Initial Results from Wells 189, 190 and 191 to Concentrations Predicted from the EMF RI Groundwater Investigation
Table 4.2-3A	Analytical Results for RCRA Appendix IX Analyses FMC 1997 Groundwater Monitoring Event
Table 4.2-3B	RCRA Appendix IX Organic Compounds FMC 1997 Groundwater Monitoring Event
Table 4.2-4	Results for FMC January 1998 Special Groundwater Monitoring Event
Table 4.2-5A	Results for FMC Pond 17 1998 RCRA Appendix III Groundwater Monitoring
Table 4.2-5B	Results for FMC Pond 18 1998 RCRA Appendix III Groundwater Monitoring
Table 4.2-6	Results for FMC 2000 Special Groundwater Monitoring Event
Table 4.2-7	Results for FMC November 2001 Special Groundwater Monitoring Event
Table 4.2-8	Results of FMC May 2002 Special Groundwater Monitoring Event
Table 4.2-9A	Results for FMC June 2003 "Tesco Property" Groundwater Monitoring Event

TABLE OF CONTENTS (continued)

Table 4.2-9B FMC June 2003 "Tesco Property" Monitoring Event Organic Compound List
Table 4.2-10A Results of FMC May 2005 Special Groundwater Monitoring Event
Table 4.2-10B FMC May 2005 Special Monitoring Event Organic Compound List
Table 4.2-11A Results of FMC May 2008 Groundwater Monitoring Event – Expanded Parameter List
Table 4.2-11B Results of FMC May 2008 Groundwater Monitoring Event – Routine Parameter List
Table 4.2-12 Summary of the Results for the Routine Groundwater Monitoring Programs from 4th Quarter 2006 through 2nd Quarter 2008
Table 4.2-13 Calciner Pond Groundwater Monitoring Results – 2007
Table 4.3-1 Summary of Representative (Background) Groundwater Wells for the Bannock and Michaud Hydrogeochemical Regimes During the Remedial Investigation and Post-RI Wells Useable to Supplement the Representative Well Networks
Table 4.3-2 Common Ion Chemistry for Representative Wells in the Michaud and Bannock Hydrogeochemical Regimes, Eastern Michaud flats Site
Table 4.3-3 Total Phosphorus Results and Means for Wells 101 and 102
Table 4.3-4 Bannock Representative Well Dataset for 2008 Calculation
Table 4.3-5 Michaud Representative Well Dataset for 2008 Calculation
Table 4.3-6 Bannock Representative Well Network – ProUCL Output File – 95% UPL
Table 4.3-7 Michaud Representative Well Network – ProUCL Output File – 95% UPL
Table 4.3-8 Combined Representative Well Network – ProUCL Output File – 95% UPL
Table 4.3-9 Bannock Representative Well Network – ProUCL Output File – 95% KM UCL
Table 4.3-10 Michaud Representative Well Network – ProUCL Output File – 95% KM UCL
Table 4.3-11 Combined Representative Well Network – ProUCL Output File – 95% KM UCL

Table 5.1-1 List of Wells and "Point Values" Posted on Figures 5.1-2 to 5.1-7
Table 5.1-2A Longer Term Mann-Kendall Trend Test Results for Selected Wells in the Western Ponds Area
Table 5.1-2B Recent Period Mann-Kendall Trend Test Results for Selected Wells in the Western Ponds Area
Table 5.1-3A Longer Term Mann-Kendall Trend Test Results for Selected Wells in the Central Plant Area
Table 5.1-3B Recent Period Mann-Kendall Trend Test Results for Selected Wells in the Central Plant Area
Table 5.1-4A Mann-Kendall Trend Test Results for Joint Fence Line/Calciner Ponds Area Wells All Available Data through May 2008
Table 5.1-4B Mann-Kendall Trend Test Results for Joint Fence Line/Calciner Ponds Area Wells Recent Data: 2002 through May 2008

TABLE OF CONTENTS (continued)

Table 5.1-5A Longer Term Mann-Kendall Trend Test Results for Selected Wells in the Area North of Highway 30 and Interstate 86 (All Available Data through 2Q2008)
Table 5.1-5B Recent Period Mann-Kendall Trend Test Results for Selected Wells in the Area North of Highway 30 and Interstate 86 (Based on Recent Data – 2002 through 2Q2008)
Table 5.2-1 EMF Potential Source Area Sulfate and Chloride Concentrations and Ratios
Table 5.2-2 EMF Potential Source Area Potassium and Chloride Concentrations and Ratios and Selenium Concentrations

Table 7-1 Baseline HHRA RME Incremental Non-Cancer Hazard Quotients (HQs) for Potential Future Residents Ingesting Groundwater from Wells in the Area North of Highway 30 and Interstate 86
Table 7-2 Baseline HHRA RME Incremental Cancer Risks for Potential Future Residents Ingesting Groundwater from Wells in the Area North of Highway 30 and Interstate 86
Table 7-3 Baseline HHRA RME Incremental Non-Cancer hazard Quotients (HQs) for Potential Future Workers Ingesting Groundwater from Wells Across the FMC Plant OU
Table 7-4 Baseline HHRA RME Incremental Cancer Risks for Potential Future Workers Ingesting Groundwater from Wells Across the FMC Plan OU
Table 7-5 Comparison of COPC/ROPC Groundwater Data to Screening Levels
Table 7-6 COC Exposure Point Concentrations and Intake Rates
Table 7-7 COC Cancer Slope Factors (CSFs)
Table 7-8 COC Chronic Oral Reference Doses (RfDs)
Table 7-9 Comparison of Current and Baseline HHRA Worker Risk Estimates for Wells in the Western Ponds Area of the FMC Plant OU
Table 7-10 Comparison of Current and Baseline HHRA Worker Risk Estimates for Wells in the Central Plant Area of the FMC Plant OU
Table 7-11 Comparison of Current and Baseline HHRA Worker Risk Estimates for Wells in the Joint Fenceline/Calciner Ponds Area of the FMC Plant OU
Table 7-12 Comparison of Current and Baseline HHRA Worker Risk Estimates for Wells in the FMC Plant OU Area North of Highway 30 and Interstate 86
Table 7-13 Comparison of Current and Baseline HHRA Residential Risk Estimates for Wells in the FMC Plant OU Area North of Highway 30 and Interstate 86

TABLE OF CONTENTS (continued)

LIST OF FIGURES

THE FOLLOWING FIGURES FOLLOW THEIR RESPECTIVE SECTIONS

Figure 1-1 Regional Setting of the FMC Plant Operable Unit
Figure 1-2 FMC Well Location Map

Figure 2.2-1 Groundwater Contour Map Shallow Wells, May 2008
Figure 2.2-2 Inferred Shallow Groundwater Flow Paths

Figure 3.2-1 Routing Groundwater Monitoring Well network 2008

Figure 4.2-1 Site Features Location Map
Figure 4.2-2A Potassium Concentrations at Pond 8S Wells
Figure 4.2-2B Chloride Concentrations at Pond 8S Wells
Figure 4.2-2C Sulfate Concentrations at Pond 8S Wells
Figure 4.2-2D Arsenic Concentrations at Pond 8S Wells
Figure 4.2-3A Potassium Concentrations at Pond 15S Wells
Figure 4.2-3B Chloride Concentrations at Pond 15S Wells
Figure 4.2-3C Sulfate Concentrations at Pond 15S Wells
Figure 4.2-3D Arsenic Concentrations at Pond 15S Wells
Figure 4.2-4A Potassium Concentrations at Phase IV Pons/Pond 8E Wells
Figure 4.2-4B Chloride Concentrations at Phase IV Pons/Pond 8E Wells
Figure 4.2-4C Sulfate Concentrations at Phase IV Pons/Pond 8E Wells
Figure 4.2-4D Arsenic Concentrations at Phase IV Pons/Pond 8E Wells
Figure 4.2-5A Potassium Concentrations at Pond 17 Wells
Figure 4.2-5B Chloride Concentrations at Pond 17 Wells
Figure 4.2-5C Sulfate Concentrations at Pond 17 Wells
Figure 4.2-5D Arsenic Concentrations at Pond 17 Wells
Figure 4.2-6 Wells Sampled During November 1997 and February 1998 Special Monitoring Program
Figure 4.2-7 Wells and Springs Sampled During January 1998 Special Monitoring Program
Figure 4.2-8 Wells Sampled During August 2000 Special Monitoring Program
Figure 4.2-9 Wells Sampled During November 2001 Special Monitoring Program
Figure 4.2-10 Wells Sampled During May 2005 Special Monitoring Program
Figure 4.2-11 Wells and Springs Sampled During May 2008 Special Monitoring Program
Figure 4.2-12 Routing Groundwater Monitoring Well Network 2008
Figure 4.2-13A Box Plot for Potassium (Data through 2007)
Figure 4.2-13B Box Plot for Suflate (Data through 2007)

TABLE OF CONTENTS (continued)

Figure 4.2-13C Box Plot for Orthophosphate (Data through 2007)
Figure 4.2-13D Box Plot for Arsenic (Data through 2007)
Figure 4.2-13E Box Plot for Selenium (Data through 2007)
Figure 4.3-1 Remedial Investigation (RI) and Post-RI Representative Well Locations
Figure 4.3-2 Total Phosphorus and Orthophosphate at Wells 101 and 102
Figure 4.3-3 Common Ion Concentrations at Wells 101 and 102
Figure 4.3-4 Arsenic Concentrations at Wells 101 and 102
Figure 4.3-5 Well Groups for 2008 Calculation of Representative Arsenic Levels

Figure 5.1-1 Groundwater Areas and Remediation Unit Boundaries
Figure 5.1-2 Arsenic Concentrations in Shallow Groundwater
Figure 5.1-3 Potassium Concentrations in Shallow Groundwater
Figure 5.1-4 Sulfate Concentrations in Shallow Groundwater
Figure 5.1-5 Nitrate Concentrations in Shallow Groundwater
Figure 5.1-5B Ammonia Concentrations in Shallow Groundwater
Figure 5.1-6 Total P / Orthophosphate Concentrations in Shallow Groundwater
Figure 5.1-7 Selenium Concentrations in Shallow Groundwater
Figure 5.1-8 Manganese Concentrations Above Representative Levels in Shallow Groundwater
Figure 5.1-9 Total cyanide Concentrations Detected in Shallow Groundwater
Figure 5.1-10 Shallow Groundwater Wells Selected for Time-Series Plots and Trend Tests
Figure 5.1-11 Elemental Phosphorus at Well 108
Figure 5.1-12 Elemental Phosphorus at Well 122
Figure 5.1-13 Groundwater Temperature at Central Plant Area Wells
Figures 5.2-1A Arsenic Concentrations – Pond 8S Downgradient Wells
Figures 5.2-1B Potassium Concentrations – Pond 8S Downgradient Wells
Figures 5.2-1C Ammonia Concentrations – Pond 8S Downgradient Wells
Figures 5.2-1D Nitrate Concentrations – Pond 8S Downgradient Wells
Figures 5.2-1E Total P / Orthophosphate Concentrations – Pond 8S Downgradient Wells
Figures 5.2-2A Arsenic Concentrations – Former Ponds 3E, 4E, 5E and 6E Downgradient Wells
Figures 5.2-2B Potassium Concentrations – Former Ponds 3E, 4E, 5E and 6E Downgradient Wells
Figures 5.2-2C Ammonia Concentrations – Former Ponds 3E, 4E, 5E and 6E Downgradient Wells
Figures 5.2-2D Nitrate Concentrations – Former Ponds 3E, 4E, 5E and 6E Downgradient Wells
Figures 5.2-2E Total P / Orthophosphate Concentrations – Former Ponds 3E, 4E, 5E and 6E Downgradient Wells

Figure 5.2-3 2007 Sulfate/Chloride Ratios in Calciner ponds Monitoring Wells
Figure 5.2-4 2007 Potassium/chloride Ratios in Calciner Ponds Monitoring Wells
Figure 5.2-5 Wells 123, 143 and 145 Selenium and Vanadium Concentrations

Figure 7-1 Wells Evaluated in Updated Human Health Risk Assessment for Groundwater Pathway

TABLE OF CONTENTS (continued)

LIST OF EMF RI TABLES

EMF RI Table 2.3-2
EMF RI Table 3.3-1

EMF RI Table 3.6-2

EMF RI Table 4.4-1
EMF RI Tables 4.4-2 and 4.4-3
EMF RI Table 4.4-4
EMF RI Table 4.4-5
EMF RI Table 4.4-6
EMF RI Table 4.4-9
EMF RI Table 4.4-11
EMF RI Table 4.4-12
EMF RI Table 4.4-13
EMF RI Table 4.4-14
EMF RI Table 4.4-15
EMF RI Tables 4.4-16 to 4.4-18
EMF RI Table 4.4-19
EMF RI Table 4.4-20 (in text)
EMF RI Table 4.4-21 (in text)
EMF RI Table 4.4-23 (in text)
EMF RI Table 4.4-24 (in text)
EMF RI Table 4.4-25 (in text)
EMF RI Table 4.4-26 (in text)

TABLE OF CONTENTS (continued)

LIST OF EMF RI FIGURES

EMF RI Figure 2.3-1

EMF RI Figures 3.1-5 through 3.1-12
EMF RI Figure 3.1-13
EMF RI Figures 3.2-1 and 3.2-2
EMF RI Figure 3.3-2
EMF RI Figure 3.3-3
EMF RI Figure 3.3-4
EMF RI Figure 3.3-5
EMF RI Figure 3.3-6
EMF RI Figure 3.3-7a and 3.3-7b
EMF RI Figure 3.3-8F
EMF RI Figure 3.3-9
EMF RI Figures 3.3-10A through 3.3-10I
EMF RI Figures 3.3-11 and 3.3-12A through 3.3-12D
EMF RI Figure 3.3-14
EMF RI Figures 3.3-15, 3.3-16 and 3.3-17

EMF RI Figure 3.6-5

EMF RI Figure 4.4-2
EMF RI Figure 4.4-3
EMF RI Figure 4.4-4
EMF RI Figures 4.4-5 through 4.4-24
EMF RI Figure 4.4-25
EMF RI Figure 4.4-26
EMF RI Figure 4.4-27

EMF RI Figure 5.3-1a
EMF RI Figure 5.3-1b
EMF RI Figure 5.3-2
EMF RI Figure 5.3-3
EMF RI Figure 5.3-4

LIST OF ACRONYMS

10X	factor of ten
ADD	average daily dose
AFLB	American Falls Lake Beds
AOC	Administrative Order Consent
ATSDR	Agency for Toxic Substances and Disease Registry
BLM	Bureau of Land Management
BTV	background threshold value
C	Celsius
CalEPA	California Environmental Protection Agency
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
cfs	cubic feet per second
COC	chemicals of concern
COCs/ROCs	chemicals and radionuclides of concern
COPC	contaminants of potential concern
COPCs/ROPCs	chemicals and radionuclides of potential concern
CSFo	cancer slope factor
CSM	Conceptual Site Model
CT	central tendency
CV	comparative values
DL	detection limit
EM	electromagnetic induction
EMF	Eastern Michaud Flats
EPC	exposure point concentration
FEDS	FMC Environmental Data Systems
ft/day	feet per day
gm/cc	grams per cubic centimeter
gpm	gallons per minute
HEAST	Health Effects Assessment Summary Tables
HHRA	Human Health Risk Assessment
HL	half lives
HQ	hazard quotient
I	intake
I-86	Interstate 86

IDEQ	Idaho Department of Environmental Quality
IDWR	Idaho Department of Water Resources
IPCo	Idaho Power
KM	Kaplan-Meier
LADD	lifetime average daily dose
MCL	maximum contaminant level
MDA	minimum detectable activity
mg/l	milligrams per liter
NC	National Center for Environmental Assessment
NPL	National Priorities List
NTU	Nephelometric Turbidity Units
ORP	oxidation/reduction potential
OU	Operable Unit
P4	elemental phosphorus
POD	point of diversion
PPRTV	Provisional Peer-Reviewed Toxicity Value
PRG	preliminary remediation goals
PSCS	Preliminary Site Characterization Summary
PWS	public water supply
Q-Q	quantile-quantile
RAO	remedial action objective
RAP	Remedial Action Plan
RBC	risk-based concentration
RD/RA	Remedial Design and Remedial Action
RFDo	Oral reference dose
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RME	reasonable maximum exposure
ROC	radionuclides of concern
RU	Remediation Unit
SC	specific conductance
SDWA	Safe Drinking Water Act
SDG	sample delivery group
SFS	Supplemental Feasibility Study
SOW	Statement of Work
SRBA	Snake River Basin Adjudication

SRI	Supplemental Remedial Investigation
SRI/SFS	Supplemental Remedial Investigation and Feasibility Study
SSL	soil screening level
STP	sewer treatment plant
TCE	trichloroethene
TDS	total dissolved solids
UCL	upper confidence limit
UPL	upper prediction limit
UPRR	Union Pacific Railroad
UTL	upper tolerance limit
VOC	volatile organic compound
WMU	Waste Management Unit

Section 1
INTRODUCTION

1.1 Scope and Objectives

Following permanent shut-down of the FMC plant in December 2001, EPA and FMC entered into an AOC for a Supplemental Remedial Investigation and Feasibility Study SRI/SFS) at the FMC Plant OU. Although the AOC and Statement of Work (SOW) for the FMC SRI/SFS did not require a supplemental groundwater investigation(s) at the FMC Plant OU, FMC recognizes the need to address groundwater (both EMF impacts identified during the EMF RI and the potential for future impacts) during the SFS for the FMC Plant OU.

This Groundwater Current Conditions Report for the FMC Plant Operable Unit (OU) provides a summary of the extensive groundwater investigations undertaken during the Eastern Michaud Flats (EMF) Remedial Investigation (RI) [Bechtel, 1996] and presents a comprehensive update of the groundwater studies and monitoring performed at the FMC Plant OU subsequent to the EMF RI up through FMC's May 2008 groundwater monitoring event. FMC recognizes the value in assembling the substantial post-RI groundwater information developed under multiple regulatory programs and agencies into a single compendium for the purpose of the Administrative Record for the FMC Plant OU. Therefore, this report should be viewed as a companion to the Supplemental Remedial Investigation (SRI) Report for the FMC Plant OU (MWH, 2008).

The scope of this groundwater current conditions report includes:

- A summary of the EMF RI geologic, hydrogeologic and groundwater investigations and findings updated with relevant post-RI information;
- A description of the additional groundwater monitoring well installations, special studies and on-going CERCLA, Calciner Pond Remedial Action, and RCRA groundwater monitoring conducted subsequent to the EMF RI;
- The results of the post-RI groundwater studies and on-going monitoring that focuses on FMC Plant Site source area; and,
- An updated evaluation of the fate and transport of EMF-impacted groundwater that focuses on FMC Plant Site source area.

The overall objectives of this groundwater current conditions report:

- Present a compendium of all groundwater information relevant to the FMC Plant OU from the EMF RI through May 2008;

- Present an up-to-date view of the nature and extent and fate and transport of groundwater impacts related to the FMC Plant Site;

- Present groundwater information adequate to support the SFS and remedy selection for the FMC Plant OU.

This report is generally organized to provide a summary of the EMF RI groundwater investigation and then describe the post-RI groundwater studies and data in chronological order up through FMC's May 2008 groundwater monitoring event. Numerous EMF RI tables and figures are referenced in the EMF RI summary sections. For easier access, the EMF RI tables and figures referenced herein are also included, in numerical order (as opposed to the order referenced in the text), under a separate tab behind the main body of the report.

1.2 Background

The FMC Plant Site is located approximately 2.5 miles northwest of Pocatello, Idaho. The FMC Plant Site is south of Highway 30, covers approximately 1,150 acres, and historically contained all of the process operations used for the production of elemental phosphorus. The Plant Site adjoins the western boundary of the Simplot Don Plant, as shown on Figure 1-1. There are an additional 212 acres owned by FMC located north of Highway 30 (excluding the 9-acre Tesco property) that are also part of the FMC Plant OU.

The FMC Plant OU is on privately-owned fee land, most of which is located within the exterior boundaries of the Fort Hall Indian Reservation. The easternmost portion of the FMC Plant OU is located outside the reservation boundary. The FMC Plant OU consists of essentially all the property that FMC owns at the EMF Site, and includes the FMC Plant Site located south of Highway 30 and all the properties apart from the former Tesco property that FMC owns north of that highway.

The FMC Plant OU is a part of the larger EMF Superfund Site, and is located in southeastern Idaho, approximately 2.5 miles northwest of Pocatello, Idaho. The EMF Site was listed on the National Priorities List (NPL) on August 30, 1990. The EMF Site includes two adjacent production facilities, a former FMC Corporation elemental phosphorus processing plant that ceased operation in 2001 and a phosphate fertilizer processing facility operated by the J.R. Simplot Company. The EMF Site is shown on Figure 1-1 and encompasses both the FMC and Simplot plants and surrounding areas affected by releases from these facilities. FMC, Simplot and EPA entered into a Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Administrative Order on Consent (AOC) in May 1991 under which the companies agreed to conduct a Remedial Investigation/Feasibility Study (RI/FS) for the site. During the RI/FS the site was divided into three "Subareas:" 1) the FMC Subarea, consisting of the FMC plant and other FMC-owned properties at the site; 2) the Simplot Subarea, consisting of the Simplot plant and other Simplot-owned properties at the site; and 3) the Off-Plant Subarea, consisting of the remainder of the site. EPA changed these designations to the FMC Plant OU, the Simplot Plant OU, and the Off-Plant OU after its June 1998 Record of Decision for the EMF Site (1998 ROD, EPA, 1998).

As required under the 1991 AOC, FMC and Simplot conducted a number of EMF Site studies and prepared reports. These included the January 1994 Preliminary Site Characterization Summary (PSCS, BEI, 1994), the August 1996 EMF Remedial Investigation Report (RI Report, BEI, 1996), and the April 1997 Feasibility Study Report FMC Subarea (FS Report, BEI, 1997). EPA reviewed and approved these reports. EPA conducted the baseline ecological and human health risk assessments concurrently with the companies' RI/FS work and issued the final reports for those studies respectively in July 1995 and July 1996. The conclusions of those risk assessments were incorporated into the FS Report and the 1998 ROD.

The 1998 ROD addressed all three Subareas at the EMF Site. The following were the major remedial action components for the FMC Subarea:

- Cap the Old Phossy Waste Ponds (identified in the SRI as Remediation Unit [RU] 22b) and the Calciner Solids Storage area (RU 16), and line the Railroad Swale (RU 22c) to reduce or eliminate infiltration of rainwater and prevent incidental exposure to contaminants.

- Monitor the groundwater and implement legally enforceable controls that would run with the land to prevent use of contaminated groundwater for human consumption under current and future ownership. The groundwater monitoring and enforceable controls were required to continue until chemicals of concern (COCs) and radionuclides of concern (ROCs) in groundwater declined below the Maximum Contaminant Levels (MCLs) or, in the absence of applicable MCLs, risk-based concentrations (RBCs) for those substances.

- Implement legally binding land use controls that would run with the land to prevent potential future residential use and control potential worker exposures under any future ownership.

- Implement a contingent groundwater extraction/treatment system if contaminated groundwater migrates beyond company-owned property and into adjoining springs or the Portneuf River. Contaminant containment was required to be achieved via hydrodynamic controls such as long-term groundwater gradient control through low level pumping. Extracted groundwater would be treated and used at the FMC Plant Site as a substitute for the unaffected groundwater that otherwise would have been extracted and used in plant operations.

- Conduct operation and maintenance on capped areas and, if implemented, the groundwater extraction system.

FMC ceased production of elemental phosphorus from phosphate ore at its Pocatello facility in December 2001. This led EPA and FMC to enter into an AOC for a Supplemental Remedial Investigation and Feasibility Study (SRI/SFS) for the FMC Plant OU in October 2003. This was driven primarily by EPA's finding that additional investigations and evaluations were needed at

the plant areas that had been actively operated at the time of the RI/FS but where operations had terminated with the plant shutdown. The AOC and SOW for the FMC SRI/SFS did not require a supplemental groundwater investigation(s) at the FMC Plant OU due in large measure to the fact the EMF RI groundwater investigation and FMC's ongoing groundwater monitoring programs provide comprehensive coverage of the site and were/are independent from the operational status of the plant. However, FMC recognizes the need to address groundwater (both EMF impacts identified during the EMF RI and the potential for future impacts) during the SFS for the FMC Plant OU. Therefore, this report should be viewed as a companion to the SRI Report for the FMC Plant OU (MWH, 2008) and the basis for re-evaluation of groundwater remedial alternatives in the Supplemental Feasibility Study (SFS) for the FMC Plant OU under the AOC.

1.2.1 Land and Groundwater Use during the EMF Remedial Investigation

1.2.1.1 Land Use during the EMF RI

The EMF study area evaluated during the RI included portions of the cities of Pocatello and Chubbuck, unincorporated areas of Bannock and Power counties, the Fort Hall Indian Reservation, and U.S. Bureau of Land Management (BLM) lands. Land use in the study area includes areas zoned for agriculture and various land uses including residential, commercial and industrial. The FMC Plant Site and the FMC properties north of Highway 30 are bordered to the north by property owned by the City of Pocatello and used for land application of municipal sewerage sludge, by the Chevron Texaco bulk petroleum tank farm, and by property owned by Rowlands, Inc, used primarily as a property housing a former milk packaging plant and currently in use for storing recreational vehicles and boats. To the east , FMC properties are bordered by properties owned by the J.R. Simplot Company, upon which the Simplot Don plant is located. To the south, FMC properties are bordered by BLM land and Shoshone Bannock Tribes land that are not developed, and by property owned by Idaho Power to support power distribution in the area. Information regarding demography and land use evaluations for the EMF Site and surrounding areas is included in Section 3.6 of the EMF RI Report and updated in the SRI Report for the FMC Plant OU. The following focuses on groundwater production and use within and immediately surrounding the FMC Plant OU.

1.2.1.2 Groundwater Use during the EMF RI

Public and private production wells within the EMF Study area (up to 3 miles away from the plants) were identified during the PSCS as part of the preliminary characterization of groundwater conditions at the EMF site. The groundwater wells identified in the EMF study area, registered as of 1992 with the Idaho State Water Resources Department, are shown in EMF RI Figure 3.6-5. These wells may have been used for potable uses, livestock, or irrigation purposes. EMF RI Table 3.6-2 lists the location, ownership, and total diversion (i.e., allowed withdrawal) at these wells. Since this list was taken from the public record without independent verification, the information contained therein may have errors.

Based on the inventory of wells within the EMF study area and the regional hydrogeology, five production wells north of the plants and Batiste Spring, formerly used by the Union Pacific

Railroad (UPRR) as an industrial and potable water supply, were sampled and analyzed during the PSCS and RI. The location, property ownership and historic use of the production wells and Batiste Spring are summarized below:

Well	**Location / Property Ownership (during PSCS/RI)**	**Historic Use**
Lindley	B/w H-30 and I-86 / FMC	Agricultural/potable
Old Pilot House	B/w H-30 and I-86 / FMC	Potable/irrigation
New Pilot House	B/w H-30 and I-86 / FMC	Potable/irrigation
Tank Farm	North of I-86 / Chevron	Industrial/potable
Rowland – old "milk plant"	North of I-86 / Rowland	Industrial/potable
Batiste Spring	North of I-86 / UPRR	Industrial/potable

Results of the EMF RI groundwater investigation showed that only the Old Pilot House well exceeded the Safe Drinking Water Act (SDWA) drinking water standards due to groundwater impacts from the EMF facilities. In 1976, FMC replaced the Old Pilot House well with a deeper well known as the New Pilot House well. The Old Pilot House well is located on FMC-owned property and has not been used as a water supply well (for any use - potable, industrial or irrigation) since 1976. The Old Pilot House well has not been abandoned so that it could potentially be used (as during the EMF RI) as a monitoring well in the future.

FMC production wells (FMC-1 and FMC-3) were the primary plant water supply wells for process, fire protection and potable use. The locations of these wells are shown on EMF RI Figure 3.6-5. The combined groundwater production from these wells averaged 875 gallons per minute (gpm) during full plant production. The FMC production wells are screened in the deeper aquifer zone, were not impacted by facility groundwater releases and consistently met the SDWA standards for drinking water.

During the EMF RI, the Simplot production wells pumped was about 3,300 to 4,000 gpm combined flow from wells SWP-4, SWP-5, SWP-6 and/or SWP-7. The locations of these wells are shown on EMF RI Figure 3.6-5. Extraction rates at each of the three Simplot production wells (SWP-6 was a standby production well) varied depending on specific production needs, but the average total flow was relatively constant.

In addition to the existing production wells, additional EMF RI groundwater monitoring wells were installed north of the FMC and J.R. Simplot plant sites to determine the northern extent of EMF impacted groundwater. The locations of these wells are shown on Figure 1-2. The

location, property ownership and historic water use on the properties where the EMF monitoring wells are located to the north of the facilities are summarized below:

Well	Location / Property Ownership (during PSCS/RI)	Property Use (during PSCS/RI)
522/523	B/w H-30 and I-86 / FMC	Unoccupied
500/501	B/w H-30 and I-86 / FMC	Drag City drag strip
514	North of I-86 / City of Pocatello	POTW sludge application / hay
515	North of I-86 / City of Pocatello	POTW sludge application / hay
516	North of I-86 / City of Pocatello	POTW sludge application / hay
502	North of I-86 / FMC	Unoccupied
TW-11S	North of I-86 / FMC	Unoccupied
524/525	North of I-86 / UPRR	Unoccupied

Based on the monitoring results from these wells during the EMF RI, the Agencies did not identify a need for any additional monitoring wells farther to the northwest, north or northeast of the FMC plant site to define the extent of EMF-impacted groundwater.

1.3 Current Status

In December 2001, the FMC plant permanently ceased production and FMC immediately initiated decommissioning, deconstruction and closure of the facility as described in greater detail in this section.

1.3.1 Plant Decommissioning

Following cessation of production at the facility in December 2001, a number of process decommissioning activities were performed, including the following:

- Isolation and securing of process equipment and utilities.
- Elimination of the discharge and termination of the NPDES permit for non-contact cooling water ("IWW" water) were completed in 2002.

- Decontamination and removal of process buildings and equipment down to foundation (ground) level. Saleable new and used equipment, recyclable materials (e.g., ferrous and copper metals) were sold and hauled off-site. Non-recyclable materials were placed in the demolition debris landfill (RU 17).

- Demolition of site office buildings down to foundation level (with the exception of the Training Center building in RU 4 and a scale-house in RU 20). Most recyclable materials were sold and hauled off-site. Most non-recyclable materials were placed in the plant landfill (RU 18).

- Recovery and sale of a portion of the ore stockpile. Remaining ore was pushed into the ore trenches, contoured, and seeded. Sales of the stockpiled ferrophoshorus ("ferrophos") are continuing.

- The only process equipment currently left in place is the rotary railcar dumper located in RU 7. This equipment was left in place for potential application to future site development. Decommissioning activities were completed in fall 2006.

1.3.2 RCRA Waste Management Unit (WMU) Closures

Numerous RCRA waste management units (WMUs) including surface impoundments (Ponds 8S, 8E, the Phase IV ponds [11S, 12S, 13S and 14S], 9E, 15S, 16S, 17, and 18 Cells A and B) and the slag pit sump were used at the facility for management of furnace and phosphorus dock process waste streams. Table 1.3-1 lists the WMUs and presents a summary of the timeline for the closure of each unit and current status.

In 1993, FMC initiated closure of Pond 8S, the last unlined waste pond at the facility with a standing hydraulic head, as a CERCLA removal action. The initial fill and temporary cover were installed and Pond 8S was dewatered in 1994 prior to completion of the EMF RI Report. As described in the EMF RI, placement of the initial fill and dewatering of Pond 8S removed the hydraulic head from the most significant identified source of impact to groundwater at the FMC Plant Site.

The RCRA Consent Decree entered on July 13, 1999 required FMC to close these WMUs in accordance with RCRA and Consent Decree requirements. FMC implemented and completed the closure of all of the WMUs during the period 1999 through 2005 as shown on Table 1.3-1. The RCRA ponds and the slag pit sump are currently under RCRA post-closure care. Post-closure groundwater monitoring of the WMUs subject to post-closure is described in greater detail in Section 3.2.2.2 of this report.

1.3.3 Calciner Pond Closures

The calciner ponds (Ponds 1C, 2C, 3C, 4C, and 5C) received treated calciner scrubber blowdown water. Following plant shutdown in 2001, the Idaho Department of Environmental Quality

(IDEQ) and FMC entered into a Consent Order for remediation of the calciner ponds. Pursuant to the IDEQ-approved Calciner Pond Remedial Action Plan (RAP) (FMC, 2003), FMC removed the free liquid and placed an initial fill and temporary cover at Ponds 1C, 3C, and 4C during 2003. Settlement rates at Ponds 1C, 3C, and 4C reached acceptable rates by the end of 2004 and IDEQ concurred with FMC's recommendation to proceed with placement of the final covers over all 5 ponds (1C through 5C). Following free liquid removal from Ponds 2C and 5C, the final covers were constructed on Ponds 1C through 5C during 2005. The final cover construction was completed in November 2005. FMC then submitted the remedial action certification and report for the calciner ponds and IDEQ concurred in 2006 that the calciner ponds had been addressed according to the IDEQ-approved Remedial Action Plan. The calciner ponds are now in post remedial action monitoring and maintenance. Post-remedial action groundwater monitoring of the calciner ponds is described in greater detail in Section 3.2.2.3 of this report.

1.3.4 Current and Future Land and Groundwater Use

As identified in the EMF RI, the area surrounding the FMC Plant OU is used for industrial, agricultural and isolated residential purposes, with little change expected in the future.

1.3.4.1 Current Land Use

Current land uses and zoning have not changed significantly since the EMF RI. This status is not surprising since the zoning of the EMF facilities and surrounding area has not and is not expected to change from the zoning that is currently in place. The FMC properties, the Simplot plant site, and other properties extending over four miles to the southwest along Highway 30 are currently zoned "heavy industrial" and generally in use as such. Additionally, Power County zoning restrictions apply a one-half mile buffer zone around the industrial zoned property, which prohibits any non-industrial use with this buffer area. A map provided by Power County depicting the zoning, the ½ mile buffer and property ownership, as well as the Power County zoning ordinance was provided in Appendix A of the FMC Plant OU SRI Report (MWH, 2008) and is not reproduced again here. The limited residential development to the northeast and south/southwest within the buffer zone is grandfathered by the zoning ordinance, because its construction pre-dated the ordinance. However the ordinance prohibits the expansion or replacement of those grandfathered areas.

1.3.4.2 Future Land Use

Future land use information, as discussed in Section 3.6 of the EMF RI Report, was based primarily on comprehensive plans (which are long-term planning documents) obtained from the municipalities of Chubbuck and Pocatello and from Bannock and Power counties. As confirmed by the Power County Zoning Map included in Appendix A of the SRI Report (MWH, 2008), there has been only minimal change in future long-term land use plans for the area at and near the FMC Plant OU since the time of the RI/FS. Further, Power County has stated in a letter to EPA (also attached as part of Appendix A of the SRI Report (MWH, 2008) to this report) that it does not foresee making any changes to its current land use zoning at or near the FMC Plant OU.

1.3.4.3 Current Groundwater Use

Overall, current groundwater uses within the EMF Study area (up to 3 miles away from the plants) have not changed significantly since the EMF RI. The groundwater wells identified in the EMF study area are used for irrigation, industrial, potable and to a lesser extent livestock purposes. There have been no significant changes in groundwater withdrawal (pumping) rates or patterns since the EMF RI due in large part to the Snake River Basin Adjudication (SRBA). The SRBA essentially "froze" water rights to 1983-1987 (the five year period prior to the commencement of the adjudication proceedings) diversion levels and evaluated water rights claims based on that production period. The EMF Site is within Basin 29 of the SRBA. The Director of the Idaho Department of Water Resources (IDWR) issued Recommendations on the water rights claims for Basin 29 in 2003 and partial decrees were issued by the SRBA court in 2004. As of July 2008, there is only one unresolved disputed water right claim (out of 2,290 claims filed with the State) in Basin 29. Due to the SRBA, there is essentially no opportunity for significant "new" water rights in Basin 29 and thus in the EMF Site area.

Although adjudicated (partial and/or final decree) water rights can be transferred (i.e., change in point of diversion ["POD"]), additional diversion at the properties north of the EMF facilities is unlikely given current and likely future land uses. The current status and use of the five production wells north of the plants and Batiste Spring that were sampled and analyzed during PSCS and RI is summarized below:

Well	Current Water Right Control / Property Ownership	Current Water / Land Use on Property
Lindley	FMC / FMC	None (FMC transferred water right POD to other FMC property) / unoccupied
Old Pilot House	FMC / FMC	None (well remains for monitoring only) / unoccupied
New Pilot House	FMC / FMC	FMC trailers / Office trailers
Tank Farm	Chevron / Chevron	Industrial and potable / Petroleum bulk terminal
Rowland	Rowland / Rowland	Rowland well used for Rowland residence, "Milk plant" not in use except for truck parking / Rowland residence, truck & RV parking, agricultural
Batiste Spring	Simplot / FMC	None (Simplot transferred water right POD to other Simplot property) / unoccupied

Following plant shutdown in December 2001, groundwater extraction for the FMC production wells (FMC-1 and FMC-3) decreased dramatically. Groundwater pumping from FMC-3 to support the plant decommissioning, dismantling and closure was approximately 98 acre-feet per year for 2003, 2004 and 2005. On an average basis, that use equates to a 24-hour per day, 365 day per year pumping rate of about 61 gpm. However, about half of the total water use was for dust control to support the RCRA pond closures and calciner pond remedial action. The dust control was performed primarily during the construction season (May – October) so short-duration pumping rates (e.g., filling water trucks) would have been higher than 61 gpm. As noted previously, the FMC production wells are screened in the deeper aquifer zone, were not impacted by facility groundwater releases and continued to meet the SDWA standards for drinking water during the shutdown and decommissioning period.

Currently, groundwater pumping from FMC-3 is approximately 35 acre-feet per year and is used for general property maintenance (roadway dust control) and dust control for the ferrophos loading / sale. On an average basis, that use equates to a 24-hour per day, 365 day per year pumping rate of about 22 gpm. However, the dust control is performed as needed and primarily during the warm/hot and dry months (May – October) so short-duration pumping rates (e.g., filling water trucks) are higher than 22 gpm.

As reported in Simplot's 2007 Groundwater Annual Report (Newfields, 2008), there were no significant changes to the relative pumping rates from the production wells in 2007 from the end of the fourth quarter 2006. Flows from SWP-4 ranged from 1,100 to 1,400 gpm, SWP-5 pumping rates were from 1,400 to 1,600 gpm, and SWP-7 remained relatively constant at 1,200 gpm. During 2007, Simplot's remedial action groundwater extraction wells pumped at a combined average of 270 gpm (Newfields, 2008). Current total combined extraction from Simplot production and extraction wells is similar the upper end of the range of Simplot's combined flow rate of 4,000 gpm as described in the EMF RI.

The EMF RI groundwater monitoring wells that were installed north of the EMF plant sites to determine the northern extent of EMF impacted groundwater are still utilized for groundwater monitoring. The current property ownership and water use on the properties where the EMF monitoring wells are located to the north of the facilities are summarized below:

Well	Current Water Right Control / Property Ownership	Current Water / Land Use on Property
514	City of Pocatello / City of Pocatello	Agricultural / POTW sludge application and hay
515	City of Pocatello / City of Pocatello	Agricultural / POTW sludge application and hay
516	City of Pocatello / City of Pocatello	Agricultural / POTW sludge application and hay
502	FMC / FMC	None / Unoccupied
TW-11S	FMC / FMC	None / Unoccupied
524/525	Simplot / FMC	None / Unoccupied

Based on the post-RI monitoring results from these wells, there have been no significant changes in groundwater quality at these wells since the EMF RI. Post- EMF RI groundwater monitoring results for these wells are presented in Section 4 of this report.

1.3.4.4 Future Groundwater Use

As described previously, the SRBA has essentially "frozen" water rights to the 1983-1987 (the five year period prior to the commencement of the adjudication proceedings) diversion levels. The SRBA process is nearing its completion with respect to Basin 29 and there is essentially no opportunity for significant "new" water rights in Basin 29 and thus in the EMF Site area. Although adjudicated water rights can be transferred (i.e., change in point of diversion), additional groundwater diversions (through transfer) at the properties north of the EMF facilities are unlikely given current and likely future land uses. In addition, there is no indication that the City of Pocatello, Chevron or Rowland plan to materially alter water or land uses within the foreseeable future.

Groundwater withdrawal from FMC's production wells has decreased dramatically since the plant was shutdown in 2001. FMC has attempted to support industrial redevelopment of the property since the time of the shutdown. Although an industrial redevelopment would likely rely on groundwater for process and potable water (there is no existing infrastructure or connection to a municipal water system), a future use (e.g., large smelter or refinery) that would match the water demand of the former FMC phosphorus production plant seems unlikely. In summary, with the exception of the FMC plant shutdown and associated reduction in groundwater withdrawal at the FMC property, there have been no significant changes in land or groundwater use since the EMF RI.

1.4 Report Organization

The remainder of this report is organized as follows:

- Section 2 describes the regional and EMF site Geologic and Hydrogeologic setting. Most of the text, tables and figures were taken directly from the EMF RI Report and edited for brevity and to reflect relevant post-RI information.

- Section 3 provides a summary of the EMF RI groundwater investigation, post-RI groundwater "special" studies and monitoring events, and the on-going CERCLA, Calciner Pond Remedial Action, and RCRA groundwater monitoring programs at the FMC Plant OU.

- Section 4 provides a summary of the EMF RI groundwater investigation and the results of the post-RI groundwater "special" studies and monitoring events, and the on-going CERCLA, Calciner Pond Remedial Action, and RCRA groundwater monitoring programs at the FMC Plant OU.

- Section 5 presents the groundwater quality assessment and trend evaluation for the entire FMC Plant OU and a source evaluation that focuses on previously identified and potential sources of groundwater impacts at the FMC Plant Site.

- Section 6 summarizes the EMF RI groundwater fate and transport findings and updates groundwater fate and transport mechanisms in the context of post-RI groundwater special studies and results.

- Section 7 presents an update to the human health risk assessment for the FMC-related constituents in groundwater beneath the FMC Plant OU.

- Section 8 presents conclusions and recommendations based on the significant groundwater investigations, studies and database of analytical results that have been amassed for the EMF Site and FMC Plant OU over the previous approximately 18 years.

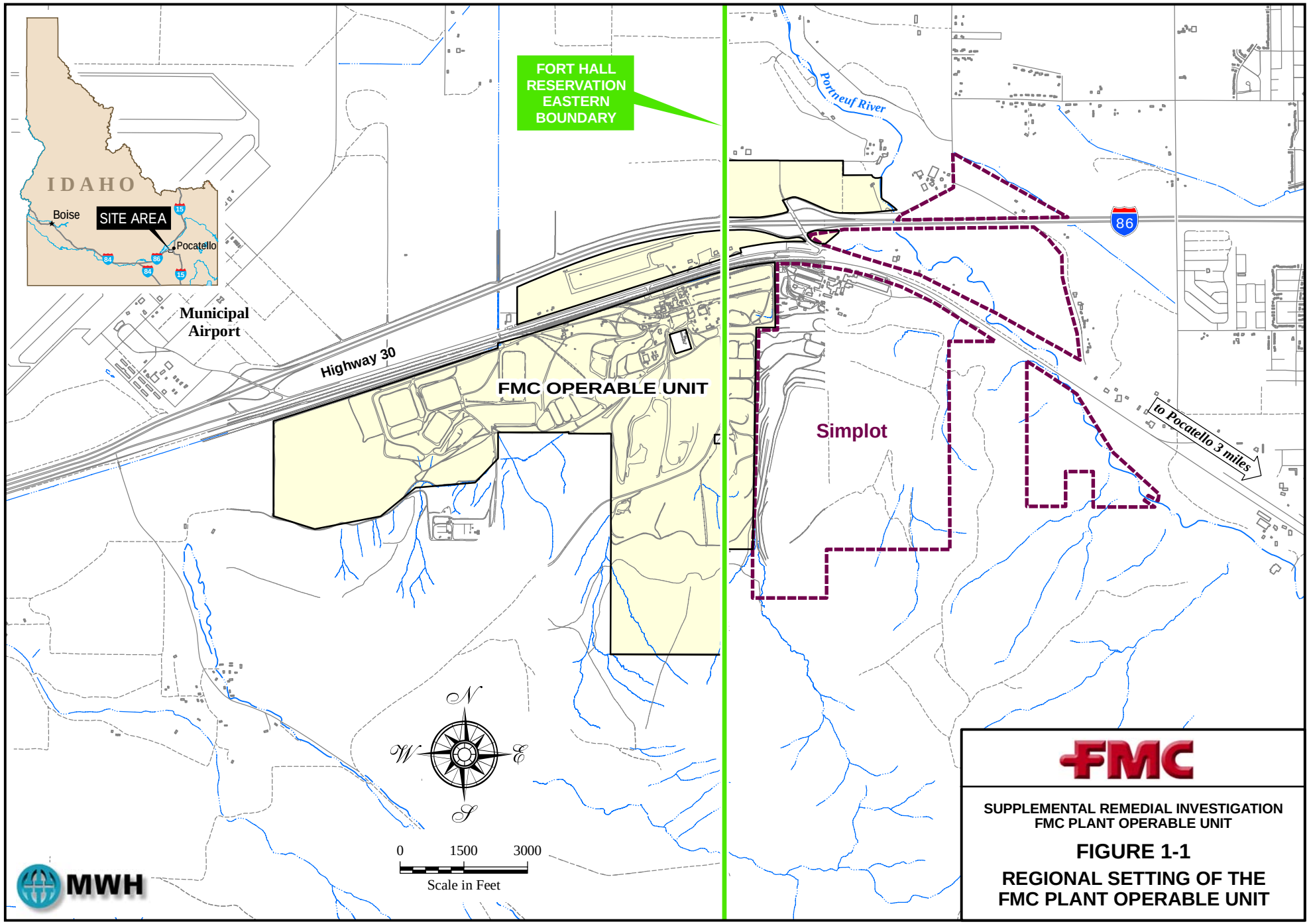
TABLE 1.3-1 RCRA Waste Management Unit (WMU) Closure Timeline and Status, FMC Pocatello

RCRA Ponds	Initial Fill	Final Cap	Closure Plan	Closure Status	Post-Closure Status
8S	Completed 1994	Completed 1999	CP/PC Plan public noticed May-June 1997 Final CP/PC Plan date Dec 1998	CP approved Aug 1998 Certified Dec 1999	Following PC Plan since Dec 1999
9E	Completed 2000		CP/PC Plan public noticed Jan-Feb1999 Final CP/PC Plan date Jan 2000	CP approved March 2000 Certified Jan 2001	Following PC Plan since Jan 2001
8E	Completed 1999	Completed 2004	CP/PC Plan public noticed Nov-Dec 1998 Final CP/PC Plan date May 2002	CP/PC Plan approved Jan 2003 Certified Jan 2005	Following PC Plan since Jan 2005
Phase IV	Completed 1999	Completed 2004	CP/PC Plan public noticed Oct-Nov 1998 Final CP/PC Plan date May 2002	CP/PC Plan approved Jan 2003 Certified Jan 2005	Following PC Plan since Jan 2005
15S	Completed 1999	Completed 2004	CP/PC Plan public noticed Oct-Nov 1998 Final CP/PC Plan date May 2002	CP/PC Plan approved Jan 2003 Certified Jan 2005	Following PC Plan since Jan 2005
16S	Completed 2000	Completed 2004	CP/PC Plan public noticed Sep-Oct 1999 Final CP/PC Plan date July 2003	CP approved Feb 2004 Certified Jan 2005	Following PC Plan since Jan 2005
17	Completed 2002	Completed 2005	CP public noticed Oct-Nov 2001 Current CP/PC Plan date June 2001 Final plans and specs to EPA Aug 2004	CP approved Feb 2005 Certified Dec 2005	Following PC Plan since Dec 2005
18 CellA **Cell B**	Completed 2002 N/A	Completed 2005 Closure by removal completed 2005	CP public noticed Oct-Nov 2001 Current CP/PC Plan date Aug 2001 Final plans and specs to EPA Aug 2004	CP approved Feb 2005 Certified Dec 2005 CP approved Feb 2005 Certified Dec 2005	Following PC Plan since Dec 2005 N/A – closure by removal

Other RCRA Units	Status	Closure Plan	Closure Status	Post-Closure Status
Wastewater Treatment Unit	Closure by removal completed 2001	CP public noticed Sep-Oct 1999 Final closure plan date Dec 1999	CP approved Feb 2001 Certified Oct 2001	N/A – closure by removal
Slag Pit Sump	Interim plan completed 1999 Final closure completed 2005	CP/PC Plan public noticed Feb-Mar 2001 Closure plan date Sep 2001	CP approved Feb 2005 Certified Dec 2005	Following PC Plan since Dec 2005
AFM Wash Station	Closure by removal completed 2002	CP public noticed Feb-Mar 2001 Final closure plan date Oct 2001	CP approved Aug 2002 Certified Feb 2003	N/A – closure by removal
Drum Storage Area	Closure by removal completed 2003	CP public noticed Feb-Mar 2001 Final closure plan date July 2000	CP approved Aug 2002 Certified June 2003	N/A – closure by removal
8S Recovery Process	Closure work completed 1993, closure documentation submitted to EPA October 1997	CP public noticed May-June 1997 Final closure plan date April 1993	CP approved Feb 2005 Certified April 2005	N/A – closure by removal

Notes:
"CP" means Closure Plan
"PC Plan" means Post-Closure Plan

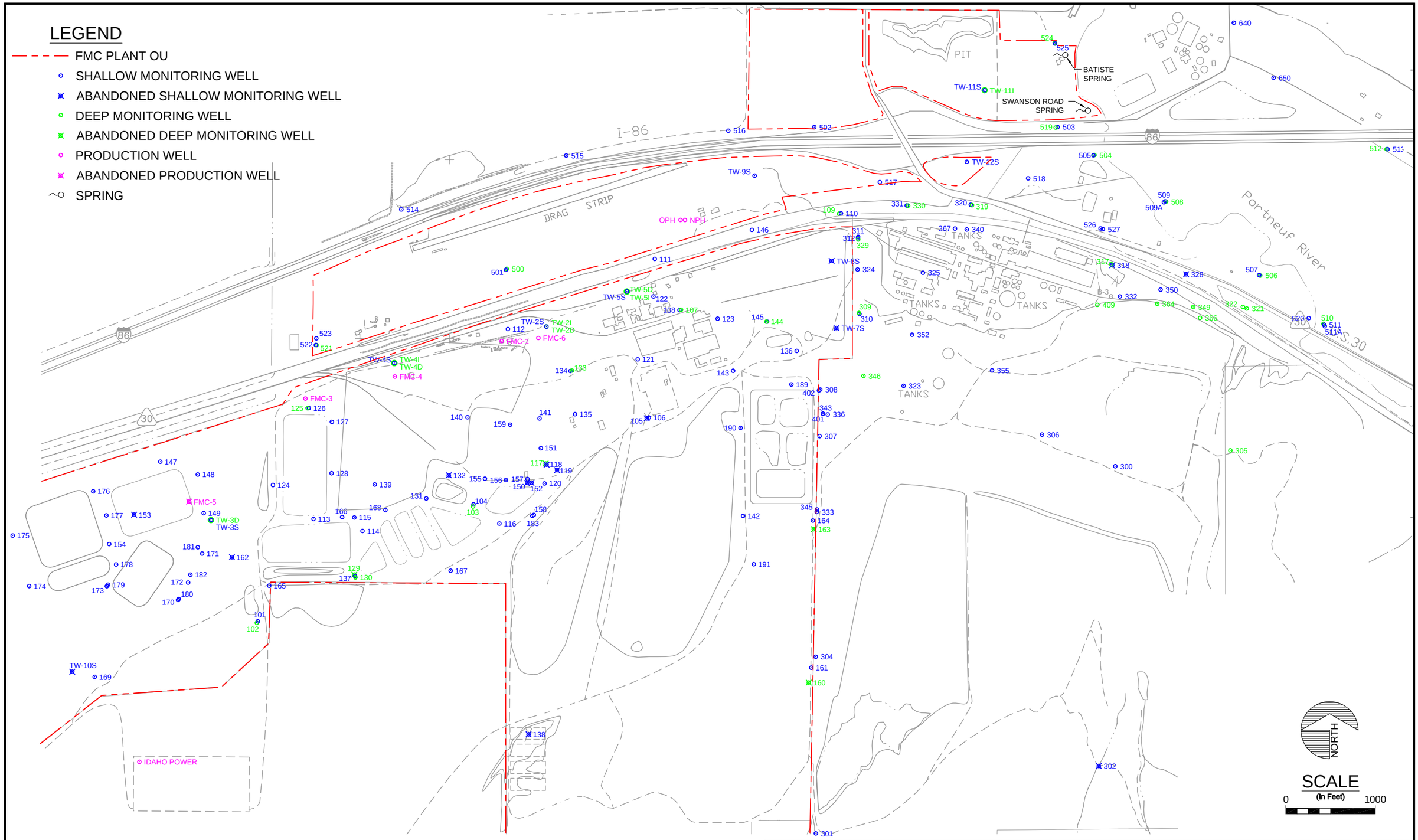
FILE *Fig 1-01 Regional Setting_508.mxd* *5/03/08*



SUPPLEMENTAL REMEDIAL INVESTIGATION
FMC PLANT OPERABLE UNIT

FIGURE 1-1

REGIONAL SETTING OF THE FMC PLANT OPERABLE UNIT



FMC CORPORATION–POCATELLO, IDAHO
FMC PLANT OU GROUNDWATER
CURRENT CONDITIONS REPORT 2008

FMC - WELL LOCATION MAP

FIGURE
1-2

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Hydrometrics, Inc.
Consulting Scientists and Engineers

Section 2
GEOLOGY AND HYDROGEOLOGY

2.1 Geology

The EMF study area is located at the base of the northern slope of the Bannock Range, where it merges with the Snake River Plain. The northern part of the EMF study area is located at the southeastern edge of Michaud Flats. The southern part extends onto the north slope of the Bannock Range.

The stratigraphy of the study area can be generally described as discontinuous layers of unconsolidated sediments deposited on an erosional surface that was incised in volcanic bedrock. The sedimentary unit immediately above the bedrock is a gravel derived from volcanic rocks.

Overlying the gravel are varying thicknesses of fine-grained silts, clays, and sands that form a discontinuous, semi-confining unit. The fines are overlain by another coarse-grained unit, called Michaud Gravel that consists of quartzite, chert, and volcanic gravels, cobbles, and boulders.

Above the second gravel unit is another fine-grained facies that consists of interfingered silts, clays, and sands. In the western part of the EMF study area, a separate but discontinuous third coarse-grained layer is present. Finally, deposits of windblown silt (loess) and a colluvial silt and gravel layer of variable thickness mantle the area. The loess layer ranges from 2 to over 100 feet (0.6 to 30 m) thick at the EMF facilities, and is calcareous. To the north and east, the Michaud Gravel occurs in scoured channels. The fine-grained layers present in the western and central areas of the facilities are generally absent here.

The Portneuf River passes northeast of the Simplot facility and Michaud Creek passes the FMC facility immediately to the west. The floodplain of the Portneuf River near the study area is approximately 0.5 mile (0.8 km) wide. The riverbed lies entrenched in the Michaud Flats at a depth of about 20 to 40 feet (6 m to 12 m). The entrenched depth increases toward the American Falls Reservoir. Several steep dry draws begin in the Bannock Range and continue northward to the flats, and occur as sediment-filled channels in the subsurface.

In general terms, the EMF study area is underlain by a sequence of Starlight Formation volcanics and sediments, overlain by the interfingered American Falls Lake Beds-Sunbeam Formation. These are overlain by Michaud Gravel and Aberdeen Terrace deposits. Finally, a mantling of loess is present at higher elevations and a veneer of alluvium covers lower areas. Loess deposits are much thicker in portions of drainages where they have been reworked and redeposited.

The Starlight Formation has three distinct members, which vary lithologically from volcanic gravels, silts, and sands to intact volcanics. Because of the marked relief on the erosional surface of the Starlight Formation, any given location can be underlain by any one of a number of Starlight lithologies. The relationship between the volcanic deposits and the overlying sedimentary deposits is shown in EMF RI Figures 3.1-5 through 3.1-12. The upper surface of

volcanic deposits can be difficult to distinguish in drill cuttings because there are places where younger Sunbeam deposits overlie similar unconsolidated Starlight Formation deposits. Inferred contours on the upper surface of the Starlight Formation and basalts are shown in EMF RI Figure 3.1-13.

Basalt was encountered beneath the EMF facilities in six borings (FMC-4, TW-2D, 129, 130, 139, and 304). The basalt in boreholes 139 and 304 was encountered beneath volcanic tuffs, indicating that the basalts may be part of the Tertiary deposits. The presence of basalt in the other four borings suggests that a late Pleistocene basalt flow may exist beneath part of the FMC facility. This basalt could be a distal lobe of the Big Hole Basalt or a part of one of the many other basalt flows in the area.

The unconsolidated sediments include Sunbeam Formation-American Falls Lake Beds, Michaud Gravel, and possibly Aberdeen Terrace Deposits. These units occur as alternating intervals of coarse-grained sediments (generally sand and gravel) and relatively fine-grained sediments (clay and silt). These units are laterally correlative between borings, although they also merge and pinch out as shown in EMF RI Figures 3.1-6 through 3.1-12.

Beneath the northern portion of the FMC facility, the thicknesses of both the coarse- and fine-grained intervals are relatively consistent. In the southern portion of FMC, the extent and thickness of different deposits is much more variable. Beneath the Simplot facility and near the Portneuf River, the fine-grained intervals are variable in thickness and extent. There is a transition zone near the FMC-Simplot boundary where fine-grained intervals are more numerous and considerably thinner.

Locally, relatively thick accumulations of clay occur beneath the Simplot facility near the edge of Michaud Flats (sections C-C' and D-D', EMF RI Figures 3.1-8 and 3.1-9). These clay deposits are distal from incised bedrock valleys. The incised valleys are typically filled with coarser sediments. The sediment distribution relative to the bedrock valleys indicates that these valleys were waterways, depositing coarser sediments under higher energy conditions and depositing fine-grained sediments in the flats or over the banks. Near the Portneuf River, the thin, fine-grained layers pinch out or are truncated by flood deposits. The northernmost cross-section G-G' reveals a clay layer in the Michaud Flats that pinches out from west to east (EMF RI Figure 3.1-12). This clay layer occurs within the saturated sediments, and acts as a local confining unit.

Many borings encountered a coarse-grained interval composed of angular volcanic gravels immediately above hard volcanic rock. These gravels are most likely derived locally and appear to be Sunbeam Formation. The overlying fine-grained interval is composed mostly of silt and clay with minor sand and gravel. This fine-grained unit may be part of the Sunbeam Formation or the American Falls Lake Beds.

The fine-grained interval identified as the American Falls Lake Beds/Sunbeam Formation is overlain by the Michaud Gravel, composed of rounded gravel, cobbles, and boulders of quartzite, chert, and volcanics. These gravels represent the Bonneville flood deposits which are relatively uniform in thickness beneath the northwestern half of the EMF facilities. The Michaud Gravel

increases in thickness toward the east, truncating the underlying fine-grained interval and probably deeper units as well. The thicker deposits of the Michaud Gravel appear to be in a scoured channel confined by the Pocatello Range and Bannock Range. When the Bonneville Floods reached the Michaud Flats, the waters spread and lost energy, dropping out most of the coarsest sediments along the eastern margin of the EMF facilities and depositing finer gravels to the west.

Above the Michaud Gravel is another fine-grained/coarse-grained couplet. This couplet may be Aberdeen Terrace deposits or it may be part of the Michaud Gravel. Since the Aberdeen Terrace deposits are reworked Michaud Gravel, it is very difficult to distinguish between the two. For characterizing the geology beneath the EMF facilities, it makes little difference which name is attached to these units.

Eolian deposits of loess and fine sand mantle the lower slopes of the Bannock Range and terrace or pediment deposits near the margin of the Michaud Flats. Loess deposits are particularly thick in the lower portions of drainages, where the silty material may be reworked and redeposited (for example, Section D-D', EMF RI Figure 3.1-9).

Finally, recent (Holocene Era) fluvial and alluvial sediments were deposited in and near present-day stream channels.

2.2 Hydrogeology

This section presents a summary of the hydrogeologic data collected during pre-RI work, the RI and post-RI studies that provide a clear picture of the primary hydrogeologic features associated with the EMF facilities and surrounding areas. A major part of the EMF RI included the development of a numerical, three-dimensional, groundwater flow model. Detailed information on the development of the EMF RI groundwater numerical model is presented in Appendix K of the EMF RI Report (Bechtel, 1996) and is not reproduced in this report.

The contents and organization of this section are as follows:

- Section 2.2.1-Regional Hydrogeologic Setting
- Section 2.2.2-Site Hydrogeology
- Section 2.2.2.1-Aquifer test results
- Section 2.2.2.2-Groundwater elevations, flow patterns, and vertical gradients
- Section 2.2.2.3-Water chemistry
- Section 2.2.2.4-Recharge and pumping rates

- Section 2.2.3-Conceptual Groundwater Flow Model
- Section 2.2.4-Groundwater Numerical Modeling Results
- Section 2.2.5-EMF Site Hydrogeology Summary

2.2.1 Regional Hydrogeologic Setting

The Eastern Snake River Plain is underlain by basalt and gravel aquifers that are recharged mostly by underflow from surrounding mountain ranges. Some recharge occurs as irrigation return and deep percolation from precipitation. Several rivers flow onto the Snake River Plain, infiltrate underground, and the water ultimately discharges to the Snake River (Lost River on EMF RI Figure 3.2-2). Groundwater flow through the basalts of the Snake River Plain occurs primarily in thin interflow zones: thin gravel and fracture zones between basalt flows and in the fracture of the basalts (some of the basalts are columnar basalts, with a large interconnected fracture network). Regionally, the Snake River defines the base level for other smaller rivers such as the Blackfoot and Portneuf Rivers. The Portneuf River drains approximately 1,250 square miles, flowing across the Eastern Michaud Flats to the American Falls Reservoir, where it joins the Snake River (EMF RI Figures 3.2-1 and 3.2-2).

The Michaud Flats are underlain by the same prolific basalt and gravel aquifers. These aquifers are recharged by underflow from the adjoining Bannock and Pocatello mountain ranges and from significant downvalley underflow from the Pocatello Valley aquifer. Smaller drainages also provide underflow to the aquifers (EMF RI Figure 3.3-2). Direct infiltration from precipitation and irrigation return are other recharge sources. Within the mountainous areas, there are no regionally continuous hydrostratigraphic units. Groundwater flows through undifferentiated volcanic and sedimentary rock units, with flow focused to sediment-filled valleys incised into the mountains. At the transition between mountainous areas and flatlands, there are alluvial fan deposits where groundwater flow occurs primarily within sand and gravel lenses.

Within the Michaud Flats, the aquifer system can be divided into a shallow aquifer and a deeper aquifer. The shallow aquifer is Michaud Gravel which is typically overlain by a silt aquitard that is generally saturated from 10 to 30 feet above the gravel, but is locally unconfined. The deeper aquifer is comprised of the gravel and volcanics of the Sunbeam and Starlight Formations, and the Big Hole Basalt. The deeper aquifer is the primary water-producing aquifer within the Michaud Flats. The deeper aquifer underlies the American Falls Lake Beds (AFLB), the regional aquitard between the shallow and deeper aquifers (Houser, 1992). Groundwater that flows into the regional aquifer system discharges to the Portneuf River (via springs and base flow contribution), American Falls Reservoir, or to one of the numerous springs and seeps in the Fort Hall Bottoms. Groundwater discharges to the Portneuf River along the reach from I-86 downstream to the American Falls Reservoir. The river gains significant flow along this reach as groundwater discharges through the riverbed and springs on both the east and west sides of the channel. The Pocatello sewer treatment plant (STP) contributes some flow along this river reach.

2.2.2 Site Hydrogeology

Geologic borings were drilled and logged, monitoring wells were installed, pumping well flow rates were measured, and groundwater chemistry data were collected as part of the RI. Numerous slug tests and pumping tests were also performed as part of this aquifer characterization. Additional hydrostratigraphic data and aquifer testing results were acquired from other sources, including Jacobson (1982, 1984, and 1989), Goldstein (1981), and the City of Pocatello.

The local hydrostratigraphic framework is generally consistent with the regional framework. Three distinct hydrogeologic areas were delineated in the vicinity of the EMF facilities on the basis of lithologic data, stratigraphic relationships, groundwater flow characteristics, and water chemistry. These areas are the Michaud Flats, Bannock Range, and Portneuf River (EMF RI Figure 3.3-3). Within the Bannock Range area there were no continuous hydrostratigraphic units delineated during the RI. Starlight Formation volcanic flows and interflow units are not correlative, and the overall distribution of rock types and saturated materials is best described as highly heterogeneous.

The transition zone between the Bannock Range hydrogeologic area and the Michaud Flats is characterized by small coalescing alluvial fans that are also relatively heterogeneous. In the Michaud Flats, distinct shallow aquifer and deeper aquifer zones were identified in the RI (EMF RI Figure 3.3-4). The shallow aquifer is a 10 to 20-feet thick gravel and sand aquifer that is locally overlain by a silt aquitard (EMF RI Figure 3.3-5). The deeper aquifer is the gravel unit of the Sunbeam Formation and the underlying basalt and rhyolite. The unconsolidated gravel and the underlying volcanic lithologies do not appear to have a large permeability differential, nor is there an intervening aquitard between these units. Therefore, both units constitute the deeper aquifer in the Michaud Flats area.

The American Falls Lake Beds form an aquitard that separates the shallow and deeper aquifers within the Michaud Flats area. These lacustrine clays and silts have very low permeability and are regionally extensive, extending from the Bannock Range area to the American Falls Reservoir, where they crop out along the reservoir embankment. The AFLB are not present along part of the Portneuf River in the area of Batiste Springs and Wells 524/525 south to Well 520 (EMF RI Figure 3.3-6). The Bonneville Flood may have scoured the AFLB, consistent with Trimble's (1976) map of boulder deposition patterns that indicate a main flood channel in this area. Elevation contours on the top of the AFLB suggest a slight dip to the north. Just to the south of I-86, there is an elongated, east-west depression in the AFLB surface, which may also be an erosional feature of the flood (EMF RI Figure 3.3-6).

In areas immediately adjacent to the Portneuf River where the AFLB are not present (as discussed above) and in the Bannock Range area, the delineation of distinct shallow and deeper aquifers was not possible. In the Bannock Range and Portneuf River areas, the monitoring wells in well pairs were classified as shallow and deep without respect to specific hydrostratigraphic units.

2.2.2.1 Aquifer Test Results

RI pumping test and slug test results are included in Section 3.3.2.1 of the EMF RI Report and summarized below. Calculated hydraulic conductivities in the shallow saturated zones are shown in EMF RI Figure 3.3-7a. Results for the deeper zones are summarized in EMF RI Figure 3.3-7b.

In the Bannock Range area, hydraulic conductivity typically ranges from 0.00001 cm/s (0.03 ft/day) to 0.099 cm/s (28 ft/day) in shallow and deeper zones. Although the lithology is highly heterogeneous, the hydraulic conductivity is fairly consistent throughout much of this area as defined by Wells 142, 300, 301, 304, 306, 323, 325, PEI-2, and PEI-5. Hydraulic conductivities are higher at Wells 307, 308 and 333, which are located along the joint fenceline of Simplot and FMC. The higher hydraulic conductivities in this area are associated with a small, narrow, and deep relict sediment-filled stream channel originating within the Bannock Range (EMF RI Figures 3.3-2 and 3.3-7a).

Hydraulic conductivity in the Michaud Flats shallow aquifer ranges from 0.0105 cm/s (30 ft/day) to 0.355 cm/s (1,000 ft/day). The highest values were at Wells 150 and 153. Slightly lower values were associated with the depression in the AFLB, and two of the lowest values were measured in Wells 515 and 516, north of this depression. In the deeper aquifer hydraulic conductivities appear to have an increasing trend to the north. Relatively low values were measured in deeper Wells 103 and 107 with slightly higher values at Well 500 and 133.

Transmissivity data from Jacobson (1984) indicate very high hydraulic conductivities in the deeper aquifer throughout the area north of I-86 (EMF RI Table 3.3-1). South of I-86, a transmissivity of 227,000 square feet per day (ft2/day) was calculated at Simplot production well SWP-7. SWP-5 has a higher transmissivity than SWP-7 as indicated by the pumping test. When SWP-5 was installed and developed, 3 feet of drawdown was measured after 48 hours of pumping at 4,100 gpm. Irrigation wells tested in the Michaud Flats had transmissivities ranging from 21,900 to 444,000 ft2/day (Jacobson, 1984).

The bouldery gravel aquifer in the Portneuf River area has the highest hydraulic conductivity. Calculated values ranged from 0.01 cm/s (28 ft/day) to 1.7 cm/s (4,800 ft/day). Most of the slug test results from the Portneuf River area indicate hydraulic conductivities are greater than 0.36 cm/s (1,000 ft/day). Hydraulic conductivities appear to be similar in the shallow and deeper wells throughout the Portneuf River area.

2.2.2.2 Groundwater Elevations, Flow Patterns, and Vertical Gradients

Depth to groundwater in wells ranged from over 150 feet in the Bannock Range to less than 10 feet near the Portneuf River. The groundwater elevations in the Bannock Range were up to 4,629 feet (above mean sea level), as measured in PEI-1. Approximately 8,500 feet north the groundwater elevations were 4,383 feet msl at Batiste Spring along the Portneuf River (EMF RI Figure 3.3-8F).

There are seasonal water level fluctuations in the Michaud Flats, typically on the order of 2 to 4 feet, which may be associated with irrigation withdrawal and recharge patterns. Long-term groundwater levels in the Michaud Flats appear to have declined on the order of 2 to 3 feet since the 1950s (Jacobson, 1982); however, Goldstein (1981) reported increasing and decreasing trends in various wells in Michaud Flats, indicating that long-term groundwater levels are regionally stable with possible local variations. Water level measurements from EMF / FMC Plant OU monitoring wells from 1990 through 2008 as shown on the hydrographs presented in Appendix A of this report. The hydrographs in Appendix A depict groundwater elevations that have been measured quarterly since installation of each well. They include a set of shallow and deep monitoring wells that provide spatial coverage from up- and cross-gradient wells to the south, southwest, northwest and north of the FMC Plant OU, throughout the FMC Plant Site and downgradient within the FMC Plant OU and extending to the east-northeast to wells 524 and 525 (proximally north of Batiste Spring).

Overall, the water levels indicate no long-term decrease in water levels at the site. Water levels in the shallow and deep wells have typically fluctuated within 4 to 8 feet between maximum and minimum measured levels over the 15 to 18 year period of monitoring for most of the wells. Maximum water levels were generally observed in the mid- to late 1990s during a cycle of average and above average regional precipitation during the monitoring period for most wells. Minimum water levels were typically observed in the 2001 and 2002 period that coincided with several years of significantly below average precipitation in the region. Water levels have slowly rebounded in recent years but generally have not recovered to levels measured during the 1990s.

Groundwater elevation contour plots for the shallow saturated zone were prepared for each quarterly sampling event from June 1992 through May 2008. The groundwater contour map for May 2008 is presented on Figure 2.2-1. The groundwater elevation contour maps from June 1992 through May 2008 are provided in Appendix B of this report. Appendix B consists of quarterly groundwater contour maps from the EMF RI Report for June 1992 through August 1993 and June 1994 (EMF RI Figures 3.3-8A through 8F) and from FMC's RCRA Annual Groundwater Monitoring Assessment Reports for the 3rd quarter 1994 through the 2nd quarter 2008 (the figures from the RCRA reports are generally labeled as Figures 3 through 6 for each calendar year). These contour patterns are very consistent from quarter to quarter and year to year. Several key features are evident in the contour patterns.

- There are very steep horizontal gradients in the Bannock Range.

- Within the western (FMC western pond area) part of the monitoring network, there is a slight northeast-trending trough in the groundwater surface extending through the area of wells 170, 168, 139 and 140.

- There is a distinct increase in the horizontal gradient in the vicinity of wells 146 and TW-9S, and a decreasing gradient further east, in the vicinity of wells 517, TW-11S and TW-12S.

- Shallow groundwater contour patterns do not appear to be influenced by production wells pumping from the deeper aquifer nor from the dramatic decrease in pumping from production wells FMC-1 and FMC-3 following plant shutdown in December 2001.

General flow patterns described by the hydraulic head contours indicate that groundwater flows north off the Bannock Range under steep gradients through low permeability lithologies (EMF RI Figure 3.3-3 and Appendix B). When this Bannock Range flow enters the highly permeable Michaud Flats and Portneuf River lithologies, groundwater flow converges sharply, with all shallow Bannock Range groundwater ultimately discharging along a short reach of the Portneuf River bounded by Batiste Spring to the north and I-86 to the south. These groundwater flow patterns are depicted on Figure 2.2-2 as inferred flow lines on the May 2008 groundwater contour map.

Horizontal groundwater seepage velocities, calculated from hydraulic conductivities, horizontal gradients, and estimated porosity, are up to 12 feet per day (ft/day) in the Portneuf River area, 0.4 ft/day in the Bannock Range area, and from 1 to 11 ft/day in the Michaud Flats area. The variable seepage velocities calculated in the Michaud Flats area illustrate the effects of variable horizontal gradients and the wide range of hydraulic conductivities calculated for this area (EMF RI Table 3.3-1). The consistently high seepage velocities in the Portneuf River area are indicative of the very high hydraulic conductivities associated with the Bonneville Flood deposits. Groundwater fluxes are discussed Section 3.3.4.

One set of data from deeper wells was contoured to illustrate the general contour patterns in the deeper saturated zones (EMF RI Figure 3.3-9). The general contour patterns are similar to the shallow saturated zone in many respects. For example, there is sharp convergence of flow to the Portneuf River reach from Batiste Spring to I-86. The increase in horizontal gradient from the area of Well 112 to TW-9S is not evident in the deeper groundwater contours. The effects of the EMF production wells are not readily apparent in the contours developed from deeper groundwater monitoring wells. This is likely due to very high transmissivity in the deeper aquifer and the minor drawdown associated with production well pumping.

Vertical head differentials were measured in well pairs installed during the RI and during previous investigations. Vertical head differentials are one measure of the flow potential between shallow and deeper saturated zones. (The other factor is the vertical hydraulic conductivity.) The vertical head differentials also provide indications of the direction of the flow or gradient between shallow and deeper zones.

The overall pattern of vertical differentials shows that in the area along the flanks of the Bannock Range there is a downward flow potential (EMF RI Figures 3.3-10A through 3.3-10I). Well pairs 130/137 and 101/102 had persistent downward gradients, and well pair 103/104 had a slight upward gradient (less than 0.10 foot head differential). This pattern is still observed based on the water levels at well pairs 101/102, 130/137 and 103/104 measured during May 2008. Water levels measured in May 2008 for site-wide shallow/deep well pairs are shown on Table 2.2-1. Further north, vertical gradients were upward in well pairs 134/133, 117/118 (now abandoned), 107/108, TW-5S/TW-5I, and 500/501 during the EMF RI. This pattern is still observed based on

May 2008 water level measurements at well pairs 133/134, 107/108 and TW-5S/TW-5I/TW-5D. During the EMF RI, there was a downward gradient measured in well pair 125/126, located near production well FMC-1, which draws water from the deeper aquifer and may have induced a local downward gradient. However, based on measurements in May 2008, the slight (less than 0.1 foot) downward gradient at well pair 125/126 does not relate to pumping of FMC's production well FMC-1 that has not been used in over 8 years.

From the area along the joint facilities' fenceline out to the Portneuf River, there were large upward vertical head differentials measured in the well pairs 309/310, 329(311)/312, 109/110, 319/320, TW-11I/11S, 504/505, 503/519, and 315/316 during the EMF RI. In these well pairs the water levels in the deeper wells were typically 2 to 6 feet higher that water levels in the shallow wells. The May 2008 water level measurements at well pair 109/110 showed the water level in the deeper well (109) was 4.6 feet higher than the shallow well (110), consistent with the EMF RI findings in this area of the site.

The slight downward gradient at the 524/525 well pair is not inconsistent with groundwater discharge to the Portneuf River through springs and as baseflow. In contrast with other well pairs to the south, a very slight (.04-.06 foot differential) downward vertical gradient exists at the 524/525 well pair (as measured during the EMF RI and May 2008), which is just north of the groundwater discharge areas at Batiste Spring, Swanson Road Spring and the Portneuf River. Adjacent wells 524 (deep) and 525 (shallow) are screened at depths of 48.5-58.5 and 17.8-27.8 feet below ground, respectively, within silty gravel deposits. No confining beds are present.

The slight vertical gradient at well 524/525 indicates that horizontal flow is dominant within the shallow gravel interval penetrated by both wells. The well pairs to the south have a greater vertical separation between screened intervals. This indicates that the vertical gradients are more prevalent between the very deep (>90 feet below ground surface [bgs]) and the shallow (<60 feet bgs) gravels near the river.

2.2.2.3 Water Chemistry

Groundwater samples were collected from 17 monitoring wells beyond the potential influence of the EMF facilities (EMF RI Section 4.4). These wells were used to characterize aquifer water chemistry in the three hydrogeologic areas. Three hydrogeochemical regimes were identified, although the extent of these regimes is not always correlative with the hydrogeologic areas (EMF RI Figure 3.3-3). These regimes are the Portneuf River, Bannock Range, and Michaud Flats hydrogeochemical regimes. The general water chemistry of these regimes is illustrated in Stiff and Piper diagrams for the selected wells in EMF RI Figures 3.3-11 and 3.3-12A through 3.3-12D. These figures illustrate two points: first, water chemistry in the Michaud Flats regime is distinctly different than either the Bannock Range or Portneuf River regimes, and second, the water chemistry of the Portneuf River is distinct from the Bannock Range, albeit the differences are more subtle.

The predominant regional groundwater type is the calcium-bicarbonate chemistry of the Bannock Range regime, with localized areas in the Michaud Flats and Portneuf River having a

distinct "overprint" from local recharge sources. The shallow aquifer beneath the Michaud Flats has a higher sodium and chloride content than Bannock Range and Portneuf River Valley groundwater. The salinity of the Michaud Flats shallow aquifer is probably due to irrigation. The higher alkalinity in wells near the Portneuf River (among other minor differences such as higher barium and lower arsenic concentrations) is likely due to river water that is lost to the aquifer along the losing reach of the Portneuf River.

The Bannock Range water chemistry is evident in the deeper aquifer beneath the Michaud Flats, within the Bannock Range, and extends to the Portneuf River. Portneuf River Valley groundwater discharges at Swanson Road Spring, whereas Bannock Range groundwater discharges at springs further north (EMF RI Figure 3.3-3).

2.2.2.4 Recharge Rates and Pumping Rates

The estimated recharge rate in the Eastern Snake River Plain is 10 percent of the mean annual precipitation (Wood and Low, 1986). Based on a mean annual precipitation at the Pocatello Airport of 10.9 inches, the average recharge is about 1 inch per year. There are slightly higher recharge rates in the Bannock and Pocatello Ranges due to greater mean annual precipitation at the higher elevations, and because more of it occurs as snow.

In the Michaud Flats and Portneuf River area, a large percentage of the land is used as irrigated cropland for potatoes, alfalfa and grain. Potatoes and alfalfa have fairly high water demand, with about 30 to 40 inches of irrigation water applied annually to these crops. Additional recharge to the shallow aquifer as a result of irrigation in the Michaud Flats may be up to several inches per year.

Major EMF-related recharge areas identified during the EMF RI included the Simplot former east overflow pond in the Simplot east plant area (closed in August 1993), former Pond 8S (filled in September 1994 and closure completed in 1999), the Simplot gypsum stacks, and the FMC IWW ditch (IWW discharge terminated in 2002). In these areas, annual recharge was or, in the case of the Simplot gypsum stack, is greater than the background average of 1 inch per year.

Withdrawal rates for irrigation wells throughout the Michaud Flats are approximately 1,000 gpm (Jacobson, 1984; Goldstein, 1981), and numerous domestic wells pump less than 50 gpm. During the EMF RI, the FMC production wells had a total combined flow rate of approximately 875 gpm. As described in Section 1.3.4, following plant shutdown in December 2001, groundwater extraction for the FMC production wells (FMC-1 and FMC-3) decreased dramatically. FMC production well (FMC-3) currently produces an annualized average flow of approximately 22 gpm for property maintenance and dust control.

Extraction from Simplot production wells was about 3,300 to 4,000 gpm combined flow. Extraction rates at each of the three Simplot production wells (SWP-6 is a standby production well) may vary depending on specific production needs, but the average total flow is relatively constant. As reported in Simplot's 2007 Groundwater Annual Report (Newfields, 2008), there were no significant changes to the relative pumping rates from the production wells in 2007 from

the end of the fourth quarter 2006. Flows from SWP-4 ranged from 1,100 to 1,400 gpm, SWP-5 pumping rates were from 1,400 to 1,600 gpm, and SWP-7 remained relatively constant at 1,200 gpm. During 2007, Simplot's remedial action groundwater extraction wells pumped at a combined average of 270 gpm (Newfields, 2008). Current total combined extraction from Simplot production and extraction wells is similar the upper end of the range of Simplot's combined flow rate of 4,000 gpm as described in the EMF RI.

2.2.3 EMF RI Conceptual Groundwater Flow Model

Groundwater flows north off the Bannock Range under steep hydraulic gradients through volcanic and sedimentary rocks of low hydraulic conductivity. There appear to be preferential flowpaths associated with interflow gravel and sand deposits and within sediment-filled valleys. The source of this flow is recharge from small watersheds within the Bannock Range. Groundwater flow from the Bannock Range represents a very small fraction of the total water budget for the Michaud Flats and Portneuf River aquifer system.

Groundwater exits the Bannock Range and enters the Michaud Flats in the western FMC area where it mixes with groundwater in the shallow aquifer of the Michaud Flats. The Bannock Range groundwater flows into the shallow Michaud Flats aquifer because upward vertical gradients and intervening aquitards prevent downward flow. The Michaud Flats groundwater flows east-southeast, away from a regional groundwater divide located further north within the Michaud Flats (Jacobson, 1982). There is a mixing zone within the western FMC area where the more saline shallow Michaud Flats water mixes with the Bannock Range groundwater. As the commingled groundwater flows toward the east-northeast, additional Bannock Range groundwater is introduced by upward flow and lateral flow from the south, diluting the Michaud Flats chemical signature.

Groundwater flowing northwest through the Portneuf River area parallels the axis of the Pocatello Valley out to the Michaud Flats, then groundwater flow is deflected west near the region where the AFLB pinch out. The source of this downvalley underflow is recharge from the Bannock Range and Pocatello Range that make up the Portneuf River watershed.

Some of the downvalley underflow discharges to the river and springs, some bypasses the river and underflows the river channel near the Simplot facilities, only to discharge to Swanson Road Springs (aka the Spring at Batiste Road) and the river. Some of the groundwater from the valley bypasses the river near the Indian Springs Trout Farm and Rowlands Wells. This occurs because the AFLB are present here, and only a portion of the groundwater discharges through this very low permeability aquitard to the river. Groundwater that bypasses the river underflows into the Michaud Flats, and eventually discharges to the springs, the reservoir, or is extracted at wells west of the river.

2.2.4 EMF RI Groundwater Numerical Modeling Results

A numerical modeling study was performed during the EMF RI to quantitatively test relationships between the hydrogeologic data and to refine the understanding of groundwater

flow patterns relative to EMF activities (Bechtel, 1994). The numerical model was also used to evaluate the effects on groundwater flow patterns associated with EMF facilities operations (active recharge from former Pond 8S and the gypsum stack and pumping from production wells) compared to no EMF-related operations.

The detailed derivation of the model input parameters, discretization of the flow model domain, and selection of the computer codes are presented in Appendix K of the EMF RI and are not reproduced here. This section presents a summary of the flow modeling results and key findings.

The numerical model simulated the general flow patterns interpreted from the groundwater elevation contours and geochemical data. In the Michaud Flats area, converging flow patterns were evident in the shallow aquifer associated with the east/west trending depression in the AFLB and the 4,392 to 4,396 feet groundwater elevation contours (EMF Figures 3.3-8F and 3.3-14). In the Bannock Range area, where there was limited data for accurately defining hydrogeologic properties and the locations of potential preferential pathways, the modeled flowpaths provided a conceptual representation of estimated groundwater flow patterns. Because actual flowpaths through the Bannock Range are not well-defined by data, and model calibration targets were not achieved in the Bannock Range area, the modeling results are only crude approximations of groundwater flow patterns.

Active EMF operations were simulated for the period of the EMF RI (1992 through 1993). These operations included recharge at the Simplot gypsum stacks and Pond 8S and groundwater extraction at the FMC and Simplot production wells. Simulated groundwater levels and flow patterns during active EMF operations confirm that the Simplot and FMC production wells have little or no discernible effect on the shallow saturated zone (EMF RI Figures 3.3-14).

The primary calibration target for the numerical flow model was the measured river gain from I-86 north to Station 10 (EMF RI Figure 3.3-2). Measured spring discharges were also calibration targets. Since the simulated discharges met the calibration targets, water fluxes within the other parts of the model domain were assumed to reflect actual conditions. Based on this, the following water budget for the model study area was compiled.

About 78 to 110 cubic feet per second (cfs) discharges to the Portneuf River between I-86 and sampling station 10 to the north (EMF RI Figure 3.3-2). The model output indicated a discharge of 74 cfs to the Portneuf River over the same reach. Measured discharge at Batiste Spring was 5.7 cfs (Perry, 1990) and 4.7 cfs at Swanson Road Spring (June 1994). The Batiste Spring channel discharge was 12 cfs as measured in June 1994 as part of this study.

Model output shows approximately 3.5 cfs underflows the study area through the southern boundary, or less than 5 percent of the total water budget for the model domain. This modeled underflow through the Bannock Range may be overestimated since the recharge from contributing watersheds is estimated to be less than 3.5 cfs. This underflow, combined with recharge within the EMF facilities portion of the model domain, is the primary limiting factor for the flux of groundwater underflow through the EMF facilities.

Westward flow into the model domain is approximately 55 cfs. Some of this underflow is water that is lost to the aquifer by the Portneuf River. The river gaging results indicate the Portneuf River does not lose water to the aquifer at a very high rate, which agrees with the observations that the river channel and banks are silty, relatively low permeability materials. A low river loss to the aquifer limits the extent of the Portneuf River Valley hydrogeochemical regime.

There is a flow contribution of less than 2 cfs through the shallow aquifer within the Michaud Flats, thus illustrating why the Michaud Flats chemistry is diluted by the regional Bannock Range chemistry as they mix and flow toward the river (EMF RI Figure 3.3-3).

One model scenario investigated the potential changes to groundwater flow patterns associated with cessation of operations at Simplot and FMC. EMF-related recharge sources were assumed to contribute no more than background recharge rates, and EMF production wells were assumed no longer in operation. The resulting groundwater flow patterns illustrate the overriding influence on groundwater flow patterns exerted by the strong hydraulic sink associated with the gaining reach of the Portneuf River from I-86 north to Batiste Spring (EMF RI Figures 3.3-16 and 3.3-17). The model simulation does not predict major shifts in flow patterns in the shallow saturated zone in the area north of the Simplot gypsum stack. In the deeper saturated zone, there were significant changes in the flow patterns as the EMF production wells ceased capturing most of the deeper underflow through the Bannock Range. The Bannock Range groundwater discharges to the river at the hydraulic sink associated with Batiste and Swanson Road Springs.

When the EMF facilities cease operations, there will be a net reduction in groundwater extraction of approximately 4,200 to 5,000 gpm (10 cfs) at the EMF production wells. Most of this 10 cfs groundwater will discharge to the Portneuf River.

2.2.5 EMF Site Hydrogeology Summary

Major groundwater flow characsteristics of the EMF study area, as shown by the potentiometric contour maps (Figure 2.2-1 and Appendix B), inferred flowpaths (Figure 2.2-2) and study area particle tracking results (EMF RI Figures 3.3-14 through 3.3-17), are as follows:

- Northward flow from the western and central portions of the FMC Plant Site is limited to the area south of I-86 by converging flow of groundwater from the west and northwest.

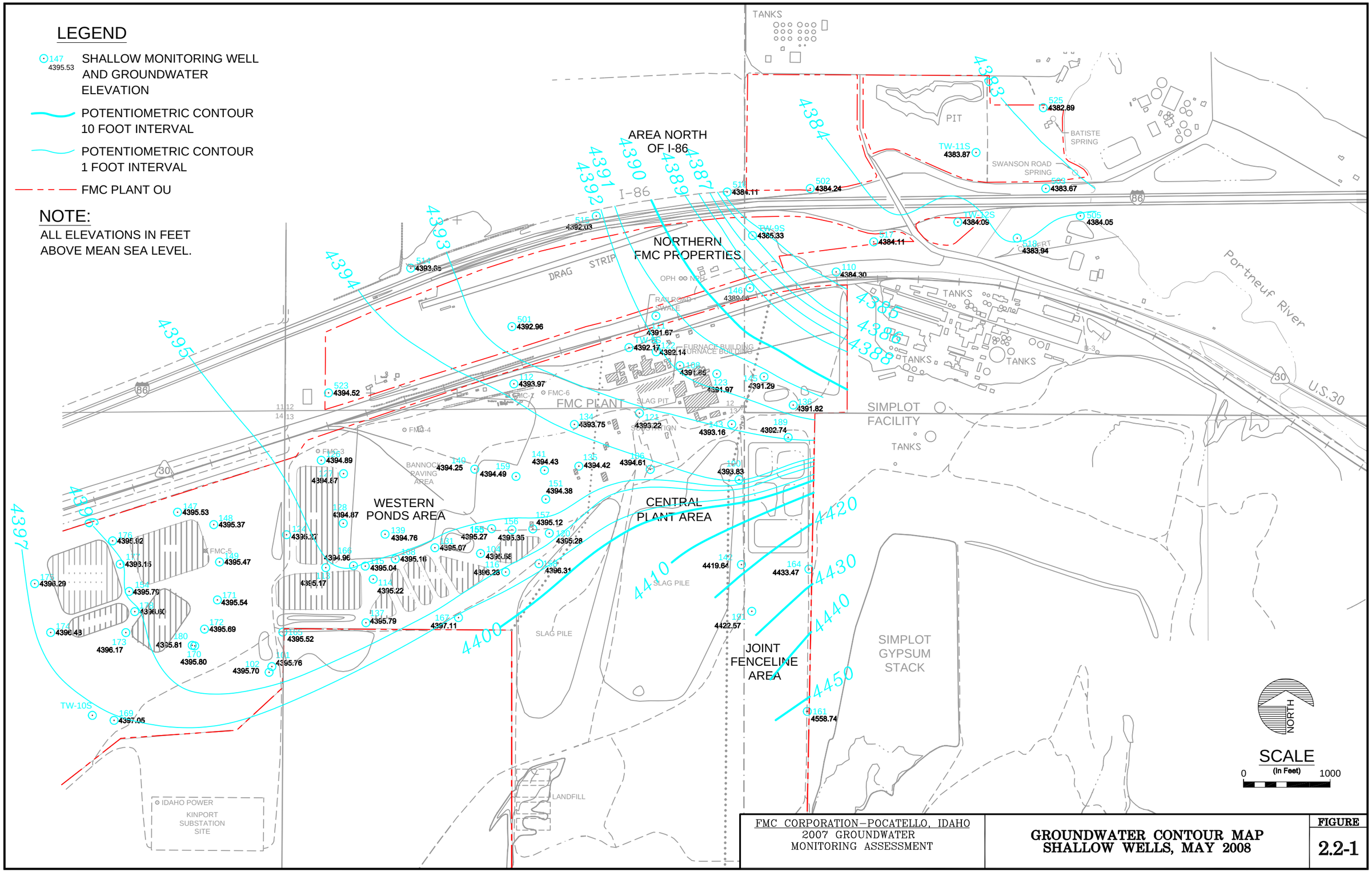
- Groundwater from the western and central portions of the FMC Plant Site is swept eastward, south of I-86, and joins groundwater from the joint fenceline / calciner ponds area and from the Simplot plant.

- In the joint fenceline / calciner ponds area, groundwater from the western part of the Simplot gypsum stack flows in a northwesterly sweeping arc across the Simplot property boundary, flows beneath FMC property, where it commingles with flows from the eastern portions of FMC, and exits from the plant boundaries to the northeast near well 110.

- Virtually all groundwater underflowing the EMF facilities discharges to the Portneuf River at Batiste and the Spring at Batiste Road (aka Swanson Road Springs) and as band seeps and baseflow to the river in the reach bounded by these springs.

TABLE 2.2-1 Vertical Head Differentials in Shallow/Deep Well Pairs, May 2008

SITE NUMBER	TIME 5/19/08	SWL (ft)	TOC Elev (ft)	SWL Elev (ft)	Aquifer Zone	Difference (ft)
101	08:06	76.24	4,472.10	4,395.86	Shallow	0.14
102	08:08	75.98	4,471.70	4,395.72	Deep	(0.14)
130	09:14	74.73	4,470.60	4,395.87	Deep	0.11
137	09:15	75.34	4,471.10	4,395.76	Shallow	(0.11)
103	08:25	90.58	4,486.40	4,395.82	Deep	0.25
104	08:26	91.13	4,486.70	4,395.57	Shallow	(0.25)
125	09:32	60.94	4,455.80	4,394.86	Deep	(0.06)
126	09:30	61.08	4,456.00	4,394.92	Shallow	0.06
133	08:51	85.75	4,479.50	4,393.75	Deep	0.03
134	08:52	85.18	4,478.90	4,393.72	Shallow	(0.03)
107	10:27	89.40	4,482.50	4,393.10	Deep	1.25
108	10:28	90.55	4,482.40	4,391.85	Shallow	(1.25)
144	10:33	86.82	4,478.30	4,391.48	Deep	0.15
145	10:35	86.97	4,478.30	4,391.33	Shallow	(0.15)
TW-5D	10:18	82.47	4,475.00	4,392.53	Deep	0.36
TW-5I	10:20	82.29	4,475.07	4,392.78	Intermediate	0.61
TW-5S	10:19	82.98	4,475.15	4,392.17	Shallow	(0.61)
109	11:19	62.38	4,451.30	4,388.92	Deep	4.59
110	11:20	66.27	4,450.60	4,384.33	Shallow	(4.59)
519	16:56	14.53	4,399.70	4,385.17	Deep	1.55
503	16:54	16.58	4,400.20	4,383.62	Shallow	(1.55)
524	17:12	17.06	4,399.90	4,382.84	Deep	(0.04)
525	17:13	16.72	4,399.60	4,382.88	Shallow	0.04



FMC CORPORATION–POCATELLO, IDAHO
2007 GROUNDWATER MONITORING ASSESSMENT

GROUNDWATER CONTOUR MAP SHALLOW WELLS, MAY 2008

FIGURE 2.2-1

UPDATE TIME: 4:25PM
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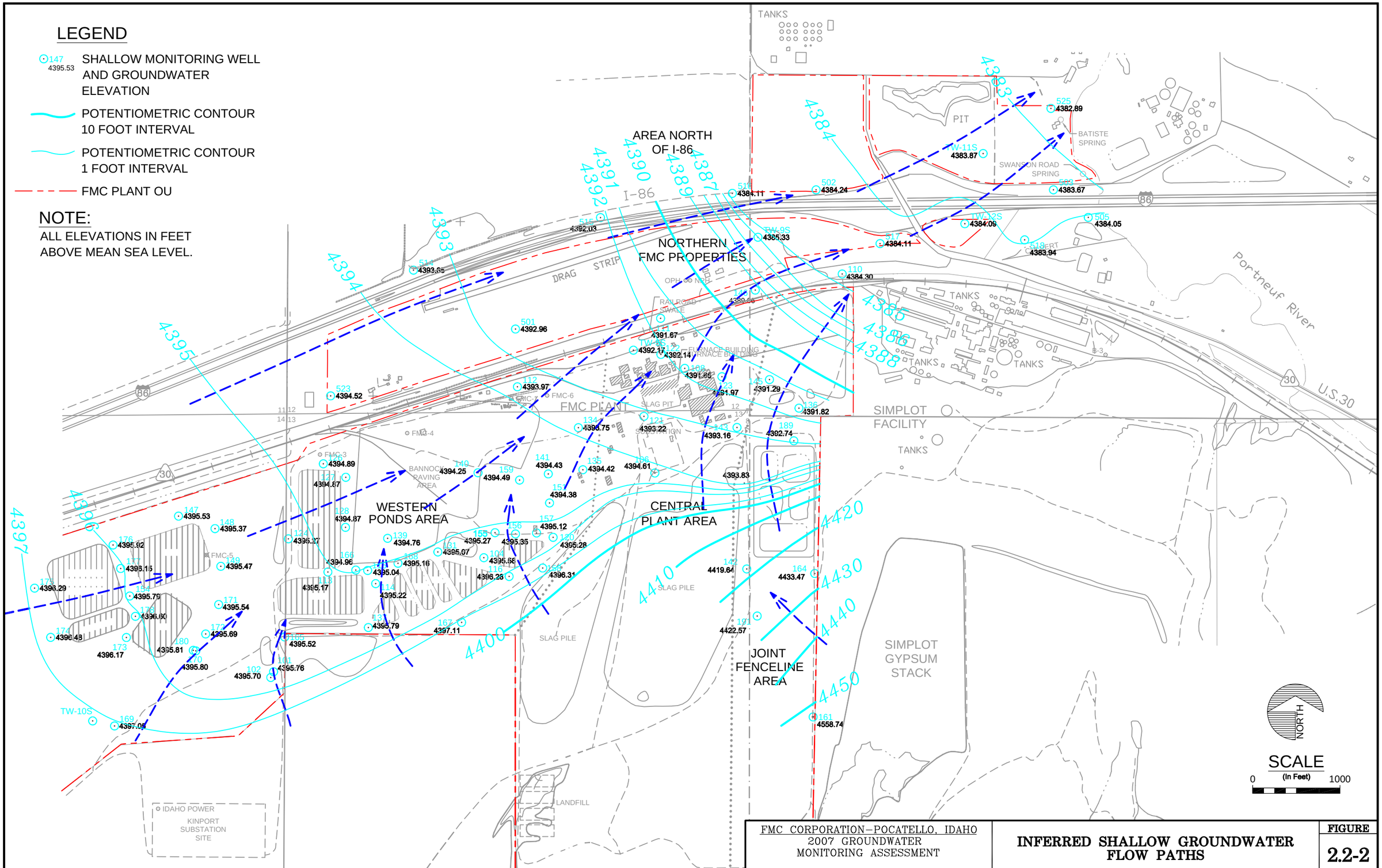
Hydrometrics, Inc.
Consulting Scientists and Engineers



FMC CORPORATION–POCATELLO, IDAHO
2007 GROUNDWATER MONITORING ASSESSMENT

INFERRED SHALLOW GROUNDWATER FLOW PATHS

FIGURE 2.2-2

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Hydrometrics, Inc.
Consulting Scientists and Engineers

Section 3
GROUNDWATER INVESTIGATIONS

3.1 Summary of Remedial Investigation – Geologic and Hydrogeologic Investigations

This section summarizes the EMF RI field activities associated with hydrogeologic and geologic site characterization. This section does not include a summary of the EMF RI facility source and subsurface characterization (i.e., surface and subsurface soil sampling and chemical analyses) presented in Section 4.2 of the EMF RI Report. The activities described occurred as part of the RI Phase I, Phase II, and Phase III hydrogeologic and geologic subsurface investigations (Bechtel, 1992b; Bechtel, 1993c).

3.1.1 Summary of RI Field Activities

During the EMF RI Phase I, II, and III hydrogeologic investigations conducted in 1992, 1993, and 1994, the EMF RI field activities included the following:

- Drilling and logging of 83 borings.
- Installation of *77* monitoring wells, one piezometer, and one nested piezometer.
- Laboratory testing of 58 soil samples from 17 borings.
- Slug testing in 63 wells.
- Five aquifer pumping tests.
- Quarterly collection of groundwater samples from Phase I and selected pre-Phase I wells from April 1992 through April 1993. The RI groundwater analytical is described below in Section 3.1.5.
- Collection of groundwater samples from pre-Phase I, RI Phase I, and Phase II wells during the June, September, and December 1993 sampling events.
- Collection and analysis of groundwater samples from 12 wells for speciation of radiological isotopes during the March 1994 sampling event. Radionuclide-specific analyses were performed for the major radionuclides in the uranium-238 decay chain (i.e., uranium -238 and -234, thorium-230, radium-226, lead-210, and polonium-210). Radionuclide-specific analyses were also performed for thorium-232, radium-228, and potassium-40.
- Collection of groundwater samples from the reduced Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) RI monitoring network and Phase III wells in June and December 1994. With EPA's concurrence, the reduced CERCLA groundwater monitoring program was implemented in 1994. The reduced CERCLA program was outlined in a proposal dated December 1993, and the revised proposal was submitted to EPA in May 1994 detailing changes made in response to EPA's comments.

The FMC and EPA correspondence related to the reduced CERCLA groundwater monitoring program is provided in Appendix C.

Other field activities involving soil borings were performed concurrently with the hydrogeologic investigation. These activities included drilling and backfilling borings to collect soil samples for physical and chemical analyses (i.e., facility source and subsurface characterization samples).

3.1.2 RI Boring and Well Location Selection Process

Selection of RI boring and well locations was guided by the need to define subsurface stratigraphy and to monitor subsurface contaminant occurrence and migration. Since subsurface lateral migration occurs mainly within permeable zones below the water table, borings and wells were drilled and installed to:

- Define the vertical and lateral extent of saturated coarse-grained intervals;
- Determine aquifer characteristics;
- Monitor water quality and contaminant levels; and,
- Obtain hydraulic head measurements.

EMF RI Figure 2.3-1 shows the locations of borings and wells drilled and installed in 1990, 1992, 1993, and 1994, and selected wells installed before 1990. The borings and wells were generally at the locations specified in the SAP (Bechtel, 1992a), the RI/FS Work Plan (Bechtel, 1992b), and the Phase II Site Investigation Plan (Bechtel, 1993c). The borings and wells were numbered as follows:

- 139 through 154, 158 through 164 at the FMC facility [continuing the sequence 101 through 138 begun in 1990 by Bechtel (1991)];
- 300 through 335 at the Simplot facility (303 and 314 were not drilled); and,
- 500 through 525 for borings and wells beyond the main plant boundaries of the two facilities.

Wells installed in these borings were assigned the same number as the boring number. Solitary wells were generally screened in the shallowest saturated coarse-grained interval. Well pairs were installed to screen one well in the shallowest saturated coarse-grained interval and the other well in a deeper saturated coarse-grained interval. EMF RI Table 2.3-1 indicates which well numbers correspond to the shallow and which to the deeper wells of the well pair or cluster.

The geologic drill logs and well construction diagrams of all wells installed by Bechtel, from the RI Phase I, Phase II, and Phase III investigations and from the 1990 investigation for FMC were provided in Appendix B of the RI Report (Bechtel, 1996) and are not reproduced in this report. The majority of the shallow and deep wells installed during the EMF RI were constructed with 10-foot screened intervals (EMF RI Appendix B). The boring logs and well construction diagrams for wells installed by Geraghty and Miller, Inc. in 1980 and 1981 for FMC (TW-series wells) were not included in the RI Report and are provided in Appendix E of this report.

3.1.3 RI Groundwater Sampling

Wells installed during the RI Phase I, Phase II, and Phase III investigations were developed, purged, and sampled. The first groundwater samples obtained from the Phase I monitoring wells were collected by Bechtel during April 1992; subsequently, these wells were placed on a quarterly groundwater sampling program along with existing groundwater monitoring wells. This quarterly sampling program was implemented by Hydrometrics, Inc., beginning in June 1992. Phase II monitoring wells were added as part of the regular quarterly groundwater sampling event in July 1993. Phase III wells were sampled during the June and December 1994 groundwater sampling events.

3.1.4 RI Chemical and Radiological Groundwater Analyses

The RI groundwater samples were analyzed for general water quality parameters, heavy metals, radium, gross alpha, and gross beta. Volatiles and semivolatiles were analyzed once during selected groundwater sampling events. EMF RI Table 2.3-2 lists the specific groundwater analyses that were performed.

All analytical methods were performed in accordance with the SAP (Bechtel, 1992a) and the RI/FS Work Plan (Bechtel, 1992b).

3.1.5 RI Hydrogeologic Testing

This section summarizes the pumping tests, slug tests, and laboratory tests performed during the RI Phase I Phase II, and Phase III hydrogeologic testing. Slug tests were performed in 63 wells to estimate hydraulic conductivity of individual, saturated, coarse-grained intervals. Pumping tests were performed in four wells to provide data for calculation of the transmissivity, hydraulic conductivity, and storativity of separate, saturated, coarse-grained intervals and to assess the degree of hydraulic connection, both laterally and vertically, within the saturated materials.

Constant-discharge pumping tests were performed in four wells: 150, 312, 322, and FMC-6. Well 152 was originally planned to be used in the pump testing program, but was not used due to low well yields. This well could not sustain a 9 gallons per minute (gpm) flow rate during step-testing. Well 150 yielded 30 gpm with much less drawdown during the step-test; therefore, the constant-rate pumping test was performed in Well 150. Wells 150 and 312 are open to the shallowest, saturated, coarse-grained interval, and Wells 322 and FMC-6 are open to deeper, saturated, coarse-grained intervals. Well FMC-6 was installed as a production well and was constructed with a much longer screened interval than Well 322. The tests were performed by pumping water at a constant rate from a selected well for an extended period, and measuring the water-level response in that well and in nearby wells. In addition, Simplot's new production well, SWP-7, was tested by the well construction contractor upon completion. Water levels were measured in several Simplot monitoring wells during this test.

Slug tests were performed in both shallow and deeper, saturated, coarse-grained intervals across the EMF facilities. The majority of these tests were conducted in wells open to the shallowest, saturated, coarse-grained interval. Slug tests involved measuring the recovery time of the water level in a well following sudden displacement of the static water level. A slug was fabricated using a 6-foot-long section of Schedule 40 PVC pipe with an outer diameter of approximately

2.4 inches. The PVC pipe was filled with clean sand and distilled water, capped at both ends, and attached to a plastic-coated rope. Water-level displacement and recovery to static conditions were monitored using a Model 2000 Hermit Environmental Data Logger and pressure transducer manufactured by In-Situ, Inc.

Laboratory tests were performed on selected soil samples to identify physical and hydrogeologic parameters in vadose and saturated zones. Seventy soil samples were collected from 16 borings and analyzed for grain size distribution (ASTM D 4220-63) and moisture content (ASTM D 2216-80). Forty-nine of these samples were also analyzed for saturated hydraulic conductivity (ASTM D 2434-68). The soil samples were collected with split-spoon samplers fitted with brass sample tubes. Most of the samples were collected from the vadose zone.

3.1.6 RI Water-Level Monitoring

Water depths in each newly completed well were measured during development and sampling. Static water-level depths in all Phase I wells, and in selected wells constructed prior to 1992, were measured on June 26, 1992, and during subsequent quarterly RI groundwater sampling rounds. Depths to water were measured with a portable water-level indicator to the nearest ±0.01 foot from the gauging mark or notch cut at the top of the well casing.

3.2 Post-RI Groundwater Special Studies and Routine Monitoring

As described above, the CERCLA groundwater investigations and monitoring conducted during the Preliminary Site Characterization Study (PSCS) and Remedial Investigation (Phases I, II and III) are described in detail in the EMF Site Characterization Summary [aka "PSCS"], Bechtel, January 1994 and the EMF Remedial Investigation Report, Bechtel, August 1996. Section 3.2.1 summarizes the numerous groundwater special studies conducted at the FMC Plant OU after completion of the EMF RI and Section 3.2.2 summarizes the routine groundwater monitoring programs conducted by FMC subsequent to the RI.

3.2.1 Groundwater Special Studies

The groundwater special studies conducted at FMC were generally, but not exclusively, driven by groundwater monitoring issues raised by EPA after the completion of the EMF RI. The special studies described below were undertaken pursuant to FMC's RCRA and voluntary post-RI CERCLA groundwater monitoring programs as well as requests from IDEQ and the Shoshone Bannock Tribes. Regardless of the program under which the special studies were conducted, these studies are summarized herein to provide additional groundwater information relevant to the FMC Plant OU. Section 3.2.1.1 presents a summary of the additional groundwater monitoring wells installed after the EMF RI and Section 3.2.1.2 presents a summary of numerous supplemental (non-routine well sets and/or analytical parameters) groundwater monitoring events. Sections 3.2.1.3 and 3.2.1.4 present a summary of groundwater sampling and analyses conducted by IDEQ and Shoshone Bannock Tribes, respectively.

3.2.1.1 Additional Wells Installed at the FMC Plant OU After the EMF RI

1995 RCRA Monitoring Wells

Shortly after the EMF Remedial Investigation groundwater monitoring well and groundwater investigation field activities were completed in 1994, the EPA RCRA program forwarded to FMC a document entitled "Technical Evaluation of RCRA Groundwater Monitoring, FMC, Pocatello, Idaho," dated January 12, 1995 and faxed to FMC on April 3, 1995 (EPA, 1995). A copy of the EPA technical evaluation document is included in Appendix D.

EPA's evaluation included a unit by unit evaluation of the following factors:

> 1) Hydrostratigraphic suitability of selected screen intervals;
>
> 2) Location of well, proximity to monitored units and down-gradient distribution along flow paths originating within the regulated unit;
>
> 3) Structural integrity and physical adequacy of the wells.

The EPA technical evaluation stated:

> "To summarize the deficiencies regarding choice of screened interval, many of the wells were found to be screening gravels at depths considerably below the top of saturation. This is an accepted practice where ground-water production is the goal. In this RCRA monitoring system the following negative effects are anticipated from these deep well completions:
>
> 1) Excessive dilution in the gravel of the constituents of concern as they are delivered to this horizon and entrained in this highly productive aquifer.
>
> 2) Undesirable attenuation of constituents of concern during interaction with aquifer silts and clays prior to detection in the monitoring system.
>
> 3) Non-detection of an active release due to upward gradients out of the gravel horizon of most of the facility which would preclude migration to this horizon and subsequent detection in the deep screened intervals."

EPA's specific unit-by-unit recommendations are summarized on Table 3.2-1. In an "Untitled letter" letter from Pamela S. French of FMC to Curt Black of EPA dated July 24, 1995 (FMC, 1995), FMC summarized agreements reached on the locations and construction intervals for the replacement RCRA wells. In summary, FMC agreed to install 7 new wells for RCRA monitoring program based on discussions with EPA (Curt Black). The letter also documents the new wells and the fact that EPA was present on site and agreed to the locations and screened depths. A copy of the FMC letter is provided in Appendix D. The new wells installed during 1995 are summarized on Table 3.2-1 and shown on Figure 1-2. Boring logs and well construction diagrams for the new 1995 wells are provided in Appendix E.

TABLE 3.2-1

Summary of Modifications to FMC's RCRA Groundwater Monitoring Network Based on EPA Review and Recommendations During 1995.

WMU (Pond)	Pre-August 1995 Network		EPA Recommendation	FMC Action	Post-August 1995 Network	
	Upgradient	Downgradient			Upgradient	Downgradient
8S	116, 158	150, 152, 118, 119, 120	Replace downgradient wells 150 and 152	New downgradient wells 155, 156, 157	158	155, 156, 157
15S	101, 130	113, 114, 115	Replace upgradient well 101, replace downgradient well 114	New upgradient well 165, new downgradient well 166	165	113, 115, 166
Phase IV / 8E	137, 130, 116	104, 131, 132, 114	Replace upgradient wells 130 and 137, replace downgradient wells 131 and 114	New upgradient well 167, new downgradient well 168	167	104, 114, 131, 168
9E	124, 113	126, 127, 128	Current network adequate	No change	124, 113	126, 127, 128
16S	154	147, 148, 149	Current network adequate	No change	154	147, 148, 149
Slag Pit Sump	121	108, 122, 123	Current network adequate	No change	121	108, 122, 123

FMC also abandoned the following wells per EPA approval in 1995: 117, 118, 119, 129, 132, 150 and 152.

After the first 4 quarters of monitoring, the data from the new wells did not reveal any substantially different findings regarding groundwater quality or the status (not leaking except for Pond 8S that was already identified as a source of groundwater impacts) of the WMUs. The results of FMC's groundwater monitoring programs are discussed in detail in Section 4.

1997 RCRA Monitoring Wells

In August 1997, EPA performed a review and evaluation of the groundwater monitoring program specific to Pond 17 (fka "the NOSAP landfill") and forwarded comments and concerns in a letter entitled "FMC Corporation, EPA I.D. No. IDD07092 9517 Pond 17 Response Action Plan / Groundwater Monitoring," from Michael A. Bussel of EPA to Dave Buttelman of FMC, August 19, 1997 (EPA 1997). A copy of the EPA letter is provided in Appendix D. The Non-hazardous Slurry Assurance Project (NOSAP) landfill was initially constructed to receive dried NOSAP-treated precipitator solids and was later converted to a surface impoundment (Pond 17) to receive NOSAP-treated precipitator slurry.

The EPA letter stated in part:

> "On May 30, 1997, as requested by EPA, FMC submitted information pursuant to 40 CFR Part 265 supporting conversion of the NOSAP Landfill to a surface impoundment (Pond 17). EPA has conducted a preliminary review of the Groundwater Monitoring Plan pursuant to 40 CFR Part 265 Subpart F. We would like to share with you our concerns regarding the locations of the existing wells for monitoring releases from Pond 17; one proposed location for an additional well is also shown. Deficiencies with the well locations are:

- Well 169 is insufficient for monitoring groundwater quality upgradient of Pond 17. FMC has stated previously that two chemically different groundwater regimes exist. Pond 17 lies near the convergence zone of the two regimes according to the flow paths shown in the figure, therefore it is important to obtain upgradient groundwater samples from both regimes.
- The well screens of well 169, and 171 are placed too deeply to properly monitor the uppermost aquifer.
- Well 170 is completed within a layer of bedrock (rhyolite) instead of overlying silty gravel and sandy silt. It is unknown if groundwater chemistry in this well is the same as that in the other monitoring wells. Further geochemistry characterization should be conducted after the baseline data are available to determine whether well 170 can be used as a downgradient monitoring well.

A total of three new wells should be installed: an upgradient well west of Pond 17, a downgradient well northeast of Pond 17 and northwest well 171, and a proposed new well. The

well screens of the new wells should be placed in the uppermost aquifer as near to the water table as possible, in a zone that yields significant amounts of groundwater (that is, enough to be a viable domestic water supply)."

During July 1997, FMC installed five (5) additional groundwater monitoring wells at Pond 17. One well (172) was installed as proposed in FMC's RCRA Groundwater Monitoring Plan for Pond 17, May 1997, and four wells (179, 180, 181 and 182) were installed in response EPA's comments on the Groundwater Monitoring Plan for Pond 17 as documented in a letter from EPA dated August 19, 1997. FMC provided details on the additional monitoring well locations and construction details in a letter to EPA entitled "Additional Groundwater Monitoring Wells at Pond 17, FMC, Pocatello," letter from Rob J. Hartman of FMC to Linda Meyer of EPA, September 23, 1997. A copy of the FMC letter is provided in Appendix D.

As described in FMC's September 23, 1997 letter to EPA, monitoring wells 179, 181 and 182 were installed at the locations and screened intervals as recommended in EPA's comments on the Pond 17 monitoring plan. The current Pond 17 monitoring well network (a total of 8 wells) is shown on Figure 1-2. Boring logs and well construction diagrams for the 1997 wells are provided in Appendix E. The additional 1997 well locations and screened interval are described below:

- Monitoring well 179: Located up-gradient and adjacent (to the extent practical) to the west of Pond 17. This well is screened from 49 to 59 feet below ground surface (bgs) in the fine-grained (silt and clayey silt) saturated zone. This well is screened across the water table (static water level was measured at 50.77 feet bgs on August 18). Pump testing of this well showed that this well will not sustain a yield of 1 gallon per minute (gpm).

- Monitoring well 181: Located down-gradient and north-east of Pond 17, northern-most down-gradient well. This location is as far north and west as practical from well 171 due to obstruction from the Chevron pipeline easement and Pond 17 access road. This well is screened from 50 to 60 feet below ground surface (bgs) in the fine-grained (silt and clayey silt) saturated zone. This well is screened at the water table (static water level was measured at 48.8 feet bgs on August 18). Pump testing of this well showed that this well will not sustain a yield of 1 gallon per minute (gpm).

- Monitoring well 180: Located down-gradient and east of Pond 17, southern-most downgradient well. This well is located in close proximity to well 170. This well is screened from 52 to 62 feet bgs in both the fine-grained (silt and clayey silt) saturated zone and uppermost coarse-grained (sand and gravel) saturated zone. This well is screened near the water table (static water level was measured at 50.7 feet bgs on August 18).

- Monitoring well 182: Located down-gradient and east of Pond 17, "middle" down-gradient well. This well is screened from 48 to 58 feet bgs in the fine-grained (silt with gravel and clayey silt) saturated zone. This well is screened at the water table (static water level was measured at 48.42 feet bgs on August 18).

- Monitoring well 172: Located as the third down-gradient well on the east side of Pond 17, between wells 170 and 171. This well is screened from 71 to 76 feet bgs in the uppermost coarse-grained (sand and gravel) saturated zone. This well is not screened across the water table (static water level was measured at 48.66 feet bgs on August 18).

1998 RCRA Monitoring Wells

During 1998, FMC proposed the installation of additional monitoring wells at Ponds 8S and Pond 17 and the installation of the new monitoring well network for new Pond 18 that was under construction during 1998. FMC's proposal for the additional and new monitoring wells was detailed in FMC's Part B permit application (January 31, 1998 revision), specifically the groundwater monitoring plans for RCRA Ponds 8S, 17 and 18.

FMC notified EPA of its intent to begin installation of the monitoring wells on September 29, 1998. Following FMC's notification, EPA reviewed FMC's proposal and provided comments in an electronic mail dated October 1, 1998. A copy of the EPA electronic mail message is provided in Appendix D.

FMC's proposal and EPA's comments are summarized below:

Pond 8S - FMC proposed installation of a new upgradient well (183) near existing upgradient well 158 and screened at or near the water table. EPA generally agreed with the proposed new well location and target screened interval, but also stated that existing well 158 should continue to be monitored as an upgradient well (i.e., new well 183 is an additional [not replacement] up-gradient well).

Pond 17 - FMC proposed installation of a new upgradient well with a screened interval in the uppermost aquifer (173) to replace existing well 179 that is screened in the saturated silt aquitard. FMC also proposed the Pond 17 groundwater monitoring well network (for routine monitoring) would consist of new upgradient well 173 and existing downgradient wells 171, 172 and 180 (i.e., Pond 17 monitoring wells 170, 179, 181 and 182 would not be monitored routinely). EPA generally agreed with the proposed new well location and target screened interval, but also stated that existing well 179 should continue to be monitored as an upgradient well (i.e., new well 173 is an additional [not replacement] up-gradient well). In addition, EPA expressed an interest in reviewing data for wells 170, 181 and 182 prior to agreeing to the FMC's proposed 4-well network.

Ponds 18 (Cells A and B) – FMC proposed installation of two new upgradient wells 174 and 175 and three down gradient wells 176, 177, and 178 screened in the uppermost aquifer. In addition, FMC proposed to install six new wells (184 and 185 upgradient, and 186, 187, 188, and 189 downgradient) as contingent water table wells. These water table wells would be paired with wells 174, 175, 176, 177, 178, and 154, respectively. EPA generally agreed with the proposed new wells and suggested that FMC drill the wells to the targeted water table depth and if there is water in the borehole, then test the yield before completing the water table wells.

FMC installed the new wells as proposed for Ponds 8S and 17. During the installation of the new wells at Pond 18 Cells A and B, FMC followed EPA's suggested approach for installation of the new wells (i.e., observe open-hole and test yield in the saturated silt/silty clay at water

table prior to well completion). During installation of the wells, FMC determined through observation of the cuttings (lithology) and lack of significant free water in the open-hole at and below the water table elevation that water table wells would not yield sufficient water. Therefore, the borings were advanced to the first laterally extensive coarse-grained (uppermost aquifer) zone at the new well locations. These new aquifer wells were designated 174, 175, 176, 177 and 178. As described above, the proposed contingency water table wells were not installed. The new wells installed during 1998 are summarized on Table 3.2-2 and shown on Figure 1-2. Boring logs and well construction diagrams for the new 1998 wells are provided in Appendix E.

Following installation of the additional RCRA wells in 1995, 1997 and 1998, the FMC RCRA groundwater monitoring well network was finalized for the RCRA groundwater monitoring plans. As described below in Section 3.2.2, EPA has approved the RCRA post-closure plans for all of the WMUs subject to post-closure including the RCRA post-closure groundwater monitoring plans incorporated in the EPA-approved post-closure plans.

TABLE 3.2-2
Summary of Modifications to FMC's RCRA Groundwater Monitoring Network Based on EPA Review and Recommendations During 1998.

WMU (Pond)	Pre-October 1998 Network		EPA Recommendation	FMC Action	Post-October 1998 Network	
	Upgradient	Downgradient			Upgradient	Downgradient
8S	158	155, 156, 157	Add upgradient well 183	New upgradient well 183	158, 183	155, 156, 157
17	179	170, 171, 172, 180, 181, 182	NA - FMC proposed new aquifer well to replace silt water table well 179	New upgradient well 173	173, 179	170, 171, 172, 180, 181, 182
18	Pond not operational, no network	154 (up-gradient well in Pond 16S network)	Install as proposed in FMC's Pond 18 GW Monitoring Plan	New upgradient wells 174, 175, new downgradient wells 176, 177, 154, 178	174, 175	176, 177, 154, 178

2003 Joint Fenceline Area Wells

As part of Simplot's implementation of the Remedial Design for Simplot's groundwater extraction remedy, EPA and Simplot contacted FMC regarding the installation of additional groundwater monitoring wells west of the Simplot gypsum stack and on FMC property. FMC granted access to Simplot for the purpose of installing and monitoring three (3) new groundwater wells on FMC's property. Wells 189, 190 and 191 were installed during June-July 2003. Boring logs and well construction diagrams are provided in Appendix E. As shown on Figure 1-2, wells 189 and 190 are located downgradient from both the Simplot gypstack and the FMC calciner pond area. Well 191 is located downgradient from the gypstack and upgradient from the calciner pond area. FMC integrated wells 189 and 190 into its Calciner Pond Remedial Action Groundwater Monitoring program and began routine monitoring of these wells during the 3rd quarter of 2003 as described below in Section 3.2.2.3.

3.2.1.2 Special Groundwater Sampling and Analysis Programs

This section presents a summary of the numerous supplemental (non-routine well sets and/or analytical parameters) groundwater monitoring events performed at the FMC Plant OU pursuant to FMC's RCRA and voluntary post-RI CERCLA groundwater monitoring programs since the EMF RI. The results of these supplemental monitoring events are presented and discussed in Section 4.

November 1997 and February 1998 RCRA Appendix IX Program

RCRA Appendix IX sampling and analysis was conducted during November 1997. FMC performed monitoring and analyses at four wells (108, 156, 139 and 143) per agreement with EPA that the selected wells provided broad spatial coverage of the potential source areas at the site. Samples were collected and analyzed from the selected wells for the RCRA Appendix IX list of parameters during November 1997 and February 1998 (to pick-up dioxins and dibenzofurans which EPA had previously agreed to exclude from November 1997 analyses). In addition to the programmatic field measurement of pH, temperature, turbidity, dissolved oxygen and specific conductance and routine laboratory analyses for arsenic (As), cadmium (Cd) (RCRA and CERCLA for this special sampling only), selenium (Se), potassium (K), ammonia (NH_3+NH_4), chloride (Cl), fluoride (F), nitrate (NO3), orthophosphate (PO4), and sulfate (SO4); FMC's samples were analyzed for:

General minerals:		
TDS		
Metals:		
Antimony	Copper	Thallium
Barium	Lead	Tin
Beryllium	Mercury	Vanadium
Chromium	Nickel	Zinc
Cobalt	Silver	
Total cyanide		
Total phenol		
Sulfide (acid insoluble)		
Volatile Organics	Method 8260A	
Semivolatile Organics	Method 8270B	
Semivolatile Organics	Method 8080A	(Pest/Herb and PCBs)
Semivolatile Organics	Method 8150B	
Dibenzo furans and dioxins		

January 1998 CERCLA / RCRA Special Program

EPA and FMC split (collocated) groundwater samples from RCRA and CERCLA sampling locations (wells TW-11S, 502, 517, TW-9S, 111, 146, 112, 110, 121, 134, 135, 141, 159, 108, 123, 151, 158, 120, 155, 157, 156 and Batiste Spring and Swanson Road Spring) for elemental phosphorus analysis (Method 7580) and an expanded general mineral and metals parameter list during January 12-15, 1998. In addition to the programmatic field measurement of pH, temperature, turbidity, dissolved oxygen and specific conductance and routine laboratory analyses for As, Cd (RCRA only), Se, K, ammonia, Cl, F, NO3, PO4, and SO4; FMC's samples were analyzed for:

Elemental phosphorus		
General minerals:		
Alkalinity	Calcium	Magnesium
Ammonia	Chloride	Nitrate
Orthophosphate	Fluoride	Sodium
Total phosphorus	Iron	Sulfate
Potassium		
Metals:		
Aluminum	Arsenic	Boron
Barium	Cobalt	Lithium
Manganese	Nickel	

February, May and November 1998 RCRA Appendix III Program

RCRA Appendix III sampling and analysis was conducted at the Pond 17 and Pond 18 wells during February and May (Pond 17) and November (Pond 18) 1998. The Pond 17 wells included 179, 170, 180, 171, 181, 172, and 182; and the Pond 18 wells included 174, 175, 176, 177, 154 and 178. In addition to the programmatic field measurement of pH, temperature,

turbidity, dissolved oxygen and specific conductance and routine laboratory analyses for As, Cd, Se, K, ammonia, Cl, F, NO3, PO4, and SO4; FMC's samples were analyzed for:

General minerals:		
Specific conductance	Sodium	TDS
Metals:		
Barium	Lead	Silver
Chromium	Manganese	
Iron	Mercury	
Total phenol		
Total organic carbon		
Total organic halogen		
Semivolatile organics		
Total colliform		
Radiological:		
Gross alpha	Gross beta	
Radium-226	Radium-228	

August 2000 RCRA Special Program

EPA and FMC split (collocated) groundwater samples from selected RCRA groundwater sampling locations (wells 104, 113, 115, 122, 123, 126, 127, 128, 131, 147, 148, 149, 155, 157, 165, 168, 171, 175, 176, and 183) for an expanded list of metals, total cyanide and radiological parameter list in August 2000 (3Q00 RCRA groundwater monitoring event). Apparently EPA did not analyze their collocated samples; instead, EPA provided its samples to the Tribes for analysis (see below under Collocated Sampling conducted by the Shoshone-Bannock Tribes). In addition to the programmatic field measurement of pH, temperature, turbidity, dissolved oxygen and specific conductance and routine RCRA laboratory analyses for As, Cd, Se, K, ammonia, Cl, F, NO3, PO4, and SO4; FMC's samples were analyzed for:

Metals:		
Aluminum	Copper	Nickel
Antimony	Lead	Silver
Barium	Lithium	Thallium
Boron	Mercury	Vanadium
Chromium	Molybdenum	Zinc
Total cyanide		
Radiological:		
Gross alpha	Gross beta	Cesium-137
Radium-226	Radium-228	

November 2001 CERCLA / RCRA Special Program

FMC allowed the Tribes to collect split (collocated) groundwater samples from selected CERCLA and RCRA groundwater sampling locations (wells 110, 142, 146, 502, 515, 523, 524, 525, TW-11S, TW-12S, TW-9S, 113, 115, 165, 175, 176, 154, 178, 171, 172, 147, 148, 149, 126, 127, 128, 104, 131, 168, 122, 123, 183, 155, 157, and Batiste Spring) for expanded metals, total cyanide and radiological parameter list in November 2001 (4Q01 CERCLA/RCRA

groundwater monitoring event). In addition to the programmatic field measurement of pH, temperature, turbidity, dissolved oxygen and specific conductance and routine laboratory analyses for As, Cd (RCRA and CERCLA for this special sampling only), Se, K, ammonia, Cl, F, NO3, PO4, and SO4; FMC's samples were analyzed for:

Metals:		
Aluminum	Copper	Nickel
Antimony	Lead	Silver
Barium	Lithium	Thallium
Boron	Manganese	Vanadium
Chromium	Mercury	Zinc
Cobalt	Molybdenum	
Total cyanide		
Radiological:		
Gross alpha	Gross beta	Cesium-137
Radium-226	Radium-228	

May 2002 CERCLA Special Program

During May 2002 FMC performed monitoring and analysis of deep wells 109 and 125 to respond to EPA questions regarding the RI conclusion that the deeper groundwater zone at FMC is not impacted. In addition to the programmatic field measurement of pH, temperature, turbidity, dissolved oxygen and specific conductance and routine laboratory analyses for As, Cd (CERCLA for this special sampling only), Se, K, ammonia, Cl, F, NO3, PO4, and SO4; FMC's samples were analyzed for:

General minerals:		
Bicarbonate	Magnesium	Total phosphorus
Calcium	Sodium	
Metals:		
Barium	Lithium	
Boron	Manganese	

June 2003 Tesco Property Well Program

During June 2003 CERCLA groundwater monitoring, FMC sampled and analyzed wells 522 and 523 for an expanded set of parameters in response to discussions between FMC, EPA and the Tribes regarding the Tesco (Williamsen) property. Wells 522 and 523 were installed as CERCLA wells during the RI on FMC-owned property that is located immediately downgradient of the Tesco property. In addition to the programmatic field measurement of pH, temperature, turbidity, dissolved oxygen and specific conductance, these samples were analyzed for:

General minerals:		
Ammonia	Chloride	Potassium
Orthophosphate	Fluoride	Sulfate
Metals:		
Arsenic	Lead	Silver
Cadmium	Nickel	Zinc
Chromium	Selenium	
Total cyanide		
Volatile organics	8260	
Semivolatile organics	8270	

May 2005 CERCLA Special Program

Organic (volatile and semi-volatile) sampling and analysis of selected wells (wells 106, 116, 143, 158, 167, 183) downgradient of the "landfills" (e.g. plant landfill) was conducted during the May 2005 groundwater monitoring event per FMC's commitment to EPA and IDEQ as part of SRI/SFS discussions. In addition to the programmatic field measurement of pH, temperature, turbidity, dissolved oxygen and specific conductance and routine laboratory analyses for As, Cd (RCRA wells 158, 167 and 183 only), Se, K, ammonia, Cl, F, NO3, PO4, and SO4; FMC's samples were analyzed for:

Volatile organics	8260B
Semivolatile organics	8270C

May 2008 CERCLA Special Program

Based on discussions between FMC and EPA regarding FMC's voluntary CERCLA groundwater monitoring program and EPA's review of the 1998 ROD groundwater COCs, FMC proposed to conduct an expanded groundwater monitoring program during May (2Q) 2008. FMC submitted a proposed list of monitoring wells, an expanded parameter list and an addendum to the EMF RI SAP on March 28, 2008. Based on April 14 and 18, 2008 teleconferences between FMC and the Agencies, FMC revised the proposed 2Q2008 monitoring plan to add oxidation/reduction potential (ORP) as a field parameter, mercury as a laboratory parameter, and total phosphorus to replace orthophosphate as a laboratory parameter. The final analytical parameter list for the 2Q2008 event is presented below.

Routine Analytical Parameters:			
Field parameters:	General Mineral:	Metals:	Additional Parameters:
Dissolved Oxygen	Ammonia	Potassium	Elemental phosphorus (Slag Pit Sump and Pond 8S only)
pH	Chloride	Arsenic	
Temperature	Fluoride	Selenium	
Turbidity	Nitrate	Cadmium (RCRA only)	
Specific Conductance	Total phosphorus [1]		
	Sulfate		

Special Analytical Parameters:			
Field parameters:	Metals:	Radionuclides:	Additional Parameters:
ORP	Antimony Boron Manganese Mercury Vanadium	Gross alpha Ra-226 Ra-228	Elemental phosphorus[2] Total cyanide Total uranium

Notes:
[1] Based on March 14, 2008 conference call between FMC and the Agencies, total phosphorus analysis replaced orthophosphate analysis for the 2Q2008 event including the routine RCRA and Calciner Pond groundwater monitoring programs.
[2] Elemental phosphorus was included as a 2Q2008 special event analyte for the following wells: 110, 111, 146, TW-9S, 502, 517, TW-11S, TW-12S, and Batiste Spring.

As part of the proposed 2Q2008 event, FMC evaluated the groundwater monitoring well network associated with its routine monitoring programs and the monitoring wells that were installed during the EMF RI and post-RI that are not currently included in one of the routine programs. Based on that evaluation, FMC proposed to analyze samples from 25 (of 52 total) routine wells and an additional 14 monitoring wells for the special analytical parameter list during the 2Q2008 monitoring event. The 25 routine wells were selected to include upgradient wells and source area specific wells in the western ponds area, former process areas and calciner ponds / joint fenceline area. The additional 14 wells were selected to include additional wells upgradient of potential FMC source areas (background wells), "sentry" wells historically outside the northern limit of EMF groundwater impacts, and downgradient wells between the EMF plant sites and Batiste Spring that had not been sampled within the preceeding several years. The routine monitoring wells that were not selected for the expanded analytical list were within areas bounded by wells that were selected for the expanded list. The final well set for the 2Q2008 groundwater monitoring event are listed on Table 3.2-3 and shown on Figure 1-2.

3.2.1.3 Sampling and Analysis Conducted by the Idaho Department of Environmental Quality

During FMC's 4Q2004 routine groundwater monitoring event, FMC collected collocated samples that were requested by and provided to IDEQ from selected CERCLA wells for an expanded parameter list. FMC provided IDEQ with collocated samples from wells 110, 123, 136, 142, 143, 145, 146, 175, 183, 189, 190, 191, TW-12S and Batiste Spring. FMC did not conduct expanded analyses of its samples from these wells and does not have a record of the IDEQ analytical list for the IDEQ samples. FMC did not receive the laboratory analytical results for the IDEQ samples from this event until February 2008, when IDEQ provided its laboratory reports for this sampling event to EPA. According to the table of IDEQ's results, IDEQ analyzed its samples for arsenic (total), chloride, nitrate, orthophosphate, pH, potassium, conductivity (specific conductance), selenium and sulfate. In addition, the IDEQ analyzed its samples for the isotopes ^{18}O, ^{2}H (deuterium), ^{13}C and ^{34}S. The results of these IDEQ analyses are discussed in the IDEQ report entitled "Evaluation Of Water Quality Impacts Associated With FMC And Simplot Phosphate Ore Processing Facilities, Pocatello, Idaho" (IDEQ, 2004).

3.2.1.4 Collocated Sampling Conducted by Sho-Ban Tribes

The Shoshone Bannock Tribes staff collected collocated groundwater samples from selected wells during the 2000 through 2006 period as listed below. This list was prepared based on FMC file information regarding the sampling events (e.g., quarterly and annually) during which FMC allowed the Tribes to obtain these samples.

The Tribes have never provided FMC with a copy of any Sampling and Analysis or Quality Assurance Plan for their groundwater samples and analyses, nor have the Tribes provided FMC with the analytical results for all of the sampling events listed below. FMC obtained only a possibly incomplete set of the laboratory reports for the Tribes 2000 and 2005 collocated groundwater samples, and an Excel spreadsheet from EPA that apparently contains at least partial results from the Tribes collocated groundwater samples from 2000, 2003, 2004, 2005 and 2006. The following summarizes the information that is available to FMC regarding the Tribes' collocated sampling.

- 3Q2000 (same event as for EPA sampling described above) the Tribes staff obtained collocated samples from RCRA wells and analyzed for an expanded general mineral, metals and radionuclide parameter list. FMC also elected to analyze its samples for an expanded parameter list (see Section 3.2.1.2, Item 4 above).

- 4Q2001 the Tribes staff collected collocated samples from RCRA and CERCLA wells and analyzed for expanded list of general mineral, metals and radionuclide parameters list. FMC elected to analyze its samples for an expanded parameter list (see Section 3.2.1.2, Item 5 above).

- 4Q2003 the Tribes staff obtained collocated samples from RCRA wells and analyzed for expanded parameter list. FMC elected not to analyze its samples for parameters other than the relevant programmatic parameter list.

- 4Q2004 the Tribes staff collected collocated samples from RCRA and CERCLA wells and analyzed for expanded general mineral, metals and radionuclide parameter list. FMC elected not to analyze its samples for parameters other than the relevant programmatic parameter list.

- 4Q2005 the Tribes staff collected collocated samples from RCRA wells and analyzed for expanded list of general mineral, metals and radionuclide parameters list. FMC elected not to analyze its samples for parameters other than the relevant programmatic parameter list.

- 2Q2006 the Tribes staff collected collocated samples from FMC wells and analyzed for an expanded parameter list. FMC elected not to analyze its samples for parameters other than the relevant programmatic parameter list.

3.2.2 Routine ("On-Going") Groundwater Monitoring Programs

FMC continues to perform routine groundwater monitoring at the FMC Plant OU under RCRA, FMC's voluntary continuation of the CERCLA RI groundwater monitoring, and the Calciner

Pond remedial action and post-remedial action monitoring. The status of these routine groundwater monitoring programs are described below.

3.2.2.1 CERCLA Groundwater Monitoring

As described in Section 3.1.2 above, the reduced, focused EMF RI CERCLA groundwater monitoring program was implemented in 1994. The FMC and EPA correspondence related to the reduced CERCLA groundwater monitoring program is provided in Appendix C. FMC continued the reduced, focused EMF RI groundwater monitoring until EPA issued the ROD for the EMF Site in 1998. Upon issuance of the ROD, the requirement for EMF RI groundwater monitoring expired pursuant to the terms of the 1991 AOC for the EMF RI/FS.

After the 1998 ROD, FMC continued monitoring of the CERCLA groundwater well network primarily to preserve spatial and temporal continuity of the groundwater database in anticipation of a Remedial Design and Remedial Action (RD/RA) Consent Decree for the FMC Plant OU. At that time, the FMC CERCLA groundwater monitoring program remained consistent with the reduced EMF RI CERCLA groundwater monitoring as follows:

- Semi-annual groundwater monitoring;
- Field parameters: water level (groundwater elevation), pH, specific conductance (SC), temperature and turbidity;
- Laboratory parameters: As, Se, K, Cl, F, NH3+NH4-N, NO3-N, PO4-P, and SO4; and,
- Twenty-three site-wide wells: 101, 110, 111, 134, 136, 139, 140, 142, 143, 146, 151, 159, 161, 164, 502, 515, 523, 524, 525, Old Pilot, TW-9S, TW-11S and TW-12S.

A RD/RA Consent Decree to implement the FMC Plant OU groundwater remedy was never entered. In 2002 FMC began to make adjustments to its voluntary CERCLA groundwater monitoring program. FMC has continued the semi-annual groundwater monitoring frequency and the same field and analytical parameters as specified in the 1998 ROD, and has made adjustments to better focus the network of wells that are routinely monitored. The current (2008) network of CERCLA wells is listed on Table 3.2-4 and shown on Figure 3.2-1.

3.2.2.2 RCRA Groundwater Monitoring

In 1991, FMC began RCRA groundwater monitoring of the Waste Management Units (WMUs) that FMC listed on its March 1991 Part B permit application for the FMC Pocatello facility. At that time, there were six WMUs subject to the RCRA quarterly groundwater monitoring requirements. FMC's RCRA groundwater monitoring analytical parameter list was consistent with the CERCLA inorganic and radiological parameter list (34 inorganic and 4 radiological parameters).

In parallel with FMC's and Simplot's request to reduce the CERCLA groundwater monitoring program, FMC in 1995 also requested a reduction in its RCRA groundwater monitoring program. In a letter dated June 13, 1995, EPA agreed with FMC's request to reduce the RCRA groundwater monitoring. A copy of that letter is included in Appendix C. Specifically, the RCRA analytical parameter list was reduced from 34 inorganic and 4 radiological parameters to

10 inorganic parameters, including cadmium that was retained at EPA's request. The RCRA groundwater monitoring well network was also modified in 1995, 1997 and 1998 as described above in Section 3.2.1.1.

During EPA's review of the Pond 8S and Slag Pit Sump Closure Plans and associated Groundwater Monitoring Plans, EPA requested and FMC agreed to add two additional inorganic parameters to the groundwater monitoring for those WMUs: total phosphorus (quarterly) and elemental phosphorus (semi-annually).

As a result of the EPA-approved reduction in parameters, well network modifications, and addition of total phosphorus and elemental phosphorus to the Pond 8S and Slag Pit Sump groundwater monitoring plans, FMC's current RCRA groundwater monitoring program consists of the following:

- Quarterly groundwater monitoring;
- Field parameters: water level (groundwater elevation), pH, specific conductance (SC), temperature and turbidity;
- Laboratory parameters: As, Cd, Se, K, Cl, F, NH3+NH4-N, NO3-N, PO4-P, and SO4. In addition, at the Pond 8S and Slag Pit Sump, Total P is analyzed quarterly and elemental phosphorus (P4) is analyzed semi-annually; and,
- The RCRA groundwater monitoring well network as listed on Table 3.2-4 and shown on Figure 3.2-1.

The RCRA groundwater monitoring is currently being conducted during the post-closure period per the RCRA Groundwater Monitoring Plans for each of the monitored RCRA WMUs. The RCRA groundwater monitoring plans are incorporated in and a part of the EPA-approved post-closure plans for these WMUs. FMC reports the results of the RCRA groundwater monitoring to EPA annually (calendar year basis) in the RCRA Annual Groundwater Monitoring Assessment Reports.

3.2.2.3 Calciner Pond Remedial Action Groundwater Monitoring

Pursuant to the Consent Order between the Idaho Department of Environmental Quality (IDEQ) and FMC for remediation of the calciner ponds, FMC has submitted a Calciner Pond Remedial Action Groundwater Monitoring Plan to IDEQ. As described in the Monitoring Plan, monitoring wells upgradient and downgradient of the calciner ponds are sampled on a routine basis to evaluate the effectiveness of the remedial action in preventing the release of constituents from the calciner ponds to groundwater. The groundwater monitoring program commenced during the second quarter of 2003 with scheduled sampling of the then existing wells 142, 161, 164, 136 and 143. New wells 189 and 190 were installed, developed and sampling began during the third quarter of 2003. The Calciner Pond Groundwater Monitoring Plan network of wells is listed on Table 3.2-4 and shown on Figure 3.2-1.

The Calciner Pond Remedial Action Groundwater Monitoring Plan is consistent with the reduced, focused EMF RI CERCLA groundwater monitoring program, as follows:

- Semi-annual groundwater monitoring;
- Field parameters: water level (groundwater elevation), pH, specific conductance (SC), temperature and turbidity;
- Laboratory parameters: As, Se, K, Cl, F, NH3+NH4-N, NO3-N, PO4-P, and SO4; and,
- Upgradient wells 142, 161, and 164; and downgradient wells 136, 143, 189 and 190.

Calciner pond groundwater monitoring was performed during implementation of the calciner ponds remedial action (2003 through 2005) and FMC currently conducts it during post-remedial monitoring and maintenance period per the IDEQ Consent Order. FMC reports the results of the calciner ponds groundwater monitoring annually (calendar year reporting period) to IDEQ in a Calciner Pond Remedial Action Groundwater Monitoring Annual Report.

3.3 2008 EMF Geophysical Study

During early 2008, FMC and Simplot ("the EMF Companies") held several meetings and discussions with the Agencies regarding the hydrogeology and groundwater transport in the area between the FMC and Simplot plant sites and the zone of groundwater discharge to the Portneuf River between Swanson Road Spring (aka the Spring at Batiste Road) and Batiste Spring. In response to those discussions, the Agencies and the EMF Companies agreed to proceed with a geophysical (resistivity) study to provide additional information in this area of the EMF site.

In April 2008, the Companies submitted a draft Work Plan for a Groundwater Geophysical Study that proposed subsurface resistivity profiles along 8 transects located between the plant sites and the Portneuf River. Based on comments from the Agencies, the Companies submitted a revised work plan in May 2008 that added an additional subsurface profile transect and also added down-hole resistivity logging of existing monitoring wells located near the transects. These were designed to aid in correlating resitivity, lithology and groundwater chemistry. The Companies began implementation of the geophysical study in June. The schedule for completion of the study is as follows:

- Field location and adjustment of profile transects – completed June 16, 2008
- Perform geophysical profiles along transects as field located – completed June 23, 2008
- Perform down-hole geophysical logging of monitoring wells – completed July 16, 2008
- Prepare and submit geophysical study report to Agencies – submitted September 16, 2008

The results of the geophysical study are summarized in Section 6.

TABLE 3.2-3 FMC'S ROUTINE GROUNDWATER MONITORING AND ADDITIONAL WELLS FOR THE 2Q2008 "SPECIAL" GROUNDWATER MONITORING EVENT

Area	Well Numbers [1]	Up / Downgradient	Program [2]
Pond 18 (Cell A and Cell B)	**174, 175**	U	RCRA
	154, 176, 177, 178	D	RCRA
Pond 17	**173**	U	RCRA
	171, 172, 180	D	RCRA
Pond 16S	154	U	RCRA
	147,148, **149**	D	RCRA
Pond 15S	165	U	RCRA
	113, 115, 166	D	RCRA
Phase IV ponds	**167**	U	RCRA
	104, 114, 131, 168	D	RCRA
Pond 9E	124, 113	U	RCRA
	126, **127**, 128	D	RCRA
Pond 8E	**167**	U	RCRA
	104, 114, 131, 168	D	RCRA
Pond 8S	158, **183**	U	RCRA
	155, **156**, 157	D	RCRA
Slag Pit Sump	121	U	RCRA
	108, 122, 123	D	RCRA
Batiste Spring	**Batiste Spring**	D	RCRA
Calciner Ponds	**164, 161**, 142	U	IDEQ
	136, 143, 189, 190	D	IDEQ
Upgradient FMC Plant	**101, 102, 169**	U	CERCLA
Within FMC plant	**139, 134, 145**	D	CERCLA
Northern edge FMC plant	**111, 146, 110, 112, 523, 501**	D	CERCLA
Downgradient from FMC plant toward Batiste Spring	**TW-9S, 517, 502, TW-12S, TW-11S**	D	
Outside EMF impact [3] - northern perimeter	**515, 524, 525, 516**	Cross	CERCLA

[1] Wells in red-colored BOLD font are routine wells that will be analyzed for the 2Q2008 special analytical parameter list in addition to the routine parameter list. Wells in red-colored BOLD and UNDERLINE font are the 14 additional wells for the 2Q2008 special sampling event (both routine and special parameter list).
[2] Program: RCRA = RCRA groundwater monitoring plans, IDEQ = Calciner Pond groundwater monitoring plan, CERCLA = FMC continuation of monitoring at "key" CERCLA wells.
[3] Impact is in reference to detection of arsenic, nitrate or selenium above representative levels.

TABLE 3.2-4 Summary of the FMC Routine Groundwater Monitoring Programs (as of the 3rd Quarter of 2008)

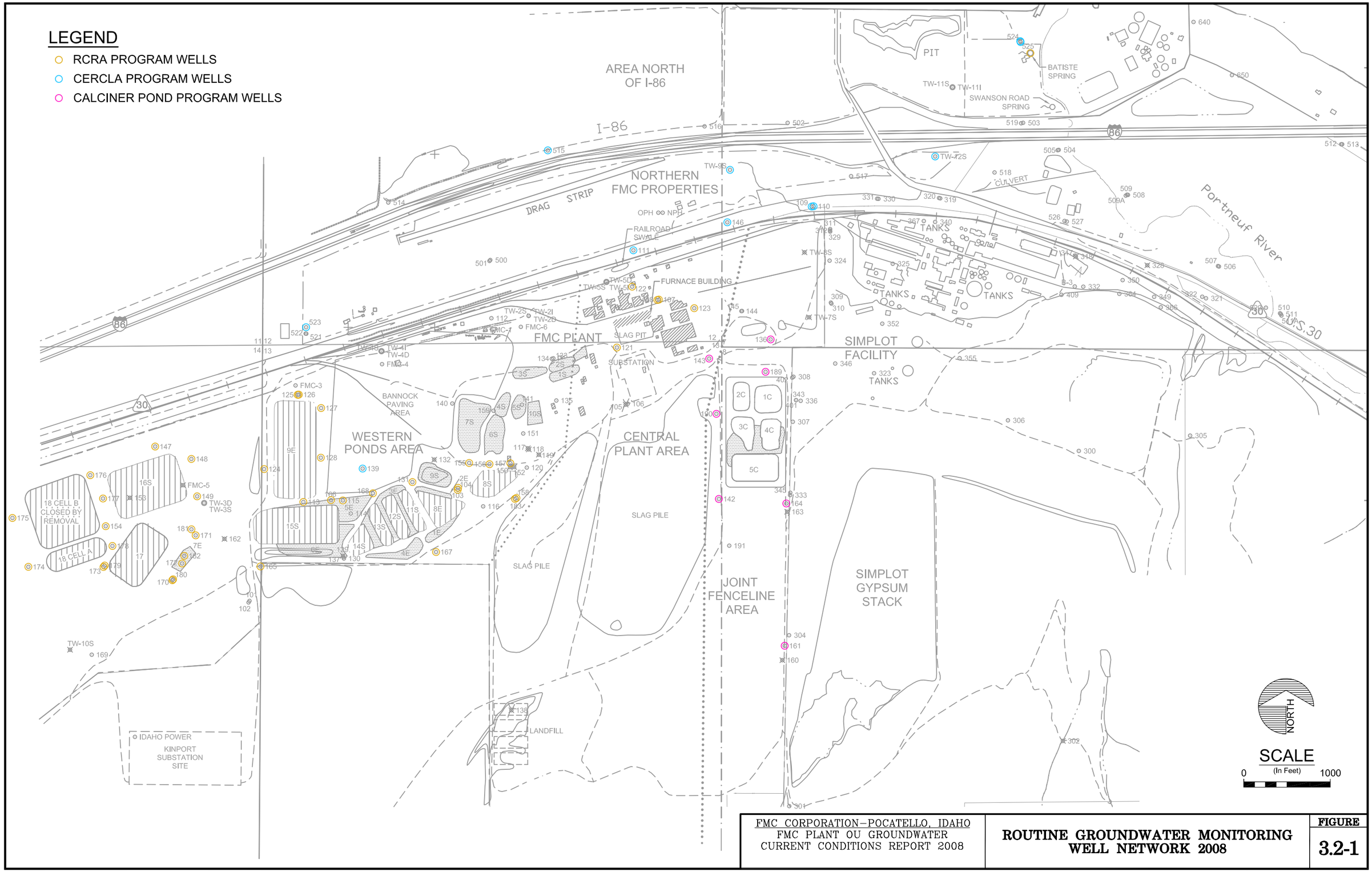
Area	Well Numbers	Up- or Down-gradient	Frequency [1]	Program [2]
Pond 18 (Cell A and Cell B [3])	174, 175	U	Q	RCRA
	154, 176, 177, 178	D	Q	RCRA
Pond 17	173	U	Q	RCRA
	171, 172, 180	D	Q	RCRA
Pond 16S	154	U	Q	RCRA
	147,148, 149	D	Q	RCRA
Pond 15S	165	U	Q	RCRA
	113, 115, 166	D	Q	RCRA
Phase IV ponds	167	U	Q	RCRA
	104, 114, 131, 168	D	Q	RCRA
Pond 9E	124, 113	U	Q	RCRA
	126, 127, 128	D	Q	RCRA
Pond 8E	167	U	Q	RCRA
	104, 114, 131, 168	D	Q	RCRA
Pond 8S	158, 183	U	Q	RCRA
	155, 156, 157	D	Q	RCRA
Slag Pit Sump	121	U	Q	RCRA
	108, 122, 123	D	Q	RCRA
Batiste Spring	Batiste Spring	D	Q	RCRA
Calciner Ponds	164, 161, 142	U	S	IDEQ
	136, 143, 189, 190	D	S	IDEQ
Within FMC plant	139	D	S	CERCLA
Northern edge FMC plant	111, 146, 110	D	S	CERCLA
Outside EMF impact [4] - northern perimeter	515, 524, 525	Cross	S	CERCLA

[1] Q means quarterly, S means semi-annually.

[2] Program: RCRA = RCRA groundwater monitoring plans, IDEQ = Calciner Pond groundwater monitoring plan, CERCLA = FMC continuation of monitoring at "key" CERCLA wells.
RCRA parameters = As, Cd, Se, K, Cl, F, NH3+NH4-N, NO3-N, PO4-P, Total P (8S and SPS only), SO4; and field measurement of pH, specific conductance (SC), temperature (temp) and turbidity.
"IDEQ" parameters = As, Se, K, Cl, F, NH3+NH4-N, NO3-N, PO4-P, SO4; and pH, SC, temp and turbidity.
CERCLA parameters = As, Se, K, Cl, F, NH3+NH4-N, NO3-N, PO4-P, SO4; and pH, SC, temp and turbidity.

[3] Pond 18 Cell B was closed by removal in 2005 and is no longer subject to groundwater monitoring under RCRA, FMC intends to discontinue monitoring well 176 after the 4th quarter of 2008.

[4] Impact is in reference to detection of arsenic, nitrate or selenium above background.



FMC CORPORATION–POCATELLO, IDAHO
FMC PLANT OU GROUNDWATER
CURRENT CONDITIONS REPORT 2008

ROUTINE GROUNDWATER MONITORING WELL NETWORK 2008

FIGURE
3.2-1

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Hydrometrics, Inc.
Consulting Scientists and Engineers

Section 4
RESULTS AND FINDINGS

Section 4.1 presents a summary of the EMF RI Section 4.4 (Groundwater) that describes the nature and extent of groundwater impacts at the EMF site. Most of the text, tables and figures were taken directly from the EMF RI Report and edited for brevity. The EMF RI Section 4.4 subsections specific to the Simplot plant site are not included herein.

Section 4.2 presents the results of the post-RI groundwater "special" studies and monitoring events described above in Section 3.2, and the results of the routine CERCLA, Calciner Pond Remedial Action, and RCRA groundwater monitoring programs at the FMC Plant OU as described above in Section 3.3.

Section 4.3 presents a summary of FMC's recent reevaluation of groundwater representative arsenic concentrations for the EMF Site.

4.1 Summary of the EMF Remedial Investigation – Groundwater

This section summarizes the EMF RI Report Section 4.4 (Groundwater) that presented an assessment of the nature and extent of EMF-related constituents in groundwater. The objectives of the EMF RI investigation were to characterize the nature of EMF-related influences on groundwater and to delineate these effects.

Section 4.1.1 describes the methodology used in the assessment and provides background information such as an explanation of the terms and conventions used in the remainder of this section. Section 4.1.2 is an overview of the nature and extent of constituents in groundwater. The nature and extent are described in detail in Sections 4.1.3 through 4.1.7. First, Section 4.1.3 describes representative, or background, groundwater quality that was characterized to assess impacted groundwater. Then, Sections 4.1.4 through 4.1.7 describe the nature and extent beneath each of the following site areas:

- FMC facility (western ponds area and central plant area);
- Joint fenceline / calciner ponds area;
- Northern company properties (north of the FMC and Simplot facility fencelines and south of I-86); and
- The area north of I-86.

These areas were delineated because the distribution of constituents in each area can be ascribed to distinct sources or influences from various sources (EMF RI Figure 4.4-2).

The discussion in each of these sections is organized by constituent group, as follows:

- Common ions;
- Physical parameters;
- Nutrients and fluoride;
- Metals;
- Radiological parameters; and
- Organic compounds.

Section 4.4.8 is a presentation of radiological speciation results and a discussion of radioisotopes detected in groundwater across the EMF Site.

4.1.1 Assessment Methodology and Background Information

This section outlines the methodology for assessing EMF-related influences on groundwater. Also, important background information is discussed to aid the reader in evaluating the presentation of data that follows. Section 2 of the EMF RI report (summarized in Section 3.1 of this report) provides a description of the data collection methods and laboratory analyses.

4.1.1.1 Definition of Terms and Conventions

This section explains some of the key terms and conventions used throughout the EMF RI Report Section 4.4.

Representative vs. Impacted Groundwater. To assess the effect on groundwater of EMF sources, the quality of unimpacted groundwater needed to be characterized. Characteristics of unimpacted groundwater are typically referred to as "background", which implies unimpacted, natural conditions. However, since the groundwater in the vicinity of the EMF facilities has been impacted by sources and anthropogenic activities outside the EMF site, the term "representative" instead of "background" was used to distinguish it from groundwater affected by EMF sources.

Hydrogeologic Areas vs. Hydrogeochemical Regimes. As discussed in Section 3.3 of the EMF RI Report (summarized in Section 2.2 of this report), there are three distinct hydrogeologic areas: the Michaud Flats, the Bannock Range, and the Portneuf River Valley. In general, each hydrogeologic area has a distinct hydrogeochemical regime, as identified using data from wells upgradient from the known EMF potential sources. However, the hydrogeochemical regimes are not necessarily restricted to a particular hydrogeologic area. For example, Bannock Range

groundwater flows northward into the Michaud Flats hydrogeologic area and eventually can be traced to the Portneuf River Valley hydrogeologic area.

4.1.1.2 Data Reduction

To simplify the large database and to decrease the impacts of spurious analyses, the mean concentration or value for each parameter was calculated for each well. FMC conducted a time-series analysis as part of its RCRA groundwater reporting program (Bechtel, 1994n). That time-series analysis did not identify any statistically definable trends in constituent concentrations in the impacted or unimpacted RCRA wells. These results supported the averaging of concentrations for the 1992 to 1993 EMF RI sampling period.

Mean concentrations presented in the EMF RI Report were calculated using the reported detection limit value where results were reported as "nondetect." This data treatment was agreed to by EPA and the Companies during a meeting on May 19, 1994.

Isoconcentration contour plots (EMF RI Figures 4.4-5 through 4.4-24) were developed using the data treatment outlined by EPA in Comment #15 on the PSCS (Bechtel, 1994a). This data treatment method uses only one-half the reported detection limit where data are reported as nondetects. The outermost purple line is the lowermost representative (background) level on most figures. This lowermost level was not plotted for constituents that displayed a wide range of background concentrations (e.g., chloride and sulfate).

4.1.1.3 Calculation of Representative Groundwater Concentrations

Representative concentrations of each constituent were calculated for each hydrogeochemical regime. This was accomplished by calculating the 95% percentile using the data from each representative well in the regime. Where the constituent was not detectable, the detection limit was used at the value for that sample. Representative well locations are shown on EMF RI Figure 4.4-3. The representative concentrations for each constituent are provided in EMF RI Table 4.4-1. Radiological parameters and organic compounds detected in the representative wells are summarized in EMF RI Tables 4.4-2 and 4.4-3, respectively.

4.1.2 Overview of Findings

The nature of EMF-related impacts to groundwater can be summarized as elevated (i.e., greater than the representative level) concentrations of common ions, decreased pH, elevated concentrations of nutrients such as ammonia, nitrate and orthophosphate, and metals such as arsenic and manganese. Cobalt, fluoride, and selenium concentrations were elevated over a smaller area and at fewer sources, when compared to the extent of elevated major ion and nutrient concentrations (EMF RI Figures 4.4-5 through 4.4-24). Gross alpha and gross beta activities were elevated in some of the monitoring wells. Gross beta activities correlated with potassium concentrations (i.e., gross beta activities were commensurate with expected activities of potassium-40, a beta emitter, given its natural abundance), whereas gross alpha activities were associated with the radioisotopes of uranium. No significant concentrations of organic

compounds were detected. Only arsenic, nitrate, and selenium were consistently above MCLs beneath limited portions of the site. Other constituents that were above primary and secondary MCLs were sulfate, fluoride, and chloride.

The extent of EMF-related constituents in groundwater is confined to areas on company-owned property, with the highest concentrations of constituents within the EMF facility boundaries. In the northern FMC/Simplot properties, the concentrations of all constituents decrease sharply to levels near the representative concentrations, and only a few constituents were above representative levels in groundwater north of I-86.

Constituent concentrations were typically much lower in the deeper aquifer. Upward vertical hydraulic gradients and/or the presence of confining strata appear to have effectively limited downward vertical migration of the dissolved constituents.

FMC Western Ponds and Central Plant Areas

The western ponds area (referred to in the EMF RI as the "southwestern area") includes the former unlined ("old phossy ponds") and the main plant facilities are located in the central plant area (referred to in the EMF RI as the "central area") of the FMC facility. These former unlined ponds were likely sources of constituents to groundwater.

Groundwater in the southwestern area migrates north, transported by Bannock Range flow. This flow merges with more east-to-northeast-flowing Michaud Flats groundwater. The result is a mixing of the unimpacted, but more saline, Michaud Flats water with the impacted Bannock Range water. The converging flow pattern has the net effect of preventing impacted water from leaving the facility to the north (EMF RI Figure 4.4-4).

Affected groundwater from the southwestern area commingles with affected groundwater in the central area and appears to migrate beyond the facility fenceline near Well 111, just north of the main plant area. This commingled groundwater continues northeast to east and likely explains the presence of the arsenic detected in samples collected from the Old Pilot House well. The concentrations of EMF-related constituents in well 111 are considerably lower than those found near the old pond sources and show the effects of attenuation and advective mixing that occur within the facility boundary.

The groundwater flow direction through the central FMC area is east-northeast. Groundwater in the central area has the same constituents of interest as the southwestern area. Another difference is that higher temperatures in the groundwater, caused by the heating of soils surrounding the slag pit operations, created a localized thermal plume in this area (EMF RI Figure 4.4-12). The groundwater in the central FMC area appears to migrate beyond the facility boundary in the vicinity of well 146.

Joint Fenceline Area

In the joint fenceline area, groundwater in the western part of the upper gypsum stack appears to flow in a northwesterly sweeping arc across the Simplot property boundary, in the general area of the FMC old calciner ponds and former kiln scrubber overflow pond, and then flow back toward the northeast (EMF RI Figure 3.3-14). This "clockwise" flow appears to be paralleled to the north of the joint fenceline area by the flow pattern of the above-mentioned thermal plume originating beneath the FMC slag pit. The groundwater in the joint fenceline area appears to commingle with groundwater from the southwestern and central FMC areas, and then flows northeast.

As with the other areas previously discussed, major ions, nutrients, fluoride, and the metals arsenic, boron, lithium, manganese, and selenium were detected at elevated concentrations in groundwater beneath the joint fenceline area. In general, deeper monitoring wells 109, 329, and 330, located along the northern side of the joint fenceline area, delineate the extent of EMF-related constituents in the deeper aquifer, with the possible exception of minor levels of some common ions and nitrate. Wells 142 and 304 appear to delineate the lateral extent of arsenic and most other metals along the western portion of the gypsum stack as evidenced by elevated concentrations of common ions and nutrients.

Northern FMC/Simplot Properties South of I-86

EMF-related effects on groundwater beneath the affected portion of the northern FMC/Simplot properties were limited to slightly elevated concentrations of common ions, nutrients, and a limited suite of metals, low pH, and elevated TDS, and gross beta activities. The metals detected above representative levels include arsenic, manganese, and selenium. The extent of EMF-related constituents was delineated by Well 501 to the west, wells along I-86 to the north, and the Portneuf River to the east. Except for nitrate, average constituent concentrations in this area did not exceed primary MCLs. The ten deeper wells in this area did not contain elevated concentrations of EMF-related constituents. Therefore, the vertical extent of these constituents appeared to be limited to the shallow groundwater in the northern FMC/Simplot properties.

Area North of I-86

All EMF-affected groundwater passes beneath Interstate Highway I-86 through the shallow aquifer between some point east of Well 502 and the Portneuf River. This water discharges to the river at Batiste and Swanson Road Springs and as base flow between these springs. Average concentrations of EMF-related constituents were below MCLs in groundwater north of I-86; furthermore, most constituents were at or below representative levels in this area. There were no EMF-related effects in groundwater north of Batiste Spring, as evidenced by water quality in Wells 524 and 525, a well pair located about 150 feet north of the spring. All of this area is company-owned property, aside from the State-owned highway right-of-way along I-86.

Some EMF-related effects were observed at Batiste Spring, Swanson Road Spring, and Well 503. These were limited to elevated concentrations of sulfate, sodium, potassium,

orthophosphate, total phosphorus, and lithium. Concentrations of ammonia, arsenic, nitrate, and selenium are very close to or below representative concentrations. The mean concentrations of arsenic and selenium at Batiste Spring were 0.015 mg/l and 0.0069 mg/l, respectively. The average concentration of all constituents at Batiste and Swanson Road Springs were below the MCLs at the time of the EMF RI (e.g., below the "old" arsenic MCL of 0.05 mg/l).

Overall levels of EMF-related constituents in Well 503, Batiste Spring, and Swanson Road Spring show a reduction of 10 to 100 times or greater when compared to concentrations observed in monitoring wells adjacent to the source areas.

4.1.3 Representative Groundwater Chemistry

This section provides a discussion of the representative monitoring well network and the representative groundwater chemistry organized by constituent group.

4.1.3.1 Selection of Representative Wells

The following criteria were used to select representative wells:

- The group of wells must be representative of the three different hydrogeochemical regimes delineated in EMF RI Section 3.3.
- The wells must be located upgradient or crossgradient from known or suspected EMF source areas, as defined by horizontal and/or vertical hydraulic gradients.

Seventeen wells representing the three hydrogeochemical regimes were selected (EMF RI Figure 4.4-3).

- Michaud Flats: Wells 101, 102, TW-10S, 147, 514, 515
- Portneuf River Valley: Wells PEI-6, 510, 511, 512, 513
- Bannock Range: Wells 158, 106, Idaho Power, 301, PEI-1, 305

These wells comprise a representative cross-section of the different hydrogeologic and hydrogeochemical conditions that exist in the EMF study area (Figure 4.4-3).

Michaud Flats. Wells 101, 102, and TW-10S are all hydraulically upgradient and furthest from the known extent of FMC's old ponds. There are no known potential sources located in areas upgradient from these wells. Well 147 is located along the far northwest boundary of FMC's facility, near Pond 16S. The data from this well were collected prior to operation of Pond 16S (a lined pond), eliminating the potential that groundwater samples from Well 147 were impacted by potential leaks in Pond 16S. Wells 514 and 515 are located north of I-86, hydraulically cross-gradient from the FMC facilities. There is a zone of converging groundwater flow located

between the FMC old pond area and these wells. The groundwater flow patterns indicate that Wells 514 and 515 are located upgradient or crossgradient from all potential EMF sources.

Portneuf River Valley. Wells PEI-6, 510, 511, 512, and 513 are located in the Portneuf River Valley area, and Wells 510, 511, 512, and 513 are located on the eastern side of the river, away from the EMF potential sources. Groundwater flow patterns indicate that these wells monitor groundwater flowing from the Pocatello area, east of the EMF site.

Bannock Range. Wells 301, PEI-1, and 305 are close to existing or former waste management facilities. Because these wells are close to potential sources, the chemical and physical groundwater parameters of these wells were compared to other representative wells in the same hydrogeologic area. The comparison confirmed that these wells were unaffected by facility activities, and therefore they were retained in the representative well network. Wells 106, 158 and Idaho Power are located upgradient from any potential sources.

4.1.3.2 Common Ions in Representative Groundwater

The mean values of the common ion concentrations are presented in EMF RI Table 4.4-1. In all three groundwaters calcium is the predominant cation. Chloride is the predominant anion in the Michaud Flats representative groundwater and bicarbonate is the dominant anion in the Bannock Range and Portneuf River groundwaters. Michaud Flats representative Wells TW-10S and 147 also have higher concentrations of sodium and potassium than representative wells to the east and south (e.g., Wells 101 and 102).

Well 514, located near I-86, has Bannock Range groundwater chemistry. Although this well is screened in the shallow aquifer, it may actually be monitoring deeper groundwater. In localized areas, the deeper aquifer may have a higher degree of hydraulic interconnection with the shallow aquifer zone due to thinning or pinching out of the intervening aquitard, which, in this case, is the American Falls Lake Beds. An alternate explanation for the different groundwater chemistry observed is that the shallow aquifer chemistry in the area may have been impacted by irrigation and agricultural activities (i.e., City of Pocatello STP sludge application to land), as indicated by the results from nearby Well 515. The impacts may not extend to the zone where Well 514 is located.

4.1.3.3 Physical Parameters in Representative Groundwater

The mean values of the physical parameters for the 17 representative wells are presented in EMF RI Table 4.4-1. All of the groundwaters are generally neutral to slightly alkaline (mean pH ranges from 7.27 to 8.37). Other physical parameters show more variability among the three hydrogeochemical regimes.

Michaud Flats representative groundwater has higher specific conductance (460 to 1,229 µmhos/cm) and total dissolved solids (281 to 736 mg/l) and generally low mean temperatures compared with the Bannock Range groundwater (11.8ºC for Michaud Flats and 16.7ºC for Bannock Range groundwater). Redox ranges from 0 mV to 169, but mean redox

values are on the order of 100 mV with Well TW-10S having a mean value of 0 mV. Higher specific conductance and total dissolved solids values are consistent with the overall higher ionic concentrations for groundwater in the Michaud Flats.

The Portneuf River groundwater is characterized by intermediate specific conductance (747 to 793 µmhos/cm) and total dissolved solids (440 to 527 mg/l), lower temperatures (12.7 to 13.3°C), and a narrower range of positive redox values (127 to 171 mV) than the other groundwaters.

Bannock Range representative groundwater is typified by slightly higher mean temperatures (14.5 to 16.6° C) and lower total dissolved solids (311 to 404 mg/l). The lower total dissolved solids correlates with lower concentrations of major ions, and lower specific conductance.

4.1.3.4 Nutrients and Fluoride in Representative Groundwater

The mean values of the nutrient and fluoride concentrations in representative groundwater are presented in EMF RI Table 4.4-1. The nutrients and fluoride occur naturally to some degree in groundwaters but are also contributed by anthropogenic activities such as discharge to septic systems, livestock raising, and fertilizer application. These constituents were also identified in the EMF feedstock, by-product, and wastestreams.

The Michaud Flats regime generally had higher nutrient concentrations than the other two hydrogeochemical regimes; the Portneuf River regime generally had lower nutrient concentrations, with the exception of nitrate. The representative nitrate concentrations in the Portneuf River regime was 4.00 mg/l (EMF RI Table 4.4-1). For some wells, none of the samples collected contained detectable concentrations of certain constituents (e.g., ammonia). Ammonia concentrations were negligible in the representative wells.

4.1.3.5 Metals in Representative Groundwater

The mean values of metal concentrations are presented in EMF RI Table 4.4-1. The metals antimony, beryllium, cadmium, chromium, cobalt, lead, mercury, molybdenum, nickel, selenium, silver, thallium, and vanadium were detected sporadically if at all. These results yield a “highly censored” dataset for defining representative concentrations of these metals. In general, the 95th percentile for these metals is defined by the 95th percentile of the detection limit values. Defining the nature and extent of potentially EMF-related metals in groundwater using the 95th percentile for the highly-censored datasets was deemed acceptable since the representative levels are typically well below levels of concern.

Arsenic, barium, and boron were detected consistently in representative groundwater for all three hydrogeochemical regimes. Arsenic was detected in representative groundwater at mean concentrations from 0.0022 to 0.016 mg/l. Barium was found in representative groundwater at mean concentrations from 0.044 to 0.199 mg/l and boron was found at mean concentrations from 0.055 to 0.219 mg/l.

The presence of iron, copper, and zinc in representative groundwater was not consistent over time or among the three regimes. Iron was found in representative groundwater at mean concentrations up to 2.00 mg/l. Measurements over 1.0 mg/l were generally limited to initial rounds of sampling. Groundwater samples collected in 1994 were collected after field turbidity measurements were taken during well purging. The turbidity measurements have a high positive correlation with iron, indicating that the initial sampling of certain wells yielded higher turbidity samples.

Two anomalously high nondetect zinc values in Well 106 were initially used in calculating the 95th percentile for Bannock Range groundwater, but the resulting value of 0.971 mg/l was deemed unrealistically high. A revised value of 0.17 mg/l was calculated for the Bannock Range zinc representative concentration after removal of the two high nondetect values.

4.1.3.6 Radiological Parameters in Representative Groundwater

A summary of the activities for radiological parameters for the 17 representative wells is presented in EMF RI Table 4.4-2.

Representative gross alpha activities ranged from not detectable to:

- 7.97 ± 1.37 pCi/l in the Michaud Flats regime;
- 5.72 ± 1.92 pCi/l for the Bannock Range groundwater; and
- 4.6 ± 2.3 pCi/l in the Portneuf River regime.

Gross alpha activities were detected more consistently and at slightly higher levels in the Michaud Flats representative groundwater and were detected less frequently and at slightly lower levels in the Portneuf River representative groundwater.

The gross beta activities were highest in the Michaud Flats regime, intermediate in the Bannock Range regime, and lowest in the Portneuf River regime. Representative gross beta activities in the three groundwaters ranged from:

- 2.93 ± 1.06 pCi/l to 45.8 ± 2.65 pCi/l (Table 4.4-2) for the Michaud Flats;
- ND to 11 ± 3.7 pCi/l for the Bannock Range; and
- ND to 9.3 ± 0.88 pCi/l for the Portneuf River.

Radium-226 was not detected in 9 of the 17 representative wells. In Wells 101, 102, 106, TW-10S, 147, 301, 305, and 511 activities ranged from 1.18 ± 0.19 to 6.35 ± 0.57 pCi/l.

Radium-228 was not detected in 7 of the 17 representative wells. In four of the remaining 12 representative wells, radium-228 was detected during only one sampling event. For these four wells, activities ranged from 1.20 ± 0.80 to 7.20 ± 1.00 pCi/l. Activity ranges in the other eight wells were 1.0 ± 0.8 pCi/l to 10.8 ± 1.1 pCi/l.

4.1.3.7 Organic Compounds in Representative Groundwater

Organic compound analyses were performed for samples from nine of the 17 representative wells. Concentrations of organic compounds detected in representative wells are presented in EMF RI Table 4.4-3. Organic compounds were detected sporadically in the representative wells. Of the 11 volatile or semivolatile organic compounds reported in representative well samples, most or all may not actually have been present in groundwater. Several of the compounds are common laboratory contaminants, including methylene chloride, acetone, and plasticizers (phthalates). Compounds reported infrequently and at low concentrations, such as 2-butanone, may represent an aberration in the analytical methodology and may not actually have been present in the samples.

One compound, tetrachloroethene, was detected at low concentrations (0.001 to 0.003 mg/l) in all three rounds of samples from Well 511, but was not detected in any other representative well. The presence of this compound most likely represents a source along the Portneuf River upstream of the EMF facilities. Studies at the Union Pacific NPL site, located hydraulically upgradient of the EMF facilities, have documented the presence of chlorinated solvents in the groundwater.

4.1.4 Nature and Extent of EMF-Related Constituents in Groundwater at FMC

The nature and extent of EMF-related constituents beneath the FMC facility focuses on the southwestern and central areas of the facility (EMF RI Figure 4.4-2). Because constituents derived from sources in the eastern portion of the FMC facility may commingle with constituents originating at Simplot sources, the eastern FMC area is included in the discussion of the joint fenceline area in Section 4.1.5.

The following discussion pertains primarily to the extent of EMF-related constituents in the upper aquifer. Impacts to the deeper aquifer are limited in extent and of much lower average concentrations than the impacts observed in the shallow aquifer.

The potential sources identified in the southwest and central FMC portion of the EMF site are:

- Former Ponds 1E through 7E, 1S through 3S, 5S through 9S, including former unlined Pond 8S, which was operational during 1992 and 1993, in the southwestern area

- The slag pit adjacent to the furnace building and the railroad swale in the central FMC area

- 4.1.4.1 Common Ions in FMC Area Groundwater

EMF RI Table 4.4-4 presents a summary of common ion concentrations and physical parameter measurements in the FMC monitoring wells. Impacted wells at the FMC facility had mean common ion concentrations above the upper representative limit for all common ions. These wells also had higher specific conductance and TDS.

In the former ponds area, the common ion with the highest concentrations relative to its representative concentration was potassium. The highest mean potassium concentration was 1,293 mg/l in Well 150, compared to representative concentrations of 12.7 and 10.5 mg/l. Other impacted wells in this portion of the site had potassium concentrations on the order of 2 to 4 times its representative concentration (EMF RI Table 4.4-4 and EMF RI Figure 4.4-5).

EMF RI Figure 4.4-5 illustrates the extent of elevated potassium concentrations in the shallow aquifer at the EMF site. Immediately apparent from this map is that the potassium plume extends from the old pond area out to the northern fenceline of the FMC facilities and beyond. None of the following wells either associated with Pond 16S, or upgradient or crossgradient from the old pond areas and the central area, contained elevated potassium concentrations: Lindley House, 106, 112, 158, 137, 124, 126, 128, 120, 147, 148, 149, 153, 154, Idaho Power, 101, and 501. Due to the presence of arsenic, orthophosphate, and nitrate in elevated concentrations in Wells 137 and 120, these wells do not completely delineate the lateral extent of impacted groundwater.

Sulfate concentrations were above the Michaud Flats representative levels (74.6 mg/l) in 24 monitoring wells. An additional five wells contained sulfate at levels ranging between the Bannock Range representative concentration (43.4 mg/l) and the Michaud Flats representative concentration. Sulfate concentrations were most elevated in Wells 139 and 140 at mean concentrations of 591 and 843 mg/l, respectively. For comparison, Wells 150 (former Pond 8S area) and Well 108 (central area) had mean sulfate concentrations of 253 and 242 mg/l, respectively (EMF RI Table 4.4-4 and EMF RI Figure 4.4-6).

Sulfate has a distribution similar to that of potassium in the upper aquifer in this portion of the EMF site, with some important differences (EMF RI Figure 4.4-6). First, its distribution does not describe a unique source, nor does it correlate completely with the potassium concentrations within the area impacted by the FMC potential sources. Another important difference is the occurrence of elevated sulfate in the Lindley House well (177 mg/l), and in Wells 128, 127, 126, and 148 located north and cross-gradient from the old pond area. In general, sulfate concentrations provide a reasonable assessment of EMF-related impacts, as delineated by Wells 124, 101, 158, 106, 120, 119, and the wells located near Pond 16S.

Calcium was present at mean concentrations of up to 375 mg/l in Well 139, compared to representative concentrations of 97.7 to 68.75 mg/l in Michaud Flats and Bannock Range

groundwater, respectively. Numerous wells contained mean calcium concentrations between the Bannock Range and Michaud Flats representative concentrations (EMF RI Table 4.4-4 and EMF RI Figure 4.4-7).

Chloride was present at mean concentrations up to 980 mg/l in Well 139; the representative concentrations were 192.9 mg/l and 52.4 mg/l for Michaud Flats and Bannock Range groundwater, respectively (EMF RI Table 4.4-4 and EMF RI Figure 4.4-8).

Magnesium was present at concentrations up to 137 mg/l in Well 139. Seventeen monitoring wells had mean magnesium concentrations greater than 33.6 mg/l, the representative concentration for Michaud Flats groundwater. Eleven wells had mean concentrations in excess of the Bannock Range representative concentrations (19.2 mg/l) but below the Michaud Flats representative concentrations (EMF RI Table 4.4-4 and EMF RI Figure 4.4-9).

Sodium concentrations were elevated in 28 monitoring wells at mean concentrations up to 542 mg/l in Well 152. There are several wells with mean sodium concentrations in the relatively broad range between the Bannock Range representative concentrations (27.5 mg/l) and Michaud Flats representative concentrations (74.3 mg/l) (EMF RI Table 4.4-4 and EMF RI Figure 4.4-10).

In general, sodium, calcium, chloride, and magnesium concentrations have a pattern similar to sulfate in the upper aquifer, each with minor variations (EMF RI Figures 4.4-6 through 4.4-10). For example, sodium exceeds representative concentrations in Well 148, as does sulfate and calcium, but this well is located upgradient from the identified FMC potential sources (recall that the data collected from Well 148 were collected prior to operation of Pond 16S). The Lindley House well, Wells 124, 126, 127, and 128 contain one or more of these common ions at a mean concentration above the representative levels.

4.1.4.2 Physical Parameters in FMC Area Groundwater

The mean values of the physical parameter measurements are presented in Table 4.4-4. The pH was typically lower in the impacted wells when compared to the representative levels (EMF RI Figure 4.4-13). Reducing conditions were noted in Wells 150, 152, 131, 132, 141, 159, TW-5S, and 122. Wells 150 and 152, however, had much lower Eh values than the other wells, indicating stronger potential reducing conditions. For comparison, all the representative wells (except TW-10S) have oxidizing Eh conditions in the groundwater.

Elevated specific conductance and TDS are indicative of elevated major ion concentrations. Throughout this portion of the EMF site, these parameters are elevated with respect to the Michaud Flats and the Bannock Range representative levels (EMF RI Table 4.4-4) in the impacted wells. Elevated groundwater temperatures (ranging up to 21 to 28°C, compared with the typical groundwater temperature of 13 to 18°C) were noted in several monitoring wells located downgradient from the slag pit (Wells 108, 122, and 146). These elevated temperatures were noted in shallow wells only, indicating the source is the heated soils around the slag pit, not geothermal groundwaters. EMF RI Figure 4.4-12 illustrates the configuration of this plume, showing groundwater flow direction through the central FMC area to be east-northeast. The

groundwater cools as it flows from the area of the slag pit and as it commingles with groundwater from other areas.

4.1.4.3 Nutrients and Fluoride in FMC Area Groundwater

The mean values of the nutrient and fluoride concentrations are presented in EMF RI Table 4.4-4. Ammonia, nitrate, orthophosphate, total phosphorus, and fluoride were detected in FMC monitoring wells at mean concentrations that exceeded the representative concentrations.

Ammonia was present at mean concentrations of 9.52 and 8.69 mg/l in Wells 150 and 152, immediately downgradient from former Pond 8S. Ammonia was also detected at elevated concentrations in Wells 104, 116, 132, 141, 151, and 159. In the central FMC area, only Well 122 had a mean ammonia concentration in excess of the representative concentrations (EMF RI Figure 4.4-21).

Nitrate was present at mean concentrations in excess of the Bannock Range representative concentration of 1.60 mg/l in numerous shallow wells associated with the former ponds area. Mean nitrate concentrations in 14 wells also exceeded the Michaud Flats representative concentration. The highest nitrate concentrations were detected in Wells 130 and 139, associated with the old ponds in the southwest FMC area and in Wells TW-5S, 121, and 122 in the central FMC area (EMF RI Figure 4.4-22).

The elevated nitrate concentrations are delineated by Wells 124, 126, 127, 101, 158, 106, and the wells located north and east of former Pond 8S. The ammonia plume map in EMF RI Figure 4.4-21 and the nitrate plume map (EMF RI Figure 4.4-22) point out an interesting relationship between ammonia and nitrate. It appears that the distribution of ammonia concentrations in the impacted wells is the inverse of the nitrate concentrations. For example, downgradient from former Pond 8S, several wells contained ammonia at elevated concentrations, with Wells 150 and 152 having the highest mean concentrations. However, none of these wells had mean nitrate concentrations in excess of the representative concentrations. Further downgradient, in the central FMC area, ammonia concentrations decreased while nitrate concentrations increased. It appears that the ammonia associated with the reducing groundwater conditions at former Pond 8S may be oxidized to nitrate further downgradient.

The two phosphate parameters were detected in nearly all the shallow monitoring wells in the former ponds area and the central FMC area. Orthophosphate and total phosphorus concentrations were highest in Wells 150 and 152 by a factor of 10 over all other impacted monitoring wells (EMF RI Figure 4.4-23).

Fluoride was detected at above-representative concentrations in 17 shallow monitoring wells in the southwest and central FMC area (EMF RI Table 4.4-4). Wells located in both the former ponds area and slag pit area contained elevated levels of fluoride, with the highest mean concentrations (up to 10.9 mg/l) detected in Wells 104, 150, and 152 (Figure 4.4-24). In the slag pit area, the mean concentrations ranged up to 2.88 mg/l in Well 108. The representative

fluoride concentrations are 0.80 and 0.60 mg/l in Michaud Flats and Bannock Range groundwater, respectively.

4.1.4.4 Metals in FMC Area Groundwater

The mean values of metal concentrations are presented in EMF RI Table 4.4-4. Because the mean concentrations of antimony, cadmium, mercury, silver, thallium, vanadium, and zinc did not exceed either the Bannock Range or Michaud Flats representative concentrations in any of the wells in this portion of the EMF site, they were eliminated from further consideration. Aluminum, beryllium, copper, lead, and possibly molybdenum were also eliminated as EMF-related constituents for this area, as discussed below.

Aluminum was detected at mean concentrations of 10.15 mg/l in Well 131 and 0.76 mg/l in Well 116, compared to 0.547 mg/l for the Bannock Range representative level. Aluminum was eliminated as an EMF-related constituent for potential sources in this portion of the EMF site due to the elevated turbidity encountered in Wells 131 and 116.

Copper was detected at mean concentrations of 0.023 mg/l in Well 116, compared to 0.011 mg/l in the Bannock Range. Copper was also be eliminated as a result of turbidity in Well 116 because there was a copper value of 0.245 mg/l reported from the October 1990 sampling event in conjunction with an elevated iron content (high iron content is also typically associated with elevated turbidity).

Chromium was above the representative level in Well 153, located upgradient from all known source areas at the EMF site, thereby indicating that the chromium level reported for this well is not due to EMF activities.

Beryllium and lead exceeded the Michaud Flats representative levels in several wells but were below the Bannock Range representative levels in all wells. Since there is commingling of these two groundwater types, and because most reported results for beryllium and lead were nondetects, these two constituents are not considered EMF-related. Additionally, the wells which contained these constituents at levels above the Michaud Flats representative concentrations were randomly located throughout this portion of the site, further indicating no unique source or “plume” of these constituents.

Molybdenum was detected in Wells 115, 122, 159, and TW-5S at concentrations that exceeded Michaud Flats and Bannock Range representative levels (EMF RI Table 4.4-4). Molybdenum was also detected in three wells (Wells 103, 104, and 114) at levels above the Michaud Flats levels, but below the Bannock Range level. Given that the concentration in Well 115 exceeded the Bannock Range level, the molybdenum detections may indicate representative concentrations rather than EMF-related impacts. The above-representative molybdenum concentrations in Wells 122, 159, and TW-5S are due to high detection limits.

Nickel was detected at mean concentrations of 0.0203 to 0.0221 mg/l in Wells 104, 131, 132, 141, and 152. These concentrations compare to representative concentrations of 0.0200 mg/l.

Nickel was eliminated as an EMF-related constituent in the southwest FMC area because the above-representative mean concentrations were estimated from nondetect data. Wells 104, 131, 132, 141, and 152 each have at least one very high nondetect value, which increases the mean concentrations.

Arsenic, barium, boron, cobalt, lithium, manganese, and selenium were detected above representative concentrations in groundwater beneath the potential FMC source areas listed above (EMF RI Figures 4.4-14 through 4.4-20).

Mean arsenic concentrations ranged from 0.020 mg/l to 0.1878 mg/l in impacted shallow wells. The arsenic concentrations decrease with distance from the old pond area toward the central FMC area, and increase again within the central area as the groundwater underflows another source area. This is illustrated by the higher arsenic concentrations associated with shallow monitoring wells immediately downgradient from potential source areas (EMF RI Figure 4.4-14). Wells 127 and 128 had mean arsenic concentrations of 0.021 and 0.023 mg/l, respectively. Combined with the elevated major ion concentrations observed in these wells, it appears that EMF-related impacts are present in these wells, but are delineated by Wells 124 and 125/126 to the west and north (EMF RI Figure 4.4-14).

The arsenic concentrations are not elevated above the representative levels in wells along the northern fenceline of FMC up to Well 112. To the south, Wells 101/102, 106, TW-10S, and 158 all define arsenic concentrations of less than representative levels. This arsenic distribution is consistent with the groundwater flow patterns, and the known source areas relative to these flow patterns.

Elevated arsenic concentrations were also present in the deeper aquifer in this area. Typically, arsenic concentrations in the deeper aquifer are localized and are much lower than those detected in the shallow aquifer. For example, at well pair 137/130 the mean arsenic concentrations in shallow Well 137 were 0.086 mg/l and 0.030 mg/l in deeper Well 130.

Barium was found in numerous wells at concentrations above the representative concentrations; however, its spatial distribution is not clearly associated with particular site sources. A key aspect of the barium distribution is that wells located in the westernmost portion of the EMF site (upgradient of known sources) often contain some of the highest concentrations of barium (EMF RI Figure 4.4-15 and EMF RI Table 4.4- 4; Wells 153, 154, 147, 148, and 149, 501 and TW-10S). Conversely, the lowest barium concentrations occur in wells known to be impacted by other EMF-related constituents, such as Wells 150 and 152, which are immediately downgradient from former Pond 8S.

Boron was detected at elevated concentrations in the shallow wells located near the old ponds in the southwest FMC area (EMF RI Figure 4.4-16). The highest mean boron concentrations (14.49 mg/l and 17.10 mg/l) were detected in Wells 150 and 152, respectively, which are located immediately downgradient from former pond 8S. Well 127, which is farther downgradient of the ponds, had a mean boron concentration of 0.310 mg/l, slightly above the Michaud Flats and Bannock Range representative concentrations of 0.294 and 0.308 mg/l, indicating the mean

concentration in this area is very close to the 95% UCL for the representative groundwater chemistry. Mean boron concentrations at other wells are between the representative level of 0.30 mg/l and 2.2 mg/l. Wells 126, 124, 101, 158, 106 and 112, which have boron concentrations below the representative levels, define the extent of this constituent. There does not appear to be a significant increase in boron concentrations through the central FMC area, although elevated concentrations persist up to and beyond the FMC's facility's fenceline at Wells TW-5S and 111 (EMF RI Figure 4.4-16).

Cobalt was detected in 15 shallow wells at above-representative levels. The highest mean cobalt concentrations were detected in wells associated with the westernmost old ponds (Wells 114, 115, 139, and 159). Lower concentrations of cobalt were detected in Wells 128, 131, 132, 103, 134, and 140 (EMF RI Figure 4.4-17). There may a secondary cobalt source in the central FMC area, as elevated concentrations were detected in Well 111, along the northern fenceline. However, only two wells in the central area had mean cobalt concentrations above either the Bannock Range or Michaud Flats representative levels. Cobalt concentrations below representative levels are defined by Wells 112 and 126 to the north, 124 and 101 to the west, 158, 120, 118, 119, 135, 121, and 108 along the southern margin of the plume (EMF RI Figure 4.4-17).

Lithium was detected in 19 wells at mean concentrations above the Bannock Range and Michaud Flats representative levels, up to 0.19 mg/l (Well 152). Numerous other wells had lithium concentrations that were above the Bannock Range representative level (0.016 mg/l), but below the Michaud Flats representative level (0.061 mg/l). In general, lithium concentrations in impacted wells are between 0.061 mg/l and 0.19 mg/l, which are not significantly elevated with respect to the Michaud Flats representative levels (EMF RI Table 4.4-4 and EMF RI Figure 4.4-18). Lithium appears to be emanating from the old ponds located upgradient from Well 116. Elevated lithium concentrations are delineated by Wells 112, 126, 124, 128, 101, 113, 119, 158, 121, and 135. In general, the area encompassed by the elevated lithium concentrations is similar to the areas defined by elevated major ion concentrations.

Manganese was detected in numerous wells at mean concentrations that were greater than the Bannock Range representative level of 0.0201 mg/l. There were also three wells with manganese concentrations between the Bannock Range and Michaud Flats representative concentrations. The highest mean manganese concentrations were detected in Wells 141, 151, and 159, downgradient from the old ponds in the southwest FMC area and downgradient from the central FMC area. There appears to be manganese sources located in both areas (EMF RI Table 4.4-4 and EMF RI Figure 4.4-19). Manganese concentrations increase downgradient from the central area indicating an additional amount of this constituent is introduced into the aquifer in the central FMC area.

Selenium was detected in Wells 116, 139, 140, 108, 121, 135, and 146 at slightly elevated levels with respect to the Michaud Flats and Bannock Range representative concentrations (EMF RI Figure 4.4-20). In the southwest FMC area, Wells 116, 139, and 140 had mean selenium concentrations ranging from 0.015 to 0.025 mg/l. In the central FMC area, the highest mean selenium concentration was 0.050 mg/l in Well 121 (EMF RI Table 4.4-4). More typically, the

mean selenium concentrations in impacted wells ranged from 0.006 to 0.008 mg/l, only slightly above the representative levels (0.0055 to 0.0057 mg/l). The extent of elevated selenium in groundwater is delineated by numerous wells with below-representative mean concentrations.

4.1.4.5 Radiological Parameters in FMC Area Groundwater

The mean values of the radiological parameters are presented in EMF RI Table 4.4-5. Wells 150 and 152 in the former ponds area had elevated gross alpha activities for at least one sampling event.

Eight wells monitoring the former ponds area (150, 152, 104, 132, 111, 134, TW-5S, and 116) had gross beta activities above the upper range of representative activity of 45.8 pCi/l with a maximum value of 1,110 pCi/l at Well 150. In the central area, gross beta also exceeded representative activities in Well 121, Well 122, Well 108, and Well 146, with a maximum value of 186 pCi/l at Well 108. Mean gross beta activities are associated with mean potassium concentrations with a correlation coefficient of greater than 0.9, which indicates that potassium-40 is the primary beta-emitter in impacted groundwater at FMC.

Radium-226 and radium-228 were sporadically detected at very low levels in most monitoring wells, including those wells that are hydraulically upgradient from the identified potential sources. Typically, radium-226 and radium-228 activities were reported as ND or not detected for each well over several sampling events. This indicates there is no persistent, elevated presence of these radioisotopes at levels above the detection limit. Additionally, there does not appear to be any "source" of these radioisotopes where activities are persistently elevated above the representative level.

4.1.4.6 Organic Compounds in FMC Area Groundwater

Several volatile organic compounds (VOCs) were found in wells used to monitor the slag pit area in the central FMC area. As shown in EMF RI Table 4.4-6, trichloroethene (TCE) was detected during three rounds of sampling at Well 121 at concentrations from 0.008 to 0.015 mg/l. TCE was also detected in Wells 108 and 146, downgradient from Well 121, at concentrations of 0.002 to 0.003 mg/l. TCE was not detected in wells located upgradient from the central area or in the northern portion of the central area. These data suggest that TCE is present in groundwater in only a limited area.

4.1.5 Nature and Extent of EMF-Related Constituents in Groundwater in the Joint Fenceline Area

The joint fenceline area is bounded by the FMC former kiln scrubber overflow ponds in the west and the Simplot gypsum stack in the east (EMF RI Figure 4.4-2). The area includes the FMC former calciner ponds, calciner sediment storage area (south of the former calciner ponds), the FMC IWW ditch, the former kiln scrubber overflow pond, and the western third of the Simplot upper gypsum stack. The joint fenceline area is discussed separately because there is a commingling of impacted groundwater from various sources.

In general, gypsum stack seepage results in elevated common ion concentrations, notably sulfate, elevated arsenic and lithium, and depressed pH in shallow groundwater. These gypsum stack effects are also apparent in portions of the joint fenceline area. Other potential sources that may influence groundwater chemistry in the joint fenceline area include the former calciner ponds, calciner sediment storage area, the IWW basin and ditch, and the former kiln scrubber overflow pond. Constituents that may be contributed by one or more of these sources include chloride, potassium, ammonia, selenium, and arsenic.

This area is very complex geologically and hydrologically, with great variation in transmissivity, hydraulic conductivity and pH. All of these factors, in association with complex chemical reactions that are occurring in the subsurface (SII, 1994), and the dynamics of facility operations (i.e., pond heads, closures, gypsum stack construction, etc.) over the years, have contributed to the complexity of this area. For these reasons, statements in this section concerning sources in this area should not be extrapolated to areas east or north of the gypsum stack, nor west or north of the FMC former kiln scrubber overflow ponds (EMF RI Figure 4.4-2).

Portneuf River Valley and Michaud Flats groundwaters do not underflow this area. The groundwater underflowing the joint fenceline area originates in the Bannock Range recharge areas.

4.1.5.1 Common Ions in Joint Fenceline Area Groundwater

EMF RI Table 4.4-11 summarizes the common ion concentrations detected in wells throughout the joint fenceline area, with a comparison to the Bannock Range representative levels. All common ions in shallow groundwater were elevated with respect to representative levels. Of particular note are potassium and sulfate.

Elevated potassium levels were detected in all shallow wells except Well 324. The highest potassium concentrations were detected in Wells 136, 145, and 309, and were, respectively, 122, 81, and 55 mg/l. Concentrations in other wells were less than 36 mg/l. These data indicate that potassium is primarily introduced into the groundwater from residuals associated with the old calciner ponds (EMF RI Figure 4.4-5).

Sulfate was detected at elevated concentrations in all shallow wells throughout the joint fenceline area. Mean concentrations reported for shallow wells 307, 308, and 333 were 1,932, 1,958, and 2,200 mg/l, respectively. These wells contained the highest mean sulfate values and all three wells are located in close proximity to the gypsum stack (EMF RI Figure 4.4-6). Deep wells 330, 109 and 329, located along the northern joint fenceline, which had the lowest mean sulfate concentrations, do not appear to be site-affected (EMF RI Table 4.4-11).

4.1.5.2 Physical Parameters in Joint Fenceline Area Groundwater

The TDS and specific conductance were above measured representative levels in all the wells in the joint fenceline area, except for Wells 109, 329, and 330. The pH was below representative levels in all wells except for Wells 330 and 331. Temperature was elevated in Wells 123, 309,

310, 324, and 331. The mean values of the physical parameter measurements are presented in EMF RI Table 4.4-11.

4.1.5.3 Nutrients and Fluoride in Joint Fenceline Area Groundwater

The mean nutrient and fluoride concentrations are presented in EMF RI Table 4.4-11. Mean ammonia concentrations exceeded the Bannock Range representative level in eight monitoring wells, with the highest mean concentration reported for Well 145.

Mean nitrate concentrations exceeded the Bannock Range level of 1.60 mg/l in 17 wells. Only Wells 324, 109, and 330 had mean nitrate concentrations below the Bannock Range representative levels. The highest mean nitrate concentration was reported in Well 331, in the northeast corner of the joint fenceline area and is affected by a source east of the joint fenceline area within the Simplot plant (EMF RI Figure 4.4-22).

Total phosphorus was elevated in 15 monitoring wells and orthophosphate was elevated with respect to the Bannock Range levels in 17 wells (EMF RI Table 4.4-11). Total phosphorus and orthophosphate concentrations were highest in Wells 136, 307, 308, and 323. The deep monitoring wells (109, 329, and 330) along the northern joint fenceline area did not contain elevated concentrations of orthophosphate or total phosphorus and do not appear to be site-affected.

Fluoride concentrations were slightly above the representative level in seven wells throughout the joint fenceline area. The highest concentrations were detected in Wells 308 and 136 (mean concentrations of 1.34 and 1.66 mg/l, respectively).

4.1.5.4 Metals in Joint Fenceline Area Groundwater

The mean values of the metals concentrations are presented in EMF RI Table 4.4-11. Metals with mean concentrations below the Bannock Range representative levels in all joint fenceline area wells were: aluminum, antimony, beryllium, chromium, iron, lead, molybdenum, silver, thallium, and zinc, and are not discussed further. In addition, barium, cadmium, copper, cobalt, and mercury were not found to be EMF-related, as discussed below.

Barium was detected at a mean concentration of 0.246 mg/l in Well 142, compared to the Bannock Range representative level of 0.1204 mg/l. Well 142 is downgradient from the upper gypsum stack at Simplot; however, none of the shallow monitoring wells located immediately adjacent to the gypsum stack had mean barium concentrations in excess of the Bannock Range representative level. This observation indicates that barium is not a EMF-related constituent in the joint fenceline area, since no potential source of this constituent has been identified upgradient from Well 142.

Cadmium was detected at a mean concentration of 0.0055 mg/l in Well 143. This value exceeds the Bannock Range representative level of 0.005 mg/l; however, several of the analytical results

that exceeded 0.005 mg/l were J-qualified (meaning the detected concentrations are estimated). All unqualified data from this well were below 0.005 mg/l, suggesting that true mean concentrations are less than the representative level for cadmium.

Copper was detected in Well 136 at a mean concentration of 0.0135 mg/l, compared to the Bannock Range representative concentration 0.0109 mg/l. The historical copper concentrations in this well indicate total copper is typically less than 0.0109 mg/l, with three samples elevated with respect to this concentration while one sample of these was nondetect. It appears that copper is not a EMF-related constituent in the joint fenceline area.

Cobalt was detected at mean concentrations in excess of the representative level in Well 144. This well had a reported mean concentration 0.0144 mg/l compared to the Bannock Range level of 0.0108 mg/l. The cobalt detected in this well does not appear to be EMF-related because this well is a deeper well, and there is no upgradient potential source of cobalt, as evidenced by cobalt concentrations in upgradient wells 142, 304, 333, 136, and 143. In any case, the concentrations detected in Well 144 are not significantly elevated when compared to the representative levels.

Mercury was detected at levels exceeding the Bannock Range representative level of 0.00078 mg/l in Well 144 at a mean concentration of 0.00221 mg/l. Well 144 is a deep monitoring well paired with shallow Well 145. Mercury is below the representative level in Well 145, and in all other shallow wells located throughout the joint fenceline area, indicating that the mercury in Well 144 is not EMF-related. Further evidence of this is that mercury was not detected in samples collected during the August 1993 and December 1993 sampling events. These results indicate that the occurrence of mercury in this well is sporadic, if it is truly present and not an artifact of laboratory contamination or field sampling contamination.

Arsenic, boron, lithium, manganese, nickel, selenium, and vanadium were detected at concentrations above representative levels in groundwater beneath the joint fenceline area. There are several key aspects regarding the distribution of these metals; selenium appears to be associated with FMC's old calciner ponds, while lithium appears to be associated with the Simplot upper gypsum stack (EMF RI Figures 4.4-18 and 4.4-20). While neither of these constituent plumes represents a unique source for these constituents at the EMF site, their distribution does indicate a stronger source of selenium and lithium in the joint fenceline area.

Elevated arsenic concentrations were more prevalent in the central portion of the joint fenceline area, with less than representative levels in Wells 142, 304, and recently installed Well 161 in the southern portion of this area. The highest mean arsenic concentrations were detected in Well 323, at a mean concentration of 0.658 mg/l. Other wells with similar levels are 123 (0.5506 mg/l), 307 (0.5970 mg/l), and 308 (0.5521 mg/l). Deeper wells 329, 330, 109, and 144 do not contain elevated arsenic concentrations. Gypsum stack seepage results in elevated arsenic in shallow groundwater. Other potential sources include the former calciner ponds and calciner sediment storage area.

Boron was detected in 15 wells at elevated concentrations ranging up to 1.03 mg/l (in Well 143). No primary source of boron was identified, but potential sources include the gypsum stack, former calciner ponds, and calciner sediment storage area.

Lithium was elevated with respect to the representative Bannock Range concentrations in all wells throughout the joint fenceline area, including deeper Wells 109, 330, 329, and 144. The highest mean concentrations were detected in Wells 136, 145, 307, 308, and 333, up to 0.6073 mg/l in Well 307 (EMF RI Table 4.4-11). Lithium appears to be primarily associated with the Simplot upper gypsum stack.

Manganese was detected in 12 wells at mean concentrations exceeding the Bannock Range representative concentration of 0.0201 mg/l. Mean manganese concentrations ranged up to 2.266 mg/l in Well 136 (EMF RI Table 4.4-11). No primary source of manganese was identified, but potential sources include the IWW basin and ditch and former kiln scrubber overflow pond.

Nickel was detected in five wells (136, 143, 145, 308, and 312) at mean concentrations exceeding the Bannock Range representative levels of 0.002 mg/l (EMF RI Table 4.4-11). The highest mean concentrations were detected in Wells 143 and 308 at levels of 0.0580 and 0.0527 mg/l, respectively.

Selenium was detected in 15 wells at mean concentrations in excess of the Bannock Range representative level (0.0055 mg/l). The highest mean concentration was detected in Well 123 (0.2896 mg/l), while most other wells had mean concentrations on the order of 0.010 to 0.100 mg/l (EMF RI Table 4.4-11). Mean selenium concentrations in wells in this area (123, 143, 145, 312, and several other shallow wells) were the highest observed throughout the EMF site (EMF RI Figure 4.4-20). Selenium appears to be primarily associated with FMC's old calciner ponds.

Vanadium was detected at mean concentrations in excess of the Bannock Range representative level (0.100 mg/l) in Wells 123, 143, and 312. The highest mean concentration was detected in Well 123 (0.186 mg/l).

4.1.5.5 Radiological Parameters in Joint Fenceline Area Groundwater

The mean values of the radiological parameter measurements are presented in EMF RI Table 4.4-12. Gross alpha and gross beta activities were both measured at above-representative levels in the joint fenceline area groundwater.

4.1.5.6 Organic Compounds in Joint Fenceline Area Groundwater

Wells 301, PEI-1, 304, and 312 had reported levels of organic compounds (EMF RI Table 4.4-9). The occurrence of these compounds in representative Wells 301 and PEI-1 indicates these compounds may have been detected as a result of laboratory contamination.

4.1.6 Nature and Extent of EMF-Related Constituents in Groundwater within the Northern FMC/Simplot Properties

The northern FMC/Simplot properties area is defined as the properties owned by the Companies located north of the facilities' fencelines and south of I-86. As discussed above, EMF-related impacts to groundwater were delineated to the south, east, and west of the facilities. No EMF-related sources were identified in the northern FMC/Simplot properties. Therefore, most the constituents detected in northern area wells that exceeded representative levels were likely derived from either EMF sources within the facilities' fencelines, or from non-EMF sources.

The following subsections describe the distribution of these constituents in more detail.

4.1.6.1 Common Ions in Northern FMC/Simplot Properties

The mean values of the common ion concentrations are presented in EMF RI Table 4.4-13. The highest concentrations of common ions detected in monitoring wells were about 10 to 100 times lower than the concentrations detected in monitoring wells located adjacent to potential sources (EMF RI Figures 4.4-5 through 4.4-11). Mean sulfate concentrations were highest in Well TW-12S (316 mg/l).

Potassium concentrations in northern site area monitoring wells were highest in Well TW-9S (127 mg/l), the Old Pilot House well (106 mg/l), Well TW-12S (20.34 mg/l), and Well 517 (76.5 mg/l). These wells are located in an area downgradient from potential potassium sources in the southwest and central FMC area and sources in the joint fenceline area.

Alkalinity (bicarbonate), calcium, chloride, magnesium, and sodium concentrations were elevated with respect to representative concentrations in the impacted wells.

4.1.6.2 Physical Parameters in Northern FMC/Simplot Properties Groundwater

The mean values of the physical parameter measurements are presented in EMF RI Table 4.4-13. Physical parameters were detected at levels above the representative levels (or were below the representative levels in the case of Eh and pH) in the northern FMC/Simplot properties.

4.1.6.3 Nutrients and Fluoride in Northern FMC/Simplot Properties Groundwater

The mean values of the nutrient and fluoride concentrations are presented in EMF RI Table 4.4-13. Ammonia was detected at a mean concentration above representative levels in Well TW 12S.

EMF site-related constituents total phosphorus and orthophosphate also occur in the impacted northern site area wells (EMF RI Figure 4.4-23), but the overall concentrations were significantly lower than the maximum concentrations detected in wells immediately adjacent to potential sources. Total phosphorus was detected at mean concentrations ranging from 1.07 mg/l

(Well 517) to 29.63 mg/l (Well TW-12S), and orthophosphate was detected at mean concentrations ranging from 0.86 mg/l to 27.47 mg/l.

Fluoride was also identified as an EMF site-related constituent in northern site area groundwater. Well TW-12S contained the most elevated mean fluoride concentration relative to representative concentrations (1.13 mg/l; EMF RI Table 4.4-13).

Nitrate was detected at concentrations exceeding representative levels in nine northern site area wells (EMF RI Table 4.4-13). Mean nitrate concentrations in impacted wells ranged from 1.81 mg/l to 13.36 mg/l. The highest mean nitrate concentrations were detected in Wells TW-12S, Old Pilot House, TW-9S, and 517 (EMF RI Table 4.4-13). Some of the nitrate in the impacted wells may be an oxidation product of ammonia. Nitrate detected in unimpacted wells occurs as a result of non-EMF-related anthropogenic activities. Representative nitrate concentrations ranged up to 5.52 mg/l in the Michaud Flats hydrogeochemical regime.

4.1.6.4 Metals in Northern FMC/Simplot Properties Groundwater

The mean values of the metals concentrations in northern site area groundwater are presented in EMF RI Table 4.4-13. The metals aluminum, antimony, beryllium, cadmium, chromium, copper, lead, mercury, molybdenum, silver, thallium, vanadium, and zinc were not detected at above-representative concentrations in northern FMC/Simplot area wells.

Groundwater from Wells TW-9S, Old Pilot House, and TW-12S contained the highest concentrations of arsenic for any of the northern FMC/Simplot area wells. Other wells with arsenic concentrations above the representative concentration included 517, 518, and the Frontier Well, with mean concentrations ranging from 0.0169 mg/l to 0.032 mg/l. The upper concentration value of arsenic in representative groundwater is 0.018 mg/l in Bannock Range groundwater and 0.0105 mg/l for the Portneuf River Valley groundwater (EMF RI Table 4.4-13 and EMF RI Figure 4.4-14).

Barium exceeded the representative level in the Old Pilot House well and Well 501. Well 501 is located hydraulically crossgradient or upgradient from EMF potential sources. Thus, the barium in this well is not considered EMF-related. This conclusion is further supported by the fact that groundwater from Well 501 does not contain other EMF-related constituents at levels in excess of the Michaud Flats representative levels. This exceedance of barium may be due to the higher barium content of Michaud Flats groundwater that converges and mixes with Bannock Range groundwater in the vicinity of the Old Pilot House well or it may be derived from EMF sources upgradient from this well (EMF RI Figure 4.4-15).

Boron exceeded representative levels in four northern site area wells: Lindley, Old Pilot House, Well TW-9S, and Well 517. The maximum mean concentrations were 0.7046 mg/l, detected in the Old Pilot House well. The Old Pilot House well is closest to onsite potential sources, and the mean concentrations decrease from this well out to Wells TW-9S and 517. The Lindley Well appears to have only slightly elevated boron concentrations relative to the representative levels (0.3269 mg/l vs. 0.3078 mg/l for Bannock Range representative levels), indicating that the boron

concentrations in the Lindley Well are not EMF-related. (The reader will recall that there will be a certain number of wells which, while not impacted by EMF sources, contain a constituent in excess of the statistically-defined representative concentrations.)

Cobalt also exceeded representative concentrations in the Old Pilot House well (EMF RI Table 4.4-13). The mean cobalt concentration in this well was 0.0154 mg/l compared to the Michaud Flats representative level of 0.0145 mg/l and the Bannock Range representative level of 0.0109 mg/l.

Iron exceeded representative levels in Wells TW-9S (1.3756 mg/l mean concentration). This well is mild steel cased, with stainless steel wire-wrapped well screens or perforated mild steel intakes. Given the well construction materials and the reduced Eh conditions observed in the TW-series wells, it appears that the mild steel may provide a source for the elevated iron content in the water sampled from these wells. An alternate explanation might be that these wells yield slightly more turbid samples due to the lack of filter pack.

Lithium occured at mean concentrations above the Bannock Range representative concentration in Well 500, the New Pilot House well, 504, and 508 at levels slightly greater than 0.0400 mg/l (EMF RI Figure 4.4-18). The representative lithium concentrations are 0.040 mg/l in Portneuf River Valley groundwater and 0.0165 mg/l in Bannock Range groundwater. These wells are not impacted by other EMF-related constituents. Additionally, none of the unimpacted wells listed above exceeded the Michaud Flats groundwater representative concentration (0.0610 mg/l). Therefore, lithium detected in these wells is likely to be within the representative range for groundwater, and the Bannock Range representative level may be underestimated.

Manganese was present at mean concentrations in excess of representative concentrations in the Old Pilot House well, Wells TW-9S, TW-12S, and Well 503. The maximum mean concentration was 1.1005 mg/l in TW-9S. The representative levels are 0.0201 mg/l in Bannock Range groundwater up to 0.1097 mg/l in the Portneuf River Valley groundwater.

Nickel exceeded the representative concentrations in Well TW-12S, where the mean concentration was 0.0606 mg/l compared to representative levels of 0.0200 mg/l. Mean nickel concentrations were not above this level in other northern site area wells.

Selenium was reported at maximum mean concentrations of 0.0112 mg/1 and 0.0153 mg/l in Wells TW-12S and 517, respectively. These concentrations are 0.0057 to 0.008 mg/l higher than the representative concentrations.

4.1.6.5 Radiological Parameters in Northern FMC/Simplot Properties Groundwater

The mean values of the radiological parameters are presented in EMF RI Table 4.4-14. The radiological parameter radium-228 was not detected at mean values above representative levels. Radium-226 was reported at a mean activity of 1.88 pCi/l in Well 508, located along the Portneuf River and unimpacted by EMF-related sources, as evidenced by common ion, nutrients, and metals concentrations in the well. Gross alpha was detected at a mean activity of 10.33 pCi/l

in the Lindley well compared to background levels of 5.57 pCi/l. The gross alpha activity in this well does not appear to be EMF-related, because there no evidence of an upgradient source for the gross alpha in this well.

Gross beta was the only radiological parameter that was consistently detected at levels above representative in northern area wells. The gross beta activity in these wells correlated with the total potassium concentrations, indicating that potassium-40 is the beta-emitter present in these wells.

4.1.6.6 Organic Compounds in Northern FMC/Simplot Properties Groundwater

The mean values of the organic compound concentrations in northern area groundwater are presented in EMF RI Table 4.4-15. No significant concentrations of organic compounds were detected.

4.1.7 Nature and Extent of EMF-Related Constituents in Groundwater North of I-86

All EMF-affected groundwater passes beneath I-86 through the shallow aquifer between some point east of Well 502 and the Portneuf River. This water discharges to the river at Batiste and Swanson Road Springs and as base flow between these springs. Average concentrations of EMF-related constituents were below MCLs (during the EMF RI) in groundwater north of I-86. Furthermore, most constituents were at or below representative levels in this area (EMF RI Tables 4.4-16 to 4.4-18). There were no EMF-related effects in groundwater north of Batiste Spring, as evidenced by water quality in Wells 524 and 525, a well pair located about 150 feet north of the spring.

EMF-related impacts were not detected in Wells 514, 515, 516, 519, 502, TW-11I, and TW-11S. The only points north of I-86 where EMF-related constituents were detected above representative values are Well 503, and Batiste and Swanson Road Springs. These springs are on company-owned property, while Well 503 is on the county right-of-way. These impacts were limited to slightly elevated concentrations of major ions, nutrients, a limited suite of metals, low pH, and elevated TDS. The pattern in the extent of EMF-related constituents is generally consistent: well 503 contained the highest levels of constituents, while Swanson Road Spring and Batiste Spring contain elevated, but lower, concentrations, of certain constituents. Batiste Spring has groundwater chemistry similar to that of Bannock Range hydrogeochemical regime. Well 503 and Swanson Road Spring have groundwater chemistry similar to that of the Portneuf River Valley hydrogeochemical regime.

Ammonia was detected in Well 503 and Batiste Spring at mean concentrations in excess of the representative concentrations (EMF RI Figure 4.4-21). In Well 503, Batiste and Swanson Road Spring, mean sulfate concentrations ranged from 115 to 238 mg/l (EMF RI Table 4.4-16), which exceed the representative levels. Orthophosphate and total phosphorus concentrations were also elevated with respect to representative levels. Mean potassium concentrations slightly exceeded representative levels in samples from Batiste Spring (10.61 mg/l) and Well 503 (8.27 mg/l).

Fluoride was also elevated with respect to representative concentrations in Well 503 (EMF RI Figure 4.4-24).

Mean concentrations of arsenic, lithium, iron, mercury, and selenium were found to exceed representative levels at one or more offsite monitoring locations (EMF RI Table 4.4-16). However, iron and mercury are not thought to be EMF-related, as discussed below.

Arsenic concentrations were elevated with respect to representative levels in Well 503 (Portneuf River regime), but not Batiste Spring (Bannock Range regime). Lithium concentrations were slightly above representative levels in Batiste Spring, Well TW-11I and Well TW-11S. Lithium in Wells TW-11I and TW-11S is not considered site related because all other site indicator parameter concentrations were below representative levels in these wells. Iron exceeded the representative level in Well TW-11I, however, this was found to be associated with the mild steel well casing. The mean mercury concentration in samples from Well 516 exceeds the representative level, but this is because of one high value with a U qualifier (i.e., nondetect).

The mean concentration of selenium in Batiste Spring was 0.0069 mg/l, compared to representative levels of 0.0055 to 0.0060 mg/l. During one sampling event (December 1992), selenium was detected in Batiste Spring water at a concentration of 0.010 mg/l. If this value is not used in calculating the mean selenium concentrations, the mean concentration at Batiste Spring is less than the representative level. Under "average" conditions, selenium concentrations are not elevated with respect to unimpacted groundwater.

Groundwater from beneath the EMF site discharges to the Portneuf River at Batiste and Swanson Road Spring and as baseflow between these springs. Although a few EMF-related constituents have been detected at Batiste and Swanson Road Springs, concentrations were from one to two orders of magnitude less than concentrations in groundwater beneath source areas. Average concentrations in the groundwater north of I-86 were below MCLs.

4.1.8 Radiological Speciation Results

Groundwater samples collected from 12 wells in March 1994 were tested for alpha, beta, and gamma emitting radioisotopes associated with the phosphate ore processed at the facilities. These wells were selected because previous samples had higher detected gross alpha and/or gross beta activities compared with other wells and because these wells represent a cross section of the various potential sources and geologic areas. These data, presented in EMF RI Table 4.4-19, were also reported to EPA in August 1994, in response to EPA's request for additional site characterization data to support the development of the baseline risk assessment.

Radionuclide-specific analyses were performed for the major radionuclides in the uranium-238 decay chain (i.e., uranium -238 and -234, thorium-230, radium-226, lead-210, and polonium-210). Radionuclide-specific analyses were also performed for thorium-232, radium-228, and potassium-40. Only radium-226, -228, uranium-234, uranium-238, and potassium-40 were detected. Lead-210, thorium-232 and -230, and polonium-210 were not detected above their minimum detectable activity (MDA) in any sample. Gross alpha and gross beta activities were

also measured in the water samples to evaluate total activities associated with the detected radioisotopes.

Section 4.4.9.1 discusses speciation data for beta-emitting radionuclides and Section 4.4.9.2 discusses speciation data for alpha-emitting radionuclides. These sections include a discussion of groundwater samples analyzed for gross alpha and beta, radium-226, and radium-228 in samples collected during the quarterly groundwater monitoring event during the period of investigation. Section 4.4.9.3 discusses potential relationships between radionuclides in soils and groundwater.

4.1.8.1 Beta-emitting Radionuclides

Gross beta was detected among the samples collected in the representative monitoring well network during the quarterly monitoring program over the course of the remedial investigation at a mean activity of 7.7 pCi/l; the minimum detected activity in this group of samples was below the MDA of 2 pCi/l and the maximum detected activity was 20.6 pCi/l. As discussed in this section, potassium-40 is the dominant beta-emitting radionuclide in most samples containing above-representative gross beta activities.

Speciation Results from March 1994. EMF RI Table 4.4-20 presents a series of comparisons related to beta particle-emitting radionuclides detected in samples collected from 12 wells in March 1994. It lists the activity of potassium-40 that would be expected given the total potassium concentration detected in the sample. This activity was calculated using the naturally-occurring ratio of potassium-40 to total potassium (0.0118%), as noted in the table. It also lists the gross beta activity that would be expected if the detected beta-emitting radionuclides (potassium-40, radium-228, and radium-226) were the only beta-emitting radionuclides in the sample. This was calculated to evaluate the accuracy of the gross beta and radionuclide-specific analyses. The gross beta activity was calculated using the established beta-emission specific activities of potassium-40, radium-226 and radium-228 as noted in the table.

These comparisons show that the detected activities of beta-emitting radionuclides were consistent with the detected gross beta activities. Potassium-40 is the dominant beta-emitting radionuclide in these groundwater samples. Its detected activities are also consistent with those predicted from the activity attributable to the total potassium concentrations.

Radium-226 and -228 activities were predicted from the gross beta activity using the assumption that radium-226 and -228 were the only beta-emitting radionuclides present. While Ra-226 itself decays by alpha particle emission, two of its daughters (Pb-214 and Bi-214) decay by beta particle emission. Therefore, if Ra-226 is present in a sample and in equilibrium with its daughters, both alpha and beta activities should be detected in the sample. The predicted radium-226 and -228 activities, shown in Table 4.4-20, are substantially greater than the measured radium-226 and -228 activities in any sample. This reinforces the interpretation that potassium-40 is the principal beta-emitting radionuclide.

EMF RI Table 4.4-20
Comparison of Measured and Predicted Beta-emitting Radionuclides in Groundwater Samples Collected from 12 Wells in March 1994

	DETECTED CONSTITUENT LEVELS					PREDICTED CONSTITUENT LEVELS			
Well Number[1]	**Gross Beta[2]**	**Potassium-40[2]**	**Potassium[3]**	**Radium-228[2]**	**Radium-226[2]**	**Gross Beta[2,4]**	**Potassium-40[2,5]**	**Radium-228[7]**	**Radium-226[7]**
121	120 ±10.7	184 ± 82	169.6	4.7 ± 1	<MDA of 1	<175.1	142.1	75.5	41.0
123	27.3 ± 3.5	<MDA[6] of 110	29.0	<MDA of 1	2.1 ± 0.3	<106.2	24.3	17.2	9.3
136	64.9 ± 17.3	126 ± 81.2	NA[6]	8.4 ± 1	1.4 ± 0.6	130.2	ND[6]	40.8	22.2
146	40.5 ± 2.4	<MDA of 110	NA	1.7 ± 0.8	<MDA of 1	<104.1	ND	25.5	13.8
150	1,110 ± 22.9	1,310 ± 143	1,295	<MDA of 1	<MDA of 1	<1177	1,085	698	379
152	849 ± 20.3	1,190 ± 133	1,188	4.5 ± 0.8	<MDA of 1	<1,073	995	534	290
306	60.3 ± 6.7	<MDA of 110	NA	<MDA of 1	<MDA of 1	<103	ND	37.9	20.6
309	90.9 ± 7.7	<MDA of 110	NA	<MDA of 1	<MDA of 1	<103	ND	57.2	31.0
Batiste Spring	10.4 ± 1.2	<MDA of 110	13.8	1.3 ± 0.4	4.6 ± 0.4	<115.8	11.6	6.5	3.5
Lindley	12.7 ± 1.7	<MDA of 110	NA	4.2 ± 0.8	1.8 ± 0.6	<110.5	ND	8.0	4.3
New Pilot	4.4 ± 0.8	<MDA of 110	NA	<MDA of 1	NA	<103	ND	2.8	1.5
Old Pilot	85 ± 5.8	122 ± 61.5	NA	<MDA of 1	1.6 ± 0.2	<106.3	ND	53.5	29.0

1 Samples collected in March, 1994
2 Expressed in pCi/l
3 Total potassium, in mg/l
4 Gross beta activity attributable to detected Potassium-40, Ra-226, and Ra-228. Gross beta = (Potassium-40 x 0.895) + (Ra-228 x 1.59) + (Ra-226 x 2.93)(see Radiological Health Handbook, U.S. Department of Commerce, NTIS, 1970.)

[5] K-40 activity predicted from total potassium concentration in groundwater sample, based on following relationship (see Radiological Health Handbook, US Dept. Commerce, NTIS, 1970):
Specific activity Potassium-40 = 3.578 E5 Ci-yrs/g; Potassium-40 half-life = 1.26 E9 yrs; Atomic mass Potassium-40 = 40 amu;
Potassium (mg/l) = Potassium-40 (mg/l)/0.000118
Potassium-40 (pCi/l) = Potassium-40 (mg/l) x (1g/1000 mg) x 7.1E6 pCi/g.

[6] NA = not analyzed ND = insufficient data to calculate MDA = minimum detectable activity

[7] Ra-228 and -226 activities each attributable to detected gross beta, assuming that Ra-228 or Ra-226 was the only beta-emitting radionuclide, where Ra-228 = beta / 1.59, and
Ra-226 = gross beta / 2.93. (ibid.)

Site-wide Distribution. These relationships can also be used to evaluate the site-wide distribution of gross beta and its association with site-related constituents in surface and subsurface soils and potential sources. EMF RI Figure 4.4-25 displays isopleths of mean gross beta activity in groundwater within the study area. These data were obtained from analysis of samples collected during the quarterly groundwater sampling events during the remedial investigation.

Examination of EMF RI Figure 4.4-25 shows that there were five areas in which gross beta activities exceeded the representative level: (1) wells 150 and 152 in the southwestern area of FMC; (2) Well 122 in the central FMC area; (3) Well 142 in the joint fenceline area; (4) Well 136 in the joint fenceline area; and (5) Well 318 in the eastern Simplot area.

EMF RI Table 4.4-21 presents the observed mean total potassium concentrations and gross beta activities for these wells, along with the gross beta activities predicted from the observed mean total potassium concentrations and radium-226 and -228 activities. The observed gross beta activities are consistent with the gross beta activities attributable to potassium-40 in each well, except wells 318 and 304. Comparison of Figure 4.4-25 with Figure 4.4-5, which displays isopleths of mean total potassium concentrations in groundwater within the study area, shows a similar pattern of elevated potassium levels in the shallow aquifer.

EMF RI Table 4.4-21
Comparisons of Beta-emitting Radionuclides and Potassium in Seven Onsite Wells

	DETECTED MEAN CONSTITUENT LEVELS				PREDICTED	
Well	**Potassium[1]**	**Gross Beta[3]**	**Radium-228[3]**	**Radium-226**	**Potassium-40[2]**	**Gross Beta[4]**
150	1294	778	<MDA of 1	<MDA of 1	1084	<977
152	1087	544	<1.7	<MDA of 1	910	<823
122	231	132.6	1.6	<1.4	194	<180
136	122	<45.3	<1.5	1.4 ± 0.6	102	<100
142	18.2	<17.9	<1.0	<1.4	15	≤20.7

1 Mean concentration in samples collected between 6/92 and 7/93, in mg/l
2 Mean activity (in pCi/l) predicted from observed total potassium concentration
3 Where gross beta, radium-228 and radium-226 were not detected, mean was calculated using minimum detectable activities. Gross beta MDA = 2 pCi/l; Ra-228 and Ra-226 MDA each = 1 pCi/l)

[4] Mean activity predicted from observed total potassium, radium-228, and radium-226 where gross beta = (K-40 x 0.895) + (Ra-228 x 1.59) + (Ra-226 x 2.93)

Radium-226. Eighty nine percent of the samples collected during the period of investigation did not contain radium-226 above the MDA (typically 1 pCi/l). The MCL for radium-226 (20 pCi/l) was not exceeded in any sample. Rather, radium-226 was detected sporadically in groundwater monitoring samples, including those collected from the representative monitoring well network. The results of radium-226 analyses in samples collected during the quarterly sampling events during the investigation were presented earlier in EMF RI Tables 4.4-2, 4.4-5, 4.4-12, 4.4-14, and 4.4-17. EMF RI Table 4.4-22 summarizes the frequency of radium-226 detection in samples collected from representative wells and wells within the geographic subareas of the EMF site study area (described in Sections 4.4.4 through 4.4.8). It also presents the highest mean radium-226 activity within each group of wells, as well as the maximum single detected activity and the average activity among those samples with detectable levels of radium-226.

EMF RI Table 4.4-22
Frequency and Range of Detection of Radium-226 in Quarterly Monitoring Events

Well Group	Samples Below the Minimum Detectable Activity		Highest Mean Activity in a Well (pCi/l)	Maximum and Average of Detected Activities (pCi/l)	
Representative	67 of 76	90%	<2.6	6.4	3.5
FMC	115 of 139	83%	<2.6 (<2.3)	7.1 (3.8)	2.2
Joint Fenceline	57 of 66	86%	<1.9	3.8	2.1
Northern Properties	55 of 58	95%	<2.1	5.4	2.9
North of I-86	33 of 34	97%	<1	1.1	1.1

The frequency with which radium-226 was reported to be below the MDA was similar among the groups of wells. The lowest frequency (83%) occurred in FMC-area wells The maximum detected activity in any sample was 7.1 pCi/l in Well 128; this result is biased high, however, because the gross alpha activity in this sample was below the MDA (2 pCi/l). The gross alpha activity in a sample containing radium-226 at 7.1 pCi/l would be expected to be approximately 28 pCi/l. The following three quarterly samples collected from Well 128 contained radium-226 activities at 1.01 and 1.40 pCi/l, and <MDA. The next highest single radium-226 activity within the FMC group of wells was 3.83 pCi/l in Well 109, which is within the range of radium-226 in representative wells (maximum activity of 6.4 pCi/l). The next highest mean radium-226 activity among wells within the FMC area was <2.6 pCi/l for Well 148.

Radium-226 is not a site-related constituent. With the exception of the single biased-high result for Well 128, it was always found within the range of activities observed in representative wells.

Additionally, the mean activities within study area wells are comparable to, or less than, the mean activities in representative network wells. This finding, as well as the sporadic and random detections of radium-226, indicate that an attempt to display radium-226 activities as isopleths would not be meaningful.

Radium 228. Seventy nine percent of the samples collected during the period of investigation did not contain radium-228 above the MDA (typically 1 pCi/l). The MCL for radium-228 (20 pCi/l) was not exceeded in any sample. Like radium-226, radium-228 was detected sporadically in groundwater monitoring samples, including those collected from the representative monitoring well network. The results of radium-228 analyses in samples collected during the quarterly sampling events during the investigation were presented earlier in EMF RI Tables 4.4-2, 4.4-5, 4.4-12, 4.4-14, and 4.4-17. EMF RI Table 4.4-23 summarizes the frequency of radium-228 detection in samples collected from representative wells and wells within the geographic subareas of the EMF site study area. It also presents the highest mean radium-228 activity within each group of wells, as well as the maximum single detected activity and the average activity among those samples with detectable levels of radium-228.

EMF RI Table 4.4-23
Frequency and Range of Detection of Radium-228 in Quarterly Monitoring Events

Well Group	Samples below the Minimum Detectable Activity		Highest Mean Activity (pCi/l)	Maximum and Average of Detected Activities (pCi/l)	
Representative	57 of 76	75%	<3.2	10.8	3.9
FMC	114 of 139	82%	<3.4	10.7	4.1
Joint Fenceline	51 of 66	77%	<4.4	13.8	4.4
Northern Properties	46 of 58	79%	<3.6	8.3	3.6
North of I-86	26 of 34	76%	<3.3	9.0	4.7

The frequency with which radium-228 was reported to be below the MDA was similar among the groups of wells. The lowest frequency (75%) occurred in representative network wells and the highest (82%) among FMC area wells. The maximum detected activity in any sample was 13.8 pCi/l in Well 304, slightly above the maximum detected activity (10.8 pCi/l) among representative network samples. Further discussion of radiological constituents in samples from Well 304 is presented in Section 4.1.8.3, where it is concluded that acidic seepage from the gypstack has dissolved native uranium and thorium from volcanic rocks within the saturated zone.

Radium-228 does not appear to be a site-related constituent. With the exception of Well 304, it was detected within the range of activities observed in representative wells. This finding, as well

as the sporadic and random detections of radium-228, indicate that an attempt to display radium-228 activities as isopleths would not be meaningful.

Summary of Beta-emitting Radionuclides. The detected gross beta activities in the shallow aquifer attributable to releases from EMF sources are related to potassium-40, which is a naturally-occurring isotope of potassium. Potassium-40 activities can be ascertained from the concentration of total potassium, which is a site-related constituent. Radium-228 is not a site-related constituent; its activities were in the range of samples collected from reference wells, with the exception of Well 304. The presence of radium-228 in Well 304 is likely attributable to dissolution of native volcanic rocks. Radium-226 activities did not exceed the average activity of samples collected from representative wells, which the exception of a biased-high result from Well 128. Radium-226 is not a site-related constituent in groundwater.

4.1.8.2 Alpha-emitting Radionuclides

Gross alpha activity was measured in groundwater samples collected during the quarterly monitoring events during the investigation. Gross alpha was detected in samples collected from the representative well network at an average activity of 3.5 pCi/l. The maximum activity detected in these representative samples was 8.0 pCi/l and the minimum was below the MDA of 2 pCi/l. Uranium-238 and uranium-234 were the dominant alpha-emitting radionuclides in samples with gross alpha activities above representative levels. The mean activity of radium-226, another alpha-emitting radionuclide, did not exceed the average activity observed in representative groundwater.

Speciation Results from March 1994. EMF RI Table 4.4-24 presents the activities of alpha particle-emitting radionuclides detected in groundwater samples collected in March 1994. It also lists the activities of gross alpha, uranium-238, uranium-234, and radium-226 that would be predicted in these samples if each of these radionuclides were the only alpha-emitting radionuclide present in the sample. These were calculated to evaluate the accuracy of the gross alpha and radionuclide-specific analyses. The gross alpha activity was calculated using the established alpha-emission specific activities of uranium-238 and -234 and radium-226, as noted in the table.

As listed in EMF RI Table 4.4-24, gross alpha was elevated above representative levels in Well 306 (28.3 ± 5.0 pCi/l), Well 309 (77.5 ± 8.3 pCi/l), and the Lindley well (12.9 ± 1.8 pCi/l). In wells 306 and 309, uranium-238 (11.2 ± 1.6 and 7.2 ± 1.1 pCi/l, respectively) and uranium-234 (29.4 ± 3.6 and 20.7 ± 2.6 pCi/l, respectively) appear to account for this gross alpha activity. Radium-226 was below the MDA of 1 pCi/l in samples from each well. In the Lindley well, the detected gross alpha activity is related to uranium-238 (3.7 ± 0.7 pCi/l), uranium-234 (7.5 ± 1.1 pCi/l), and radium-226 (1.8 ± 0.6 pCi/l).

The detected activities of radium-226 in Well 123 (2.1 ± 0.3 pCi/l), Well 136 (1.4 ± 0.6 pCi/l), and the Old Pilot House Well (1.6 ± 0.2 pCi/l) are not consistent with the reported gross alpha activities for each well (below MDA of 2 pCi/l). One pCi/l of radium-226 would correlate to a

gross alpha activity of 4 pCi/l. This suggests that either the detected radium-226 activities are biased high or that the gross alpha activities are biased low. Despite these inconsistencies, these detected radium-226 activities are each below the average activity of radium-226 (2.6 pCi/l) in samples collected from the representative well network. Hence, further evaluation of these results is not considered to be necessary.

EMF RI Table 4.4-24
Comparison of Measured and Predicted Alpha-emitting Radionuclides in Groundwater Samples collected from 12 Wells in March 1994

	DETECTED ACTIVITIES (pCi/l)				PREDICTED ACTIVITIES (pCi/l)			
Well Number[1]	**Gross Alpha[2]**	**Uranium-238[2]**	**Uranium-234[2]**	**Radium-226[2]**	**Gross Alpha[2,4]**	**Uranium-238[5]**	**Uranium-234[5]**	**Radium-226[5]**
121	<MDA of 2	<MDA of 500	ND[3]	<MDA of 1	<MDA of 500	<2	<2	<0.5
123	<MDA of 2	<MDA of 500	ND	2.1 ± 0.3	<MDA of 500	<2	<2	<0.5
136	<MDA of 2	<MDA of 500	ND	1.4 ± 0.6	<MDA of 500	<2	<2	<0.5
146	<MDA of 2	<MDA of 500	ND	<MDA of 1	<MDA of 500	<2	<2	<0.5
150	<MDA of 2	<MDA of 500	ND	<MDA of 1	<MDA of 500	<2	<2	<0.5
152	<MDA of 2	1.6 ± 0.4	<MDA of 1	<MDA of 1	<6.6 ± 0.4	<2	<2	<0.5
306	28.3 ± 5.0	11.2 ± 1.6	29.4 ± 3.6	<MDA of 1	<44.6 ± 5.2	14.2	14.2	7.1 ± 1.3
309	77.5 ± 8.3	7.2 ± 1.1	20.7 ± 2.6	<MDA of 1	<31.9 ± 3.7	38.8	38.8	19.4 ± 2.1
Batiste Spring	<MDA of 2	1.1 ± 0.4	1.5 ± 0.5	4.6 ± 0.4	21 ± 2.5	<2	<2	<0.5
Lindley	12.9 ± 1.8	3.7 ± 0.7	7.5 ± 1.1	1.8 ± 0.6	18.4 ± 4.2	6.5	6.5	3.2
New Pilot	3.1 ± 0.7	<MDA of 1	2.0 ± 0.5	NA	<7 ± 0.5	1.6	1.6	0.8
Old Pilot	<MDA of 2	<MDA of 1	<MDA of 1	1.6 ± 0.2	<8.4 ± 0.8	<2	<2	<0.5

[1] Samples collected in March, 1994
[2] Expressed in pCi/l
[3] Not detected in gamma spec analysis
[4] Gross alpha activity attributable to detected alpha-emitting radionuclides. Gross alpha = (uranium-238 x 1) + (uranium-234 x 1) + (radium-226 x 4), in pCi/l (see Radiological Health handbook, US Dept. Commerce, NTIS, 1970)
[5] Activity predicted assuming that detected gross alpha activity was attributable to these radionuclides. Due to secular equilibrium and similar chemical properties,
uranium-238 and uranium-234 were assumed to be present at equal activities. (Ibid.)

The detected gross alpha activity (below the MDA of 2 pCi/l) in the sample collected at Batiste Spring is less than the activity that would be expected (18.4 ± 1.6 pCi/l) given the reported activity of radium-226 (4.6 ± 0.4 pCi/l) in this sample. The detected activities of uranium-238 (1.1 ± 0.4 pCi/l) and uranium-234 (1.5 ± 0.5 pCi/l) in this sample are consistent with the reported gross alpha activity. This suggests that the reported radium-226 activity in this sample is biased high. The detected gross alpha activity in Well 309 (77.5 ± 8.3 pCi/l) is greater than the activity that would be expected (i.e., <31.9 ± 3.7 pCi/l) given the detected activities of uranium-238 (7.2 ± 1.1 pCi/l), uranium-234 (20.7 ± 2.6 pCi/l), and radium-226 (below MDA of 1 pCi/l) in this sample. This indicates that either the detected gross alpha activity is biased high; one or more of the radionuclide-specific activities are biased low; or that an additional alpha-emitting radionuclide was present.

With the exceptions noted for wells 123, 136, and 309, Batiste Spring and the Old Pilot House Well, the detected gross alpha activities are consistent with the detected activities of the naturally-occurring alpha-emitting radionuclides uranium-238, uranium-234, and radium-226.

Site-wide Distribution. Isopleths of mean gross alpha activities in the shallow aquifer are shown in EMF RI Figure 4.4-26. Four areas of elevated activity can be seen: (1) the Lindley well, where the mean activity was 10.3 pCi/l; (2) Well 318, where the mean activity was 1166 pCi/l; (3) Well 142, where the mean activity was ≤24.8 pCi/l; and (4) wells 306, 313, and 325, where the mean activity was 43.6, 14.8, and 10.0 pCi/l, respectively. The mean gross alpha activity (192 pCi/l) was also elevated in samples collected from Well 304. Isopleths in EMF RI Figure 4.4-26 were not extended south to Well 304 because this Bannock Range well is screened in an area where the shallow and deeper aquifers are not differentiated. EMF RI Table 4.4-25 presents the gross alpha activities and detected alpha-emitting radionuclides in samples collected from these wells.

Lindley Well. Radium-226 was not detected in samples collected from the Lindley well during this period (MDA of 1 pCi/l). Both uranium-238 and uranium-234 were detected in the March 1994 sample from this well. Thus it is likely that the gross alpha activity in the Lindley well (10.3 pCi/l) was attributable to uranium-238 and uranium-234, each possibly present at a mean activity of 5.2 pCi/l. However, the Lindley well was not downgradient from potential source areas within the FMC or Simplot facilities during the period of investigation. Thus the presence of elevated gross alpha activity in this well is not believed to be associated with releases to groundwater from these sources.

Well 318. The mean gross alpha activity for Well 318 in samples collected in 1992 and the first half of 1993 (1166 pCi/l) is greater than the predicted gross alpha activity (<4 pCi/l) attributable to radium-226, which was the only alpha-emitting radionuclide analyzed in samples from this well during this period. This indicates that one or more additional alpha-emitting radionuclides were present in these samples. The evaluation of gross beta activities in samples collected from this well (see Section 4.4.9.1) suggested that thorium-234 and protactinium-234, both short-lived beta-emitting radionuclides derived from decay of uranium-238, were present in these samples, and that uranium-238 had been released to groundwater through acidic dissolution from the

potential source material. The excess gross alpha activity detected in these samples is likely attributable to uranium-238 and uranium-234.

However, levels of site-related constituents declined significantly in Well 318 following closure of the former east overflow pond at Simplot in August 1993. The mean gross alpha activity detected at Well 318 during this latter period was ≤9.8 pCi/l. Radium-226 was not detected in these samples, at an MDA of 1 pCi/l. The alpha activity in these samples might be attributable to uranium-238 and uranium-234, each potentially present at a mean activity of 5 pCi/l.

Wells 306, 313, and 142 Association with Volcanic Lithology. The mean gross alpha activity (43.6 pCi/l) in Well 306 exceeded the representative level. Radium-226 was not detected above the MDA of 1 pCi/l in samples collected from this well. Uranium-238 (11.2 ± 1.6 pCi/l) and uranium-234 (28.4 ± 3.6 pCi/l) were detected in the March 1994 sample from Well 306. It is likely that the observed gross alpha activity in other samples collected from this well is attributable to uranium-238 and uranium-234.

The mean gross alpha activity of samples collected from Well 313 (14.8 pCi/l) and the absence of radium-226 (less than MDA of 1 pCi/l) suggest that uranium-238 and uranium-234 also accounted for the detected gross alpha activity. The potential mean activities of uranium-238 and uranium-234 that would correspond to the detected mean gross alpha activity in the well are 7.4 pCi/l and 7.4 pCi/l, respectively.

Radium-226 in Well 142 was detected at a mean activity of less than 1.4 pCi/l, which is less than the activity of radium-226 (≤6.2 pCi/l) that would be necessary to account for the mean gross alpha activity detected in this well (≤24.8 pCi/l) if radium-226 were the only alpha-emitting radionuclide. Samples from Well 142 were not analyzed for other alpha-emitting radionuclides. The gross alpha activity in Well 142 is likely attributable to uranium-238 and uranium-234, with each potentially present at a mean activity of ≤12.4 pCi/l, comparable with the activities detected at Well 306.

The presence of uranium isotopes in samples from wells 306, 313, and 142 are related to the lithology of the screened interval of these wells, rather than to seepage from the gypstack. Well 306 is screened in a welded tuff of the Starlight Formation. Well 313 is screened in a sandy gravel stratum of the Sunbeam Formation; these gravels contain volcanic tuff granules derived from the underlying Starlight Formation. Well 142 is a deep well screened in the Sunbeam Formation; the screened interval is placed in sediments derived from rhyolitic volcanic rocks of the Starlight Formation. (See Appendix B of Part II for geologic drilling log for wells and borings). Gamma logging was performed in these and other well borings (Appendix D of Part II of the EMF RI Report which is not reproduced herein). Gamma logging in boreholes measures gamma radiation emitted from the decay of radionuclides in the uranium-238 series and potassium-40, which are naturally present in igneous rocks and fine-grained (shale and clay) sediments. Relatively high gamma counts may indicate clays, acidic to intermediate igneous rocks, or deposits derived from these igneous rocks, and any micaceous or orthoclase-rich material.

EMF RI Table 4.4-25
Radionuclides Detected or Predicted in Groundwater with Elevated Gross Alpha Activities

	DETECTED MEAN ACTIVITIES (pCi/l)				PREDICTED ACTIVITIES[2] (pCi/l)			
Well	**Gross Alpha**	**Uranium-238**	**Uranium-234**	**Radium-226**	**Gross Alpha**	**Uranium-238**	**Uranium-234**	**Radium-226**
Lindley	10.3	3.7 ± 0.7[1]	7.5 ± 1.1[1]	<MDA of 1	15.2 ± 1.8	5.2	5.2	2.6
142	≤24.8	NA[3]	NA	<1.4	≥5.6	≤12.4	≤12.4	≤6.2
304	192	NA	NA	<1.2	≥4.7	96	96	48
306	43.6	11.2 ± 1.6[1]	29.4 ± 3.6[1]	<MDA of 1	<44.6 ± 5.2	21.8	21.8	10.9
313	14.8	NA	NA	<MDA of 1	≥4	7.4	7.4	3.7
325	10.0	NA	NA	<1.2	≥4.8	5	5	2.5
318	1166	NA	NA	<MDA of 1	≥4	583	583	291
318 (12/93 - 12/94)	≤9.8	NA	NA	<MDA of 1	≥4	≤5	≤5	≤2.5

1 Lindley and 306 sampled for U-238 and U-233/234 in March 1994

2 Activities predicted from mean gross alpha activities assuming that (U-238 + U-234) or Ra-226 were the only alpha-emitting radionuclides present, using: gross alpha/2 = U-238; gross alpha/2 = U-234; gross alpha/4 = Ra-226

3 NA - not analyzed

Intervals of comparatively high and constant gamma counts (approximately 200 cps, as described in Appendix D of the EMF RI Report) correlate very closely with rhyolite or hard rhyolitic welded tuff of the Starlight Formation in wells 142, 144, and 313. An underlying deposit of softer volcanic ash in Well 142 also correlates with an interval of constant, but lower, gamma counts (approximately 100 cps). Strata of the Sunbeam Formation containing gravels and sands derived from the volcanic rocks of the Starlight Formation also show a high gamma count in wells 300, 301, 305, 306, 307, 308, 309, and 313 (approximately 100 to 200 cps). In contrast, the non-volcanic, quartzitic Michaud Gravel typically has a low uniform gamma signature (Wells 107, 109, 319, 321, and most of the 500-series wells) of approximately 50 to 100 cps.

These relationships suggest that the gross alpha activities detected in wells 306, 313, and 142 are associated with naturally-occurring radionuclides in the Starlight and Sunbeam Formations.

Further Associations with Volcanic Lithologies. The association of elevated gross alpha activities observed in samples from wells 142, 306, and 313 with volcanic lithologies in the saturated zone is further supported by examination of data for well pairs 315/316, 309/310, and 143/144. EMF RI Table 4.4-26 presents the mean gross alpha activities for these latter wells and a description of the lithology of their screened intervals. Gross alpha activities in the deeper wells ranged between 13.1 to 20.6 pCi/l, whereas gross alpha activities in the shallower wells ranged between 4.2 to 9.7 pCi/l. Uranium-238 (7.2 ± 1.1 pCi/l) and uranium-234 (20.7 ± 2.6 pCi/l) were detected in the March 1994 sample collected from Well 309. These wells are either screened within the volcanic rocks of the Starlight Formation (rhyolite, tuff, or basalt) or in gravels of the Sunbeam Formation composed of 50 to 90% of volcanic rock fragments derived from the Starlight Formation.

Representative wells in the Bannock Range are not screened in the Starlight Formation. Nor are these wells screened in strata that contain volcanic rock fragments in proportions as high as those encountered in the previously-listed wells. The screened interval of representative Well 106 encountered the highest reported proportion (30%) of volcanic lithologies among the representative wells in the Bannock Range. Consequently, the gross alpha activity detected in samples collected from the representative well network may understate the natural activity of alpha-emitting radionuclides in groundwater.

EMF RI Table 4.4-26
Relationship Between Lithology and Gross Alpha Activity in Seven Wells

Well Pairs	Screened Interval[1]	Lithology[2]	Gross Alpha (pCi/l)
315 (deep)	120-140	gravel containing andesite, basalt , and pumiceous tuff granules	20.6
316 (shallow)	82-87	gravel containing 80% andesitic granules	9.7
309 (deep)	148-168	gravel containing up to 70% andesitic granules	19.2
310 (shallow)	82-87	gravel containing up to 90% andesitic granules and weathered tuff	6.5
144 (deep)	189-219	weathered rhyolite and rhyolite	13.1
143 (shallow)	112.2-116.4	gravel containing rhyolite and andesite	4.2

[1] In feet below ground surface. See Appendix B, attachment B-6 (100-series wells) and B-7 (300-series wells) of Part II for further information on well construction.
[2] See Appendix B for detailed well boring logs.

Well 304. The mean gross alpha activity in Well 304 (192 pCi/l) exceeded the representative level. Radium-226 was detected at a mean activity of <1.2 pCi/l, which is less than the activity (48 pCi/l) necessary to account for the observed mean gross alpha activity if radium-226 were the only alpha-emitting radionuclide present in these groundwater samples. The observed gross alpha activity could have been attributable to uranium-238 and uranium-234, if each had been present at a mean activity of 96 pCi/l.

The screened interval of Well 304 (between 275.5 and 290.2 feet below ground surface) encompasses weathered basalt of the Starlight Formation and a sandy gravel of the Sunbeam Formation containing basalt and tuff fragments. The screened interval encountered a greater proportion of mafic volcanic rocks compared with other wells screened in volcanic lithologies, such as wells 306 and 315. The gamma activity in the screened interval of Well 304 (approximately 60 to 100 cps) is less than the gamma activity recorded in well borings containing a greater proportion of acidic to intermediate rocks. Mafic rocks, such as basalt, generally contain a lower proportion of radionuclides in the uranium-238 and thorium-232 decay

series, compared with acidic to intermediate rocks, such as rhyolite and andesite. Consequently, the lower gamma activity in the Well 304 boring is consistent with the observed higher proportion of basalt in the screened interval of Well 304, compared with other wells screened in volcanic lithologies.

The mean gross alpha activity in Well 304 was, however, approximately 4 and 9 times greater than that detected in wells 306 and 315, respectively. The mean concentrations of the site-related constituents sulfate (737 mg/l) and total phosphorus (11.5 mg/l) were also elevated in samples from Well 304, suggesting that the elevated gross alpha activity may be related to seepage from the gypstack. However, other geochemical data indicate that the gross alpha activity in samples from this well might not be directly related to migration of alpha-emitting radionuclides from the gypstack. The mean arsenic concentration in Well 304 was 1% of the concentration expected if arsenic were a non-attenuated constituent. It was suggested that this lower-than-expected arsenic concentration might be associated with the lower permeability region of the Bannock Range in which Well 304 is screened. The longer residence time of groundwater within this lower permeability region might have reduced arsenic concentrations through a rate-limited attenuation mechanism. It is also possible that a relatively longer residence time could increase the gross alpha activity of groundwater. The reduced pH seepage from the gypstack, if given a longer contact period with igneous rocks, would dissolve more alpha-emitting radionuclides from these rocks, compared with potential reactions in higher permeability regions. Thus the elevated gross alpha activity might reflect an indirect site-related effect—dissolution from native materials—rather than a direct site-related effect—migration of alpha-emitting radionuclides.

Well 325. The mean gross alpha activities in Well 325 (10.0 pCi/l) exceeded the representative level. Radium-226 was detected at a mean activity of <1.2 pCi/l, which is less than the mean activity (2.5 pCi/l) needed to account for the observed gross alpha activity. It is likely that the gross alpha activity was attributable to uranium-238 and uranium-234, each at a mean activity of 5 pCi/l.

Well 325 is screened in sand and gravel containing predominantly quartzite, and the elevation of gross alpha above the representative level appears to be site-related. It is possible, however, that groundwater containing naturally elevated gross alpha was introduced into this well due to the positive vertical gradient from the lower aquifer observed in this area. Given the relationship previously noted in the shallow/deep well pairs, gross alpha activity in groundwater from this lower aquifer should be higher than the activity in the shallow zone within which Well 325 is screened.

Summary of Alpha-emitting Radionuclides. With several exceptions, the elevated gross alpha activities do not appear to be associated with releases from EMF sources. Rather, they are attributable to natural radioactive constituents in volcanic rocks of the Starlight Formation and sediments of the Sunbeam Formation containing materials derived from the Starlight Formation. Representative wells are not screened in volcanic rocks of the Starlight Formation, nor in strata containing a high proportion of detrital material derived from this formation. Consequently, the average and maximum gross alpha activity (3.5 and 8 pCi/l, respectively) in samples collected

from the representative well network are likely less than the naturally-occurring gross alpha activity in wells that are more closely associated with the Starlight Formation, such as wells 142, 143/144, 306, 309/310, 313, and 315/316. Based on these observations, the natural gross alpha activity in wells screened within the volcanic rocks of the Starlight Formation and in gravels of the Sunbeam Formation derived from the Starlight Formation ranges between approximately 13 to 20 pCi/l.

The elevated gross alpha activity in samples from Wells 304 may also have been attributable to uranium isotopes, because radium-226 was not detected at a sufficient activity in these wells to account for the observed gross alpha activity. Well 304 is downgradient from the gypstack at Simplot. It is more likely, however, that the gross alpha activity in Well 304 is related to the dissolution of uranium from rocks and gravels in the saturated zone due to a longer residence time of acidic seepage within this lower permeability region, rather than to migration of uranium isotopes from the gypstack.

The above-representative gross alpha activity in Well 325 may be related to upward migration of naturally-elevated groundwater from the lower aquifer. The cause of elevated mean gross alpha activity at the Lindley well is unknown but is not associated with groundwater releases from EMF potential source areas.

4.1.8.3 Relationship with Surface Soils

As reported in Section 4.2 of the EMF RI Report, soil samples were collected within the industrial operations area of the EMF facilities beneath potential sources of groundwater impact (e.g., former unlined ponds, material stockpiles, areas containing waste materials used as fill). Evaluation of these data indicated that exceedences of the representative levels of gross alpha and gross beta were confined to the fill materials and certain source materials within former ponds. As described in Section 4.2 of the EMF RI Report, there was no evidence of radionuclide migration into native soils from unlined sources that lacked a current or previous sustained hydraulic head.

Unlined sources within the industrial operations area that had a current or previous sustained hydraulic head were found to have affected groundwater. As reported in Section 4.1.8.1, gross beta activities in groundwater above representative levels was predominantly attributable to the release of potassium-40 from these sources in all but one case. In samples collected from Well 318 prior to closure of the east overflow pond, the activity of gross beta above representative level may have been attributable to thorium-234 and protactinium-234. As reported in Section 4.1.8.2, gross alpha activities in groundwater were found to be attributable to either naturally-occurring uranium-238 and uranium-234 derived from volcanic rocks, or to the release of these constituents from the former east overflow pond before its closure.

To assess the relationship between radionuclides in groundwater and soil samples that had been collected outside of the industrial operations areas of the facilities, the distribution of gross alpha and gross beta activities in groundwater were compared with the activities of alpha- and beta-

emitting radionuclides in surface soils. This was done to evaluate whether radionuclides deposited onto these soils through fallout from air emissions had leached to groundwater.

As discussed in Section 4.3 of the EMF RI Report, surface soils were found to have been affected by fallout of wind blown dusts from ore handling operations. This effect was identified to have occurred predominantly within the area between the northern fenceline of the industrial operations area and Interstate 86. The distribution of uranium-238 in surface soils was primarily attributable to these fugitive dust emissions. In addition, an overprinting of lead-210 and polonium-210 on surface soils above activities attributable to secular equilibrium with their parent, uranium-238, was noted both within this area and along several radials within a mile beyond the Interstate.

As discussed in Sections 4.1.8.1 and 4.1.8.2, lead-210 and polonium-210 were not detected in samples analyzed from 12 wells that routinely contained elevated gross alpha or beta activities. Rather, the activities of gross alpha and gross beta in all but a few wells were found to be attributable to uranium-234 and uranium-238 (alpha) and potassium-40 (beta). It was speculated, however, that uranium isotopes and beta-emitting radionuclides such as protactinium-234 in the uranium-238 decay series might have been present in groundwater samples collected from Well 318 prior to closure of the former east overflow pond at Simplot. Gross alpha and beta activities in this well have nearly returned to their representative levels since closure of this pond. Consequently, there is no relationship between lead-210 and polonium-210 in surface soils and groundwater.

The distribution of uranium-234 and uranium-238 in groundwater (as reflected by the distribution of gross alpha activities) is attributable to their natural presence in volcanic rocks of the Starlight Formation and sediments derived from this formation, releases from the gypstack, or past releases from the former east overflow pond. This can be further illustrated by examination of EMF RI Figure 4.4-27, which displays uranium-238 activities in surface soils and gross alpha activities in groundwater. If gross alpha activities in groundwater were related to uranium-238 activities in surface soils, one would expect to observe a correlation between the spatial distributions of uranium-238 in soils and gross alpha in groundwater.

EMF RI Figure 4.4-27 shows there to be no spatial correlation between uranium-238 activities in surface soils and gross alpha activities in groundwater. Several observations can be made by examination of this figure. First, uranium-238 is elevated above its reference level (3.88 pCi/g) in several surface soil samples collected on the east side of the Portneuf River. However, gross alpha activities in this area (as reflected in samples from Well 509) were not above the representative level. Second, uranium-238 activities are elevated (ranging from greater than 14 to 3.9 pCi/g) in surface soils collected in the area between the northern fenceline of the Simplot operations area and the Portneuf River to the north and east of the operations area. Gross alpha activities in wells within this area were below representative levels. Third, uranium-238 was elevated (ranging from greater than 14 to less than 7 pCi/g) in soil samples collected along the northern side of Interstate 86. Gross alpha activities in ground water samples collected within this area did not exceed the average activity in representative wells.

In summary, the distributions of lead-210, polonium-210, and uranium-238 in surface soils show no relationship with the distribution of alpha- and beta-emitting radionuclides in groundwater.

4.2 Results of the Post-RI Groundwater Studies and Routine Monitoring

This section describes the results of the FMC groundwater studies and routine monitoring performed subsequent to the EMF RI groundwater investigation. Section 4.2.1 presents the results of the numerous special groundwater studies and Section 4.2.2 presents the results of the routine (on-going) groundwater monitoring performed by FMC.

4.2.1 Results and Findings of Groundwater Studies

This section presents the results of the special groundwater studies in the same order as described in Section 3.2.1 above. In the following sections, the groundwater analytical results from these post-EMF RI groundwater studies are compared to groundwater representative (background) concentrations to assess whether those results indicate that an individual well is or is not impacted by releases to groundwater from the EMF facilities. For the post-RI special groundwater monitoring events, the results are also compared to regulatory or risk-based thresholds ("comparative values') particularly for those parameters for which no representative concentration was calculated during the EMF RI. Table 4.2-1 presents the representative concentrations and comparative values for all of the parameters discussed in the following sections.

4.2.1.1 Additional Wells Installed after the EMF RI

As described in Section 3.2.1.1 above, FMC installed additional wells at the FMC Plant OU during 1995, 1997 and 1998 primarily due to the EPA RCRA program evaluations regarding the adequacy of FMC's RCRA groundwater monitoring well networks for specific RCRA regulated units. The discussion of the new RCRA wells in this section focuses on evaluation of the groundwater chemistry and hydrogeology at the EPA-directed new wells compared to existing and/or proposed FMC wells for the regulated units.

<u>1995 RCRA Wells</u>

Additional and/or replacement wells were installed for the monitoring well networks for Pond 8S, Pond 15S and the Phase IV ponds / Pond 8E that share a common well network. An evaluation of the new wells compared to the preexisting well network that focuses on groundwater chemistry and whether the new wells led to different conclusions as to groundwater impacts at these areas is discussed below for each of these units.

<u>Pond 8S</u>

Three new downgradient wells (155, 156 and 157) were installed at Pond 8S due to EPA's comments that existing downgradient well 150 was "unlikely to encounter any release from the

regulated unit" because the well was located "too far to the east." In addition, EPA commented that due to the close proximity of downgradient wells 120 and 152, those wells were monitoring essentially the same flow path.

Time series graphs for the Pond 8S pre-1995 and post-1995 well network for the groundwater impact indicator parameters potassium, chloride, sulfate and arsenic are presented on Figures 4.2-2A through D. As shown on the graphs, the potassium, chloride, sulfate and arsenic concentrations measured at the new wells 155, 156 and 157 were within the same range as existing wells 150 and 152 and clearly indicate groundwater impact from the formerly unlined Pond 8S. For example, potassium in wells 150, 152, 156 and 157 were all greater than 1,000 mg/l (over 80 times the representative potassium concentration) at the time the new wells were installed. Existing well 120, located farther east on wells 150 and 152, is located on the fringe of the Pond 8S impact with concentrations of potassium, chloride, sulfate and arsenic near representative concentrations. Clearly, EPA's assertion that well 150 was unlikely to encounter a release from Pond 8S and that wells 152 and 120 were monitoring the same flow path was not correct and is not consistent with the water level or water quality data from the then existing and new 1995 wells. Although the new wells 155 and 156 (well 157 is redundant to well 152) did and will continue to provide appropriate downgradient coverage of Pond 8S, the new wells did not yield any new information regarding the pre-1995 conclusion that Pond 8S was a significant source of impacts to groundwater. Groundwater monitoring results for Pond 8S are discussed in greater detail in Sections 4.2.2 and 5 below.

Pond 15S

One new upgradient well (165) and one new downgradient well (166) were installed at Pond 15S. Well 165 was installed to replace well 101 as an upgradient well due to EPA's evaluation that "this wel1 is located more than 700 feet up-gradient from the unit. This distance from the unit precludes isolating the changes in water chemistry produced by interaction with the regulated unit." Well 166 was installed to replace well 114 due to EPA's comment that well 114 is too far east to monitor Pond 15S although EPA did state that well 114 appeared to be suitable to monitor the Phase IV ponds.

Time series graphs for the Pond 15S pre-1995 and post-1995 well network for the groundwater impact indicator parameters potassium, chloride, sulfate, arsenic and fluoride are presented on Figures 4.2-3A through D. At EPA's direction, new upgradient well 165 was installed as close as practical to Pond 15S and was located at the southern edge of a historic unlined phossy pond 5E ("old phossy pond 5E"). Chloride, sulfate and arsenic concentrations measured at the new upgradient well 165 were all slightly above representative levels. Sulfate and arsenic were approximately two-times their respective representative concentrations. The groundwater chemistry at well 165 shows that the well was installed within the area of previously identified groundwater impact from the old phossy ponds. By contrast, in addition to being 700 feet upgradient from Pond 15S, well 101 is not site-impacted as demonstrated by the potassium, chloride and sulfate concentrations below their respective representative concentrations. In summary, FMC agrees that well 165 is a more appropriate upgradient well for Pond 15S as well 165 accounts for pre-existing groundwater impacts upgradient from the monitored unit.

As expected based on data from existing wells within the area impacted by the old phossy ponds, potassium, sulfate and arsenic results from well 166 were approximately two-times their respective representative concentrations. Although potassium is higher in well 166, chloride, sulfate and arsenic concentrations in well 166 are essentially identical to those parameter concentrations in the new upgradient well 165. Although new well 166 did and continues to provide appropriate downgradient coverage of Pond 15S, the new well did not yield any new information regarding the known old phossy ponds groundwater impact nor did the data from the new well change the conclusion of the RCRA groundwater assessment for this unit. Groundwater monitoring results for Pond 15S are discussed in greater detail in Section 4.2.2 below.

Phase IV Ponds and Pond 8E

One new upgradient well (167) and one new downgradient well (168) were installed at the Phase IV ponds / Pond 8E. Well 167 was installed to replace upgradient wells 130 and 137 due to EPA's evaluation that wells 130 and 137 are "too far west." Well 168 was installed to replace well 114 because it is "too far west," well 131 that EPA's evaluation concluded was screened too deep (EPA suggested the well should have been screed in a clayey gravel horizon approximately 50 feet higher), and well 132 that EPA's evaluation concluded was "redundant to well 104" and an "excessive distance" from the unit. EPA originally requested two new wells to replace the three existing wells, but during EPA's field observation of the replacement wells agreed that there was no physically feasible location for the second replacement well that would be superior to the locations of existing wells 114 and 131 in conjunction with the new well 168.

Time series graphs for the Phase IV pond and Pond 8E pre-1995 and post-1995 well network for the groundwater impact indicator parameters potassium, chloride, sulfate, arsenic and fluoride are presented on Figures 4.2-4A through D. Existing wells 130 and 137 were previously identified as impacted by the old phossy ponds as evidenced by sulfate and arsenic above their respective representative concentrations. New well 167 was also installed within the old phossy pond impacted area as evidenced by sulfate and arsenic concentrations above the representative concentrations, although not as high as existing well 137. Although new well 167 may be a more appropriate upgradient well for the Phase IV ponds and Pond 8E, the new well did not yield any new information regarding the known old phossy ponds groundwater impact nor did the data from the new well change the conclusion of the RCRA groundwater assessment for this unit.

As expected based on data from existing wells within the area impacted by the old phossy ponds, potassium, sulfate and arsenic results from well 168 were higher than the representative concentrations. Initially, potassium in well 168 was about 33 times higher than the representative potassium concentration. The initial highly elevated potassium concentration were comparable to downgradient well 104; however, within the first four quarters of monitoring, the potassium levels dropped to about 25 mg/l (2-times representative levels) that was comparable to downgradient wells 114, 131 and 132. The high initial potassium concentrations at well 168 may have come from the bentonite seal and/or grout seal leaching into the sand pack during well completion and/or well development. Although new well 168 did and

will continue to provide appropriate downgradient coverage of the Phase IV ponds and Pond 8E, the new well did not yield any new information regarding the known old phossy ponds groundwater impact nor did the data from the new well change the conclusion of the RCRA groundwater assessment for this unit. Groundwater monitoring results for the Phase IV ponds and Pond 8E are discussed in greater detail in Section 4.2.2 below.

1997 RCRA Wells

As described in Section 3.2 above, five new wells were installed at Pond 17 prior to commencement of its operation due to the following EPA objections to FMC's proposed monitoring well network:

- Replace upgradient Well 169 because it is in the Bannock hydrochemical regime and Pond 17 is in an area where the Bannock and Michaud hydrogeochemistries coverge.

- Replace downgradient well 171 because it is screened too deep to properly monitor the uppermost aquifer.

- Replace downgradient well 170 because it is screened in the bedrock (rhyolite) instead of overlying silty gravel and sandy silt.

FMC installed new upgradient well 179 on the west side and adjacent to Pond 17 to replace well 169. Well 179 is screened from 49 to 59 feet bgs in the fine-grained (silt and clayey silt) saturated zone and the screen straddles the water table. Pump testing of well 179 showed that this well will not sustain a yield of 1 gpm. The well 179 monitoring results show the well is within the Michaud hydrogeochemical regime and is within the range of representative concentrations for potassium, chloride, sulfate and arsenic. Time series graphs for the Pond 17 well network for the groundwater impact indicator parameters potassium, chloride, sulfate, arsenic and fluoride are presented on Figures 4.2-5A through D. The well 179 potassium concentrations have slightly exceeded the potassium representative concentration and chloride concentrations are typically 1.4-times the representative level; however, this is probably due to the well being screened in the saturated silt/clayey silt horizon rather than the underlying gravel aquifer horizon encountered at 72 feet bgs at well 173. Well 173 is essentially collocated with well 179 as described in the next subsection "1998 wells").

FMC installed new downgradient well 181 on the east side of Pond 17 to replace well 171. This location was as far north and west as practical from well 171 due to obstruction from the Chevron pipeline easement and Pond 17 access road. Well 181 is screened from 50 to 60 feet bgs in the fine-grained (silt and clayey silt) saturated zone and the screen straddles the water table. Pump testing of well 181 showed that this well will not sustain a yield of 1 gpm. The potassium, chloride and arsenic results from new well 181 were virtually identical to the replaced well 171 and exceeded representative concentrations in both wells. Sulfate was higher in well 181 than in well 171 by a factor of about 2.5.

FMC installed new downgradient well 180 on the east side of Pond 17 to replace well 170. Well 180 was located in close proximity to well 170 and is screened from 52 to 62 feet bgs in both the fine-grained (silt and clayey silt) saturated zone and the uppermost coarse-grained (sand and gravel) saturated zone. This well is screened near the water table (the top of screen is within 5 feet of the static water level). The potassium, chloride, sulfate and arsenic results from new well 180 were comparable to the replaced well 171. Potassium and arsenic exceeded representative concentrations in both wells and sulfate also exceeded the representative concentration at well 180.

FMC also installed new downgradient wells 172 and 182 on the east side of Pond 17 as a new pair of "middle" downgradient wells. Well 182 is screened from 48 to 58 feet bgs in the fine-grained (silt with gravel and clayey silt) saturated zoneand the screen straddles the water table. Well 172 is screened from 71 to 76 feet bgs in the uppermost coarse-grained (sand and gravel) saturated zone and the top of screen is approximately 22 feet below the water table. The potassium, chloride, sulfate and arsenic results from new wells 172 and 182 are comparable. Potassium and arsenic exceeded representative concentrations in both wells and sulfate also exceeded the representative concentration at well 172.

As described in FMC's September 23, 1997 letter to EPA (Appendix D), monitoring wells 179, 181 and 182 were installed at the locations and screened intervals as recommended in EPA's comments on the Pond 17 monitoring plan. However, as FMC had stated in the past, the fine-grained saturated zone does not yield a significant quantity of water as demonstrated at wells 179 and 181. The silt with gravel encountered at well 182 does yield more water (well 182 yielded greater than 1 gpm), however this more permeable horizon is not laterally extensive (was not encountered at well 179 or 181) and does not represent a zone that could be correlated to the other monitoring wells in the Pond 17 network. The installation of water table wells screened in the silt produced less than 1 gpm supporting FMC position that, although saturated, the silt is an aquitard and not the uppermost aquifer (that is, the saturated silt does not produce sufficient water to be a viable domestic water supply).

In addition, the new EPA recommended water table wells screened in the fine-grained saturated aquitard did not yield any information regarding the old unlined pond 7E ("old phossy pond" 7E) groundwater impact that was not also detected by the wells installed in the sand/gravel uppermost aquifer zone. That is, the preexisting groundwater impact in the area of old pond 7E was detected in all of the downgradient wells (170, 180, 171, 181, 172 and 182). Groundwater monitoring results for Pond 17 are discussed in greater detail in Section 4.2.2 below.

1998 RCRA Wells

As described in Section 3.2 above, seven new wells were installed at the FMC plant site. A summary of the groundwater chemistry and hydrogeology at the new 1998 wells compared to existing wells is summarized below.

Pond 8S - New upgradient well 183 was installed near existing upgradient well 158. Well 183 is screened from 100 to 115 feet bgs and the static water level is approximately 100 feet bgs. As

shown on Figures 4.2-2A through D, the new well 183 results for potassium, chloride and arsenic were comparable to concentrations observed at existing well 158. The potassium, chloride and arsenic concentrations in both wells are below their respective representative concentration. The well 183 sulfate concentrations are lower than well 158 by a factor of about 3. The sulfate concentration in well 183 is below the representative concentration, but well 158 sulfate concentrations are higher than the representative concentration. In summary, the new "water table" well did not provide new information regarding groundwater chemistry upgradient of Pond 8S.

Pond 17 - New upgradient well 173 was installed with a screened interval in the uppermost aquifer to replace existing well 179 that was screened in the saturated silt aquitard pursuant to EPA's recommendations on the Pond 17 groundwater monitoring well network in 1997. As shown on Figures 4.2-5A through D, the potassium, sulfate and arsenic concentrations are comparable at both wells 173 and 179. The higher chloride concentrations observed at well 179 may be related to the fine-grained silt and clayey silt horizon in which the well is screened.

Ponds 18 (Cells A and B) – New upgradient wells 174 and 175 and three new down gradient wells 176, 177, and 178 were installed at Pond 18 prior to operation of the unit. During the installation of the new wells at Pond 18, FMC followed EPA's suggested approach for installation of the new wells (i.e., observe open-hole and test yield in the saturated silt/silty clay at water table prior to well completion). During installation of the wells, FMC determined through observation of the cuttings (lithology) and lack of significant free water in the open-hole at and below the water table elevation that water table wells would not yield sufficient water. Therefore, the borings were advanced to the first laterally extensive coarse-grained (uppermost aquifer) zone at the new well locations. As there were no existing wells at this newly constructed unit at the westernmost extent of FMC's operational area, there is no data with which to compare these new wells. Groundwater monitoring results for Pond 18 are discussed in greater detail in Section 4.2.2 below.

2003 Joint Fenceline / Calciner Ponds Area Wells

During 2003, Simplot installed three new wells on FMC property as part of Simplot's implementation of the Remedial Design for Simplot's groundwater extraction remedy. New wells 189, 190 and 191 were installed in the joint fenceline area of the EMF Site. As shown on Figure 4.2-1, wells 189 and 190 are located downgradient from both the Simplot gypstack and the FMC calciner pond area. Well 191 is located downgradient from the gypstack and upgradient from the calciner pond area.

A comparison of the initial results from new wells 189, 190 and 191 to the concentration ranges predicted by the EMF RI groundwater investigation based on the pre-existing network of wells in the joint fenceline area is shown on Table 4.2-2. As shown on the table, the initial results for the new wells were very accurately predicted by the existing joint fenceline well network and interpretations presented in the EMF RI Report Section 4.4. The only exceptions were sulfate was slightly higher than predicted for well 189, chloride and fluoride were slightly higher than predicted for well 190, and chloride and selenium were higher than predicted for well 191. Note

that while the pH measured at well 190 and 191 was higher than the predicted range, the pH associated with joint fenceline sources (e.g., Simplot gypstack, old calciner ponds, etc.) is acidic (low pH) so that a higher pH indicates these wells were less impacted than predicted. Although these wells were installed for other purposes (i.e., Simplot's Remedial Design), these wells did not provide significantly new or different data relative to the EMF RI identified nature and extent of groundwater impacts in the joint fenceline area. Groundwater monitoring results for the Calciner Pond area and joint fenceline area are discussed in greater detail Sections 4.2.2 and 4.3 below.

4.2.1.2 Special Groundwater Sampling and Analysis Programs

As described above in Section 3.2.1.2, FMC conducted numerous special groundwater sampling and analysis programs since the EMF RI. The results from these special programs are presented in this section in the same order (chronologically) as in Section 3.2.1.2. For consistency with the EMF RI Report, the discussion for each of the special programs is organized by constituent group, as follows:

- Common ions;
- Physical parameters;
- Nutrients and fluoride;
- Metals;
- Radiological parameters (if included in the special program);
- Organic compounds (if included in the special program); and
- Other inorganic parameters not included in the EMF RI investigations (if included in the special program).

The FMC groundwater results for the special sampling and analysis events described below have all been validated and evaluated for usability. The data validation and usability evaluation for the May 2008 special event is provided in Appendix F. This report as an example of the FMC data validation and usability evaluations for each groundwater monitoring event performed at the FMC Plant OU including the special events and routine monitoring programs described in this section. Only the May 2008 data validation and usability evaluation is included due to document size considerations.

With few exceptions, the analytical parameter lists for these special programs included parameters that were analyzed during the EMF RI. Therefore, most of the results are discussed in the context of comparisons to EMF RI results for the same wells (or nearby wells) that were sampled and analyzed during the EMF RI. The results are also compared to representative

concentrations and/or comparative values, particularly for those parameters for which no representative concentration was calculated during the EMF RI. Table 4.2-1 presents the representative concentrations and comparative values for all of the parameters discussed below.

November 1997 and February 1998 RCRA Appendix IX Program

As described above in Section 3.2.1.2, four wells 108, 139, 143 and 156 were selected for sampling and analysis for the RCRA Appendix IX list. FMC selected and EPA agreed to these wells because the wells provide broad coverage of the site and to specifically evaluate wells previously identified as site-impacted by EMF source areas. The wells were selected based on the following rationale:

- Well 156 was selected to evaluate the identified and most highly impacted well immediately downgradient from Pond 8S. The former unlined Pond 8S was identified as a significant source of constituents to groundwater during the EMF PSCS and RI. The wells downgradient from Pond 8S had and continue to have the highest concentrations of the key FMC-impact indicator potassium, as well as other EMF-impact constituents including chloride, sulfate, total phosphorus / orthophosphate and arsenic.

- Well 139 was selected to evaluate the northern portion of the FMC western ponds (i.e., old phossy ponds) area impact.

- Well 108 was selected to evaluate identified impacts from the slag pit sump and impacts from the upgradient old phossy ponds (i.e., RU 22b) in the central plant area.

- Well 143 was selected to evaluate identified impacts in the joint-fenceline area.

The wells that were sampled and analyzed for the November 1997 and February 1998 Appendix IX parameter list are highlighted on Figure 4.2-6. The results for the November 1997 and February 1998 RCRA Appendix IX sampling and analysis program are presented on Table 4.2-3A. As footnoted on Table 4.2-3A, only the organic compounds that were detected are shown on the table, the full list of organic compounds that were analyzed is shown on Table 4.2-3B.

Common ions

Only wells 108 and 156 were analyzed for common ions, nutrients and fluoride during this event because common ions, nutrients and fluoride are not included on the RCRA Appendix IX list and wells 139 and 143 were not within FMC's routine groundwater monitoring programs at the time of this special program.

The potassium, chloride and sulfate concentrations at well 108 were lower than but comparable to EMF RI means of 180; 173; and 242 milligrams per liter (mg/l) respectively. The potassium, chloride and sulfate concentrations at well 156 were comparable to EMF RI means for well 150 (also immediately downgradient from Pond 8S) of 1,294; 409; and 253 mg/l respectively. As

described above, both wells 108 and 156 were identified as site-impacted, particularly as evidenced by the potassium concentrations over 10-times background at well 108 and 100-times background at well 156. The EMF RI calculated representative potassium concentration for the Michaud hydrogeochemical regime is 12.7 mg/l.

Physical parameters

The pH and specific conductance results for wells 108, 139, 143 and 156 were all in the range of the EMF RI. These wells all exhibit pH levels below background (7.3 to 7.7) and specific conductance above background (1,136 uS/cm) indicative of EMF-impacts.

Nutrients and fluoride

The nitrate, fluoride and orthophosphate concentrations at well 108 were lower than but comparable to EMF RI means of 12; 2.9; and 0.72 mg/l respectively. The nitrate and orthophosphate concentrations at well 156 were comparable to EMF RI means for well 150 (also immediately downgradient from Pond 8S) of 0.05 and 387mg/l respectively. The fluoride concentration at well 156 was significantly lower than the EMF RI means for well 150 of 8.6 mg/l. As described above, both wells 108 and 156 were identified as site-impacted. The orthophosphate (and EMF total phosphorus) concentrations at the wells immediately downgradient from Pond 8S (150, 152, 155, 156 and 157) were and continue to be the highest within the FMC Plant OU.

Metals

Antimony, beryllium, copper, lead, mercury, silver and tin were not detected in any of the four wells. The detection limits for antimony, mercury and silver were equal to or lower than the EMF RI groundwater representative concentrations and were below the groundwater comparative values (Table 4.2-1). The detection limits for copper and lead were slightly higher than the EMF RI groundwater representative concentrations but were below the groundwater comparative values. The detection limit for beryllium (0.005 mg/l) was slightly higher than both the EMF RI groundwater representative concentrations (0.002 mg/l for the Michaud regime and 0.004 mg/l for the Bannock regime) and the groundwater comparative value (0.004 mg/l). Because tin was not an EMF RI groundwater investigation parameter, a representative groundwater concentration was not calculated and is not available for comparison; however, the detection limit for tin was well below the comparative value of 22 mg/l.

Cadmium was detected only in the sample from well 143. The result for well 143 was slightly higher than the representative concentrations and the comparative value of 0.005 mg/l (Table 4.2-1). Chromium was detected only in the sample from well 156. The result for well 156 was above the representative concentration but below the comparative value. Cobalt was detected only in samples from wells 139 and 156. The results for both wells were higher than representative concentrations but were below the comparative value. Nickel was detected only in samples from wells 143 and 156. Those results for both wells were higher than the representative concentration but below the comparative value. Zinc was detected only in

samples from wells 108 and 143. The zinc results for both wells were below the representative concentrations and the comparative value.

Thallium was detected in wells 108, 139 and 156 and was not detected in well 143 (detection limit was 0.01 mg/l). The detected results and detection limit were higher than the Michaud representative concentration but below the Bannock representative concentration. The results for wells 108, 139 and 156 were higher than the comparative value of 0.002 mg/l (Table 4.2-1).

Barium and vanadium were detected in all four wells. All of the barium results were below both the representative concentrations and the comparative value. Only the vanadium result for well 143 was higher than the representative concentrations and all of the results were below the comparative value.

Consistent with the EMF RI findings, arsenic was detected at concentrations significantly higher than representative concentrations at wells 108, 143 and 156. These results are also higher than the comparative value. The result for well 139 (nondetect at a 0.012 mg/l detection limit) was below the representative concentration. Selenium was detected in all four wells. The results for wells 108 and 156 were below representative concentrations. The results for wells 139 and 143 were higher than the representative concentrations, but the result for well 139 was below the comparative value. The selenium result for well 143 was significantly higher (by a factor of approximately 5) than the comparative value.

Organic compounds

Total phenol was not detected in any of the wells. Only the organic compound N-Nitrosomorpholine was reported in one well (156) just above its detection limit at a concentration of 0.011 mg/l (detection limit equal 0.01 mg/l). No other organic compounds were reported as detected above their respective detection limits. The full list of organic compounds analyzed pursuant to the RCRA Appendix IX list is shown on Table 2.1-1B.

Other inorganic parameters

Total cyanide was detected in wells 108, 139 and 156, but was not detected in well 143. Because total cyanide was not an EMF RI groundwater investigation parameter, a representative groundwater concentration was not calculated and is not available for comparison. Therefore, the results were compared to the comparative value (Table 4.2-1) for total cyanide of 0.2 mg/l. The result for well 108 was approximately one-tenth the comparative value and the results for wells 139 and 156 were approximately one-half the comparative value, but none of the results exceeded the comparative value.

Acid-insoluble sulfide was detected slightly above the 0.5 mg/l detection limit at wells 108, 139 and 156; however, the significance of these results is not apparent. Because acid-insoluble sulfide was not an EMF RI groundwater investigation parameter, a representative groundwater concentration is not available for comparison and there does not appear to be a published comparative value for groundwater consumption.

January 1998 CERCLA / RCRA Special Program

As described above in Section 3.2.1.2, twenty-one wells and Batiste Spring and Swanson Road Spring (aka the Spring at Batiste Road) were selected for sampling and analysis for elemental phosphorus and an expanded list of general water quality parameters and metals. This sampling event was primarily prompted by the fact that EPA had just finalized updating SW-846 and the update included method 7580 for elemental phosphorus. Elemental phosphorus was not an EMF RI groundwater analytical parameter because no EPA method existed at the time of the EMF RI. EPA selected the wells to provide broad coverage of the site and to specifically evaluate wells previously identified as site-impacted by EMF source areas. The wells that were sampled and analyzed for the January 1998 expanded parameter list are highlighted on Figure 4.2-7. The results for the January 1998 special sampling and analysis program are presented on Table 4.2-4 and are described below.

Common ions

The common ion results including potassium, chloride and sulfate were comparable to concentrations measured during the EMF RI. Wells beyond the northern extent of EMF-impacted groundwater 112, 502 and TW-11S and up-gradient Pond 8S well 158 continued to show no site impact with common ion results below their respective representative concentrations. The remaining wells sampled during the January 1998 event are generally within the EMF RI defined area of groundwater impact as evidenced by potassium concentrations from 2 to over 100 times (well 156) the representative concentrations, chloride up to 2 times representative concentrations, and sulfate up to 9 times background (well 110). Common ion concentrations were below representative concentrations at Swanson Road Spring (aka the Spring at Batiste Road). Common ion concentrations at Batiste Spring were elevated compared to representative concentrations with potassium about 1.5 times and sulfate about 4 times their respective representative concentrations.

Physical parameters

The physical parameter results including pH and specific conductance were comparable to concentrations measured during the EMF RI. Wells beyond the northern extent of EMF-impacted groundwater 112, 502 and TW-11S and up-gradient Pond 8S well 158 continued to show no site impact. The remaining wells sampled during the January 1998 event are generally within the EMF RI defined area of groundwater impact as evidenced by decreased pH (less than about pH 7) and specific conductance greater than representative levels (Michaud representative level for specific conductance is 1,136 umhos/cm). The pH at Swanson Road Spring (aka the Spring at Batiste Road) was slightly lower than representative pH level. The pH at Batiste Spring was below 7 and the specific conductance was above the representative level.

Nutrients and fluoride

The nitrate, orthophosphate/total phosphorus and fluoride concentrations were comparable to concentrations measured during the EMF RI. Wells beyond the northern extent of EMF-

impacted groundwater 112, 502 and TW-11S and up-gradient Pond 8S well 158 continued to show no site impact with nutrient and fluoride results below their respective representative concentrations. The remaining wells sampled during the January 1998 event are generally within the EMF RI defined area of groundwater impact as evidenced by elevated nitrate concentrations up to 6 times (well 121) the representative concentrations, orthophosphate/total phosphorus concentrations up to 820 mg/l (well 156), and fluoride concentrations up to 9.4 mg/l (well 156). Nutrient and fluoride concentrations were below representative concentrations at Swanson Road Spring (aka the Spring at Batiste Road). Nitrate and orthophosophate/total phosphorus concentrations at Batiste Spring were elevated compared to representative concentrations with nitrate about 3 times the representative concentration and a total phosphorus concentration of 16 mg/l.

Metals

Overall, the metals results were comparable to the EMF RI. Aluminum and iron were not detected above their respective representative concentrations in any of the wells or springs. The detection limit for nickel during this sampling event (0.04 mg/l) and reported concentrations for numerous wells were higher than the representative concentration for nickel (0.02 mg/l); however, none of the results were higher than the comparative value of 0.1 mg/l.

Barium, boron, cobalt, lithium and manganese concentrations were below representative concentrations in the wells beyond the northern extent of EMF-impacted groundwater (112, 502 and TW-11S and up-gradient Pond 8S well 158). The remaining wells sampled during the January 1998 event are generally within the EMF RI defined area of groundwater impact as evidenced by barium, boron, cobalt, lithium and manganese detected at concentrations above representative levels. Manganese concentrations were also higher than the comparative value at wells 134, 141, 159, 123, 151, 155, 156, 157, 111 and TW-9S. Boron concentrations were higher than the comparative value at wells 159, 155, 156 and 157 (wells downgradient from Pond 8S). The barium, cobalt and lithium concentrations were below their respective comparative values in all of the wells.

Arsenic concentrations were below representative concentrations in the wells beyond the northern extent of EMF-impacted groundwater (112, 502 and TW-11S and up-gradient Pond 8S well 158). The remaining wells sampled during the January 1998 event are generally within the EMF RI defined area of groundwater impact. Arsenic was detected at concentrations significantly higher than representative concentrations and the comparative value in the wells within the EMF impacted area.

None of the metals concentrations for the Swanson Road Spring (aka the Spring at Batiste Road) sample were higher than the representative concentrations. Arsenic, manganese and lithium concentrations at Batiste Spring were higher than the comparative concentrations. Arsenic and manganese concentrations at Batiste Spring also exceeded the comparative values.

Other inorganic parameters

As described above, the primary purpose of the January 1998 special monitoring event was to analyze groundwater samples from wells and springs for elemental phosphorus. As shown on Table 4.2-4, elemental phosphorus was not detected above the detection limit of 0.00002 mg/l at Batiste Spring, Swanson Road Spring or any of the monitoring wells with the exception of well 108. The elemental phosphorus concentration reported for well 108 was 0.0013 mg/l. Because elemental phosphorus was not an EMF RI groundwater parameter, no representative concentration was calculated during the EMF RI. However, based on the fact that elemental phosphorus is not naturally occurring and the results from the non-site impacted wells (e.g., 112, 502 and TW-11S) were below the detection limit; the elemental phosphorus representative concentration should be considered to be essentially zero. The elemental phosphorus result for well 108 was higher than the comparative value (Table 4.2-1).

Well 108 is one of the three downgradient Slag Pit Sump RCRA groundwater monitoring wells. The Slag Pit Sump was previously identified as a source of groundwater impacts. In addition to its location downgradient from the Slag Pit Sump and the slag pit area, well 108 is downgradient from the furnace building and secondary condenser areas (FMC Plant OU Remediation Units 1 and 2). Well 108 is also located within the groundwater thermal plume defined during the EMF RI. The thermal plume originates from the slag pit area and was due to heating of the soil column all the way to groundwater from molten slag tapping over the life of the FMC facility until slag ladling was fully implemented in 2000. Based on documented releases to groundwater from the slag pit sump and phosphorus releases to the subsurface from the furnace building phosphorus product sumps, the detection of elemental phosphorus in well 108 was not entirely unexpected. A more detailed discussion of elemental phosphorus detected in well 108 and, subsequent to the January 1998 monitoring event, well 122 that is also downgradient from RUs 1 and 2 is provided in Section 4.3 below.

February, May and November 1998 RCRA Appendix III Program

As described above in Section 3.2.1.2, the Pond 17 and Pond 18 wells were sampled and analyzed for the RCRA Appendix III list of parameters prior to beginning operation of each of the units respectively. The wells that were sampled and analyzed for the RCRA Appendix III parameter list are shown on Figure 4.2-1. The results for the February, May and November 1998 RCRA Appendix III special sampling and analysis program are presented on Table 4.2-5A (Pond 17) and Table 4.2-5B (Pond 18) and are described below.

Common ions

The common ion results including potassium, chloride and sulfate for the Pond 17 upgradient well 179 were within representative levels. The potassium and sulfate concentrations at wells (170, 180, 171, 181, 172 and 182) were above representative concentrations for potassium (1.3 to 5 times the representative concentration) and sulfate (up to 4.5 times the representative concentration. As described above in Section 4.2.1.1 above, the common ion concentrations at these wells indicates an impact from former old pond 7E.

The common ion results for the Pond 18 wells were generally within the range of the representative concentrations. At wells 174, 176 and 177, the potassium and chloride concentrations were at the upper end or slightly exceeded the representative concentrations. These results for the Pond 18 wells were consistent with the fact that there were no previous FMC operations at or upgradient of the location of the then newly constructed Pond 18. Note that the area of Pond 18 and the area hydraulically upgradient and to the west of Pond 18 was used historically for agricultural purposes which may explain why the common ion results for some of these wells are at the upper range of the representative concentrations.

Physical parameters

The pH results for the Pond 17 wells were all within the representative range (greater than pH of 7). Specific conductance was slightly greater than the representative level in upgradient well 179 and downgradient well 180, 181 and 182. The measured specific conductance may be due to the influence of the fine grained (silt and clayey silt aquitard) horizon in which these wells were completed.

The ph and specific conductance for the Pond 18 wells were all within the range of representative wells. The specific conductance at wells 174, 175, 176 and 177 was at the upper end of the representative level may relate to historic agricultural use of this area and the area upgradient to the west of Pond 18.

Nutrients and fluoride

The results for nitrate and fluoride for the Pond 17 wells 179, 171, 172 and 181 were below their respective representative concentrations. Nitrate and orthophosphate concentrations were greater than the representative concentrations in downgradient wells 170, 180, 171, 181, 172 and 182. Fluoride concentrations in downgradient well 170 was also greater than the representative concentration.

The nitrate, orthophosphate and fluoride results for the Pond 18 wells were generally within the range of the representative concentrations. At wells 154 and 178, the fluoride concentrations were slightly higher than the representative concentration and may relate to the historic agricultural use of this area of the site.

Metals

Cadmium, mercury and silver were not detected in any of the Pond 17 wells above their respective representative levels or comparative values. Barium was detected in upgradient well 179 at a concentration slightly above the representative concentration but lower than the comparative value. Barium was not detected above the comparative concentration or the comparative value in any of the downgradient wells at Pond 17. Lead was detected in upgradient well 179 at a concentration higher than the representative level, and the detection limit for the remaining results is also higher than the Michaud representative concentration of 0.002 mg/l; however, the result for well 179 as well the other undetected results were below the comparative

value. Iron was detected in upgradient well 179 at concentrations higher than the representative level and the comparative value. Only the one iron result (May 1998) for downgradient well 171 was higher than the representative concentration and the CV, but the prior iron result (February 1998) for well 171 was undetected at a detection limit (0.1 mg/l) below the representative concentration and the CV.

Manganese concentrations in upgradient well 179 and downgradient well 181 were higher than the representative concentration and the comparative value. Selenium concentrations in upgradient well 179 and downgradient wells 180, 181 and 182 were higher than representative concentrations, but below comparative values.

Arsenic concentrations in upgradient well 179 were below the representative concentration. Consistent with the potassium and sulfate results indicative of an impact from old pond 7E, arsenic concentrations in all of the downgradient wells 170, 180, 171, 181, 172 and 182 were above the representative concentration and comparative value.

Arsenic, cadmium, chromium, iron, manganese, mercury and silver results for the Pond 18 wells were below their respective representative concentrations. The lead results were all undetected but at a detection limit (0.003 mg/l) slightly higher than the Michaud representative concentration of 0.002 mg/l; however, the detection limit was lower than the comparative value. The barium results for upgradient well 175 and downgradient wells 176 and 177 were slightly higher than the representative concentration but were below the comparative value. The selenium results for upgradient wells 174 and 175 and downgradient wells 176 and 177 were slightly higher than the Michaud representative concentration of 0.0057 mg/l, but were below the comparative value.

Radiological parameters

Gross alpha, radium-226 and radium-228 results for all of the Pond 17 and Pond 18 wells were within their respective ranges for representative groundwater (Table 4.2-1). Gross beta results for all of the Pond 18 wells and all but two of the Pond 17 wells were within the range for representative groundwater. The gross beta activities at Pond 17 downgradient wells 170 and one result (February 1998) from well 180. As described in the EMF RI Report, gross beta is attributable and correlates with potassium-40 in its naturally-occurring ratio with potassium. As described above, the potassium results for well 170 were the highest of the Pond 17 wells (about 5 times the potassium representative concentration) and the February 1998 result for well 180 (about 3 times the potassium representative concentration).

Organic compounds

The RCRA Appendix III analytical list includes Total Organic Carbon, Total Organic Halogen, Total Phenol and 6 specific organic compounds (organochlorine pesticides and herbicides). None of the specific organic compounds were detected above their respective detection limits in any of the Pond 17 and Pond 18 wells.

Total phenol was reported in one sample from Pond 17 upgradient well 179 and one sample each from downgradient wells 172 and 182. The highest reported total phenol result was 0.12 mg/l in well 182, the second sample from well 182 was undetected for total phenol at a detection limit of 0.02 mg/l. Total phenol was not detected in any of the Pond 18 wells.

The total organic halogen method for the RCRA Appendix III analytical program requires collection and analysis of quadruplicate samples (four separate containers per sample per well), the results on Tables 4.2-5A and B show only the unique results for each sample and well (i.e., if all four samples were reported as undetected at the 0.03 mg/l detection limit, <0.03 appears only once in the table). The total organic halogen (TOX) results for the Pond 17 wells reported low level detections in samples from upgradient well 179 for all four containers and for both sampling rounds. The TOX results for well 179 ranged from 0.042 to 0.204 mg/l compared to the detection limit of 0.03 mg/l. Low concentrations (0.033 to 1.02 mg/l) of TOX were also reported in one or more quadruplicate sample per event at the Pond 17 downgradient wells 170, 180, 171 (May 1998 samples only), 181, 172 and 182. Low concentrations (0.0426 to 0.439 mg/l) of TOX were also reported in one or more quadruplicate sample per event at Pond 18 upgradient well 174 and downgradient wells 176 and 177.

The total organic carbon method for the RCRA Appendix III analytical program requires collection and analysis of duplicate samples (two separate containers per sample per well), the results on Tables 4.2-5A and B show only the unique results for each sample and well (i.e., if both samples were reported as undetected at the 1 mg/l detection limit, <1 appears only once in the table). Total organic carbon was reported slightly above the detection limit of 1 mg/l in one sample container from one sampling event from Pond 17 downgradient wells 181 (2 mg/l) and 182 (1 mg/l), but was undetected in the other sample container and analysis associated with each of these wells. Total organic carbon was reported slightly above the detection limit of 1 mg/l in one sample container from one sampling event from Pond 18 upgradient wells 174 at 2 mg/l, but was undetected in the other sample container and analysis associated with this well. The remainder of the results for the Pond 17 and Pond 18 well were undetected.

August 2000 RCRA Special Program

As described above in Section 3.2.1.2, twenty wells within the FMC RCRA monitoring well network were selected for sampling and analysis for an expanded parameters list in addition to the routine RCRA analytical program. EPA selected the wells for the expanded parameter list. The wells that were sampled and analyzed for the August 2000 expanded parameter list are highlighted on Figure 4.2-8. The results for this August 2000 RCRA special program are presented on Table 4.2-6.

Common ions

The common ion results including potassium, chloride and sulfate were comparable to concentrations measured during the EMF RI. Wells outside or near the northern fringe of EMF-impacted groundwater 126, 147 and 176; up-gradient Pond 8S well 183; and up-gradient Pond 18 well 175 continued to show no site impact with common ion results below their respective

representative concentrations. The remaining wells sampled during the August 2000 event are generally within the EMF RI defined area of groundwater impact as evidenced by potassium concentrations from 2 to 100 times (well 157) the representative concentrations, chloride up to 2 times representative concentrations, and sulfate up to 10 times background (well 168).

Physical parameters

The physical parameter results including pH and specific conductance were comparable to concentrations measured during the EMF RI. Wells outside or near the northern fringe of EMF-impacted groundwater 126, 147 and 176; up-gradient Pond 8S well 183; and up-gradient Pond 18 well 175 continued to show no site impact. The remaining wells sampled during the August 2000 event are generally within the EMF RI defined area of groundwater impact as evidenced by decreased pH (less than about pH 7) and specific conductance greater than representative levels (Michaud representative level for specific conductance is 1,136 umhos/cm).

Nutrients and fluoride

The nitrate, orthophosphate/total phosphorus and fluoride concentrations were comparable to concentrations measured during the EMF RI. Wells outside or near the northern fringe of EMF-impacted groundwater 126, 147 and 176; up-gradient Pond 8S well 183; and up-gradient Pond 18 well 175 continued to show no site impact with nutrient and fluoride results below their respective representative concentrations. The remaining wells sampled during the August 2000 event are generally within the EMF RI defined area of groundwater impact as evidenced by elevated nitrate concentrations up to 5 times (well 122) the representative concentrations, orthophosphate/total phosphorus concentrations up to 240 mg/l (well 157), and fluoride concentrations up to 9.5 mg/l (well 131).

Metals

Overall, the metals results were comparable to the EMF RI. Aluminum was not detected above the representative concentrations in any of the wells except for the total aluminum result of 6.33 mg/l for well 131. As shown on Table 4.2-6, the high turbidity from silts and clays in groundwater samples from well 131 (82 Nephelometric Turbidity Units [NTU]) is likely the cause of the high reported total aluminum. This conclusion is supported by the dissolved aluminum result (undetected at 0.0391 mg/l detection limit) for well 131 during this sampling event.

Cadmium, copper, lead, mercury and silver were undetected in all or essentially all of the wells. In a few samples, cadmium (well 147) copper (wells 104, 131 [total copper result only] and 176) and lead (well 131 [total lead result only] were reported as quantitated at concentrations below their respective detection limits. The detection limits for copper and lead were slightly higher than the EMF RI groundwater representative concentrations but were below the groundwater comparative values. The detection limits for cadmium, mercury and silver were equal to or lower than the EMF RI groundwater representative concentrations and were below the

groundwater comparative values (Table 4.2-1). The zinc results and detection limit were below both representative concentrations and the comparative value for all the wells.

The chromium results were all below the representative concentration with the exception of the result for well 157 (0.0118 mg/l) that was slightly higher than the representative concentration, but was below the comparative value of 0.1 mg/l. Molybdenum concentrations were higher than representative concentrations in wells 104, 115, 148, 155 and 157 (0.046 mg/l, the highest result) and below the representative concentrations in the other 16 wells. None of the molybdenum results were higher than the comparative value of 0.18 mg/l. The detection limit for nickel during this sampling event (0.04 mg/l) was higher than the representative concentration for nickel (0.02 mg/l). The detection limit and the highest reported result for nickel (0.0451 mg/l at well 155) were lower than the comparative value of 0.1 mg/l.

Antimony was not detected in any of the wells; however, the detection limit of 0.01 mg/l does not allow a comparison to the comparative value of 0.006 mg/l (Table 4.2-1). Thallium was reported as quantitated below the detection limit at wells 123 and 147 and was undetected in the other wells; however, the detection limit of 0.01 mg/l does not allow a comparison to the comparative value of 0.002 mg/l.

Barium, boron, cobalt, lithium and manganese concentrations were within the range of their respective representative concentrations in the wells outside or near the northern fringe of EMF-impacted groundwater 126, 147 and 176; up-gradient Pond 8S well 183; and up-gradient Pond 18 well 175. The remaining wells sampled during the January 1998 event are generally within the EMF RI defined area of groundwater impact as evidenced by barium, boron, cobalt, lithium and manganese detected at concentrations above representative levels. Manganese and boron concentrations were also higher than their respective comparative value at wells 104, 115, 131, 155, 157 and 168. The barium, cobalt and lithium concentrations were below their respective comparative values in all of the wells. Only the vanadium result from well 123 (0.178 mg/l) was higher than the representative concentration and that result was also higher than the comparative value.

Arsenic and selenium concentrations were within the range of their respective representative concentrations in the wells outside or near the northern fringe of EMF-impacted groundwater 126, 147 and 176; up-gradient Pond 8S well 183; and up-gradient Pond 18 well 175. The remaining wells sampled during the January 1998 event are generally within the EMF RI defined area of groundwater impact. Arsenic was detected at concentrations significantly higher than the representative concentrations and the comparative value in the wells within the EMF impacted area with the exception of wells 127, 148 and 149 that were below the representative concentration. Consistent with the EMF RI findings, selenium is elevated in wells in much smaller areas within the larger arsenic-impacted groundwater area. Only the selenium results for wells 123 (joint fenceline area), 127, 165 and 168 were higher than the representative concentrations, and only the result for well 123 (0.204 mg/l) was higher than the comparative value.

Radiological parameters

The gross alpha results were generally with the range for representative groundwater; however, the result for well 104 was reported above the upper representative range and numerous samples were reported undetected at a MDA higher than the upper representative range. The reported result for well 104 was below the comparative value. Gross beta results for 13 of the 20 wells were within the range for representative groundwater. The gross beta activities at wells 104, 113, 122, 123, 155, 157 and 168 were higher than the upper representative range. As described in the EMF RI Report, gross beta is attributable and correlates with potassium-40 in its naturally-occurring ratio with potassium. The potassium results for wells 104, 113, 122, 123, 155, 157 and 168 ranged from 1.4 times the representative concentration at well 168 (gross beta result = 21.7 pCi/l) to 100 times the representative concentration at well 157 (gross beta result = 960 pCi/l).

The radium-226 and radium-228 results for all of the wells were within their respective ranges for representative groundwater and below the comparative value (Table 4.2-1).

The Cesium-137 results were below the MDA for all of the wells. FMC did not understand or agree with EPA's direction to analyze for Cesium-137 in groundwater the FMC facility. Cesium-137 is a man-made radioisotope formed mainly by nuclear fission. There is no reason to suspect the presence of Cesium-137 at the EMF Site other than possibly "general" fallout and deposition on soils within the entire southeast Idaho region from the Nevada Test Site.

Other inorganic parameters

The total cyanide results for wells 128, 147, 149, 171, 175, 176 and 183 were undetected at a detection limit of 0.01 mg/l. Total cyanide was detected in the other wells ranging from 0.012 (well 113) to 0.34 mg/l (well 168). Because total cyanide was not an EMF RI groundwater investigation parameter, a representative groundwater concentration was not calculated and is not available for comparison. Therefore, the results were compared to the comparative value (Table 4.2-1) for total cyanide of 0.2 mg/l. The result for wells 113, 122, 123, 126, 127, 148, 157and 165 were less than one-half the comparative value (0.1 mg/l). The results for wells 104, 115 and 155 were between 0.1 and 0.2 mg/l and the results for wells 131 and 168 were greater than the 0.2 mg/l comparative value.

November 2001 CERCLA / RCRA Special Program

As described above in Section 3.2.1.2, thirty-four wells and Batiste Spring within the FMC CERCLA and RCRA monitoring well networks were selected for sampling and analysis for an expanded parameters list in addition to the routine CERCLA and RCRA analytical programs. EPA selected the wells for the expanded parameter list. The wells that were sampled and analyzed for the November 2001 expanded parameter list are highlighted on Figure 4.2-9. The results for this November 2001 CERCLA and RCRA special program are presented on Table 4.2-7.

Common ions

The common ion results including potassium, chloride and sulfate were comparable to concentrations measured during the EMF RI. Wells outside or near the northern fringe of EMF-impacted groundwater 126, 147, 148, 176, 523, 515, 502, TW-11S, 524 and 525; and up-gradient Pond 8S well 183; and up-gradient Pond 18 well 175 continued to show no site impact with common ion results below their respective representative concentrations. The remaining wells sampled during the November 2001 event are generally within the EMF RI defined area of groundwater impact as evidenced by potassium concentrations from 2 to 75 times (well 157) the representative concentrations, chloride up to 2 times representative concentrations, and sulfate up to 9 times background (well 168). Common ion concentrations at Batiste Spring were within their respective representative concentrations.

Physical parameters

The physical parameter results including pH and specific conductance were comparable to concentrations measured during the EMF RI. Wells outside or near the northern fringe of EMF-impacted groundwater 126, 147, 148, 176, 523, 515, 502, TW-11S, 524 and 525; up-gradient Pond 8S well 183; and up-gradient Pond 18 well 175 continued to show no site impact. The remaining wells sampled during the November 2001 event are generally within the EMF RI defined area of groundwater impact as evidenced by decreased pH (less than about pH 7) and specific conductance greater than representative levels (Michaud representative level for specific conductance is 1,136 umhos/cm). Physical parameter results for Batiste Spring were within the representative ranges.

Nutrients and fluoride

The nitrate, orthophosphate/total phosphorus and fluoride concentrations were comparable to concentrations measured during the EMF RI. Wells outside or near the northern fringe of EMF-impacted groundwater 126, 147, 148, 176, 523, 515, 502, TW-11S, 524 and 525; up-gradient Pond 8S well 183; and up-gradient Pond 18 well 175 continued to show no site impact with nutrient and fluoride results below their respective representative concentrations. The remaining wells sampled during the November 2001 event are generally within the EMF RI defined area of groundwater impact as evidenced by elevated nitrate concentrations up to 6 times (well 122) the representative concentrations, orthophosphate/total phosphorus concentrations up to 290 mg/l (well 157), and fluoride concentrations up to 4.7 mg/l (wells 157 and 168). Ammonia, nitrate and fluoride results for Batiste Spring were below their representative concentration. The total Phosphorus result for Batiste Spring was 1.9 mg/l and was higher than the representative concentration.

Metals

Overall, the metals results were comparable to the EMF RI. The aluminum results were not higher than the representative concentrations in any of the wells and Batiste Spring, except for the total aluminum result of 0.899 mg/l for well 131. As shown on Table 4.2-7, the high

turbidity from silts and clays in groundwater samples from well 131 (30 Nephelometric Turbidity Units [NTU]) is likely the cause of the high reported total aluminum.

Cadmium, lead, mercury and silver were undetected in all or essentially all of the wells and at Batiste Spring. In a few samples, cadmium (wells TW-12S, TW-9S, 131 and 524) and mercury (wells 104, 122, 149, 165, 168 and 502) were reported at concentrations slightly above or quantitated below their respective detection limits. The detection limits for copper and lead were slightly higher than the EMF RI groundwater representative concentrations but were below the groundwater comparative values. The detection limits for cadmium, mercury and silver were equal to or lower than the EMF RI groundwater representative concentrations and were below the groundwater comparative values (Table 4.2-1). All of the barium results were below the representative concentrations except the result from well 176 of 0.244 mg/l that was slightly higher than the representative concentration of 0.2297 mg/l. The barium result from well 176 was well below the comparative value. The zinc results and detection limit were below both representative concentrations and the comparative value for all the wells and at Batiste Spring.

The chromium results were all below the representative concentration and below the comparative value of 0.1 mg/l. The molybdenum results for wells 155 and 157 and the undetected limits for some of the wells were higher than the representative concentrations, but none of the molybdenum results were higher than the comparative value of 0.18 mg/l. The detection limit for nickel during this sampling event (0.04 mg/l) was higher than the representative concentration for nickel (0.02 mg/l). The detection limit and the highest reported result for nickel (0.0367 mg/l at well 155) were lower than the comparative value of 0.1 mg/l.

Antimony was detected in wells TW-12S and 142, but the results were below the representative concentration and the comparative value of 0.006 mg/l (Table 4.2-1). Antimony was not detected in the samples from wells 154, 171 and 178 and the undetected values were below the representative concentration and comparative value. Antimony was reported undetected in all of the other samples; however, the detection limit of 0.01 mg/l does not allow a comparison to the comparative value. Thallium was not detected in any of the samples; however, the detection limits ranged from 0.0052 to 0.01 mg/l and does not allow a comparison to the comparative value of 0.002 mg/l.

Boron, cobalt, lithium and manganese concentrations were within the range of their respective representative concentrations in the wells outside or near the northern fringe of EMF-impacted groundwater 126, 147, 148, 176, 523, 515, 502, TW-11S, 524 and 525; and up-gradient Pond 8S well 183; and up-gradient Pond 18 well 175 continued to show no site impact. The lithium results for wells 147 and 148 of 0.0614 and 0.062 mg/l respectively were slightly higher than the representative concentration of 0.061, but were well below the comparative value. The cobalt results were undetected at a detection limit that was higher than the representative concentration, but lower than the comparative value. The remaining wells sampled during the January 1998 event are generally within the EMF RI defined area of groundwater impact as evidenced by boron, cobalt, lithium and manganese detected at concentrations above representative levels. Manganese and boron concentrations were also higher than their respective comparative value at wells 104, 115, 131, 155, 157 and 168. The barium, cobalt and lithium

concentrations were below their respective comparative values in all of the wells and at Batiste Spring. Only the vanadium result from well 123 (0.181 mg/l) was higher than the representative concentration and the result was also higher than the comparative value.

The arsenic and selenium results were within the range of their respective representative concentrations in the wells outside or near the northern fringe of EMF-impacted groundwater 126, 147, 148, 176, 523, 515, 502, TW-11S, 524 and 525; and up-gradient Pond 18 well 175 continued to show no site impact. The arsenic result for Pond 8S upgradient well 183 of 0.0181 mg/l was slightly higher than the Bannock representative concentration of 0.017 mg/l, but the selenium result was below the representative concentration. The remaining wells sampled during the November 2001 event are generally within the EMF RI defined area of groundwater impact. Arsenic was detected at concentrations significantly higher than the representative concentrations and the comparative value in the wells within the EMF impacted area with the exception of wells 126, 154 and 178 that were below the representative concentration. Consistent with the EMF RI findings, selenium is elevated in wells in much smaller areas within the larger arsenic-impacted groundwater area. The only selenium results detected above the representative concentrations were at wells 110 and 123 (joint fenceline area), and only the result for well 123 (0.196 mg/l) was higher than the comparative value.

The arsenic and selenium results for Batiste Spring were 0.0063 mg/l and undetected at 0.005 mg/l detection limit respectively. Both results were below the representative concentrations and the comparative value.

Radiological parameters

Only the samples from Batiste Spring and wells TW-11S, TW-9S, 110, 115, 122, 123, 131, 155, 157, 183, 523, 524 and 525 were analyzed for radiological analyses. The gross alpha results were generally with the range for representative groundwater; however, the result for well 157 was reported above the upper representative range and the comparative value. The gross beta results for Batiste Spring and 7 of the 13 wells analyzed for radiological parameters were within the range for representative groundwater (Table 4.2-1). The gross beta activities at wells TW-9S, 110, 122, 123, 155 and 157 were higher than the upper representative range. As described in the EMF RI Report, gross beta is attributable to and correlates with potassium-40 in its naturally-occurring ratio with potassium. The potassium results for wells TW-9S, 110, 122, 123, 155 and 157 ranged from 1.9 times the representative concentration at well 123 (gross beta result = 23.1 pCi/l) to 70 times the representative concentration at well 157 (gross beta result = 836 pCi/l).

The radium-226 and radium-228 results for all of the wells and Batiste Spring were within their respective ranges for representative groundwater and below the comparative value (Table 4.2-1).

The Cesium-137 results were below the MDA for all of the wells. As previously stated, FMC did not understand or agree with EPA's direction to analyze for Cesium-137 in groundwater the FMC facility. Cesium-137 is a man-made radioisotope formed mainly by nuclear fission. There is no reason to suspect the presence of Cesium-137 at the EMF Site other than possibly "general"

fallout and deposition on soils within the entire southeast Idaho region from the Nevada Test Site.

Other inorganic parameters

The total cyanide results for Batiste Spring and wells TW-12S, 147, 149, 154, 176 and 183 were undetected at a detection limit of 0.01 mg/l. Total cyanide was detected in the other wells ranging from 0.01 (wells 171, 172 and 175 [Pond 18 upgradient well]) to 0.43 mg/l (well 131). Because total cyanide was not an EMF RI groundwater investigation parameter, a representative groundwater concentration was not calculated and is not available for comparison. Therefore, the results were compared to the comparative value (Table 4.2-1) for total cyanide of 0.2 mg/l. The result for wells 104, 123, 126, 127, 128, 148, 165,171, 172 and 175 were less than one-half the comparative value (0.1 mg/l). The results for wells 115 and 155 were between 0.1 and 0.2 mg/l and the results for wells 131 and 168 were greater than the 0.2 mg/l comparative value.

May 2002 CERCLA Special Program

As described above in Section 3.2.1.2, two deep aquifer zone wells within the FMC Plant OU were selected for sampling and analysis for the routine CERCLA and an expanded parameters list. This special program was conducted in response to EPA questions regarding the EMF RI findings that the deep aquifer zone was not impacted in the FMC western ponds area and EMF joint fenceline area. Well 109 is the deep well paired with shallow well 110 at the northeastern corner of the FMC Plant Site and monitors groundwater converging from the joint fenceline area and the FMC central plant area. Well 125 is the deep well paired with shallow well 126 outside the northern fringe of the identified FMC western ponds area impacted groundwater. Well 125 was selected to evaluate the EMF RI finding that impacted groundwater was not migrating to the north of this area of the site in the deep aquifer zone. The wells that were sampled and analyzed for the May 2002 CERCLA special parameter list are shown on Figure 4.2-1. The results for this May 2002 CERCLA special program are presented on Table 4.2-8.

Common ions

The common ion results were all below their respective representative concentrations in wells 109 and 125.

Physical parameters

The physical parameter results were all below their respective representative concentrations in wells 109 and 125.

Nutrients and fluoride

The ammonia, nitrate, orthophosphate and total phosphorus results were all below their respective representative concentrations in wells 109 and 125. The fluoride result for well 109

was below the representative concentration. The fluoride result for well 125 (0.98 mg/l) was slightly higher than the Michaud representative concentration (0.80 mg/l), but was far below the comparative value of 4 mg/l (Table 4.2-1).

Metals

The arsenic, cadmium, barium, boron, lithium and manganese results were all below their respective comparative concentrations and comparative values. The selenium results for well 109 (0.007 mg/l) and 125 (0.0059 mg/l) were slightly higher than the Michaud representative concentration of 0.0057 mg/l, but both results were far below the comparative value of 0.05 mg/l/.

June 2003 Tesco Property Well Program

As described above in Section 3.2.1.2, FMC conducted a special groundwater montoring program at two shallow wells that were installed during the EMF RI to evaluate potential EMF-impacts in the areas north of Highway 30 that are also downgradient from the Tesco property (aka Williamson or Elias property). FMC acquired the Tesco property in 1999 and performed a voluntary cleanup of the property during the 1999 through 2002 period. In 2003, EPA raised questions regarding potential groundwater impacts from the former tenant and operator Alan Elias' (aka A.E.I.) operations at the property. In response, FMC performed the special groundwater monitoring at wells 522 and 523 located downgradient from the former Tesco building that housed Alan Elias' operations. Although the Tesco property is not a part of the FMC Plant OU, the results are reported here for completeness and in the context of these wells status as EMF RI wells. The wells that were sampled and analyzed for the June 2003 program are shown on Figure 4.2-1. The results for this June 2003 CERCLA special program are presented on Table 4.2-9A. As noted on Table 4.2-9A, no volatile or semi-volatile organic compounds were detected and the full list of organic compounds that were analyzed is shown on Table 4.2-3B.

Common ions

The common ion results were all below their respective representative concentrations in wells 522 and 523.

Physical parameters

The physical parameter results were all below their respective representative concentrations in wells 522 and 523.

Nutrients and fluoride

The ammonia and fluoride results were below their respective representative concentrations in wells 522 and 523. The orthophosphate result for well 522 was undetected at a detection limit of

0.03 mg/l which is below the representative concentration. The orthophosphate result for well 523 was undetected at an elevated detection limit of 0.53 mg/l which is higher than the representative concentration.

Metals

The arsenic, cadmium, selenium, chromium, silver and zinc results and associated detection limits were below their respective representative concentrations and comparative values. The lead and nickel results were undetected at detection limits slightly higher than their respective representative concentrations, but the detection limits for lead and nickel were well below the comparative values.

Organic compounds

Total phenol was not detected at a detection limit of 0.01 mg/l in wells 522 and 523. As noted on Table 4.2-9A, none of the volatile organic compounds (method 8260) or the semi-volatile organic compounds (method 8270) were detected above their associated detection limits. The full volatile and semi-volatile organic compound analytical list is shown on Table 4.2-9B.

Other inorganic parameters

Total cyanide was not detected at a detection limit of 0.01 mg/l in wells 522 and 523. The total cyanide detection limit is well below the comparative value.

May 2005 CERCLA Special Program

As described above in Section 3.2.1.2, organic (volatile and semi-volatile) sampling and analysis of selected wells (wells 106, 116, 143, 158, 167, 183) downgradient of the FMC landfill areas (e.g., old landfill under the west slag pile, "new" plant landfill) was conducted during the May 2005 groundwater monitoring event pursuant to FMC's commitment to EPA and IDEQ as part of the FMC Plant OU SRI/SFS discussions. The wells that were sampled and analyzed for the May 2005 expanded parameter list are highlighted on Figure 4.2-10. The results for this May 2005 CERCLA special program are presented on Table 4.2-10A. As noted on Table 4.2-10A, only the results for volatile or semi-volatile organic compounds that were detected are shown on Table 4.2-10A. The full list of organic compounds that were analyzed is shown on Table 4.2-10B.

Common ions

The common ion results were comparable to the results from the EMF RI. The potassium, chloride and sulfate results for wells 116 and143 were significantly higher than their respective representative concentrations. Wells 116 (western pond area) and well 143 (joint fenceline area) are located within the EMF RI identified groundwater impacted areas as evidenced by potassium results 2 to 4 times the representative concentration and sulfate results 2 to 7 times the representative concentration. The potassium and sulfate results for wells 158 and 167 (western

pond area) and 106 (central plant area) were only slightly higher than the representative concentrations. The potassium results for these wells were less than 1.4 times the representative concentration and sulfate was less than 2 times the representative concentration at wells 167 and 106. The common ion results for well 183 were below the representative concentrations.

Physical parameters

The physical parameter results including pH and specific conductance were comparable to concentrations measured during the EMF RI. The specific conductance results for wells 116 and 143 were significantly higher and wells 158 and 167 were slightly higher than the representative level. The specific conductance results for wells 106 and 183 were below the representative level. The pH result for well 143 was less than the lower range of representative pH.

Nutrients and fluoride

Consistent with the results from the EMF RI, the nitrate and orthophosphate results for wells 116 and 143 were higher than the representative concentrations as was the ammonia result for well 143. The orthophosphate result for well 167 was also higher than the representative concentration. The nutrient results for wells 106, 158 and 183 were within their respective representative concentrations. The fluoride results for all of the wells were within the representative concentrations.

Metals

Consistent with the results from the EMF RI, the arsenic results for wells 116, 143 and 167 were significantly higher than the representative concentrations and the comparative value. The arsenic result for well 183 was 0.018 mg/l which was slightly higher than the Bannock representative concentration of 0.017 mg/l (Table 4.2-1). The arsenic results for the other wells were below the representative concentrations. The selenium result for well 143 (joint fenceline area) was higher than the representative concentration but below the comparative value. The selenium results for the other wells were below the representative concentrations.

Organic compounds

Total phenol was not detected in any of the wells at a detection limit of 0.01 mg/l. The organic compound carbon disulfide was reported in well 167 at a concentration of 0.0041 mg/l (detection limit equal 0.001 mg/l). The carbon disulfide result for well 167 was well below the comparative value of 1.0 mg/l (Table 4.2-1). The organic compound dimethyl phthalate was reported in wells 106, 116, 143 and 183 at concentrations of 0.011, 0.014, 0.03 and 0.03 mg/l, respectively. The detection limit for dimethyl phthalate was 0.01 mg/l. Dimethyl phthalate is a common plasticizer and a common laboratory contaminant and the reported results are likely laboratory artifacts. The results for dimethyl phthalate were all well below the comparative value of 360 mg/l. No other organic compounds were reported as detected above their respective detection limits. The full list of organic compounds analyzed pursuant to the RCRA Appendix IX list is shown on Table 2.1-1B.

May 2008 CERCLA Special Program

As described above in Section 3.2.1.2, FMC conducted an expanded CERCLA groundwater monitoring program during May 2008. The program included sampling and analysis of an expanded parameter list from 24 (of 52 total) routine wells and Batiste Spring and an additional 14 monitoring wells that have not been routinely sampled within the last several years. The sampling and analysis was performed in accordance with the FMC proposed list of monitoring wells, expanded parameter list and addendum to the EMF RI SAP (March 28, 2008), and as further revised to add ORP as a field parameter, mercury as a laboratory parameter, and total phosphorus to replace orthophosphate as a laboratory parameter. The wells that were sampled and analyzed for the May 2008 CERCLA expanded parameter list are highlighted on Figure 4.2-11.

As FMC discussed during the EMF groundwater meeting on July 30, 2008, certain of the results for the May 2008 special samples analyzed by method 6020 were reported at elevated detection limits compared to the project requested detection limits specified in the EMF RI SAP Addendum for this special groundwater monitoring event. According to the laboratory, Test America, the sample digestates for certain of the Sample Delivery Groups (SDGs) were not analyzed undiluted but were diluted by a factor of ten (10X) prior to analysis by method 6020. As stated during the meeting, this issue did not impact any of the results for any of the other methods (e.g., water quality parameters, fluoride, elemental phosphorus, mercury, cyanide and radiological parameters).

FMC directed the laboratory to reanalyze the retained undiluted digestates by method 6020 for those samples and analytes with the initially reported elevated detection limits. Test America completed the reruns and the preliminary results were forwarded electronically to FMC on September 11, 2008.

The validated results for the analytical parameters, including the specific samples and metals that were subject to the reanalysis by method 6020, for this May 2008 CERCLA special program are presented on Table 4.2-11A. The validated results for the wells monitored during the May 2008 event for the routine RCRA or CERCLA parameter lists are presented on Table 4.2-11B. The data validation and usability evaluation for the May 2008 groundwater monitoring event is provided in Appendix F.

Common ions

The common ion results including potassium, chloride and sulfate were comparable to concentrations measured during the EMF RI. The southwestern upgradient representative wells 101, 102 and 169; western upgradient wells 173, 174 and 175; wells outside or near the northern fringe of EMF-impacted groundwater 147, 149, 523, 501, 515, 516, 502, TW-11S, 524 and 525; and up-gradient Pond 8S well 183 continued to show no site impact with common ion results below their respective representative concentrations. The remaining wells sampled during the May 2008 event are generally within the EMF RI defined area of groundwater impact as evidenced by potassium concentrations from 2 to 75 times (well 156) the representative

concentrations, chloride up to 2 times representative concentrations, and sulfate up to 38 times background (well 189 in the joint fenceline area). The potassium and sulfate results for Batiste Spring were higher than their respective representative concentrations by a factor of 1.2 and 2.4 respectively.

Physical parameters

The physical parameter results including pH and specific conductance were comparable to concentrations measured during the EMF RI. The southwestern upgradient representative wells 101, 102 and 169; western upgradient wells 173, 174 and 175; wells outside or near the northern fringe of EMF-impacted groundwater 147, 149, 523, 501, 515, 516, 502, TW-11S, 524 and 525; and up-gradient Pond 8S well 183 continued to show no site impact. The remaining wells sampled during the May 2008 event are generally within the EMF RI defined area of groundwater impact as evidenced by decreased pH (less than about pH 7) and specific conductance greater than representative levels (Michaud representative level for specific conductance is 1,136 umhos/cm). The pH result for Batiste Spring was below the representative pH range and the specific conductance was slightly below the representative concentration.

Nutrients and fluoride

The nitrate, total phosphorus and fluoride concentrations were comparable to concentrations measured during the EMF RI. The southwestern upgradient representative wells 101, 102 and 169; western upgradient wells 173, 174 and 175; wells outside or near the northern fringe of EMF-impacted groundwater 147, 149, 523, 501, 515, 516, 502, TW-11S, 524 and 525; and up-gradient Pond 8S well 183 continued to show no site impact with nutrient and fluoride results below their respective representative concentrations. The remaining wells sampled during the November 2001 event are generally within the EMF RI defined area of groundwater impact as evidenced by elevated nitrate concentrations up to 7 times (well 139) the representative concentrations, total phosphorus concentrations up to 464 mg/l (well 156 at Pond 8S), and fluoride concentrations up to 1.2 mg/l (wells 149). The ammonia and nitrate results for Batiste Spring were higher than their respective representative concentration, but the fluoride result was below the representative concentration. The total phosphorus result for Batiste Spring was 22.1 mg/l and was significantly higher than the representative concentration of 0.33 mg/l (Table 4.2-1).

Metals

Overall, the metals results were comparable to the EMF RI and the post-RI special monitoring events. Cadmium was only analyzed for samples from the routine RCRA wells that were also samples for the May 2008 expanded parameter list. Consistent with the extensive prior sampling and analysis for cadmium, the cadmium results for this monitoring event were reported as undetected at detection limits of 0.0005 mg/l and 0.005 mg/l (diluted digestates) or were reported as quantitated below the 0.0005 mg/l detection limit. All of the undetected and reported quantitated cadmium results were less than the representative concentration and comparative value.

The results for mercury were undetected in the majority of the wells and at Batiste Spring. In the samples from wells 101, 122, 134, 139, 143, 145, 161, 164 and 501, the mercury results were reported as quantitated below the 0.0002 mg/l detection limit. The detection limit for mercury was lower than the representative concentration and one-tenth the groundwater comparative value (Table 4.2-1).

The antimony results were undetected at a detection limit of 0.005 mg/l for 32 of the 38 wells. The antimony results for wells 112, 122 and 156 and Batiste Spring (0.00096 mg/l) were reported as quantitated below the 0.005 mg/l detection limit and were below the representative concentration and the comparative value of 0.006 mg/l (Table 4.2-1). The antimony results for wells 111 and 146 were undetected at an elevated detection limit of 0.05 mg/l which is lower than the representative concentration. The antimony result for well 110 was 0.0073 mg/l which is below the representative concentration but slightly higher than the comparative value.

Boron and manganese concentrations were within the range of their respective representative concentrations in the southwestern upgradient representative wells 101, 102 and 169; western upgradient wells 173, 174 and 175; wells outside or near the northern fringe of EMF-impacted groundwater 147, 149, 523, 501, 515, 516, 502, TW-11S, 524 and 525; and up-gradient Pond 8S well 183. The remaining wells sampled during the May 2008 event are generally within the EMF RI defined area of groundwater impact as evidenced by boron and manganese detected at concentrations above their representative levels. Manganese and boron concentrations were higher than the representative concentrations at wells TW-9S, 108, 111, 122, 123, 134, 136, 143, 145, 156, 167 and 189. The boron and manganese results for Batiste Spring were below the representative concentrations.

Only the vanadium result from well 123 (0.182 mg/l) was higher than the representative concentration and that result was also higher than the comparative value.

The arsenic and selenium results were within the range of their respective representative concentrations in the southwestern upgradient representative wells 101, 102 and 169; western upgradient wells 173, 174 and 175; wells outside or near the northern fringe of EMF-impacted groundwater 147, 149, 523, 501, 515, 516, 502, TW-11S, 524 and 525. The arsenic result for Pond 8S upgradient well 183 of 0.0144 mg/l was lower than the Bannock representative concentration of 0.017 mg/l, but the selenium result of 0.0073 mg/l was slightly higher than the representative concentration. The remaining wells sampled during the May 2008 event are generally within the EMF RI defined area of groundwater impact. Arsenic was detected at concentrations significantly higher than the representative concentrations and the comparative value in the wells within the EMF impacted area with the exception of wells 112, 127, 147 and 149; and wells 139, 161, 169 that were reported as undetected at an elevated detection limit of 0.01 mg/l. Consistent with the EMF RI findings, selenium is elevated in wells in much smaller areas within the larger arsenic-impacted groundwater area. The selenium results detected above the representative concentrations were at wells 108, 110, 122, 134, 136, 143, 145, 139, 164, 189 and 517. The selenium results for wells 143, 145 and 123 (all in the joint fenceline area) were higher than the comparative value.

Because total uranium was not an EMF RI groundwater investigation parameter, a representative groundwater concentration was not calculated. Therefore, the uranium results for the wells that are hydraulically upgradient or cross-gradient from any potential EMF source areas (i.e., representative wells) were evaluated to establish a screening value for a representative groundwater uranium value. The uranium results for wells 101, 102, 169, 173, 174, 175, 515 and 516 ranged from 0.0016 mg/l at wells 169 and 173 to 0.014 mg/l at well 515. However, the uranium result for well 515 appears to be anomalously high as discussed below, so the next highest result for the representative wells, 0.0043 mg/l at well 175 was used as the upper range for the representative wells.

The uranium results for 26 of the 38 wells and Batiste Spring were within the representative range. The uranium results for wells TW-9S, 139, 143, 164, 183, 502 and 515 were higher than the representative range but were below the comparative value of 0.03 mg/l. The result for well 502 was 0.0044 mg/l is likely within the representative range. The uranium results for wells 110, 111, 134 and 146 were undetected at an elevated detection limit of 0.01 mg/l. The uranium result for well 161 was 0.257 mg/l and was greater than the representative range and the comparative value.

Wells 515, 161 and 164 were the only wells with uranium concentrations above 0.01 mg/l. Wells 161 and 164 are located on the fenceline between the FMC and Simplot properties and upgradient from the FMC calciner pond area. Well 161 is with about 100 feet of Simplot well 304 and well 164 is with about 100 feet of Simplot well 333. As described in the EMF RI Report, Section 4.4 and summarized in Section 4.1 above, the gross alpha measured at well 304 during the EMF RI was 192 pCi/l. As stated in the EMF RI Report, the elevated gross alpha activity in samples from well 304 may also have been attributable to uranium isotopes, because radium-226 was not detected at a sufficient activity in this well to account for the observed gross alpha activity. Well 304 is downgradient from the gypstack at Simplot. It is more likely, however, that the gross alpha activity in Well 304 is related to the dissolution of uranium from rocks and gravels in the saturated zone due to a longer residence time of acidic seepage within this lower permeability region, rather than to migration of uranium isotopes from the gypstack. This hypothesis would also apply the uranium results and elevated gross alpha (see discussion below) at well 164. Note that well 333 was not part of the EMF RI groundwater radiological speciation program, so no RI data is available for comparison.

The uranium result for well 515 may also be related to naturally occurring uranium associated with the underlying volcanic lithology of the Sunbeam and/or Starlight Formations and upward groundwater movement from the lower to the upper aquifer zone in the area of well 515. Other than specific conductance and sulfate concentrations slightly higher than the comparative values, all of the other indicator parameters indicate that well 515 is not impacted by EMF sources.

Radiological parameters

The gross alpha results were generally with the range for representative groundwater with only a few exceptions. The gross alpha result for well 143 was 13.2 pCi/l which is higher than the representative range but below the comparative value. The gross alpha results for wells 515, 161

and 164 were higher than the representative range and the comparative value. The gross alpha activities, radium-226 plus radium-228 activities and total uranium results are summarized below:

Well	Gross Alpha (pCi/l)	Ra-226/-228 Combined (pCi/l)	Total Uranium (mg/l)
115	15.8	0.436	0.014
164	36	1.42	0.0129
161	325	0.57	0.257

Although the total uranium results cannot be directly related to the gross alpha activities, the elevated gross alpha activities appear to correlate to the elevated uranium results.

The radium-226 and radium-228 results for all of the wells and Batiste Spring were within their respective ranges for representative groundwater and below the comparative value (Table 4.2-1).

Other inorganic parameters

The total cyanide results for Batiste Spring and wells TW-11S, TW-12S, TW-9S, 101, 102, 110, 112, 123, 127, 136, 145, 147, 149, 161, 164, 169, 173, 174, 175, 183, 189, 501, 502, 515, 516, 517, 523, 524 and 525 were undetected at a detection limit of 0.01 mg/l. Total cyanide was detected in the other wells ranging from 0.011 (well 146) to 0.13 mg/l (well 167). Because total cyanide was not an EMF RI groundwater investigation parameter, a representative groundwater concentration was not calculated and is not available for comparison. Therefore, the results were compared to the comparative value (Table 4.2-1) for total cyanide of 0.2 mg/l. The result for wells 108, 111, 122, 134, 139, 143, 146 and 156 were less than one-half the comparative value (0.1 mg/l). The result for well 167 was between 0.1 and 0.2 mg/l but no results were higher than the comparative value.

The elemental phosphorus results for all of the wells downgradient from wells 108 and 122 including Batiste Spring were undetected at a detection limit of 0.00005 mg/l (0.05 ug/l). As previously known based on the January 1998 CERCLA special monitoring program and the routine RCRA semiannual monitoring for elemental phosphorus at the slag pit sump and Pond 8S wells, the elemental phosphorus results for slag pit sump wells 108 and 122 were 0.03 mg/l and 0.00101 mg/l respectively. Consistent with previous elemental phosphorus results, the results for wells 108 and 122 are greater than the comparative value. Elemental phosphorus was also reported as detected at well 156 at a concentration of 0.000023 mg/l. As described in greater detail in Section 5.1, elemental phosphorus has been sporadically reported as detected at the upgradient and downgradient pond 8S wells as well as in rinseate blanks. During the over the ten years of routine monitoring for elemental phosphorus at pond 8S, there has been a higher frequency of reported detections for the rinsate blank samples compared to the downgradient

pond 8S wells 155, 156 and 157 and upgradient well 158 suggests that the reported results for the pond 8S wells may be laboratory artifacts. In any event, none of the reported results for the pond 8S wells have exceeded the comparative value of 0.73 ug/l for elemental phosphorus.

4.2.1.3 Sampling and Analysis Performed by IDEQ and the Sho-Ban Tribes

IDEQ November 2004 Samples

As described above in Section 3.2.1.3, during November 2004, FMC collected collocated samples that were requested by and provided to IDEQ from selected CERCLA wells for an expanded parameter list. FMC provided IDEQ with collocated samples from wells 110, 123, 136, 142, 143, 145, 146, 175, 183, 189, 190, 191, TW-12S and Batiste Spring. FMC did not conduct expanded analyses of its samples from these wells and did not receive the laboratory analytical results for the IDEQ samples from this event until IDEQ recently provided their laboratory reports for this sampling event to EPA in February 2008. According to the table of IDEQ's results, IDEQ analyzed their samples for arsenic (total), chloride, nitrate, orthophosphate, pH, potassium,

conductivity (specific conductance), selenium and sulfate. In addition the IDEQ samples were analyzed for the isotopes ^{18}O, ^{2}H (deuterium), ^{13}C and ^{34}S isotopes.

Overall, the IDEQ results for water quality parameters, physical parameters, nutrients and metals were consistent with the findings of the EMF RI. FMC does not have any basis with which to compare the IDEQ isotope results. The results of these IDEQ analyses are discussed in detail in the IDEQ report entitled "Evaluation Of Water Quality Impacts Associated With FMC And Simplot Phosphate Ore Processing Facilities, Pocatello, Idaho" (IDEQ, 2004).

Shoshone Bannock Tribes 2000 through 2006 Samples

As described above in Section 3.2.1.4, the Shoshone Bannock Tribes staff collected collocated groundwater samples from selected wells during the 2000 through 2006 period. The Tribes did not and have not provided FMC with a copy of any Sampling and Analysis or Quality Assurance Plans for their groundwater samples and analyses nor have the Tribes provided FMC with the analytical laboratory reports and/or results for all of the various sampling events. FMC obtained the laboratory reports for at least a portion of the Tribes 2000 and 2005 collocated groundwater samples and has obtained an Excel spreadsheet from EPA that apparently contains at least partial results from the Tribes collocated groundwater samples from 2000, 2003, 2004, 2005 and 2006.

Due to the lack of information regarding data validation or evaluation of the usability of any of the Tribes results, FMC performed only a cursory review of the data. Overall, the Tribes results for water quality parameters, physical parameters, and nutrients were consistent with the EMF RI and FMC post-RI results. In general, most metals results were also consistent with the EMF RI and FMC post-RI results. However, a number of metals results appear erroneous and, as stated above, those reported values cannot be substantiated. Finally, the Tribes radiological analytical results for the EMF RI parameters gross alpha, gross beta, radium-226 and radium-228 were

generally consistent with the EMF RI and FMC post-RI results. However, to the extent that duplicate samples were analyzed and included with the Tribes data, there were numerous instances of unacceptable analytical precision based on the relative percent difference between the primary and duplicate results for the radiological analyses. Again, the underlying laboratory data for the radiological results was not made available to FMC so the reported results cannot be substantiated.

4.2.2 Results and Findings of Routine Groundwater Monitoring

As described in Section 3.2.2 above, FMC performed routine quarterly RCRA groundwater monitoring concurrently during the EMF RI and continuously thereafter as required by the RCRA regulations. Following completion of the EMF RI, FMC continued to perform routine semiannual monitoring of a CERCLA groundwater monitoring network. As part of the Calciner Pond Remedial Action performed pursuant to the IDEQ-FMC Consent Order, five of the wells that were being monitored routinely under FMC's CERCLA groundwater monitoring program and two new wells installed by Simplot on the FMC property were folded into FMC's Calciner Pond Remedial Action groundwater monitoring program.

This section provides a summary of the recent monitoring results from these three routine groundwater monitoring programs. Section 5 provides a discussion of the overall groundwater conditions and trends that combines the results for the entire FMC Plant OU (e.g, groundwater special studies and routine monitoring under all three programs). The CERCLA, RCRA and Calciner Pond remedial action groundwater monitoring well networks are shown on Figure 4.2-12.

4.2.2.1 CERCLA Groundwater Monitoring

Table 4.2-12 shows the average of the results for the routine CERCLA (and RCRA and Calciner Pond) monitoring well networks and parameters for the 4th quarter 1996 through 2nd quarter 2008 period. This period was chosen so that the most recent 7 quarters of data could be compared to the EMF RI data that were collected and averaged over 8 quarters (1993-1994). Similar to the EMF RI Report, the results for the routine monitoring programs were averaged to simplify presentation of the data covering a multi-year period. However, comparisons of the results to representative concentrations in the discussion below are based on the underlying data points and not the averages.

As described in Section 3.2 above, the CERCLA groundwater monitoring network includes well 139 within the western ponds area, wells 111, 146 and 110 at the northern boundary of the FMC Plant Site, and wells 515, 524 and 525 in the area north of Interstate 86. In addition, for the fourth quarter 2007 and second quarter 2008 CERCLA groundwater monitoring, FMC added wells 523, TW-9S and TW-12S into the CERCLA monitoring network. These three wells are located in the area north of Highway 30. The average results for wells 523, TW-9S and TW-12S presented on Table 4.2-12 are for two data points for each well during the 4th quarter 1996 through 2nd quarter 2008 period.

Overall, the recent results for the CERCLA wells are comparable to those presented in the EMF RI Report with respect to the extent of the area of impacted groundwater. Concentrations of site-related constituents are comparable or lower than during the EMF RI period as discussed in Section 5.1 (Groundwater Quality Assessment and Trends). The concentrations at well 139 continue to show site impacts based on water quality parameters (potassium, chloride and sulfate), nutrients (nitrate and orthophosphate / total phosphorus), arsenic and selenium above representative concentrations.

The recently observed concentrations at the northern FMC Plant Site boundary wells 111, 146 and 110 continue to show site impacts based on water quality parameters above representative concentrations. Potassium concentrations are higher by a factor of 2 to 4, and sulfate concentrations are higher by a factor of 1.5 to 3 than the representative concentrations. Total phosphorus / orthophosphate concentrations are also higher than the representative concentrations and ranged from 1 to 5 mg/l at these wells. The total phosphorus and orthophosphate results were combined for the averages presented in Table 4.2-12 so that the total phosphorus results from the May 2008 groundwater monitoring could be included in the averages. Combining the total phosphorus and orthophosphate is appropriate based on previous monitoring results that have shown that essentially all of the phosphorus is in the orthophosphate form in the majority of monitoring wells at the FMC Plant OU. Nitrate concentrations in wells 111 and 146 are also higher than the representative concentration. Arsenic concentrations are in the range of 2 to 5 times their representative concentrations in wells 111, 146 and 110. Selenium concentrations were higher than the representative concentration in well 110, but not in wells 111 and 146.

The recently observed concentrations in the wells located north of Highway 30 were comparable to the EMF RI results. Well 523 is below representative concentrations for water quality parameters (potassium, chloride and sulfate), nutrients (nitrate and orthophosphate), fluoride, arsenic and selenium and does not appear to be site impacted. Wells TW-9S and TW-12S are located within the EMF-impacted area and, consistent with the EMF RI, their water quality parameters are above representative concentrations. Total phosphorus / orthophosphate concentrations are also higher than the representative concentrations and ranged from 2 to over 20 mg/l at wells TW-9S and TW-12S. Well TW-12S is downgradient from both the FMC Plant Site and the Simplot Don Plant and is impacted by sources from both facilities. This location may account for the higher total phosphorus / orthophosphate concentrations at this well compared to FMC Plant Site northern boundary wells 111, 146 and 110. Nitrate concentrations at wells TW-9S and TW-12S are higher than the representative concentration. Arsenic concentrations are higher than the representative concentration in all three wells, and are in the range of 1.2 to 2 times the representative concentration. Selenium concentrations at well TW-12S slightly exceeded the representative concentration, but well TW-9S was below the representative concentration.

The wells north of Interstate 86 are monitored as sentry wells outside the northern extent of the EMF groundwater impacted area, as determined during the EMF RI. The chloride and sulfate concentrations in well 515 are higher than the representative concentrations, but potassium, nitrate and total phosphorus / orthophosphate were below their respective representative

concentrations. Arsenic and selenium concentrations are also below their representative concentrations at well 515. Wells 524 and 525, located just north of Batiste Spring, are below representative concentrations for water quality parameters (potassium, chloride and sulfate), nutrients (nitrate and orthophosphate), fluoride, arsenic and selenium.

4.2.2.2 RCRA Groundwater Monitoring

As described in Section 3.2 above, the RCRA groundwater monitoring program is performed in accordance with the EPA-approved RCRA post-closure plans for the WMUs subject to post-closure monitoring and maintenance. There are nine WMUs at the property that are subject to the RCRA groundwater monitoring standards. The WMUs and associated monitoring well networks are shown on Table 3.2-4. All nine of the WMUs were closed prior to 2006. Post-closure monitoring continued during 2007 and 2008 (Table 1.3-1). The RCRA groundwater monitoring well network is shown on Figure 4.2-12.

Pursuant to RCRA requirements, the RCRA groundwater monitoring data is reported annually to EPA. FMC has prepared and submitted a "RCRA Interim Status Groundwater Monitoring Assessment" report for each calendar year beginning with the 1992 monitoring year. The most recent assessment report is the "RCRA Interim Status 2007 Groundwater Monitoring Assessment" (FMC, February 2008) and is summarized below.

The analytical results for the RCRA groundwater monitoring program for each year are tabulated in each of the annual assessment reports and are not reproduced in this report. However, the results for the RCRA monitoring wells are provided in Table 4.2-12. As stated above, Table 4.2-12 shows the average of the results for the routine RCRA (and CERCLA and Calciner Pond) parameters for the 4th quarter 2006 through 2nd quarter 2008 period. Although the discussion of results below is from the 2007 assessment report, the 2007 data represents over half the data points used to calculate the averages for the RCRA wells.

Temperature, specific conductance, pH, and turbidity are generally consistent with monitoring data from previous years. Nitrate, ammonia, sulfate and chloride data are generally comparable to monitoring data from previous years.

Potassium concentrations are generally consistent with monitoring data from previous years. Well 108, which showed a slight increasing trend in 1999, reversed the trend and returned to near the historic mean during 2000, and remained near the historic mean through 2007.

Wells downgradient from former Pond 8S and the Slag Pit Sump continued to have elevated (18 to 100 times average upgradient well concentrations for Pond 8S wells for 2007 data) potassium concentrations due to historic releases from these WMUs. Potassium concentrations in the Pond 8S downgradient wells are steadily decreasing, as are concentrations of arsenic and other constituents. This is shown on Figures 4.2-2A through D.

Total cadmium was not detected above the reporting limit in the 140 samples collected and analyzed from the RCRA well network during 2007. The reporting limit concentration was

0.001 mg/L. The non-detect results during 2007 and historically sporadic detection continue to indicate that cadmium is not site-related.

As described in detail in the RCRA annual assessment reports, the results for arsenic, fluoride and selenium are statistically analyzed to assess the status (i.e., whether currently releasing constituents to groundwater) of the WMUs. Seven of the nine WMUs that are subject to the RCRA groundwater monitoring standards are in detection monitoring (i.e., groundwater impacts have not been detected from these WMUs as of the 2007 reporting period). As described below, groundwater impacts from Pond 8S and the Slag Pit Sump have been identified and these WMUs are in assessment monitoring. For brevity, the description of the statistical tests and detailed results from the RCRA Interim Status 2007 Groundwater Monitoring Assessment are not reprinted in this report. The results of the 2007 statistical analyses concluded that there were no statistically significant differences in groundwater chemistry for 2007 compared to the data reported for the previous calendar years 1992 through 2006. Ponds that were not leaking in 2006 (Ponds 8S, 9E, 15S, 16S, 17, 18, the Phase IV ponds / Pond 8E, and the slag pit sump, as discussed in the "RCRA Interim Status 2006 Groundwater Monitoring Assessment" (FMC, February 2007), also were not leaking in 2007.

Due to identified historic releases to groundwater from the Slag Pit Sump and Pond 8S, the rate and extent of constituents released from these units are also described in the RCRA annual assessment reports as required under assessment monitoring, and are summarized below.

Slag Pit Sump

Releases have occurred from the unit in the past due to the presence of wastewater in the unlined sump. Due to commingling of constituents from other, non-RCRA regulated sources, it is difficult to define the extent of constituents attributable solely to the slag pit sump. However, the facility-wide extent of these constituents is presented in the EMF RI Report and is summarized in Section 4.1 of this report. The overall direction and rate of movement of the groundwater flow, as described in Section 2.2 and shown on the groundwater contour maps in Appendix B, supports the use of the EMF RI and post-RI findings to describe the extent of various constituents associated with the slag pit sump.

The rate of migration of slag pit sump constituents was estimated using the calculated groundwater flow velocity as the "worst-case" or highest rate of migration. Using K (hydraulic conductivity) of 286 ft/day (as measured in Well 108), i (gradient) of 0.008, and n (porosity) of 0.20, the groundwater flow velocity is 11 feet per day. Typically, solutes in the groundwater migrate at a slightly slower rate than the groundwater flow velocity due to attenuation effects such as adsorption, precipitation/dissolution reactions, and ion exchange.

Pond 8S

The 2007 statistical results presented in the 2007 assessment report are consistent with the prediction that, after removal of the standing hydraulic head in 1994 and capping of Pond 8S in 1999, leakage of pond solute has been substantially decreased and will eventually be eliminated.

Consequently, pond-related constituent concentrations in groundwater downgradient from Pond 8S are expected to gradually decrease over many years. The Pond 8S time-series graphs (Figures 4.2-2A through D) show decreasing long-term trends in all downgradient wells, particularly for arsenic. Arsenic concentrations reached minimum values for the period of record at all three downgradient wells (155, 156, and 157) in 2007.

Since Pond 8S has leaked in the past, the rate and extent of constituent migration in the aquifer must be monitored. As with the slag pit sump, commingling of constituents from other, non-RCRA regulated sources has occurred. The overall direction and rate of movement of the groundwater flow, as described in Section 2.2 and shown on the groundwater contour maps in Appendix B, support the use of the EMF RI and post-RI findings to describe the extent of various constituents associated with Pond 8S.

The rate of migration of Pond 8S constituents was estimated using the calculated groundwater flow velocity as the "worst-case" or highest rate of migration. Using K (hydraulic conductivity) of 1000 ft/day (as measured in Well 150), i (gradient) of 0.010, and n (porosity) of 0.20, the groundwater flow velocity is 50 feet per day. As with the slag pit sump area, this is the groundwater flow rate; the actual constituent migration rate may be less because of attenuation.

4.2.2.3 Calciner Pond Remedial Action Groundwater Monitoring

The Calciner Pond Remedial Action groundwater monitoring data is reported annually to IDEQ in accordance with the Calciner Pond Remedial Action Groundwater Monitoring Plan (FMC, 2008). The most recent report is the "Calciner Pond Remedial Action 2006 Groundwater Monitoring Annual Report" (FMC, 2008). The Calciner Pond groundwater monitoring well network is shown on Figure 4.2-12.

The results for the Calciner Pond monitoring wells are provided in Table 4.2-12. As stated above, Table 4.2-12 shows the average of the results for the routine Calciner Pond (and CERCLA and RCRA) parameters for the 4th quarter 2006 through 2nd quarter 2008 period. The average results presented on Table 4.2-12 are useful for comparison with the EMF RI results for the joint fenceline area. The results for the Calciner Pond well network for the 2007 monitoring year are provided on Table 4.2-13.

Groundwater quality in the Calciner Ponds monitoring wells in 2007 was generally similar to that observed in previous years. Groundwater pH values in 2007 ranged from 5.96 to 6.73 in the Calciner Ponds monitoring wells. All of these measured pH values are below the representative groundwater ph range. The pH data indicates an east to west (away from the joint fenceline) increasing pH gradient, and a slightly decreasing pH gradient from south to north (hydraulically upgradient to downgradient).

Concentrations of many parameters vary considerably among wells in the Calciner Ponds area. For example, observed 2007 concentrations of orthophosphate (<0.1 to 166) and total arsenic (0.0034 to 0.331 mg/L) varied over two to five orders of magnitude, with similar variability observed in both upgradient and downgradient well sets (Table 4.2-13). Concentration ranges

for sulfate, fluoride, nitrate, ammonia, potassium, and selenium were also variable, although differences between minimum and maximum concentrations were less dramatic than for arsenic and orthophosphate. Chloride concentrations in 2007, however, were relatively consistent across the Calciner Ponds monitoring well network, with concentrations ranging from 108 to 189 mg/L in upgradient wells and 112 to 454 mg/L in downgradient wells.

Comparison of concentrations for upgradient wells and downgradient wells as individual groups suggests that concentrations tend to be higher (on average) in downgradient wells. However, arsenic, orthophosphate and sulfate concentrations in wells 136, 189 (downgradient) and 164 (upgradient) on the eastern side of the calciner ponds area (i.e., nearer the joint fenceline) are markedly elevated compared to the concentrations of these constituents in wells 143, 190 (downgradient) and 142 (upgradient) on the western side of the calciner ponds area. The data indicate an east to west (away from the fenceline) decreasing concentration gradient for arsenic, orthophosphate and sulfate and a slightly increasing concentration gradient for these constituents from south to north (hydraulically upgradient to downgradient).

The overall data distribution (period of record through 2007) and relative concentrations for key water quality indicator parameters at individual Calciner Pond monitoring wells are summarized in the boxplots presented in 4.2-13A through E for potassium, sulfate, orthophosphate, arsenic and selenium. Boxplots show the median concentration (horizontal line within the box), 25th and 75th percentile concentrations (lower and upper ends of the box), and minimum and maximum values (lowermost and uppermost horizontal lines). These boxplots provide a more detailed picture of the variability and differences in concentration between individual wells, as opposed to upgradient and downgradient wells as a group. Figures 4.2-13A through E are organized to show hydraulically upgradient wells 142, 161, and 164 on the left side of the graph, and hydraulically downgradient wells 136, 143, 189, and 190 on the right side of the graph.

The boxplots indicate that for arsenic, potassium, orthophosphate, and sulfate, concentrations in eastern downgradient wells 136 and 189 are elevated as a whole compared with upgradient wells, while concentrations in western downgradient wells 143 and 190 are more similar to those observed in upgradient wells. Downgradient well 190, in fact, generally has lower concentrations than upgradient wells. For selenium, downgradient wells 136, 143, and 189 all show slightly higher concentrations than any of the upgradient wells. The boxplots for orthophosphate and sulfate also display the similarity in the overall ranges of concentrations observed in upgradient and downgradient monitoring wells. Orthophosphate concentrations observed at upgradient well 164 have bracketed the range of concentrations observed at downgradient wells, although it should be noted that the maximum concentration of over 400 mg/L at well 164 (observed in November 2005) appears to be an anomaly, since the next highest concentration in the well 164 data set is less than 150 mg/L (observed in May 2006). Similarly, for sulfate the maximum concentrations at upgradient well 161 and downgradient wells 136 and 189 are similar, although the median concentration at well 161 is lower.

Overall, the 2007 groundwater quality data from the Calciner Ponds monitoring wells were reasonably consistent with previous data. Comparison of 2007 data results for individual wells, along with a review of concentration ranges at individual upgradient and downgradient wells

(Figures 4.2-13A through E), suggests that parameter concentrations have historically been and currently remain elevated in downgradient wells (particularly wells 136 and 189) relative to upgradient wells. The results from the 2007 and prior years monitoring suggest an attenuating impact from the former unlined calciner ponds [located in the area underneath the now remediated lined calciner ponds] and potentially from the former unlined kiln scrubber ponds and kiln scrubber overflow pond near downgradient well 143 and an impact from the gypstack, particularly in the eastern (fenceline) wells 161, 164, 189, and 136.

Given the wide variability in parameter concentrations among the Calciner Ponds monitoring wells, and that the Calciner Ponds Remedial Action was completed in 2005, evaluation of water quality trends for individual wells in the Calciner Ponds area is likely a more critical and pertinent issue than comparison of upgradient and downgradient concentrations. Groundwater quality trends in the joint fenceline (calciner pond) area are discussed in Section 5.1.

4.3 Reevaluation of Groundwater Representative Arsenic Concentrations

As summarized in Section 4.1, groundwater representative concentrations were calculated and presented in the EMF RI Report. The development of the groundwater representative concentrations was based on significant discussions between FMC and Simplot and the Agencies prior to the EMF RI Report as summarized in Section 4.3.1 below. In late 2007, EPA raised questions regarding the groundwater representative concentrations specifically for arsenic due to the EPA lowering the Safe Drinking Water Act MCL for arsenic from 50 ug/l to 10 ug/l and the fact that the EMF RI calculated groundwater representative arsenic concentrations are higher than the current 10 ug/l MCL.

During the EMF Site meetings held on February 12 and 13, 2008, FMC committed to: (1) perform a reevaluation of the representative (or background) concentration of arsenic in groundwater flowing onto the FMC Plant OU; and (2) prepare a report that will include:

- Identification of representative (background) wells and information on the location and well construction details of each applicable well;
- Tabulation of the entire arsenic data set for the representative wells; and,
- Formulating the appropriate problem statements and determining the appropriate statistical methods for determining whether arsenic concentrations in down-gradient wells contain arsenic levels above the background levels established from the upgradient data set.

This section presents the results of the re-evaluation including, 1) identification of representative groundwater wells (EMF RI and post-RI) and location / construction details, 2) tabulated total arsenic results for the EMF RI and post-RI representative groundwater wells, 3) adjustment of the representative well network following the FMC-Agency teleconference on April 14, 2008, 4) identification of the representative well sets and data for this 2008 recalculation, and 5) statistical

calculation of representative groundwater arsenic concentrations for the Bannock, Michaud and Combined (or "mixed") Bannock and Michaud hydrogeochemical regimes. For the purpose of this reevaluation, only groundwater wells within the Michaud and Bannock hydrogeochemical regimes are presented as the discussion here is focused on wells upgradient and cross-gradient of the FMC Plant OU.

4.3.1 Representative Groundwater Wells

As detailed in the Section 4.4 of the EMF Site Characterization Summary, also referred to as the "PSCS" or "PSCR," the representative wells were selected based on their hydraulic relationship to known source areas within the EMF site. Analytical data from the selected wells were compared to those from site-impacted wells. EMF sources that impacted groundwater all also contributed high concentrations of major ions (K, Ca, Na, Cl and sulfate). The major ions are mobile and conservative, and were used as primary indicators of site impacts to groundwater. Section 4.4 of the PSCS and other documents relevant to the determination of EMF groundwater representative levels were provided to the Agencies via electronic mail on February 1, 2008 and are provided in Appendix C (correspondence related to the EMF Companies' request for reduction of the EMF RI groundwater monitoring program and associated groundwater representative concentration calculation) and Appendix G (EMF PSCS documentation related to development of EMF groundwater representative concentrations).

The representative wells were grouped based on the three hydrogeochemical regimes that were identified at the EMF Site. The Michaud Flats regime is that groundwater occurring in the upper saturated gravels beneath the northern and westernmost portions of the site. The Bannock Range and Portneuf River valley regimes were also identified, although these two water types have similar geochemistries. The EMF RI Report presents the rationale for selection of the set of representative wells for the Bannock Range and Michaud Flats hydrogeochemical regimes.

EMF RI Representative wells:

- Michaud Hydrogeochemical Regime = TW-10S, 101, 102, 147, 514 and 515
- Bannock Hydrogeochemical Regime = Idaho Power, PEI-1, 106, 158, 301 and 305

Subsequent to the RI, additional groundwater monitoring, sampling and analysis for arsenic and other parameters has been performed at the RI representative groundwater wells. Furthermore, new upgradient groundwater monitoring wells have been installed and monitored for arsenic and other parameters. These provide additional data to add to the data set for determining groundwater background chemistry for arsenic. Based on a review of the locations (hydraulic relationship to potential source areas) and data from these additional wells, FMC has identified four additional representative wells in the Michaud hydrogeochemical regime and one additional well within the Bannock hydrogeochemical regime.

The following are the additional post-RI up-gradient representative wells:

- Michaud Hydrogeochemical Regime = Wells 173, 174, 175, and 179
- Bannock Hydrogeochemical Regime = Well 169

The attached Figure 4.3-1 shows the locations of the RI and post-RI Bannock and Michaud hydrogeochemical regime representative wells. The groundwater contour maps for the EMF site show that the groundwater flow direction and gradients are consistent and stable quarter-to-quarter and year-over-year. This is shown on the EMF RI and post-EMF RI quarterly groundwater contour maps from 1995 through May 2008 that are provided in Appendix B.

The attached Table 4.3-1 summarizes the status of the Bannock and Michaud hydrogeochemical regime RI representative wells and the additional upgradient wells installed at the FMC Plant OU that should be included in the representative well networks and data sets. The table provides summary information on the construction and lithology of the screened intervals of the wells. The boring logs and well construction diagrams for the representative wells, with the exception of the Idaho Power and PEI-1 wells that could not be located in FMC's files, were provided to the Agencies on March 17, 2008 and are not reproduced in this report.

Arsenic Analytical Results for Representative Wells

Table 4.3-1 also provides a summary of the total arsenic results for each well, but does not include analytical results for dissolved arsenic. Dissolved results are not included, as FMC anticipates that EPA would not allow the use of dissolved results in potentially impacted wells to compare to the representative groundwater level for arsenic. In addition, dissolved arsenic analyses were performed on a relatively small subset of the representative wells and total number of samples and would add relatively few additional data points to the re-calculation of the representative level. Dissolved results thus should not be included in the data set for the representative level re-calcuation.

As documented in the PSCS and the EMF RI Report, there is significant variability in arsenic levels in wells up-gradient of the EMF Site and the FMC Plant OU. However, as evidenced by comparing the RI data set with longer-term data sets at wells such as 158, 305, 101, 147 and 515, the range and averages of arsenic results at these wells have not changed significantly since the time of the RI.

In summary, the locations of the RI and post-RI wells are appropriate to define representative or background groundwater chemistry that flows from upgradient of the FMC Plant OU. Consistent with the findings of the RI, wells located in the Bannock Hills to the south of the facilities are typically within the Bannock (calcium bicarbonate) hydrogeochemical regime and wells in the flats to the west of FMC's operations are located within the Michaud (calcium chloride) hydrogeochemical regime. The data from these wells span over 17 years and provide a more than adequate data set for statistical evaluation of groundwater representative levels for

arsenic for the Bannock and Michaud regimes, or alternately, a combination ("Combined" or "mixed") representative level for groundwater from both regimes flowing beneath the site.

Common Ion Results for Representative Wells

Based on a request from IDEQ representatives to review the general chemistry data for the representative wells, FMC provided the Agencies with a summary of the common ion data via electronic mail on April 16, 2008. The attached Table 4.3-2 is a revised version of the summary of common ion data for the representative wells that was provided to the Agencies. The table has been revised to include well 516 and the summary nutrient (nitrate, total phosphorus and orthophosphate) data for the representative wells. The addition of well 516 and the nutrient data are discussed below under "Adjustment of Representative Well Networks."

As stated previously, EMF sources that impacted groundwater all contributed high concentrations of major ions (K, Ca, Na, Cl and sulfate). The common ion concentrations for these wells are not elevated for the key EMF-impact indicators, particularly potassium, chloride and sulfate, and therefore are appropriate for selection as representative (non-EMF impacted) wells. The chloride and sodium data illustrate the difference between the Bannock (calcium-bicarbonate) and Michaud (calcium-chloride) hydrogeochemical regimes as identified in the RI.

Adjustment of Representative Well Networks

During the Agencies-FMC teleconference call on April 14, 2008, the Agencies provided the following input regarding the representative well networks:

- EPA's stated rationale for dropping wells PEI – 1 and IPCo was the lack of boring logs or well construction diagrams available for these wells. FMC agreed to exclude these wells from statistical analyses due to the lack of well construction details.

- Exclude wells 106 and 158 from the Bannock regime well network. EPA's stated rationale for dropping wells 106 and 158 was that these wells are not unequivocally located hydraulically upgradient from any potential EMF sources. FMC agreed to exclude these wells given the location of the wells hydraulically downgradient from potential sources on the FMC Plant OU. However, the common Exclude wells PEI-1 and the Idaho Power (IPCo) well from the Bannock regime well network. ion data for these wells do not indicate these wells have been impacted by an EMF-related source(s).

- Exclude wells 101 and 102 from the Michaud regime well network. EPA's stated rationale for dropping wells 101 and 102 was the apparent "high" total phosphorus mean concentrations as reported in Table 4.4-1 of the EMF RI Report. FMC does not agree that these wells should be excluded from the representative well network. During the teleconference on April 14, FMC pointed out the fact that these wells are hydraulically upgradient from any potential EMF sources and the major ion results for these wells are not elevated and do not indicate any EMF-impact. FMC speculated that the apparently

elevated mean total phosphorus reported for these wells may be anthropogenic (prior agricultural use of area). FMC restated the fact that the common ion data show that groundwater at these wells is not EMF site-impacted and groundwater at these wells flows beneath the FMC Plant OU; therefore, wells 101 and 102 should remain in the representative well set regardless of the reason for the apparently elevated total phosphorus. Upon review of the RI total phosphorus results for wells 101 and 102, the EMF RI-reported means appears to be erroneous, as further discussed and described below in "Status of Wells 101 and 102 as Upgradient Representative Wells."

- Add cross-gradient well 516, presumably as a logical addition to cross-gradient wells 514 and 515 that were originally selected as RI representative wells. FMC agreed to add well 516 to the Michaud representative well network. FMC noted that the well 514 common ion chemistry is more similar to Bannock hydrogeochemistry despite inclusion of well 514 in the Michaud regime, which was likely due to its location, for the EMF RI representative level calculations. No recommendation was made to change the classification of well 514 from Michaud to Bannock.

In addition, EPA also suggested during the April 14, 2008 teleconference that calculation of the representative groundwater arsenic concentration should include a well set that is a combination of the Bannock and Michaud regime well sets (e.g., "Combined" well set). Based on the April 14, 2008 teleconference, the following well sets were developed:

Representative Well Network Designation	Monitoring Well Set
Bannock	169, 301, 305
Michaud	101, 102, 173, 174, 175, 179, TW-10S, 147, 514, 515, 516
Michaud w/o wells 101/102	173, 174, 175, 179, TW-10S, 147, 514, 515, 516
Combined	101, 102, 173, 174, 175, 179, TW-10S, 147, 514, 515, 516, 169, 301, 305
Combined w/o wells 101/102	173, 174, 175, 179, TW-10S, 147, 514, 515, 516, 169, 301, 305

Status of Wells 101 and 102 as Upgradient Representative Wells

As discussed during the April 14, 2008 conference call and shown on Table 2, the mean concentrations of common ions for wells 101 and 102 are very similar to the means of the other selected Michaud representative wells with the exception of well 514, which as discussed above

is more similar to Bannock hydrogeochemistry. In particular, the key indicators of FMC-related groundwater impacts – potassium, chloride and sulfate are well within the range of the other Michaud representative well mean concentrations. Thus, the weight of evidence does not suggest that wells 101 and 102 are influenced by FMC-impacted groundwater.

During the April 14, 2008 discussion, EPA pointed to the mean total phosphorus concentrations reported for wells 101 and 102 in Table 4.4-1 of the EMF RI Report as indicative of a site-related impact that made these wells unsuitable as representative wells. Although the mean total phosphorus concentration in wells 101 and 102 appears elevated compared to the other RI representative wells, FMC stated that other non-FMC sources may have contributed elevated total phosphorus at these wells. However, prompted by EPA's concerns, a rigorous review of the underlying RI and post-RI data was conducted and a more likely and straightforward explanation is evident.

As a starting point, the reported RI mean orthophosphate concentrations for wells 101 and 102 are not elevated compared to the other representative wells. In addition, the orthophosphate and total phosphorus mean concentrations are essentially the same (within acceptable laboratory accuracy/precision for each method and rounding calculated means) in all of the other representative wells. Therefore, the underlying total phosphorus results reported for well 101 and 102 were re-examined in order to understand the anomalously elevated total phosphorus means at wells 101 and 102.

The total phosphorus results for wells 101 and 102 are presented on Table 4.3-3. As shown on the table, the first (initial sample following well installation) total phosphorus results reported for each of wells 101 and 102 (October 2 and 12, 1990, respectively) was 3 mg/l. The next highest total phosphorus results from subsequent analyses are 0.1 and 0.41 mg/l for wells 101 and 102, respectively. In addition, the total phosphorus results for both wells 101 and 102 decrease rapidly and steadily over the October 1990 through December 1991 quarterly sampling period as shown on Figure 4.3-2.

The orthophosphate results for wells 101 and 102 from the October 2 and 12, 1990 sampling (reported at 0.12 mg/l for both wells) also appear anomalously elevated compared to the remaining results and means (as shown in EMF RI Table 4.4-1, the means are 0.02 mg/l for both wells). Further evidence that the initial total phosphorus and orthophosphate results are anomalous is that, if valid, they would describe a pattern of sharp decreasing levels of these constituents over time given the much lower results reported subsequently. Yet such a pattern of sharp decrease is not observed for any other constituents. This is shown on Figure 4.3-2. There also is no decreasing (or other discernable) pattern for the common ions or arsenic results for wells 101 and 102 during the October 1990 through December 1991 sampling period. Those results are shown on Figures 4.3-3 and 4.3-4 respectively. The fact that no other constituent levels have sharply decreased since the initial sampling strongly suggests that the October 1990 results for total phosphorus and orthophosphate, which describe such a pattern for those constituents, are spurious.

The initial total phosphorus results reported for both well 101 and 102 are very likely erroneous, potentially due to contamination introduced during construction of the wells that was not purged during well development but was purged during subsequent sampling in 1990-1991. The RI means (replicating the means shown on Table 4.4-1 of the EMF RI Report), the mean total phosphorus values for wells 101 and 102 excluding only the October 2, 1990 (initial) sample result as an outlier, and the mean total phosphorus values for wells 101 and 102 excluding the first three (October 1990, April 1991 and June 1991) results for each well are shown on Table 4.3-3. A comparison of the RI means and recalculated mean values are summarized below:

Mean Total Phosphorus Calculation Basis	**Well 101**	**Well 102**
EMF RI Table 4.4-1 (all results prior to 1994)	0.27	0.32
All data excluding 10/2/90 result	0.039	0.091
All data excluding first 3 results (10/90 – 6/91)	0.034	0.042

* Mean values are in mg/l.
** Means calculated using undetected results at full reported value.

The mean total phosphorus values calculated excluding the first three (October 1990, April 1991 and June 1991) results for wells 101 and 102 are consistent with the RI reported orthophosphate means and with the total and orthophosphate means reported for the other representative wells as shown on Table 4.3-2. This detailed review of the data for wells 101 and 102 has shown that the apparently elevated total phosphorus in these wells (EMF RI Table 4.4-1) was based on erroneous data. The well 101 and 102 total phosphorus concentrations are consistent with the common ion concentrations in demonstrating that these are clearly upgradient representative wells. Therefore, wells 101 and 102 have been retained for the calculation of the Michaud regime and Combined ("mixed") representative groundwater arsenic concentrations as presented below.

4.3.2 Data for Calculation of Groundwater Arsenic Representative Levels

The locations of the Bannock and Michaud hydrogeochemical regime representative wells used for the reevaluation are shown on Figure 4.3-5. The representative groundwater arsenic concentrations for the Bannock and Michaud regimes and a Combined well group were calculated based on the following representative well sets:

Representative Well Groups	**Monitoring Well Set**
Bannock	169, 301, 305
Michaud	101, 102, 173, 174, 175, 179, TW-10S, 147, 514, 515, 516
Combined	101, 102, 173, 174, 175, 179, TW-10S, 147, 514, 515, 516, 169, 301, 305

Dissolved (filtered) arsenic data were excluded from the data set for each well and calculation of representative concentrations for the well sets. As stated previously, FMC anticipates that EPA would not allow the use of dissolved results in potentially impacted wells to compare to the representative groundwater level for arsenic. Dissolved results thus should not be included in the data set for re-calculation.

Total arsenic data for the period covering the initial sample collected (dependent on the date of well installation and initial sampling) through the fourth quarter of 2007 were used for each of the selected wells and representative well groups. The Bannock and Michaud representative well data sets used in the calculations described below are provided on Tables 4.3-4 and 4.3-5, respectively.

As noted on Table 4.3-4, the well 305 sample # S212406A (12/13/1992) was excluded from the calculation. The FEDS database indicates this result is associated with a primary sample; however, the sample number suggests (but could not be verified) that the sample/result was a duplicate of sample S212404A.

As noted on Table 4.3-5, the well 101 sample # F212480 (12/2/1992) was also excluded from the calculation. The FMC Environmental Data System (FEDS) database that contains the cumulative groundwater monitoring results for the FMC groundwater monitoring wells similarly indicates this result is associated with a primary sample; however, the sample number suggests (but could not be verified) that the sample/result was a duplicate of sample F212412. In addition, the well 175 result for sample # 611175 (11/7/2006) was incorrectly entered into the FEDS database at 0.078 mg/l. Per the original laboratory report, the correct value is 0.0078 mg/l and the correct value has been used in the calculations.

Following standard practice, the duplicate pairs were used as a single sample result following these rules:

- If there were detections in both samples, the results were averaged;
- If both results were non-detects, the sample with the lower detection limit value was used (e.g., if the results were <5 and <10, the actual concentration was assumed to be less than 5); and,
- If there was both a detect and a non-detect, and the positive result was less than the reporting limit in the 2nd sample, the positive result was used (e.g., 3 and <5 was assigned a value of 3).

Non-detected data for primary sample results (without duplicate pairs) were treated as recommended by ProUCL as discussed below.

4.3.3 Statistical Evaluation and Calculation of Representative Arsenic Concentration using ProUCL

Consistent with the EMF RI and the post-RI groundwater results discussed in Section 4.2 above, the groundwater results for site wells are compared to the representative concentrations on an individual observation (i.e., point-by-point) basis. That is, the result for each well, parameter and sampling event is compared to the representative concentration calculated for each parameter and appropriate hydrogeochemical regime to evaluate whether the result is higher (potentially site impacted) or below (potentially not site impacted). For example, the well 156 potassium result for the May 2008 sampling event is compared to the Michaud representative potassium concentration. In this example, the well 156 potassium result for May 2008 is higher than the Michaud representative concentration and is indicative that the well is site impacted.

In some sections of this report, the text states that an average parameter concentration for a specific well is above the representative concentration. These comparisons acknowledge the fact that most if not all of the individual data points used to calculate the average for the specified well exceed the representative concentration and therefore a point-by-point comparison is excluded for brevity. Concentration averages are not used to conclude that a specific parameter at a well is below the representative concentration and only the underlying (single) data points are compared to the representative concentration.

Consistent with the ProUCL guidance, background threshold values (BTVs) were calculated for the Bannock, Michaud and Combined representative well data sets using EPA's ProUCL v.4 software (U.S. EPA 2007a; 2007b). This software calculates three different general types of BTVs: upper percentiles, upper tolerance limits (UTLs), and upper prediction limits (UPLs). Each of these can be calculated from normal, lognormal, or gamma distributions, as well as with nonparametric (distribution-free) methods.

The ProUCL guidance recommends the use of upper threshold limits for the point-by-point comparisons utilized in the EMF RI and in this report for the post-RI groundwater results. The following quotes are taken directly from the ProUCL guidance in support of the approached used in the EMF RI (95th percentile) and in this reevaluation of the representative arsenic concentration:

"In background versus site comparison studies, the population parameters of interest are typically represented by *upper threshold limits* (e.g., upper percentiles, upper confidence limits of an upper percentile, upper prediction limit) of the background data distribution. It should be noted that the upper threshold values are estimated and represented by upper percentiles and other values from the upper tail of the background data distribution. These background upper threshold values do not represent measures of central tendency such as the mean, the median, or their upper confidence limits."

"There are many instances in background evaluations and background versus site comparison studies, when it is not appropriate to use a 95% UCL. Specifically, when point-by-point site

observations are to be compared with a BTV, then that BTV should be estimated (or represented) by a limit from the upper tail of the reference set (background) data distribution."

"A UPL, an upper percentile, or an UTL represents an upper limit to be used for point-by-point individual site observation comparisons. UPLs and UTLs are computed based upon background data sets, and individual site observations are compared with those limits. A site observation for a contaminant exceeding a background UTL or UPL may lead to the conclusion that the contaminant is a contaminant of potential concern (COPC) to be included in further risk evaluation and risk management studies."

"When individual point-by-point site observations are compared with a threshold value (pre-determined or estimated) of a background population or some other threshold and compliance limit value, such as a PRG, MLC, or ACL, then that threshold value should represent a not-to-exceed value. Such BTVs or not-to-exceed values are often estimated by a 95% UPL, UTL 95%-95%, or by an upper percentile."

Prior to calculating the BTVs, ProUCL recommends an evaluation of outliers and notes the sensitivity of nonparametric methods to the presence of upper tail outliers. ProUCL was used to perform outlier statistical tests on the Bannock, Michaud and Combined data sets. For the Michaud and Combined data sets (where there are more than 25 detections), Rosner's test was used. This test can identify up to 10 potential outliers. The test was run at a 5% significance level. For the Bannock data set, Dixon's test for extreme values was used, which is appropriate when there are less than 25 detections. In addition, quantile-quantile (Q-Q) plots were reviewed for all of the data sets.

No outliers were identified by the Rosner or Dixon tests. The Q-Q plots indicated that the data are self-consistent as well. It was concluded that there are no outliers in the data sets.

Per the recommendations of the ProUCL documentation and the recommendations accompanying the ProUCL outputs, the representative groundwater arsenic concentrations (BTVs) for the Bannock, Michaud and Combined data sets were calculated using 95% UPLs based on the nonparametric higher order statistics method. The rationale for this benchmark is discussed below.

An upper percentile, such as the 95th percentile of the background data set, can be calculated very simply. For example, if there are 100 data points, the 95th percentile is simply the 95th highest data point. Interpolation can be performed if necessary. For example, with the Michaud data set where there are 273 data points, one could obtain a 95th percentile by performing an appropriate interpolation between the 259th and 260st highest data points. If the data follow a specific distribution, the distributional information can be used to infer a specific percentile. For example, with a normal (Gaussian) distribution, 95 percent of the data points will be less than or equal to the mean plus 1.65 times the standard deviation.

UTLs and UPLs are similar in concept. The UTL establishes a concentration range that will contain a specified proportion of the population with a specified degree of confidence. For

example, one can calculate a 95/90 UTL, which is the concentration that includes 95% of the background population with 90% confidence. A UPL is a concentration expected to contain a specified percentage of all future measurements of the same population.

Previous U.S. EPA guidance suggested the use of a 95/95 UTL as a background comparison value (U.S. EPA, 1989). However, subsequent analysis indicated that this statistic was likely to contain 98% of the population (U.S. EPA, 2007a). In fact, the UTLs were constructed in a manner to contain a *minimum* of the indicated percent coverage. In contrast, the UPL is calculated in a manner that will converge on a specified upper percentile with large data sets, while providing a reasonable inference of this statistic with smaller data sets. The ProUCL documentation recommends the use of the UPL as a background comparison value (U.S. EPA, 2007a).

The manner in which the UPL is calculated depends on the nature of the data set. For the Bannock, Michaud and Combined representative well data sets, ProUCL recommends using a nonparametric method of calculating the UPL. Nonparametric methods can handle non-detect values with variable detection limits as is the case for the Bannock, Michaud and Combined data sets. Details of the nonparametric calculation methods can be found in the ProUCL documentation (U.S. EPA, 2007a).

A nonparametric method is preferred because non-detect results make it much more difficult to determine the distribution of a data set (U.S. EPA, 2007a). Note that tests of a distribution (such as the Shapiro-Wilk test for normality) are set up such that the null hypothesis is that the data are consistent with the assumed distribution. Thus, data need to show a significant deviation from normality for the null hypothesis to be discarded. With the presence of non-detects, the task of determining whether a data set fits a particular distribution becomes even more challenging. Using an assumed distribution to estimate an upper percentile value can give a highly erroneous result if the data are distributed differently. Thus, there is a preference for nonparametric methods.

ProUCL calculates nonparametric UPLs using three basic methods: one makes use of higher order statistics, another is based on the Student's t statistic (Kaplan-Meier), and one makes use of Chebyshev polynomials. As described in the ProUCL Technical Guide, the Chebyshev method has relatively low power that can result in inflated values of the UPL and is not discussed further here. The Kaplan-Meier (KM) method assumes a t-distribution and the ProUCL Technical Guide indicates that the KM method is not recommended as the use of the t-statistic might fail to provide the specified coverage (e.g., 95%). Thus, based on the ProUCL Technical Guide and evaluation of the data set, the most appropriate statistical method for the Bannock, Michaud and Combined data sets is the 95% UPL based on higher order statistics.

Following the initial ProUCL run, a high non-detect (U) value was identified within the Michaud (and thus the Combined) data set, specifically the result of 0.016 mg/l (U) for well 101, sample # 611101, sample date 11/22/1996. A non-detect with an elevated reporting limit has the potential to inflate the background threshold, given that the actual arsenic concentration could be just below 0.016 mg/l, but also could be close to zero. In effect, this data point has an unacceptably

high degree of uncertainty. Consequently, this data point was removed from the Michaud and Combined data sets and the calculation was rerun in ProUCL. As expected, the ProUCL rerun without the high non-detect value resulted in a calculated 95% UPL that is slightly lower than the initial data set run. The results presented below are from the ProUCL rerun without the high non-detect in either the Michaud or Combined data sets.

Results

The ProUCL output files for the Bannock, Michaud and Combined representative well data sets are provided on Tables 4.3-6, 4.3-7 and 4.3-8, respectively. The results are summarized below:

Representative Well Group Designation	**Arsenic Representative Level (ug/l) 95% UPL**
Bannock	17.0
Michaud	14.1
Combined	14.2

A comparison of the EMF RI-calculated 95th percentile Bannock and Michaud representative groundwater arsenic concentrations (EMF RI Table 4.4-1) and the calculated 95% UPL representative levels for the Bannock, Michaud and Combined data sets is provided below:

Representative Well Group Designation	**Arsenic Representative Level (ug/l) 95th Percentile (EMF RI)**	**Arsenic Representative Level (ug/l) 95% UPL**
Bannock	18.0	17.0
Michaud	14.9	14.1
Combined	16 [a]	14.2

[a] A "Combined" 95th percentile value was not calculated or reported in the EMF RI Report, the value shown on this table is a calculation using the same data (EMF RI representative wells, pre-1994 results) used to calculate the EMF RI Bannock and Michaud 95th percentile representative values.

4.3.4 EPA Review Comments on the Reevaluation of Groundwater Representative Arsenic Concentrations

EPA provided comments on FMC's re-evaluation of groundwater representative arsenic concentrations in a memorandum and attachment dated *August 18, 2008 ("Review comments, the EMF Groundwater Representative Arsenic Concentration Review and Reevaluation, July 2008, FMC"*). A copy of the EPA memorandum is included in Appendix H. The EPA memorandum comments focused on discrediting the use of wells 101 and 102 as representative wells based on several points summarized below:

- "FMC has stated that the commons ion data at locations of MW-101 &102 do not show any impact of contaminated ground water. The common ion data which is being used for this line of evidence may not be sensitive enough. This data (common ions) is measured in 10's to 100's of parts per million (mg/l). The arsenic concentration data are in the range of 5 to 15 parts per billion (µg/l). The change of the common ion data at a range of 10 part per million may be unaffected when measuring arsenic changes in the range of tens of part per billion."

- "The general up-gradient ground water flow direction (to wells 101 and 102) is coming from the southeast near the area of an existing landfill and near the location of MW-138." The EPA hypothesis that the at FMC landfill is the source of arsenic at wells 101 and 102 is advanced using a surfer generated groundwater elevation plot and a comparison of arsenic results from wells 101 and 102 to FMC-impacted wells in proximity to the former unlined phossy pond and Pond 8S.

The EPA memorandum then presents a variety of data presentation methods and statistics to conclude that "wells 101 and 102 have statistically higher total arsenic concentrations than the other wells in the Michaud regime."

<u>Use of Common Ions as Indicators of EMF Groundwater Impacts</u>

In response to the first point, EPA has apparently misinterpreted the purpose and utility of evaluating the common ion data for the EMF Site. The potassium, chloride, sulfate and other common ion data are NOT used to predict or track changes in other parameters, arsenic or otherwise. As described in Sections 4.1 and 4.2 of this report, common ions are compared to their individual representative levels to evaluate EMF-impacts and the common ions potassium and sulfate are very reliable indicators of EMF groundwater impacts. The Michaud regime representative concentrations for potassium, chloride and sulfate are 12.7, 192.9 and 72.6 mg/l respectively (Table 4.2-1). Wells impacted by FMC sources in the western pond area and central plant area are readily identified by potassium and sulfate concentrations as little as 1.3 times the representative concentrations (e.g., potassium concentration of 16 mg/l and sulfate concentrations of 94 mg/l). The EMF RI and post-RI analytical methods used for potassium, chloride and sulfate analyses typically have a detection limit of 0.1, 1.0 and 1.0 mg/l respectively. These methods and detection limits are more than adequately sensitive to discern site-related groundwater impacts when comparing, for example, potassium concentrations in

wells 101 and 102 that range from a minimum of 6.2 mg/l to maximum of 11.5 mg/l for all results from October 1990 through May 2008 to the representative concentration of 12.7 mg/l. As described above under Common Ion Results for Representative Wells and Status of Wells 101 and 102 as Upgradient Representative Wells, the common ion and nutrient concentrations at wells 101 and 102 are consistently below representative concentrations and provide significant evidence that these wells are not impacted by FMC (or EMF) sources.

EPA's Plant Landfill Hypothesis

In response to EPA's hypothesis that the FMC plant landfill is the source of "statistically higher total arsenic concentrations than the other wells in the Michaud regime," the EPA lines of evidence are addressed in the same general order as discussed in the EPA memorandum.

First, the EPA hypothesis ignores the fact that two borings F027 and 138 were drilled at the FMC plant landfill to total depths of 140 and 168 bgs and did not encounter groundwater in either the loess and alluvial sediments or the underlying volcanic bedrock. During the EMF PSCS in 1990, boring 138 was installed in the northwestern (expected downgradient) corner of the FMC plant landfill with the intent to convert the boring into shallow groundwater zone monitoring well 138. However, no monitoring well was installed because the boring did not encounter groundwater in the loess/alluvial layer or the underlying volcanic bedrock to a total depth of 168 feet bgs. Although "abandoned shallow well" 138 is shown on the EMF RI well location maps and the well location maps contained in this report, this is the location of "dry hole" 138. During the EMF RI in 1992, boring F027 was drilled at the FMC plant landfill. Boring F027 was located approximately 165 feet to the east and 23 feet north of boring 138 and was located near the middle of the northern edge of the plant landfill area. Boring F027 was drilled to collect soil samples for analysis of potential migration of landfill-related constituents in the subsurface at the landfill. Boring F027 did not encounter groundwater in the loess/alluvial layer or the underlying volcanic bedrock to a total depth of 140 feet bgs. The results of the soil sampling and analysis from boring F027 are presented in the EMF RI Section 4.2, subsection 4.2.3 Characterization of Potential Sources and FMC Facility Soils - Active Landfill, pages 4.2-144 through -146 and are not reproduced here. However, specific to potential arsenic migration in the subsurface at the plant landfill, arsenic was below the detection limits in all of the soil samples collected from boring F027. A copy of the boring logs for 138 and F027 are included as Appendix I.

Soil Sample Results for Arsenic from EMF RI boring F027

STA_ID	CHEM_NAME	SAMP_ID	SAMP_DATE	CONC_DET	UNITS	QUAL
F027B	Arsenic, total	F027B000	9/14/1992	4.00000	mg/kg	U
F027B	Arsenic, total	F027B010	9/14/1992	6.50000	mg/kg	UJ
F027B	Arsenic, total	F027B020	9/14/1992	5.00000	mg/kg	UJ
F027B	Arsenic, total	F027B030	9/14/1992	4.60000	mg/kg	U
F027B	Arsenic, total	F027B040	9/14/1992	4.40000	mg/kg	U
F027B	Arsenic, total	F027B050	9/14/1992	3.60000	mg/kg	U
F027B	Arsenic, total	F027B060	9/14/1992	2.30000	mg/kg	U
F027B	Arsenic, total	F027B070	9/14/1992	4.50000	mg/kg	U
F027B	Arsenic, total	F027B080	9/14/1992	3.50000	mg/kg	U
F027B	Arsenic, total	F027B090	9/14/1992	4.00000	mg/kg	U
F027B	Arsenic, total	F027B100	9/14/1992	3.10000	mg/kg	U
F027B	Arsenic, total	F027B110	9/14/1992	4.20000	mg/kg	U
F027B	Arsenic, total	F027B120	9/14/1992	5.00000	mg/kg	U

Second, the EPA memorandum implies that arsenic concentrations are perceived to be elevated (above EPA's view of the representative arsenic concentration) in other wells located north of the plant landfill area. EPA cites arsenic concentrations at wells 165, 137, 167 and 158. But EPA's memorandum fails to acknowledge that wells 165, 137 and 167 are located adjacent to or within the footprint of former unlined phossy ponds that are known to have impacted groundwater in the western ponds area as described above in Section 4.2. In summary, the average potassium, chloride and sulfate concentrations in well 165 all exceed their respective Michaud representative concentrations; individual potassium results and the average sulfate concentration in well 137 exceed their respective Michaud representative concentrations; and the average potassium and sulfate concentration in well 167 exceed their respective Michaud representative concentrations. Finally, individual potassium results and the average sulfate concentration in well 158 exceed their respective Michaud representative concentrations. Note that for the purpose of this summary, the comparison of an average concentration above the

representative concentration acknowledges the fact the most if not all of the individual data points used to calculate the average exceed the representative concentration. Concentration averages are not used to conclude that a specific parameter at a well is below the representative concentration.

Third, the EPA memorandum groundwater "surfer-generated" plot of groundwater elevations not only ignores the fact that alluvial and bedrock groundwater is not encountered at the plant landfill area, the plot also does not respect data from other wells within the plot area and projects groundwater elevations where there are insufficient data to support the interpretation. Even if the plot is taken as accurate, the groundwater contour and flow lines (perpendicular to the contours) contradict EPA's hypothesis. The coordinates for dry hole 138 at the northwest corner of the plant landfill are N 447575.4 and E554886.3. A flow line from dry hole 138 projected downgradient leads to the approximate location of well 167 (not shown on EPA's surfer plot). Well 167 is approximately 1,000 feet to the east of well 137 and over 2,000 feet to the east of wells 101 and 102. As shown on the numerous EMF RI and FMC post-RI quarterly groundwater contour maps (Appendix B), if there was shallow or deep groundwater beneath the plant landfill, the EMF/FMC groundwater contours maps would suggest a flowpath from the landfill area to the area between wells 137 and 167. Again, well 137 is located over 1,000 feet to the east of wells 101 and 102.

In conclusion, the EPA hypothesis regarding the FMC plant landfill area as the source of arsenic concentrations at wells 101 and 102 must be rejected based on the evidence presented above.

<u>EPA evaluations of the arsenic ground water data from the representative well groups</u>

The EPA memorandum at pages 4 through 13 and Table 1 presents an evaluation of the arsenic results from the representative well groups. In summary, the memorandum uses various data presentation methods and statistics to conclude that "wells 101 and 102 have statistically higher total arsenic concentrations than the other wells in the Michaud regime." The memorandum also suggests that the Michaud regime wells "cluster into 3 distinct well groupings," and raises issues regarding the use of "old data."

With respect to the use of "old data," the memorandum raises questions regarding the analytical methods and reporting limits used for the "old samples" and whether the "old data still accurately reflects current background conditions." On the first point, groundwater samples were analyzed for arsenic using EPA 7060A with a MDL of 0.001 mg/l during the EMF PSCS, EMF RI and for FMC's routine groundwater monitoring programs up until about 1997. After about 1997, groundwater samples have been routinely analyzed for arsenic using EPA 6010 with MDLs in the range of 0.002 mg/l. As expected, some results have elevated detection limits due to sample and/or SDG-specific data quality issues (e.g., matrix interference, blank contamination, etc.). Overall, the methods and MDLs have met the DQOs for the groundwater monitoring programs. Although the arsenic analytical method has changed since the EMF RI, there is no valid reason to reject the data simply because they are classified as "old." On the second point, there have been no significant changes in land occupancy or land use in the areas hydraulically upgradient from the site (i.e., no identifiable anthropogenic "sources" have been

removed or added) during the 1990 - 2008 period. Surrounding land and water use during the EMF RI and currently are described in Sections 1.2 and 1.3 above. Considering the lack of changes in surrounding land and/or groundwater uses in areas hydraulically upgradient and downgradient from the EMF Site, there is no reason to expect that representative groundwater quality has changed significantly in the last 18-plus years.

The EPA memorandum concludes that the Michaud wells group together into three (3) distinct groups with statistically different levels of arsenic concentrations. Based on EPA's analysis of arsenic concentration means, wells 101 and 102 are in one group, wells TW-10S, 179, 175, 514 and 516 are in a different group, and wells 173, 174 and 515 are in a third group. The EPA evaluation does not acknowledge the fact that, for example, wells 173 and 179 are located right next to each other (within 100 feet) and, despite their different screened intervals (4379.8 to 4364.8 feet msl in well 173 and 4401.5 to 4391.5 feet msl in well 179), both monitor the shallow groundwater zone. Similarly, wells 514, 515 and 516 would be grouped together if only these wells' hydraulic relationship to the EMF Site was taken into consideration. EPA's suggested well groupings are contrary to the hydraulic and hydrogeochemical relationships of these wells.

Because the EPA statistical evaluation is based only on arsenic results for the representative wells, the EPA evaluation and well grouping fails to recognize the underlying groundwater chemistry and, thus, fails to acknowledge the variability of groundwater arsenic concentrations upgradient from the EMF Site. The Bannock and Michaud hydrogeochemistries are well documented in the EMF PSCS and EMF RI Reports based on underlying common ion chemistry (Section 2.2 above and the Stiff and Piper diagrams – EMF RI Figures 3.3-11 and 3.3-12A through D). As described above, FMC did not propose the "Combined" data set and that set is not supported by the hydrogeology (hydraulic relationships to the site) or hydrogeochemistry. The underlying common ion geochemistry for the Michaud well group (except well 514 as pointed out above) is consistent with Michaud hydrogeochemistry. The Combined data set ProUCL calculation of the representative arsenic concentration was performed at the direction of EPA.

The variability in background arsenic concentrations is influenced by the underlying geology (andesites, rhyolites, and tuffs) in the Bannock Range to the south (hydraulically upgradient) and by irrigated and dry land agricultural uses to the west, northwest and north (hydraulically up- and cross gradient) of the EMF Site. Of note are the arsenic results from the Idaho Power well that is located hydraulically upgradient from the EMF Site and also over 900 feet south and generally upgradient of wells TW-10S, 169, 101 and 102. The arsenic results from the Idaho Power well ranged from 0.0105 to 0.0204 mg/l and had an average of 0.0156 mg/l. Although FMC did not take issue with EPA's direction to exclude the Idaho Power well from the representative arsenic concentration recalculation (due to the lack of well construction information), the Idaho Power well results provide additional evidence that arsenic concentrations in groundwater upgradient from the EMF Site are variable and should not be used as a primary indicator of the fundamental hydrogeochemical association of the groundwater at any given well. Note that the groundwater geochemistry at the Idaho Power well and well 169 is Bannock, while wells TW-10S, 101 and 102 are Michaud. An evaluation of arsenic concentrations alone would suggest that the Idaho Power well and wells 101 and 102 should be grouped together.

The variability in arsenic concentrations in this area of Idaho is also apparent from the arsenic results for wells in the "NE American Falls" Arsenic Area within the "Arbon Valley" Aquifer System (west, northwest and north of the EMF Site) obtained by the IDEQ. The IDEQ reported that for the 35 Arbon Valley area wells and springs nine (9) results (26%) were > 10 ug/l. Excluding the public water supply (PWS) wells that included the FMC and Simplot facility production wells, the arsenic results for the 23 private wells and 3 springs in the NE American Falls Arsenic Area, Arbon Valley Aquifer System ranged from 0.99 to 57 ug/l, and 5 of the 26 results (19%) were > 10 ug/l. The IDEQ report is entitled "Groundwater Technical Report 23, Preliminary Evaluations of Arsenic Detections in Ground Water: A County-Level Arsenic Review," IDEQ 2004.

In summary, EPA's evaluation is too narrowly focused on a single parameter (arsenic) to determine a "grouping" for wells that are hydraulically upgradient or cross-gradient from the EMF Site. The Bannock and Michaud hydrogeochemical regimes are well documented and are based on well-established hydrogeochemical principles that evaluate the underlying common ion relationships. The evaluation also fails to acknowledge the variability in groundwater arsenic concentrations in the areas upgradient from the EMF Site that is likely due to a combination of natural and anthropogenic influences.

<u>EPA Calculation of a 95% Upper Confidence Limit (UCL) on the Mean for Groundwater Aresenic Concentrations form the Representative Well Data</u>

An untitled and undated EPA paper received by FMC via electronic mail on September 3, 2008 included the results of EPA's calculation of the 95-percent upper confidence limit (UCL95) on the mean for the Combined data set (combined Bannock and Michaud – 14 wells) and the Combined data set excluding well 101 and 102 (12 wells). A copy of the EPA paper is included in Appendix H. EPA apparently did not calculate either a Bannock or Michaud regime arsenic UCL95. In addition, EPA apparently did not follow the suggestion in the paper that the Michaud wells be further divided into 3 groups. The mean for the 12 well grouping was 0.0045 mg/l and the UCL95 was 0.005 mg/l. The mean for the 14 well grouping was 0.0056 mg/l and the UCL95 was 0.0062 mg/l. As footnoted in Table 1 of this EPA paper, half the reported values were used for non-detects. This treatment of non-detects is arguable and not fully supported by the ProUCL guidance.

Rather than rebut the details of the EPA calculation of the UCL95, FMC utilized ProUCL to calculate a 95% Upper Confidence Limit for representative arsenic concentrations as described below.

4.3.5 Calculation of 95% Upper Confidence Limit for Representative Arsenic Concentrations using ProUCL

The National Primary Drinking Water Regulations; Arsenic and Clarifications to Compliance and New Source Contaminants Monitoring; Final Rule, 40 CFR Parts 9, 141 and 142 [Federal Register: January 22, 2001 (Volume 66, Number 14), Page 6975-7066] states "compliance with the [arsenic] MCL is determined by a running annual average." Consistent with the Drinking Water Regulations, EPA has represented its intention that FMC's performance and compliance

monitoring with respect to meeting the groundwater Remedial Action Objectives (RAOs) will be determined based on average concentrations from multiple wells and sampling events. Consistent with the ProUCL guidance, a mean groundwater representative arsenic concentration is necessary for comparison to the threshold value (i.e., arsenic MCL) that is also based on an average value (e.g., water system compliance with the arsenic MCL).

As described in the ProUCL guidance:

> *"A UCL represents an average value that should be compared with a threshold value also representing an average value (pre-established or estimated), such as a mean cleanup standard, Cs. For an example, a site 95% UCL exceeding a cleanup value, Cs, may lead to the conclusion that the cleanup level, Cs, has not been attained by the site area."*

Therefore, FMC calculated a 95% UCL for the representative arsenic concentrations for the Bannock, Michaud and Combined data sets. FMC used the same Bannock, Michaud and Combined data sets presented in Tables 4.3-4 and 4.3-5 as were used for the calculation of the 95% UPL. For a discussion of the development of that dataset (data treatment, outlier evaluation and elimination of 3 data points), refer to Section 4.3.2 and 4.3.3 above. These final data sets are appropriate for both the 95% UPL and 95% UCL calculation. As noted in 4.3.4 above, the ProUCL guidance does not support the use of half the reported values for non-detects. As stated in the ProUCL Technical Guide, Section 4.2.4.2 Do Not Use DL/2 (t) UCL Method:

> *"The DL/2 goodness of fit tests and UCL computation methods are included for historical reasons. It is suggested that the use of DL/2 (t) method should be avoided to estimate the EPC term or other threshold values. This UCL computation method does not provide adequate coverage (for any distribution and sample size) for the population mean, even for censoring levels as low as 10%, 15%. This is contrary to the conjecture and assertion (e.g., EPA (2006)) often made that the DL/2 method can be used for lower (≤ 20%) censoring levels. The coverage provided by the DL/2 (t) method deteriorates fast as the censoring intensity increases."*

FMC performed the 95% UCL calculation using ProUCL 4.0 and the recommendations contained in the ProUCL Technical Guide. As noted in the ProUCL Technical Guide, Section 4.1 Introduction;

> "**Note**: *It should be noted that it is not easy to verify the distribution of left-censored data sets, especially when a large percentage (> 40% -50%) of observations are being censored (nondetected). In such cases, it is desirable to use nonparametric methods to compute various statistics (upper limits, hypotheses testing statistics) of interest. Several nonparametric methods to compute various upper limits based upon data sets with ND observations are available in ProUCL 4.0."*

FMC evaluated the Bannock, Michaud and Combined representative well data sets using parametric and nonparametric methods and, as recommended in the ProUCL Technical Guide and software output, utilized the nonparametric Kaplan-Meier (KM) Estimation Method. The Kaplan-Meier method, also known as the product limit estimate (PLE), is based upon a statistical

distribution function estimate, like the sample distribution function, except that this method adjusts for censoring and has an added advantage as it can be used on data sets with multiple detection limits. The KM method is described in greater detail in Section 4.6 of the ProUCL Technical Guide.

Results

The ProUCL output files for the Bannock, Michaud and Combined representative well data sets are included as Tables 4.3-9, 4.3-10 and 4.3-11, respectively. The 95% KM UCL results are summarized below:

Representative Well Group Designation	Arsenic Representative Level (ug/l) 95% UCL
Bannock	7.4
Michaud	6.2
Combined	6.2

Mean or 95% UCL on the mean groundwater representative concentrations were not calculated or presented in the EMF RI Report so no comparisons are presented herein. The 95% KM UCL groundwater arsenic representative concentrations are below the current National Primary Drinking Water Regulation Maximum Contaminant Level (MCL) of 10 ug/l (i.e., the representative well networks would be expected to meet the NPDWR arsenic MCL if utilize for a public drinking water system as defined in the regulation).

4.3.6 Summary of Recalculation of Groundwater Representative Arsenic Concentrations

FMC performed a re-evaluation of the representative (or background) concentration of arsenic in groundwater flowing onto the FMC Plant OU following a transparent and reproducible process.

Seven Bannock regime and ten Michaud regime RI and post-RI representative wells were initially identified as candidate representative wells for the re-evaluation. Following review and input from the Agencies and additional evaluation and identification of erroneous total phosphorus means reported in the RI for wells 101 and 102, three Bannock regime wells and eleven (the Agencies added well 516) Michaud regime wells were selected for the representative well groups. A Combined ("mixed" Bannock and Michaud) well group was also evaluated per the Agencies' direction.

Total arsenic data for the entire period of record for each well within the well groups was utilized for the calculation of representative groundwater arsenic concentrations. One Bannock well

(305) and one Michaud well (101) data point each was eliminated and one Michaud well (175) data point was corrected prior to use of the data set. After treating duplicate sample results appropriately, the Bannock data set consisted of 32 data points, Michaud 273 data points and the Combined group 305 data points. Following testing for outliers and review of the Q-Q plot for the Bannock data set, no upper tail outliers were eliminated from the data sets. Finally, one high non-detected value was eliminated from the Michaud and Combined data sets following the initial ProUCL statistical calculations. Therefore, the final Bannock data set consisted of 32 data points, Michaud 272 data points and the Combined group 304 data points.

Pursuant to EPA's direction, the data sets were analyzed using EPA's ProUCL v.4 software. The ProUCL documentation recommends the use of an UPL as a background (representative) comparison value (U.S. EPA, 2007a) and, based upon the characteristics of the input data, the software recommended the use of a nonparametric calculation method to characterize background for the Bannock, Michaud and Combined data sets.

The calculated 95% UPL values are comparable to the RI-calculated values. As expected due to the much larger data set for the Michaud representative well group, the Michaud and Combined 95% UPL are essentially the same value (14.1 and 14.2 ug/l, respectively). Consistent with the findings in the RI, the Bannock representative arsenic concentration 95% UPL of 17.0 ug/l is slightly higher than the Michaud and Combined value.

Based on the National Primary Drinking Water Regulations and EPA's represented intent to evaluate FMC's future groundwater monitoring results based on average concentrations from multiple wells and sampling events, FMC also calculated a 95% UCL for the arsenic representative concentrations for the Bannock, Michaud and Combined data sets. As recommended by the Pro UCL Technical Guide, the 95% UCL was calculated using the Kaplan-Meier method. The calculated 95% KM UCL groundwater arsenic representative concentrations for the Bannock, Michaud and Combined representative well data sets are 7.4, 6.2 and 6.2 ug/l, respectively.

Mean or 95% UCL on the mean groundwater representative concentrations were not calculated or presented in the EMF RI Report, so no comparisons are presented. The 95% KM UCL groundwater arsenic representative concentrations are below the current National Primary Drinking Water Regulation Maximum Contaminant Level (MCL) of 10 ug/l (i.e., the representative well networks would be expected to meet the NPDWR arsenic MCL if utilized for a public drinking water system as defined in the regulation).

For future purposes, the 95% UPL groundwater representative arsenic concentrations should be used for comparison to any individual (point-by-point) result for any existing or new wells after determining the underlying geochemistry, and thus the hydrogeochemical regime present in groundwater, at the specific well. The 95% KM UCL for the groundwater arsenic representative concentrations should only be used for comparison where a statistically meaningful average and 95% UCL is or can be calculated for any existing, new, or grouping of wells. The 95% UCL comparison should take into consideration the underlying geochemistry and thus the hydrogeochemical regime present in groundwater at the specific well or well group.

TABLE 4.2-1 Groundwater Representative Concentrations and Comparative Values

ANALYTE	Michaud 95th Percentile (a)	Bannock 95th Percentile (a)	Groundwater Comparative Values (CVs) (b)	Source of Groundwater CV (c)
COMMON IONS (mg/l)				
Alkalinity, bicarbonate	198	171		
Calcium	97.71	68.75		
Chloride	192.90	52.42	250	Secondary Standard
Magnesium	33.59	19.20		
Potassium	12.72	10.52		
Sodium	74.28	27.53		
Sulfate	72.57	43.40	250	Secondary Standard
PHYSICAL PARAMETERS				
Spec.Conductivity (umhos/cm)	1136	569		
pH	(d)	(d)	6.5 to 8.5	Secondary Standard
Temperature (degrees Celcius)	(d)	(d)		
Total Dissolved Solids (mg/l)	867	412	500	Secondary Standard
Redox (mV)	(d)	(d)		
NUTRIENTS AND FLUORIDE (mg/l)				
Ammonia (NH3 as N)	0.50	0.50		
Nitrate (NO3 as N)	5.52	1.60	10	MCL
Orthophosphate (PO4 as P)	0.06	0.13		
Phosphorous	0.33	0.31		
Fluoride	0.80	0.60	4	MCL
METALS (mg/l)				
Aluminum	0.0977	0.5472	0.05 to 0.2	
Antimony	0.1000	0.1340	0.006	MCL
Arsenic	0.0141	0.0170	0.01	MCL
Barium	0.2297	0.1204	2	MCL
Beryllium	0.0020	0.0040	0.004	MCL
Boron	0.2935	0.3078	7.3	PRG
Cadmium	0.0050	0.0050	0.005	MCL
Chromium	0.0114	0.0110	0.1	MCL
Cobalt	0.0145	0.0108	0.73	PRG
Copper	0.0085	0.0109	1	Secondary Standard
Iron	0.7690	0.8402	0.3	Secondary Standard
Lead	0.0020	0.0068	0.015	TT Action Level
Lithium	0.0610	0.0165	0.73	PRG
Manganese	0.0518	0.0201	0.05	Secondary Standard
Mercury	0.00074	0.00078	0.002	MCL
Molybdenum	0.0245	0.0330	0.18	PRG
Nickel	0.0200	0.0200	0.73	PRG
Selenium	0.0057	0.0055	0.05	MCL
Silver	0.0050	0.0052	0.1	Secondary Standard
Thallium	0.0040	0.0400	0.002	MCL
Vanadium	0.0745	0.1000	0.18	PRG
Zinc	0.0501	0.1700	71	PRG
RADIOLOGICAL				
Gross alpha	ND to 7.97 pCi/l		15 PCi/l	MCL
Gross beta	ND to 20.6 pCi/l		4 mrem/year	MCL
Radium-226	ND to 6.35 pCi/l		5 PCi/l combined	MCL
Radium-228	ND to 10.8 pCi/l			

TABLE 4.2-1 Groundwater Representative Concentrations and Comparative Values

ANALYTE	Michaud 95th Percentile (a)	Bannock 95th Percentile (a)	Groundwater Comparative Values (CVs) (b)	Source of Groundwater CV (c)
Other Inorganics				
Elemental Phosphorus	(e)	(e)	0.00073	PRG
Tin	(e)	(e)	22	PRG
Total Cyanide	(e)	(e)	0.2	MCL
Uranium	(e)	(e)	0.03	MCL
ORGANICS				
Total Organic Carbon	(e)	(e)	None found	
Total Organic Halogen	(e)	(e)	None found	
Total phenol	(e)	(e)	None found	
N-Nitrosomorpholine	(e)	(e)	None found	
Carbon disulfide	(e)	(e)	1	PRG
Dimethyl phthalate	(e)	(e)	360	PRG

(a) The Bannock and Michaud representative concentrations are 95th percentile values for pre-1994 data as presented in Table 4.4-1 in the EMF RI Report with the exception of the representative arsenic concentration that is a 95% Upper Prediction Limit as described in Section 4.4 of the Groundwater Current Conditions Report for the FMC Plant OU.

(b) All values are in milligrams per liter (mg/l) unless the units are otherwise specified.

(c) Secondary Standard per National Secondary Drinking Water Regulations; MCL means Maximum Contaminant Level per National Primary Drinking Water Regulations; PRG means Preliminary Remedial Goal for Tap Water per EPA Region VI PRG Table (3/8/2008), except Lithium PRG is from the Region IX PRG Table (2004); TT Action Level means Treatment Technique action level per the National Primary Drinking Water Regulations.

(d) Representative values were not calculated for pH, temperature and redox during the EMF RI.

(e) These parameters were not analyzed or detected during the EMF RI so no representative concentrations were calculated during the EMF RI.

TABLE 4.2-2 Comparison of Initial Results from Wells 189, 190 and 191 to Concentrations Predicted from the EMF RI Groundwater Investigation

Well 189	Result (8/21/2003)	Units	Qual	Result (11/20/2003)	Units	Qual	Result (5/21/2004)	Units	Qual	Predicted Range (RI Section 4.4)	Units	Comparison
PH (FLD)	6.29	pH		6.12	pH		6.17	pH		6.0-6.25	pH	Within
POTASSIUM (K) TOT	57.30	mg/L	J	52.60	mg/L		53.30	mg/L		50-75	mg/L	Within
SULFATE (SO4)	2390.00	mg/L		2430.00	mg/L		2670.00	mg/L		1500-1750	mg/L	Higher
CHLORIDE (CL)	155.00	mg/L		161.00	mg/L		131.00	mg/L		<193	mg/L	Within
TOTAL AMMONIA (NH3+NH4 AS N)	1.30	mg/L		1.50	mg/L		2.10	mg/L		4-5	mg/L	Lower
ORTHOPHOSPHATE (PO4-P)	115.00	mg/L		117.00	mg/L		112.00	mg/L		100-200	mg/L	Within
ARSENIC (AS) TOT	0.35800	mg/L		0.31600	mg/L		0.29700	mg/L		0.4-0.5	mg/L	Lower
CADMIUM (CD) TOT	0.00023	mg/L	J	NA	mg/L		NA	mg/L		<0.005	mg/L	Within
SELENIUM (SE) TOT	0.03760	mg/L		0.03550	mg/L		0.02940	mg/L		0.05-0.1	mg/L	Lower
FLUORIDE (F) TOT	0.43000	mg/L		0.44000	mg/L		0.57000	mg/L		<1.0	mg/L	Within

Well 190	Result (8/21/2003)	Units	Qual	Result (11/20/2003)	Units	Qual	Result (5/21/2004)	Units	Qual	Predicted Range (RI Section 4.4)	Units	Comparison
PH (FLD)	7.11	pH		6.87	pH		6.97	pH		6.25-6.5	pH	Higher
POTASSIUM (K) DIS	5.09	mg/L	J		mg/L			mg/L		20-30	mg/L	Lower
POTASSIUM (K) TOT	5.60	mg/L		3.74	mg/L	J	4.12	mg/L		20-30	mg/L	Lower
SULFATE (SO4)	262.00	mg/L		156.00	mg/L		155.00	mg/L		900-1250	mg/L	Lower
CHLORIDE (CL)	234.00	mg/L		198.00	mg/L		195.00	mg/L		<193	mg/L	Higher
TOTAL AMMONIA (NH3+NH4 AS N)	0.20	mg/L	U	0.20	mg/L	U	0.20	mg/L	U	3-4	mg/L	Lower
ORTHOPHOSPHATE (PO4-P)	1.40	mg/L		1.00	mg/L		0.40	mg/L		10-50	mg/L	Lower
ARSENIC (AS) DIS	0.01620	mg/L			mg/L			mg/L		0.2-0.3	mg/L	Lower
ARSENIC (AS) TOT	0.01990	mg/L		0.01140	mg/L		0.00940	mg/L		0.2-0.3	mg/L	Lower
CADMIUM (CD) DIS	0.00018	mg/L			mg/L			mg/L		<0.005	mg/L	Within
CADMIUM (CD) TOT	0.00027	mg/L	J	NA	mg/L		NA	mg/L		<0.005	mg/L	Within
SELENIUM (SE) TOT	0.01310	mg/L		0.01110	mg/L			mg/L		0.1-0.15	mg/L	Lower
SELENIUM (SE) DIS	0.01720	mg/L			mg/L		0.00750	mg/L		0.1-0.15	mg/L	Lower
FLUORIDE (F) TOT	1.10000	mg/L		1.20000	mg/L		1.00000	mg/L		<1.0	mg/L	Higher

Well 191	Result (8/21/2003)	Units	Qual	Not Sampled 4Q03	Not Sampled 2Q04	Predicted Range (RI Section 4.4)	Units	Comparison
PH (FLD)	7.27	pH				6.5-6.75	pH	Higher
POTASSIUM (K) TOT	13.20	mg/L	J			<20	mg/L	Within
SULFATE (SO4)	396.00	mg/L				900-1250	mg/L	Lower
CHLORIDE (CL)	499.00	mg/L	J			<193	mg/L	Higher
TOTAL AMMONIA (NH3+NH4 AS N)	0.20	mg/L	U			<0.5	mg/L	Within
ORTHOPHOSPHATE (PO4-P)	0.53	mg/L				2-5	mg/L	Lower
ARSENIC (AS) TOT	0.00770	mg/L				<0.025	mg/L	Within
CADMIUM (CD) TOT	0.00100	mg/L	U			<0.005	mg/L	Within
SELENIUM (SE) TOT	0.02490	mg/L				<0.012	mg/L	Higher
FLUORIDE (F) TOT	0.25000	mg/L				<1.0	mg/L	Within

TABLE 4.2-3A Analytical Results for RCRA Appendix IX Analyses
FMC 1997 Grounwater Monitoring Event

ANALYTE	Wells Sampled for RCRA Appendix IX Parameters			
	Well-108	Well-139	Well-143	Well-156
Routine Parameters				
Field Measurements				
PH (FLD)	6.95	6.94	6.06	6.97
SC (UMHOS/CM AT 25 C) (FLD)	1500	5520	4269	7237
TURBIDITY (NTU) (FLD)	1.3	0.1	0.3	0.4
WATER TEMPERATURE (C) (FLD)	31.2	8.3	10.1	14.9
General WQP				
TDS (MEASURED AT 180 C)	1000			7800
POTASSIUM (K) TOT	139			1630
SULFATE (SO4)	210			260
CHLORIDE (CL)	99			380
FLUORIDE (F)	0.57			0.37
TOTAL AMMONIA (NH3+NH4 AS N)	0.4 U			14
NITRATE (NO3-N)	4.3 J			< 0.1 J
ORTHOPHOSPHATE (PO4-P)	0.6 J			360 J
Metals				
ARSENIC (AS) TOTAL	0.038	0.012 U	0.43	0.18
CADMIUM (CD) TOTAL	0.00028 U	0.0001 BUJ	0.0066	< 0.0002 G
SELENIUM (SE) TOTAL	0.0048 BJ	0.025	0.27	0.0043 BJ
Additional Appendix IX Parameters				
Metals				
ANTIMONY (SB) TOTAL	0.0024 BUJ	0.0027 BUJ	0.0044 BUJ	0.0054 BUJ
BARIUM (BA) TOTAL	0.12 BJ	0.052 BJ	0.074 BJ	0.04 BJ
BERYLLIUM (BE) TOTAL	< 0.005 J	< 0.005 J	< 0.005 J	< 0.005 J
CHROMIUM (CR) TOTAL	0.0068 U	0.0064 U	< 0.005 J	0.046 BJ
COBALT (CO)TOTAL	0.0037 BUJ	0.041 BJ	0.0007 BUJ	0.025 J
COPPER (CU) TOTAL	< 0.025 J	< 0.025 J	< 0.025 J	< 0.025
LEAD (PB) TOTAL	< 0.003	< 0.003	< 0.003	< 0.003
MERCURY (HG) TOTAL	< 0.0002 J	< 0.0002 J	< 0.0002 J	< 0.0002 J
NICKEL (NI) TOTAL	< 0.04	< 0.04	0.082	0.041
SILVER (AG) TOTAL	< 0.005	< 0.005	< 0.005	< 0.005
THALLIUM (TL) TOTAL	0.0044 BJ	0.007 BJ	< 0.01	0.0078 BJ
TIN (SN) TOTAL	< 0.1	< 0.1	< 0.1	< 0.1
VANADIUM (V) TOTAL	0.014 BJ	0.0029 BJ	0.1	0.012 BJ
ZINC (ZN) TOTAL	0.028 BJ	0.0048 BUJ	0.02 BJ	0.014 BUJ
Other				
PHENOL TOTAL	< 0.02	< 0.02	< 0.02	< 0.02
CYANIDE (CN) TOTAL	0.022	0.12	< 0.01	0.12
ACID-INSOLUBLE SULFIDE	1 J	0.9 J	< 0.5 J	0.9 J
Organics [a]				
N-NITROSOMORPHOLINE	< 0.01	< 0.01	< 0.01	0.011

[a] Only those organic compounds that were detected are shown, full list of organic compounds analyzed is shown on Table 4.2-3B.

TABLE 4.2-3B RCRA Appendix IX Organic Counpounds
FMC 1997 Groundwater Monitoring Event

Organics	
1,1,1,2-TETRACHLOROETHANE	4,4'-DDD
1,1,1-TRICHLOROETHANE	4,4'-DDE
1,1,2,2-TETRACHLOROETHANE	4,4'-DDT
1,1,2-TRICHLOROETHANE	4,6-DINITRO-2-METHYLPHENOL
1,1-DICHLOROETHANE	4-AMINOBIPHENYL
1,1-DICHLOROETHENE	4-BROMOPHENYL PHENYL ETHER
1,2,3-TRICHLOROPROPANE	4-CHLORO-3-METHYLPHENOL
1,2,4,5-TETRACHLOROBENZENE	4-CHLOROANILINE
1,2,4-TRICHLOROBENZENE	4-CHLOROPHENYL PHENYL ETHER
1,2-DIBROMO-3-CHLOROPROPANE	4-METHYL-2-PENTANONE (MIBK)
1,2-DIBROMOETHANE (EDB)	4-METHYLPHENOL
1,2-DICHLOROBENZENE	4-NITROANILINE
1,2-DICHLOROETHANE	4-NITROPHENOL
1,2-DICHLOROPROPANE	4-NITROQUINOLINE-1-OXIDE
1,3,5-TRINITROBENZENE	5-NITRO-O-TOLUIDINE
1,3-DICHLOROBENZENE	7,12-DIMETHYLBENZ(A)ANTHRACENE
1,3-DINITROBENZENE	A,A-DIMETHYLPHENETHYLAMINE
1,4-DICHLOROBENZENE	ACENAPHTHENE
1,4-DIOXANE	ACENAPHTHYLENE
1,4-NAPHTHOQUINONE	ACETONE
1-NAPHTHYLAMINE	ACETONITRILE
2,3,4,6-TETRACHLOROPHENOL	ACETOPHENONE
2,4,5-T	ACROLEIN
2,4,5-TP (SILVEX)	ACRYLONITRILE
2,4,5-TRICHLOROPHENOL	ALDRIN
2,4,6-TRICHLOROPHENOL	ALLYL CHLORIDE
2,4-D	ALPHA-BHC
2,4-DICHLOROPHENOL	ANILINE
2,4-DIMETHYLPHENOL	ANTHRACENE
2,4-DINITROPHENOL	ARAMITE
2,4-DINITROTOLUENE	AROCLOR 1016
2,6-DICHLOROPHENOL	AROCLOR 1221
2,6-DINITROTOLUENE	AROCLOR 1232
2-ACETYLAMINOFLUORENE	AROCLOR 1242
2-BUTANONE (MEK)	AROCLOR 1248
2-CHLORONAPHTHALENE	AROCLOR 1254
2-CHLOROPHENOL	AROCLOR 1260
2-HEXANONE	BENZENE
2-METHYLNAPHTHALENE	BENZO(A)ANTHRACENE
2-METHYLPHENOL	BENZO(A)PYRENE
2-NAPHTHYLAMINE	BENZO(B)FLUORANTHENE
2-NITROANILINE	BENZO(GHI)PERYLENE
2-NITROPHENOL	BENZO(K)FLUORANTHENE
2-PICOLINE	BENZYL ALCOHOL
2-SEC-BUTYL-4,6-DINITROPHENOL	BETA-BHC
3,3'-DICHLOROBENZIDINE	BIS(2-CHLOROETHOXY)METHANE
3,3'-DIMETHYLBENZIDINE	BIS(2-CHLOROETHYL) ETHER
3-METHYLCHOLANTHRENE	BIS(2-ETHYLHEXYL) PHTHALATE
3-METHYLPHENOL	BROMODICHLOROMETHANE
3-NITROANILINE	BROMOFORM
BROMOMETHANE	ISOPHORONE
BUTYL BENZYL PHTHALATE	ISOSAFROLE
CARBON DISULFIDE	KEPONE
CARBON TETRACHLORIDE	METHACRYLONITRILE
CHLORDANE (TECHNICAL)	METHAPYRILENE
CHLOROBENZENE	METHOXYCHLOR
CHLOROBENZILATE	METHYL METHACRYLATE

TABLE 4.2-3B RCRA Appendix IX Organic Counpounds
FMC 1997 Groundwater Monitoring Event

Organics (Cont.)	
CHLOROBENZILATE	METHYL METHANESULFONATE
CHLOROETHANE	METHYLENE CHLORIDE
CHLOROFORM	NAPHTHALENE
CHLOROPRENE	NITROBENZENE
CHRYSENE	N-NITROSODIETHYLAMINE
CIS-1,3-DICHLOROPROPENE	N-NITROSODIMETHYLAMINE
DELTA-BHC	N-NITROSODI-N-BUTYLAMINE
DIALLATE	N-NITROSODI-N-PROPYLAMINE
DIALLATE	N-NITROSODIPHENYLAMINE
DIBENZ(A,H)ANTHRACENE	N-NITROSOMETHYLETHYLAMINE
DIBENZOFURAN	N-NITROSOMORPHOLINE
DIBROMOCHLOROMETHANE	N-NITROSOPIPERIDINE
DIBROMOMETHANE	N-NITROSOPYRROLIDINE
DICHLORODIFLUOROMETHANE	O,O,O-TRIETHYL PHOSPHOROTHIOATE
DIELDRIN	O-TOLUIDINE
DIETHYL PHTHALATE	P-DIMETHYLAMINOAZOBENZENE
DIMETHOATE	PENTACHLOROBENZENE
DIMETHYL PHTHALATE	PENTACHLOROETHANE
DI-N-BUTYL PHTHALATE	PENTACHLORONITROBENZENE
DI-N-OCTYL PHTHALATE	PENTACHLOROPHENOL
DIPHENYLAMINE	PHENACETIN
DISULFOTON	PHENANTHRENE
ENDOSULFAN I	PHENOL
ENDOSULFAN II	PHORATE
ENDOSULFAN SULFATE	P-PHENYLENE DIAMINE
ENDRIN	PRONAMIDE
ENDRIN ALDEHYDE	PROPIONITRILE
ETHYL METHACRYLATE	PYRENE
ETHYL METHANESULFONATE	PYRIDINE
ETHYLBENZENE	SAFROLE
FAMPHUR	STYRENE
FLUORANTHENE	TETRACHLOROETHENE
FLUORENE	TETRAETHYLDITHIOPYROPHOSPHATE
GAMMA-BHC (LINDANE)	THIONAZIN
HEPTACHLOR	TOLUENE
HEPTACHLOR EPOXIDE	TOXAPHENE
HEXACHLOROBENZENE	TRANS-1,2-DICHLOROETHENE
HEXACHLOROBUTADIENE	TRANS-1,3-DICHLOROPROPENE
HEXACHLOROCYCLOPENTADIENE	TRANS-1,4-DICHLORO-2-BUTENE
HEXACHLOROETHANE	TRICHLOROETHENE
HEXACHLOROPROPENE	TRICHLOROFLUOROMETHANE
INDENO(1,2,3-CD)PYRENE	VINYL ACETATE
IODOMETHANE	VINYL CHLORIDE
ISOBUTYL ALCOHOL	XYLENES (TOTAL)
ISODRIN	
Dibenzofurans / Dibenzodioxins	
COCDD	1,2,3,4,7,8-HxCDF
OCDF	1,2,3,6,7,8-HxCDD
Total HxCDD	1,2,3,6,7,8-HxCDF
Total HxCDF	1,2,3,7,8,9-HxCDD
Total PeCDD	1,2,3,7,8,9-HxCDF
Total PeCDF	1,2,3,7,8-PeCDD
Total TCDD	1,2,3,7,8-PeCDF
Total TCDF	2,3,4,6,7,8-HxCDF
1,2,3,4,6,7,8-HpCDD	2,3,4,7,8-PeCDF
1,2,3,4,6,7,8-HpCDF	2,3,7,8-TCDD
1,2,3,4,7,8,9-HpCDF	2,3,7,8-TCDF
1,2,3,4,7,8-HxCDD	

TABLE 4.2-4 Results for FMC January 1998 Special Groundwater Monitoring Event

ANALYTE	Wells Analyzed for January 1998 Expanded Parameter List							
	Batiste Spring	Swanson Road Spring	Well-TW-11S	Well-502	Well-517	Well-TW-9S	Well-111	Well-146
Routine Parameters								
Field Measurements								
FLOW CFS	7							
PH (FLD)	6.63	6.82	7.28	7.53	6.81	6.8	6.67	6.92
SC (UMHOS/CM AT 25 C) (FLD)	1355	876	564	709	1750	1884	2105	980
OXIDATION REDUCTION POTENTIAL			122.7	163.8	185.9	-24.8	108.7	153.3
OXYGEN (O) (FLD) DISSOLVED	0.2	3.83	6.41	6.98	1.45	0.16	0.21	2.49
TURBIDITY (NTU) (FLD)	0.16	0.3	6.2	0.3	0.2	9	0.8	0.2
WATER TEMPERATURE (C) (FLD)	14	12.7	11.7	11.8	18	16.7	16.3	23.7
General WQP								
CALCIUM (CA) TOT	124	98	54.5	57.3	110	114	127	66.8
MAGNESIUM (MG) TOT	50.6	34.7	18.2	21.3	42.7	54.3	68.1	22.1
SODIUM (NA) TOT	98.3 ,J	48.6	35.8 ,J	52.8 ,J	103 ,J	131 ,J	143 ,J	47.9 ,J
POTASSIUM (K) TOT	18.1	7.1	3.9 B,J	5.9	106	145	106	44
TOTAL ALKALINITY (AS CaCO3)	350	300	230	190	340	390	380	240
SULFATE (SO4)	306	81.5	57.2	77.2	234	220	282	94
CHLORIDE (CL)	71.1	64.5	27.6	65.8	207	283	321	61.3
FLUORIDE (F)	0.32	0.25	0.57	0.68	0.23	< 0.1	< 0.1	0.49
TOTAL AMMONIA (NH3+NH4 AS N)	7.9	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
NITRATE (NO3-N)	15.5	3.2	2.3	3.6	10.9	17.7	21.5	2.2
TOTAL PHOSPHORUS (P)	16	6.1 ,U	1.2 ,U	0.4 ,U	1.3 ,U	6.5 ,U	12 ,U	0.9 ,U
ORTHOPHOSPHATE (PO4-P)	8.4	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5.9	< 0.5
Metals								
ARSENIC (AS) TOTAL	0.042	0.005 B,J	< 0.005	< 0.005	0.034	0.024	0.041	0.014
Additional Parameters								
Metals								
ALUMINUM (AL) TOTAL	0.041 B,UJ	0.1 B,J	0.023 B,UJ	0.019 B,UJ	0.012 B,UJ	0.022 B,UJ	0.024 B,UJ	< 0.2
BARIUM (BA) TOTAL	0.068 B,J	0.16 B,J	0.062 B,J	0.073 B,J	0.076 B,J	0.12 B,J	0.22	0.089 B,J
BORON (B) TOTAL	0.27	0.21	0.13 B,U	0.15 B,UJ	0.54	0.67	0.82	0.25
COBALT (CO)TOTAL	0.0016 B,J	< 0.007	< 0.007	< 0.007	0.0063 B,J	0.013	0.019	0.0016 B,UJ
IRON (FE)	0.54 ,J	< 0.1 ,J	0.7 ,J	< 0.1 ,J	< 0.1 ,J	1.6 ,J	0.14 ,UJ	< 0.1 ,J
LITHIUM (LI) TOTAL	0.085	0.039 B,J	0.043 B,J	0.048 B,J	0.094	0.086	0.1	0.061
MANGANESE (MN) TOTAL	0.09	0.0022 B,UJ	0.0053 B,J	< 0.015	0.0063 B,J	0.98	1.1	0.022
NICKEL (NI) TOTAL	0.039 B,J	< 0.04	< 0.04	< 0.04	< 0.04	0.0066 B,J	0.011 B,J	< 0.04
Elemental Phosphorus								
ELEMENTAL PHOSPHORUS (P4)	< 0.00002 ,J	< 0.00002 ,J	< 0.00002 ,J	< 0.00002 ,J	< 0.00002 ,J	< 0.00002 ,R	< 0.00002 ,J	< 0.00002 ,J

TABLE 4.2-4 Results for FMC January 1998 Special Groundwater Monitoring Event

ANALYTE	Wells Analyzed for January 1998 Expanded Parameter List							
	Well-112	Well-110	Well-121	Well-134	Well-135	Well-141	Well-159	Well-108
Routine Parameters								
Field Measurements								
FLOW CFS								
PH (FLD)	7.24	6.23	6.57	6.6	6.89	6.66	6.47	6.99
SC (UMHOS/CM AT 25 C) (FLD)	914	2160	2460	1855	1180	1534	2180	1310
OXIDATION REDUCTION POTENTIAL	162.6	199.4	204.9	186.3	199.3	1.1	-130.7	
OXYGEN (O) (FLD) DISSOLVED	3.74	2	0.73	0.16	2.68	0.19	0.15	3.88
TURBIDITY (NTU) (FLD)	0.2	0.2	0.4	0.2	0.2	0.2	0.2	1
WATER TEMPERATURE (C) (FLD)	12.4	16.1	21.1	17.5	16	16.6	16.8	31
General WQP								
CALCIUM (CA) TOT	80.8	249	157	102	130	109	123	62.6
MAGNESIUM (MG) TOT	25.8	79.1	54.6	61.7	45.3	50.7	68.5	32
SODIUM (NA) TOT	57.9 ,J	172 ,J	122	115	41.2	138	282	91.5
POTASSIUM (K) TOT	7.6	20.3	251	144	13.3	42.4	24	128
TOTAL ALKALINITY (AS CaCO3)	200	570	330	470	230	470	670	460
SULFATE (SO4)	96.4	650	435	187	127	165	177	185
CHLORIDE (CL)	120	115	327	270	195	218	358	113
FLUORIDE (F)	0.46	0.25	1.34	< 0.1	< 0.1	< 0.1	< 0.1	0.46
TOTAL AMMONIA (NH3+NH4 AS N)	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	1	< 0.2
NITRATE (NO3-N)	4.8	3.6	33.1	12.7	13.1	0.65	< 0.5	2.9 ,J
TOTAL PHOSPHORUS (P)	12 ,U	2.6 ,U	0.7 ,UJ	55 ,J	5.7 ,UJ	63 ,J	12 ,UJ	0.5 ,UJ
ORTHOPHOSPHATE (PO4-P)	< 0.5	7.2	< 0.5	20.6	< 0.5	20.9	13.4	< 0.5 ,J
Metals								
ARSENIC (AS) TOTAL	< 0.005	0.11	0.014	0.089	0.016	0.086	0.082	0.035
Additional Parameters								
Metals								
ALUMINUM (AL) TOTAL	0.13 B,J	< 0.2	0.028 B,UJ	< 0.2	0.012 B,UJ	0.087 B,UJ	0.11 B,UJ	0.048 B,UJ
BARIUM (BA) TOTAL	0.087 B,J	0.085 B,J	0.079 B,J	0.12 B,J	0.15 B,J	0.28	0.35	0.12 B,J
BORON (B) TOTAL	0.16 B,J	0.5	0.74	0.76	0.16	0.9	1.9	0.48
COBALT (CO)TOTAL	0.0016 B,UJ	0.0021 B,UJ	0.004 B,UJ	0.016	0.0012 B,UJ	0.014	0.067	0.005 B,J
IRON (FE)	0.05 B,UJ	< 0.1 ,J	< 0.1 ,J	0.32 ,J	< 0.1 ,J	< 0.1 ,J	1.3 ,J	0.056 B,UJ
LITHIUM (LI) TOTAL	0.051	0.14	0.067	0.083	0.03 B,J	0.069	0.086	0.06
MANGANESE (MN) TOTAL	< 0.015	0.051	0.16	2.8	0.0054 B,J	5.4	8.4	0.01 B,UJ
NICKEL (NI) TOTAL	< 0.04	0.0033 B,J	0.0031 B,J	0.012 B,J	< 0.04	0.02 B,J	0.011 B,J	0.0036 B,J
Elemental Phosphorus								
ELEMENTAL PHOSPHORUS (P4)	< 0.00002 ,J	< 0.00002 ,J	< 0.00002 ,J	< 0.00002 ,J	< 0.00002	< 0.00002	< 0.00002	0.0013

TABLE 4.2-4 Results for FMC January 1998 Special Groundwater Monitoring Event

ANALYTE	Wells Analyzed for January 1998 Expanded Parameter List						
	Well-123	Well-151	Well-158	Well-120	Well-155	Well-157	Well-156
Routine Parameters							
Field Measurements							
FLOW CFS							
PH (FLD)	5.96	6.72	7.11	7.08	6.89	7.1	6.99
SC (UMHOS/CM AT 25 C) (FLD)	3370	978	712	858	4753	5076	7340
OXIDATION REDUCTION POTENTIAL	126.9	83	145.7	196.3	6.8	-217.1	-181.9
OXYGEN (O) (FLD) DISSOLVED	0.23	1.4	4.35	3.65	0.17	0.21	0.16
TURBIDITY (NTU) (FLD)	0.2	0.2	0.3	0.2	0.4	0.4	0.5
WATER TEMPERATURE (C) (FLD)	17.2	16.5	16.3	15.2	14.1	14.9	15.1
General WQP							
CALCIUM (CA) TOT	407	74.9	66.8	75.7	44.3	23.6	18.6
MAGNESIUM (MG) TOT	175	30.8	26.5	29.4	72.1	62.9	70.2
SODIUM (NA) TOT	205	58.7	24.2	35.5	402	336	560
POTASSIUM (K) TOT	32.8	24.1	9.6	8.3	768	1020	1730
TOTAL ALKALINITY (AS CaCO3)	710	320	230	230	1800	1400	2700
SULFATE (SO4)	964	129	108	62.9	289	239	254
CHLORIDE (CL)	462	81.9	45.7	119	363	374	417
FLUORIDE (F)	0.51	< 0.1	0.47	0.13	< 0.1	9.4	0.1
TOTAL AMMONIA (NH3+NH4 AS N)	3.3	< 0.2	< 0.2 ,J	0.2 ,J	< 0.2 ,J	< 0.2 ,J	11 ,J
NITRATE (NO3-N)	17.1 ,J	< 0.5 ,J	0.56 ,J	0.73 ,J	< 0.5 ,J	< 0.5 ,J	< 0.5 ,J
TOTAL PHOSPHORUS (P)	2.6 ,UJ	8.6 ,UJ	0.1 ,U	0.3 ,U	7 ,U	7.1 ,U	820
ORTHOPHOSPHATE (PO4-P)	< 5 G,J	10.8 ,J	< 0.5 ,J	2 ,J	119 ,J	296 ,J	363 ,J
Metals							
ARSENIC (AS) TOTAL	0.4	0.043	0.012	0.012	0.33	0.17	0.17
Additional Parameters							
Metals							
ALUMINUM (AL) TOTAL	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
BARIUM (BA) TOTAL	0.055 B,J	0.19 B,J	0.082 B,J	0.1 B,J	0.083 B,J	0.013 B,J	0.042 B,J
BORON (B) TOTAL	0.81	0.3	0.097 B,UJ	0.16 B,J	2.5	2.9	4.7
COBALT (CO)TOTAL	0.0036 B,J	0.0018 B,J	< 0.007	0.0011 B,J	0.032	0.018	0.024
IRON (FE)	< 0.1 ,J	< 0.1 ,J	< 0.1	0.012 B,UJ	0.046 B,UJ	0.56	0.1 ,U
LITHIUM (LI) TOTAL	0.23	0.039 B,J	0.027 B,J	0.028 B,J	0.15	0.12	0.14
MANGANESE (MN) TOTAL	0.46	2.5	0.0021 B,UJ	0.037	1.1	1.4	0.9
NICKEL (NI) TOTAL	0.013 B,J	0.0088 B,J	< 0.04	< 0.04	0.041	0.015 B,J	0.039 B,J
Elemental Phosphorus							
ELEMENTAL PHOSPHORUS (P4)	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002

TABLE 4.2-5A Results for FMC Pond 17 1998 RCRA Appendix III Groundwater Monitoring

	Pond 17 Wells Analyzed for RCRA Appendix III Parameters				
ANALYTES	**Well-170**	**Well-170**	**Well-179**	**Well-179**	**Well-180**
Routine Parameters	**Feb-98**	**May-98**	**Feb-98**	**May-98**	**Feb-98**
Field Measurements					
PH (FLD)	7.38	7.53	6.65	7.52	7.46
PH					7.4 ,J
PH	7.6 ,J	7.4	7.7	7.6	7.5 ,J
SC (UMHOS/CM AT 25 C)	770	840	1100	1200	
SC (UMHOS/CM AT 25 C)		860	1200	1086	
SC (UMHOS/CM AT 25 C)		880			1300
SC (UMHOS/CM AT 25 C) (FLD)	920	833	1152		1308
TURBIDITY (NTU) (FLD)	0.1	0	17.7	155	0.1
WATER TEMPERATURE (C) (FLD)	12.2	12.8	11.9	16.8	11.9
General WQP					
TDS (MEASURED AT 180 C)	560	560	860	880	800
SODIUM (NA) DIS			78.1	78.4	
SODIUM (NA) TOT	98.2	100	73.5	77.3	155
POTASSIUM (K) DIS			9.6		
POTASSIUM (K) TOT	58.6	60.5	12.3	11	38.3
SULFATE (SO4)	30	41.8	33	34.8	67
CHLORIDE (CL)	86	100	120	245	120
FLUORIDE (F)	1.28	1.26	0.83	0.51	0.68
TOTAL AMMONIA (NH3+NH4 AS N)	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
NITRATE (NO3-N)	3.9 ,J	5.4	5.1 ,J	5.3	15 ,J
ORTHOPHOSPHATE (PO4-P)	0.7	0.56 ,J	< 0.1	< 0.1	0.4
Metals					
ARSENIC (AS) DISSOLVED			0.003 B,UJ		
ARSENIC (AS) TOTAL	0.043	0.04	0.008 ,U	0.006	0.041
CADMIUM (CD) DISSOLVED			< 0.0001		
CADMIUM (CD) TOTAL	< 0.0001	0.00009 B,UJ	0.00039 ,U	0.00018 ,U	< 0.0001
SELENIUM (SE) DISSOLVED			0.0073		
SELENIUM (SE) TOTAL	0.0042 B,J	0.0049 B,J	0.0069	0.0082	0.0069
Additional Appendix III Parameters					
Metals					
BARIUM (BA) DISSOLVED			0.15 B,J	0.151 B,UJ	
BARIUM (BA) TOTAL	0.053 B,J	0.057 B,J	0.26	0.2 B,J	0.074 B,J
CHROMIUM (CR) DISSOLVED			0.0043 B,J	0.0035 B,J	
CHROMIUM (CR) TOTAL	0.0044 B,J	0.0063	0.032	0.012	0.013
IRON (FE) DISSOLVED			< 0.1	0.0174 B,UJ	
IRON (FE) TOTAL	< 0.1	0.078 B,UJ	11.3	4.93	< 0.1
LEAD (PB) DISSOLVED			< 0.003 ,J	< 0.003	
LEAD (PB) TOTAL	< 0.003	< 0.003	< 0.003	0.0025 B,J	< 0.003
MANGANESE (MN) DISSOLVED			0.003 B,U	0.0023 B,UJ	
MANGANESE (MN) TOTAL	0.0009 B,UJ	0.0015 B,UJ	0.29	0.124	0.0043 B,U
MERCURY (HG) DISSOLVED			< 0.0002	< 0.0002	
MERCURY (HG) TOTAL	< 0.0002	< 0.0002	< 0.0002	< 0.0002	0.00018 B,J
SILVER (AG) DISSOLVED			< 0.005	< 0.005	
SILVER (AG) TOTAL	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Other					
PHENOL TOTAL	< 0.02 ,J	0.005 B,J	< 0.02 ,J	0.005 B,J	< 0.02 ,J
TOTAL ORGANIC CARBON	< 1	< 1 ,J	< 1	< 1 ,J	< 1
TOTAL ORGANIC CARBON					
TOTAL ORGANIC HALOGEN (TOX)	0.0454	0.0334	0.042	0.159	0.108
TOTAL ORGANIC HALOGEN (TOX)	< 0.03	0.0442	0.0439	0.17	0.11
TOTAL ORGANIC HALOGEN (TOX)		< 0.03	0.0535	0.181	0.12
TOTAL ORGANIC HALOGEN (TOX)			0.0675	0.204	0.132
ENDRIN	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005
GAMMA-BHC(LINDANE)	< 0.000025	< 0.000025	< 0.000025	< 0.000025	< 0.000025
METHOXYCHLOR	< 0.00025	< 0.00025	< 0.00025	< 0.00025	< 0.00025
TOXAPHENE	< 0.0012	< 0.0012	< 0.0012	< 0.0012	< 0.0012
2,4-DICHLOROPHENOXYACETIC ACID	< 0.0004 ,J	< 0.0004	< 0.0004 ,J	< 0.0004	< 0.0004 ,J
SILVEX (2,4,5-TP)	< 0.0001 ,J	< 0.0001	< 0.0001 ,J	< 0.0001	< 0.0001 ,J
TOTAL COLIFORM (NO./100ML)	5600 ,R	< 10	19200 ,R	0	0 ,R
Radiological					
GROSS ALPHA (pCi/l)	0.86	4.46	3.79	1.92	0.58
GROSS BETA (pCi/l)	39 ,J	47.8	8.5 ,J	8.25	25.9 ,J
RADIUM 226 (pCi/L)	0.12	0.1	0.64	0.29	0.21
RADIUM 228 (pCi/L)	0.58	0.44	0.58	0.84	0.37

TABLE 4.2-5A Results for FMC Pond 17 1998 RCRA Appendix III Groundwater Monitoring

	Wells Analyzed for RCRA Appendix III Parameters				
ANALYTES	**Well-180**	**Well-171**	**Well-171**	**Well-181**	**Well-181**
Routine Parameters	**May-98**	**Feb-98**	**May-98**	**Feb-98**	**May-98**
Field Measurements					
PH (FLD)	7.43	7.33	7.46	7.94	7.66
PH	7.2	7.5 ,J	7.4	8.1 ,J	7.6
PH	7.3		7.5	8.2 ,J	7.7
SC (UMHOS/CM AT 25 C)					
SC (UMHOS/CM AT 25 C)					
SC (UMHOS/CM AT 25 C)	1200	1100	940	1700	1600
SC (UMHOS/CM AT 25 C) (FLD)	1167	1050	999	1669	1649
TURBIDITY (NTU) (FLD)	0	0.1	0	3.5	0.7
WATER TEMPERATURE (C) (FLD)	13.1	12.6	13	12.8	14
General WQP					
TDS (MEASURED AT 180 C)	780	690	700	1200	1200
SODIUM (NA) DIS					
SODIUM (NA) TOT	161	74.4	74.8	170	152
POTASSIUM (K) DIS					
POTASSIUM (K) TOT	32	16.1	16	18.3	17.9
SULFATE (SO4)	102	64	73.6	320	301
CHLORIDE (CL)	127	150	175	240	232
FLUORIDE (F)	0.57	0.61	0.56	0.5	0.45
TOTAL AMMONIA (NH3+NH4 AS N)	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
NITRATE (NO3-N)	17.3	3 ,J	2.6	5.7 ,J	6.8
ORTHOPHOSPHATE (PO4-P)	0.45 ,J	0.1	0.1 ,J	0.1	0.1 ,J
Metals					
ARSENIC (AS) DISSOLVED					
ARSENIC (AS) TOTAL	0.0433	0.021	0.021	0.019	0.02
CADMIUM (CD) DISSOLVED					
CADMIUM (CD) TOTAL	0.0001 ,U	< 0.0001	< 0.0001	< 0.0001	0.00007 B,UJ
SELENIUM (SE) DISSOLVED					
SELENIUM (SE) TOTAL	0.0081	< 0.005	0.0044 B,J	0.01	0.01
Additional Appendix III Parameters					
Metals					
BARIUM (BA) DISSOLVED					
BARIUM (BA) TOTAL	0.0625 B,J	0.079 B,J	0.084 B,J	0.041 B,J	0.0345 B,J
CHROMIUM (CR) DISSOLVED					
CHROMIUM (CR) TOTAL	0.013	0.0048 B,J	0.015	0.016	0.013
IRON (FE) DISSOLVED					
IRON (FE) TOTAL	0.046 B,UJ	< 0.1	0.54	0.055 B,JU	0.16 ,U
LEAD (PB) DISSOLVED					
LEAD (PB) TOTAL	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
MANGANESE (MN) DISSOLVED					
MANGANESE (MN) TOTAL	0.0022 B,UJ	0.002 B,UJ	0.0032 B,UJ	0.049	0.057
MERCURY (HG) DISSOLVED					
MERCURY (HG) TOTAL	0.00019 B,J	< 0.0002	< 0.0002	< 0.0002	< 0.0002
SILVER (AG) DISSOLVED					
SILVER (AG) TOTAL	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Other					
PHENOL TOTAL	< 0.02	< 0.02 ,J	< 0.02	< 0.02 ,J	< 0.02
TOTAL ORGANIC CARBON	< 1 ,J	< 1	< 1 ,J	2	< 1 ,J
TOTAL ORGANIC CARBON				< 1	< 1 ,J
TOTAL ORGANIC HALOGEN (TOX)	0.0681	< 0.03	0.609	0.208	0.134
TOTAL ORGANIC HALOGEN (TOX)	0.073		0.68	0.278	0.153
TOTAL ORGANIC HALOGEN (TOX)	0.0907		0.796	0.286	0.188
TOTAL ORGANIC HALOGEN (TOX)	0.116		1.02	0.295	
ENDRIN	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005
GAMMA-BHC(LINDANE)	< 0.000025	< 0.000025	< 0.000025	< 0.000025	< 0.000025
METHOXYCHLOR	< 0.00025	< 0.00025	< 0.00025	< 0.00025	< 0.00025
TOXAPHENE	< 0.0012	< 0.0012	< 0.0012	< 0.0012	< 0.0012
2,4-DICHLOROPHENOXYACETIC ACID	< 0.0004	< 0.0004 ,J	< 0.0004	< 0.0004 ,J	< 0.0004
SILVEX (2,4,5-TP)	< 0.0001	< 0.0001 ,J	< 0.0001	< 0.0001 ,J	< 0.0001
TOTAL COLIFORM (NO./100ML)	< 10	5600 ,R	< 10	13700 ,R	< 10
Radiological					
GROSS ALPHA (pCi/l)	0.85	1.14	2.02	1.62	4.16
GROSS BETA (pCi/l)	15.4	12.2 ,J	10.9	9.82 ,J	13.6
RADIUM 226 (pCi/L)	0.14	0.2	0.12	0.27	0.13
RADIUM 228 (pCi/L)	0.68	0.13	0.54	0.73	0.58

TABLE 4.2-5A Results for FMC Pond 17 1998 RCRA Appendix III Groundwater Monitoring

	Wells Analyzed for RCRA Appendix III Parameters			
ANALYTES	**Well-182**	**Well-182**	**Well-172**	**Well-172**
Routine Parameters	**Feb-98**	**May-98**	**Feb-98**	**May-98**
Field Measurements				
PH (FLD)	7.24	7.19	7.63	7.38
PH	7.1 ,J	7.2	7.5 ,J	7.6
PH	7.2 ,J	7.3	7.6 ,J	
SC (UMHOS/CM AT 25 C)				
SC (UMHOS/CM AT 25 C)			990	950
SC (UMHOS/CM AT 25 C)	1900	1800	1000	940
SC (UMHOS/CM AT 25 C) (FLD)	1913	1799	975	
TURBIDITY (NTU) (FLD)	0.1	0	0.1	0
WATER TEMPERATURE (C) (FLD)	11.7	12.7	11.8	12.6
General WQP				
TDS (MEASURED AT 180 C)	1300	1200	620	610
SODIUM (NA) DIS				
SODIUM (NA) TOT	317	275	75.8	77
POTASSIUM (K) DIS				
POTASSIUM (K) TOT	13.3	14	16.6	17
SULFATE (SO4)	130	151	53	58.4
CHLORIDE (CL)	110	114	140	148
FLUORIDE (F)	0.36	0.33	0.37	0.37
TOTAL AMMONIA (NH3+NH4 AS N)	< 0.2	< 0.2	< 0.2	< 0.2
NITRATE (NO3-N)	35 ,J	52	4.4 ,J	3.7
ORTHOPHOSPHATE (PO4-P)	0.9	0.9 ,J	0.4	0.4 ,J
Metals				
ARSENIC (AS) DISSOLVED				
ARSENIC (AS) TOTAL	0.049	0.05	0.024	0.023
CADMIUM (CD) DISSOLVED				
CADMIUM (CD) TOTAL	< 0.0001 Wa	0.00016 ,U	< 0.0001	0.00008 B,UJ
SELENIUM (SE) DISSOLVED				
SELENIUM (SE) TOTAL	0.02	0.02	0.0029 B,J	0.0043 B,J
Additional Appendix III Parameters				
Metals				
BARIUM (BA) DISSOLVED				
BARIUM (BA) TOTAL	0.048 B,J	0.044 B,J	0.095 B,J	0.0965 B,J
CHROMIUM (CR) DISSOLVED				
CHROMIUM (CR) TOTAL	0.02	0.019	0.0087	0.0052
IRON (FE) DISSOLVED				
IRON (FE) TOTAL	0.098 B,UJ	0.1 ,U	< 0.1	0.036 B,UJ
LEAD (PB) DISSOLVED				
LEAD (PB) TOTAL	< 0.003	< 0.003	< 0.003	< 0.003
MANGANESE (MN) DISSOLVED				
MANGANESE (MN) TOTAL	0.035	0.033	0.0032 B,UJ	0.0012 B,UJ
MERCURY (HG) DISSOLVED				
MERCURY (HG) TOTAL	0.00015 B,J	0.00017 B,J	< 0.0002	< 0.0002
SILVER (AG) DISSOLVED				
SILVER (AG) TOTAL	< 0.005	< 0.005	< 0.005	< 0.005
Other				
PHENOL TOTAL	0.12 ,J	< 0.02	< 0.02 ,J	0.079 ,J
TOTAL ORGANIC CARBON	1 N	< 1 ,J	< 1	< 1 ,J
TOTAL ORGANIC CARBON	< 1 N	< 1 ,J		
TOTAL ORGANIC HALOGEN (TOX)	0.279	0.238	0.0352	0.037
TOTAL ORGANIC HALOGEN (TOX)	0.312	0.294	0.0377	0.0378
TOTAL ORGANIC HALOGEN (TOX)	0.326	0.298	0.0421	0.0449
TOTAL ORGANIC HALOGEN (TOX)	0.335	0.311	< 0.03	< 0.03
ENDRIN	< 0.00005	< 0.00005	< 0.00005	< 0.00005
GAMMA-BHC(LINDANE)	< 0.000025	< 0.000025	< 0.000025	< 0.000025
METHOXYCHLOR	< 0.00025	< 0.00025	< 0.00025	< 0.00025
TOXAPHENE	< 0.0012	< 0.0012	< 0.0012	< 0.0012
2,4-DICHLOROPHENOXYACETIC ACID	< 0.0004 ,J	< 0.0004	< 0.0004 ,J	< 0.0004
SILVEX (2,4,5-TP)	< 0.0001 ,J	< 0.0001	< 0.0001 ,J	< 0.0001
TOTAL COLIFORM (NO./100ML)	1800 ,R	< 10	11600 ,R	< 10
Radiological				
GROSS ALPHA (pCi/l)	1.97	1.74	1.84	0.6
GROSS BETA (pCi/l)	8.08 ,J	7.2	11.6 ,J	12.3
RADIUM 226 (pCi/L)	0.3	0.24	0.16	0.14
RADIUM 228 (pCi/L)	0.52	0.15	0.47	1.04

TABLE 4.2-5B Results for FMC Pond 18 1998 RCRA Appendix III Groundwater Monitoring

	Pond 18 Wells Analyzed for RCRA Appendix III Parameters					
ANALYTE	**Well-154**	**Well-174**	**Well-175**	**Well-176**	**Well-177**	**Well-178**
Routine Parameters	**Nov-98**	**Nov-98**	**Nov-98**	**Nov-98**	**Nov-98**	**Nov-98**
Field Measurements						
PH (FLD)	7.56	8.13	7.39	7.29	7.45	7.58
PH	7.4	7.6	7.3	3.4	7.4	3
PH		7.7		4.6		5.9
PH				7.2		6
PH				7.4		6.2
SC (UMHOS/CM AT 25 C)	710	1100	1000	1100	1000	870
SC (UMHOS/CM AT 25 C)	720		1100	1096	1100	870
SC (UMHOS/CM AT 25 C)	730					
SC (UMHOS/CM AT 25 C) (FLD)	694	1157	1020		1060	842
TURBIDITY (NTU) (FLD)	0.1	5.1	1.3	1	0.5	2.9
WATER TEMPERATURE (C) (FLD)	16.6	16.6	15.6	16.6	16.8	16.1
General WQP						
TDS (MEASURED AT 180 C)	370					
SODIUM (NA) TOT	71.1	92.4	64.5	74	75.6	81.5
POTASSIUM (K) TOT	12.2	14	12.9	14.8	13.4	12.8
SULFATE (SO4)	41.8 ,J	94.8 ,J	68.8 ,J	73 ,J	72.6 ,J	55.7 ,J
CHLORIDE (CL)	76 ,J	195 ,J	155 ,J	195 ,J	168 ,J	118 ,J
FLUORIDE (F)	1.21	0.76	0.59	0.68	0.83	1.06
TOTAL AMMONIA (NH3+NH4 AS N)	0.8	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
NITRATE (NO3-N)	0.92 ,J	4.1 ,J	5.4 ,J	4.5 ,J	3.3 ,J	1.5 ,J
ORTHOPHOSPHATE (PO4-P)	< 0.1	< 0.1 ,J	< 0.1 ,J	< 0.1 ,J	< 0.1 ,J	< 0.1 ,J
Metals						
ARSENIC (AS) TOTAL	0.0065	< 0.005	0.0055	0.0034 B,J	< 0.005	0.0064
CADMIUM (CD) TOTAL	< 0.0001	0.00009 B,UJ	0.00006 B,UJ	< 0.0001	0.00005 B,UJ	0.00007 B,UJ
SELENIUM (SE) TOTAL	0.0048 B,UJ	0.0066 ,U	0.0063 ,U	0.0091 ,U	0.006 ,U	0.0041 B,UJ
Additional Appendix III Parameters						
Metals						
BARIUM (BA) TOTAL	0.17 B,J	0.16 B,J	0.29	0.3	0.26	0.17 B,J
CHROMIUM (CR) TOTAL	0.0025 B,J	0.0088	0.0053	0.0077	0.0055	0.0041 B,J
IRON (FE) TOTAL	0.038 B,UJ	0.074 B,UJ	0.048 B,UJ	0.034 B,UJ	< 0.1	0.056 B,UJ
LEAD (PB) TOTAL	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
MANGANESE (MN) TOTAL	0.0011 B,UJ	0.0057 B,J	0.0055 B,J	0.0027 B,UJ	0.014 B,J	0.0046 B,UJ
MERCURY (HG) TOTAL	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
SILVER (AG) TOTAL	< 0.005	< 0.005	< 0.005	< 0.005	0.0007 B,J	< 0.005
Other						
PHENOL TOTAL	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
TOTAL ORGANIC CARBON	< 1	2	< 1	1	< 1	< 1
TOTAL ORGANIC CARBON		< 1		< 1	< 1 ,J	
TOTAL ORGANIC CARBON				< 1		
TOTAL ORGANIC CARBON				< 1		
TOTAL ORGANIC HALOGEN (TOX)	< 0.03	0.0426	< 0.03 ,J	0.439	0.138 ,J	< 0.03
TOTAL ORGANIC HALOGEN (TOX)		< 0.03		< 0.03	< 0.03	
TOTAL ORGANIC HALOGEN (TOX)		< 0.03 ,J			< 0.03 ,J	
TOTAL ORGANIC HALOGEN (TOX)						
ENDRIN	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005
GAMMA-BHC(LINDANE)	< 0.000025	< 0.000025	< 0.000025	< 0.000025	< 0.000025	< 0.000025
METHOXYCHLOR	< 0.00025	< 0.00025	< 0.00025	< 0.00025	< 0.00025	< 0.00025
TOXAPHENE	< 0.0012	< 0.0012	< 0.0012	< 0.0012	< 0.0012	< 0.0012
2,4-DICHLOROPHENOXYACETIC ACID	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004
SILVEX (2,4,5-TP)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
TOTAL COLIFORM (NO./100ML)	2750	< 10	< 10	< 10	< 10	< 10
Radiological						
GROSS ALPHA (pCi/l)	4.33	4.86	5.39	2.92	5.78	3.94
GROSS BETA (pCi/l)	9.08	12.6	9.3	12.3	11.7	11
RADIUM 226 (pCi/L)	0.26	0.21	0.2	0.14	0.18	0.078
RADIUM 228 (pCi/L)	0.84	0.7	0.83	0.53	0.8	0.34

TABLE 4.2-6 Results for FMC 2000 Special Groundwater Monitoring Event

Parameter	Wells Analyzed for August 2000 Expanded Parameter List				
Routine Analytes	**Well-104**	**Well-113**	**Well-115**	**Well-122**	**Well-123**
Field Measurements					
PH (FLD)	7.27	7.26	7.4	6.84	6.42
SC (UMHOS/CM AT 25 C) (FLD)	2140	1109	1788	2230	3260
TURBIDITY (NTU) (FLD)	0.7	0.6	0.8	0.8	0.7
WATER TEMPERATURE (C) (FLD)	13.7	11.4	11.1	19.5	17.5
General WQP					
POTASSIUM (K) DIS				161 N	
POTASSIUM (K) TOT	260 N	27.5	13	174 N,J	37 N,J
SULFATE (SO4)	169	86.2	137	197	641
CHLORIDE (CL)	147	153	154	343	534
FLUORIDE (F)					
FLUORIDE (F)	4.8	0.41 ,J	< 0.1	0.11	0.78
TOTAL AMMONIA (NH3+NH4 AS N)	3.5	< 0.2	< 0.2	< 0.2	4.2
NITRATE (NO3-N)	26.3	6.2	0.41	28	22.8
ORTHOPHOSPHATE (PO4-P)	4.1	0.24	2.7	5	2.7
Metals					
ARSENIC (AS) TOTAL	0.0716	0.0286	0.254	0.0479	0.34
CADMIUM (CD) TOTAL	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
SELENIUM (SE) TOTAL	< 0.005	0.0037 B,J	< 0.005	< 0.005	0.204
Expanded Parameter List					
Metals					
ALUMINUM (AL) DIS					
ALUMINUM (AL) TOTAL	< 0.2	0.0692 B,UJ	0.0702 B,UJ	< 0.2	< 0.2
ANTIMONY (SB) DIS					
ANTIMONY (SB) TOTAL	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
BARIUM (BA) DIS				0.181 B,J	
BARIUM (BA) TOTAL	0.255	0.0577 B,J	0.122 B,J	0.181 J	0.0453 B,J
BORON (B) DIS				0.646	
BORON (B) TOTAL	1.98	0.613	2.7	0.646	0.854
CHROMIUM (CR) DIS					
CHROMIUM (CR) TOTAL	< 0.005	0.0048 B,J	< 0.005	< 0.005	< 0.005
COBALT (CO) DIS				0.0154	
COBALT (CO) TOTAL	0.0874	0.0049 B,J	0.033	0.0154	0.005 B,J
COPPER (CU) DIS					
COPPER (CU) TOTAL	0.0022	< 0.025	< 0.025	< 0.025	< 0.025
LEAD (PB) DIS					
LEAD (PB) TOTAL	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
LITHIUM (LI) DIS				0.088	
LITHIUM (LI) TOTAL	0.121	< 0.05	< 0.05	0.088	0.202
MANGANESE (MN) DIS				0.859	
MANGANESE (MN) TOTAL	2.37	0.0014 B,U	0.662	0.859	0.361
MOLYBDENUM (MO) DIS				0.0299	
MOLYBDENUM (MO) TOTAL	0.0246	0.0054 B,UJ	0.0286	0.030	0.02
MERCURY (HG) DIS					
MERCURY (HG) TOTAL	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
NICKEL (NI) DIS				0.0085 B,J	
NICKEL (NI) TOTAL	0.0095	< 0.04	0.0025 B,J	0.0085 J	0.009 B,J
SILVER (AG) DIS					
SILVER (AG) TOTAL	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
THALLIUM (TL) DIS					
THALLIUM (TL) TOTAL	< 0.01	< 0.01	< 0.01	< 0.010	0.0085 B,J
VANADIUM (V) DIS				0.010	
VANADIUM (V) TOTAL	0.0146	0.0097	0.0175	0.010	0.178
ZINC (ZN) DIS					
ZINC (ZN) TOTAL	< 0.02	0.0079 B,UJ	0.0019 B,UJ	< 0.02	< 0.02
Other					
CYANIDE (CN) TOTAL	0.15	0.012	0.14	0.017 ,J	0.025 ,J
Radiological					
GROSS ALPHA (pCi/l)	10.4	< 7.4	< 9.4	< 13	< 17
GROSS BETA (pCi/l)	247	44.3	< 12	77	35
CESIUM-137 (pCi/l)	< 15	< 15	< 15	< 16	< 14
RADIUM 226 (pCi/L)	< 0.25	< 0.21	< 0.18	0.38	< 0.2
RADIUM 228 (pCi/L)	< 0.87	< 0.66	< 0.73	< 0.71	< 0.75

TABLE 4.2-6 Results for FMC 2000 Special Groundwater Monitoring Event

Parameter	Wells Analyzed for August 2000 Expanded Parameter List				
Routine Analytes	**Well-126**	**Well-127**	**Well-128**	**Well-131**	**Well-147**
Field Measurements					
PH (FLD)	7.34	7.25	7.3	6.98	7.32
SC (UMHOS/CM AT 25 C) (FLD)	909	1638	1186	1638	999
TURBIDITY (NTU) (FLD)	0.6	0.5	0.5	82	0.6
WATER TEMPERATURE (C) (FLD)	16.2	13.8	12.1	13.4	16.7
General WQP					
POTASSIUM (K) DIS				13.7 N,J	
POTASSIUM (K) TOT	13	17.9	16.9	15.6 N,J	14.9
SULFATE (SO4)	105	210	99.3	150	64.8
CHLORIDE (CL)	114	287	198	178	157
FLUORIDE (F)				0.14	0.77 ,J
FLUORIDE (F)	0.94 ,J	0.4 ,J	0.27 ,J	9.5	
TOTAL AMMONIA (NH3+NH4 AS N)	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
NITRATE (NO3-N)	2	3.8	3.4	0.23	3.3
ORTHOPHOSPHATE (PO4-P)	< 0.1	0.063 B,UJ	0.2	5.7	< 0.1
Metals					
ARSENIC (AS) TOTAL	0.0099 ,U	0.0089 ,U	0.0184	0.0731	0.005 B,UJ
CADMIUM (CD) TOTAL	< 0.001	< 0.001	< 0.001	< 0.001	0.0002 B,J
SELENIUM (SE) TOTAL	< 0.005	0.0068	< 0.005	< 0.005	0.006
Expanded Parameter List					
Metals					
ALUMINUM (AL) DIS				0.0391 B,UJ	
ALUMINUM (AL) TOTAL	0.0784 B,UJ	0.0819 B,UJ	0.0716 B,UJ	6.33	0.076 B,UJ
ANTIMONY (SB) DIS				< 0.01	
ANTIMONY (SB) TOTAL	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
BARIUM (BA) DIS				0.085 B,J	
BARIUM (BA) TOTAL	0.156 B,J	0.0741 B,J	0.06 B,J	0.149 B,J	0.234
BORON (B) DIS				2.55	
BORON (B) TOTAL	0.203 ,U	0.365	0.396	2.6	0.168 B,UJ
CHROMIUM (CR) DIS				0.0028 B,J	
CHROMIUM (CR) TOTAL	0.0051	0.0053	0.0035 B,UJ	0.0079	0.0056
COBALT (CO) DIS				0.0385	
COBALT (CO) TOTAL	0.0019 B,UJ	0.0078	0.0043 B,J	0.0405	< 0.007
COPPER (CU) DIS				< 0.025	
COPPER (CU) TOTAL	< 0.025	< 0.025	< 0.025	0.0038 B,J	< 0.025
LEAD (PB) DIS				< 0.003	
LEAD (PB) TOTAL	< 0.003	< 0.003	< 0.003	0.0018 B,J	< 0.003
LITHIUM (LI) DIS				< 0.05	
LITHIUM (LI) TOTAL	0.0588	0.0557	0.0741	< 0.05	0.0603
MANGANESE (MN) DIS				1.85	
MANGANESE (MN) TOTAL	0.0022 B,UJ	0.0011 B,UJ	0.0016 B,UJ	1.97	0.0012 B,UJ
MOLYBDENUM (MO) DIS				0.0119	
MOLYBDENUM (MO) TOTAL	0.0037 B,UJ	0.0032 B,UJ	0.0035 B,UJ	0.0119	0.0041 B,U
MERCURY (HG) DIS				< 0.0002	
MERCURY (HG) TOTAL	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
NICKEL (NI) DIS				0.0117 B,J	
NICKEL (NI) TOTAL	0.0023 B,J	< 0.04	< 0.04	0.0174 B,J	< 0.04
SILVER (AG) DIS				< 0.005	
SILVER (AG) TOTAL	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
THALLIUM (TL) DIS				< 0.01	
THALLIUM (TL) TOTAL	< 0.01	< 0.01	< 0.01	< 0.01	0.0051 B,J
VANADIUM (V) DIS				0.0078	
VANADIUM (V) TOTAL	0.0066 B,J	0.005 B,J	0.0083	0.017	0.0039 B,J
ZINC (ZN) DIS				< 0.02	
ZINC (ZN) TOTAL	0.0132 B,UJ	0.0107 B,UJ	0.0042 B,UJ	0.0077 B,J	0.0064 B,UJ
Other					
CYANIDE (CN) TOTAL	0.016	0.045	< 0.01	0.28 ,J	< 0.01
Radiological					
GROSS ALPHA (pCi/l)	< 7.2	< 12	< 9.4	< 13	< 7.9
GROSS BETA (pCi/l)	10.2	17.6	14.2	20.2	13.6
CESIUM-137 (pCi/l)	< 16	< 14	< 18	< 16	< 19
RADIUM 226 (pCi/L)	< 0.16	< 0.2	< 0.24	0.25	< 0.25
RADIUM 228 (pCi/L)	< 0.54	< 0.56	< 0.67	< 0.71	0.06

TABLE 4.2-6 Results for FMC 2000 Special Groundwater Monitoring Event

Parameter	Wells Analyzed for August 2000 Expanded Parameter List				
Routine Analytes	**Well-148**	**Well-149**	**Well-155**	**Well-157**	**Well-165**
Field Measurements					
PH (FLD)	7.31	7.38	6.89	7.06	7.22
SC (UMHOS/CM AT 25 C) (FLD)	1060	737	4250	5090	1627
TURBIDITY (NTU) (FLD)	0.6	0.5	0.8	0.6	0.5
WATER TEMPERATURE (C) (FLD)	16	16.1	14.3	15.4	12.1
General WQP					
POTASSIUM (K) DIS			569 N	1200 ,J	
POTASSIUM (K) TOT	16.8	13.3	569 N,J	< 5 N	14.4 N,J
SULFATE (SO4)	90.1	48.6	357	242	196
CHLORIDE (CL)	163	81.7	419	348	303
FLUORIDE (F)	0.64 ,J	1 ,J	< 0.1	3.2	0.12
FLUORIDE (F)			< 0.1	5.3	
TOTAL AMMONIA (NH3+NH4 AS N)	< 0.2	< 0.2	3	6.7	< 0.2
NITRATE (NO3-N)	2.8	1.3	0.5	< 0.2	4
ORTHOPHOSPHATE (PO4-P)	0.03 B,UJ	< 0.1	54.9	240	0.46
Metals					
ARSENIC (AS) TOTAL	0.008 ,U	0.0111 ,U	0.196	0.193	0.0302
CADMIUM (CD) TOTAL	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
SELENIUM (SE) TOTAL	0.0036 B,J	< 0.005	0.0047 B,J	< 0.005	0.0063
Expanded Parameter List					
Metals					
ALUMINUM (AL) DIS					
ALUMINUM (AL) TOTAL	0.0887 B,UJ	0.0759 B,UJ	< 0.2	< 0.2	0.0307 B,UJ
ANTIMONY (SB) DIS					
ANTIMONY (SB) TOTAL	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
BARIUM (BA) DIS					
BARIUM (BA) TOTAL	0.143 B,J	0.0859 B,J	0.103 B,J	0.0218 B,J	0.0474 B,J
BORON (B) DIS					
BORON (B) TOTAL	0.347	0.181 B,UJ	2.4	3.33	0.517
CHROMIUM (CR) DIS					
CHROMIUM (CR) TOTAL	0.0081	0.003 B,UJ	0.0028 B,J	0.0118	0.0041 B,J
COBALT (CO) DIS					
COBALT (CO) TOTAL	0.0065 B,J	< 0.007	0.0305	0.017	0.016
COPPER (CU) DIS					
COPPER (CU) TOTAL	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025
LEAD (PB) DIS					
LEAD (PB) TOTAL	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
LITHIUM (LI) DIS					
LITHIUM (LI) TOTAL	0.0596	0.0636	0.157	0.123	0.0532
MANGANESE (MN) DIS					
MANGANESE (MN) TOTAL	0.0021 B,UJ	0.00055 B,UJ	2.3	1.94	0.0602
MOLYBDENUM (MO) DIS					
MOLYBDENUM (MO) TOTAL	0.031 B,UJ	0.0029 B,UJ	0.0332	0.046	0.0048 B,J
MERCURY (HG) DIS					
MERCURY (HG) TOTAL	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
NICKEL (NI) DIS					
NICKEL (NI) TOTAL	< 0.04	< 0.04	0.0451	0.0177 B,J	0.0022 B,J
SILVER (AG) DIS					
SILVER (AG) TOTAL	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
THALLIUM (TL) DIS					
THALLIUM (TL) TOTAL	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
VANADIUM (V) DIS					
VANADIUM (V) TOTAL	0.0062 B,J	0.0055 B,J	0.005 B,J	< 0.007	0.0095
ZINC (ZN) DIS					
ZINC (ZN) TOTAL	0.0076 B,UJ	0.0026 B,UJ	< 0.02	< 0.02	< 0.02
Other					
CYANIDE (CN) TOTAL	0.02	< 0.01	0.13 ,J	0.095 ,J	0.038 ,J
Radiological					
GROSS ALPHA (pCi/l)	< 7.9	< 6	< 21	< 19	< 11
GROSS BETA (pCi/l)	12.3	18.8	531	960	< 14
CESIUM-137 (pCi/l)	< 16	< 13	< 19	< 11	< 17
RADIUM 226 (pCi/L)	< 0.19	< 0.19	< 0.19	< 0.2	< 0.23
RADIUM 228 (pCi/L)	< 0.64	< 0.73	< 0.76	< 0.95	< 0.91

TABLE 4.2-6 Results for FMC 2000 Special Groundwater Monitoring Event

Parameter	Wells Analyzed for August 2000 Expanded Parameter List				
Routine Analytes	**Well-168**	**Well-171**	**Well-175**	**Well-176**	**Well-183**
Field Measurements					
PH (FLD)	7.09	7.37	7.22	7.22	7.44
SC (UMHOS/CM AT 25 C) (FLD)	2280	1001	1032	1064	558
TURBIDITY (NTU) (FLD)	1.4	0.5	0.6	0.6	0.9
WATER TEMPERATURE (C) (FLD)	13.3	12.9	15.8	16.9	16.7
General WQP					
POTASSIUM (K) DIS					
POTASSIUM (K) TOT	16.6 N,J	19.9	14.2	14	8.58 N,J
SULFATE (SO4)	721	68.2	67.2	69.1	19.8
CHLORIDE (CL)	145	167	156	172	59.4
FLUORIDE (F)	5.5	0.71 ,J	0.61 ,J	0.65 ,J	0.47
FLUORIDE (F)					0.5
TOTAL AMMONIA (NH3+NH4 AS N)	0.4	< 0.2	< 0.2	< 0.2	< 0.2
NITRATE (NO3-N)	17.2	3.5	5.3	4.3	0.95
ORTHOPHOSPHATE (PO4-P)	0.039 B,UJ	0.039 B,UJ	< 0.1	< 0.1	< 0.1
Metals					
ARSENIC (AS) TOTAL	0.0304	0.0185	0.0075 ,U	< 0.005	0.0162
CADMIUM (CD) TOTAL	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
SELENIUM (SE) TOTAL	0.013	0.0027 B,J	0.0036 B,J	0.0029 B,J	< 0.005
Expanded Parameter List					
Metals					
ALUMINUM (AL) DIS					0.0984 B,UJ
ALUMINUM (AL) TOTAL	0.061 B,UJ	0.0816 B,UJ	0.0776 B,UJ	0.142 B,UJ	
ANTIMONY (SB) DIS					
ANTIMONY (SB) TOTAL	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
BARIUM (BA) DIS					
BARIUM (BA) TOTAL	0.0178 B,J	0.0787 B,J	0.193 B,J	0.232	0.0955 B,J
BORON (B) DIS					
BORON (B) TOTAL	2.6	0.223	0.158 B,UJ	0.145 B,UJ	0.104 B,UJ
CHROMIUM (CR) DIS					
CHROMIUM (CR) TOTAL	0.0031 B,J	0.0034 B,UJ	0.0043 B,J	0.0052	0.004 B,J
COBALT (CO) DIS					
COBALT (CO) TOTAL	0.039	0.0012 B,UJ	0.00065 B,UJ	0.00055 B,UJ	< 0.007
COPPER (CU) DIS					
COPPER (CU) TOTAL	< 0.025	< 0.025	< 0.025	0.0033 B,J	< 0.025
LEAD (PB) DIS					
LEAD (PB) TOTAL	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
LITHIUM (LI) DIS					
LITHIUM (LI) TOTAL	0.16	< 0.05	< 0.05	0.0555	< 0.05
MANGANESE (MN) DIS					
MANGANESE (MN) TOTAL	0.212	0.0015 B,UJ	0.0019 B,UJ	0.0048 B,J	0.0032 B,UJ
MOLYBDENUM (MO) DIS					
MOLYBDENUM (MO) TOTAL	0.0028 B,J	0.0045 B,UJ	0.0026 B,UJ	< 0.01	0.0093 B,J
MERCURY (HG) DIS					
MERCURY (HG) TOTAL	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
NICKEL (NI) DIS					
NICKEL (NI) TOTAL		< 0.04	< 0.04	< 0.04	0.0029 B,J
SILVER (AG) DIS	< 0.005				
SILVER (AG) TOTAL		< 0.005	< 0.005	< 0.005	< 0.005
THALLIUM (TL) DIS					
THALLIUM (TL) TOTAL	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
VANADIUM (V) DIS					
VANADIUM (V) TOTAL	0.0077	0.0085	0.0034 B,J	0.0034 B,J	0.0066 B,J
ZINC (ZN) DIS					
ZINC (ZN) TOTAL	< 0.02	0.0104 B,UJ	0.0046 B,UJ	0.0379 ,U	< 0.02
Other					
CYANIDE (CN) TOTAL	0.34 ,J	< 0.01	< 0.01	< 0.01	< 0.01 ,J
Radiological					
GROSS ALPHA (pCi/l)	< 13	< 8.4	< 7.5	< 5.5	5.1
GROSS BETA (pCi/l)	21.7	13	15	12.5	8.1
CESIUM-137 (pCi/l)	< 15	< 17	< 13	< 10	< 11
RADIUM 226 (pCi/L)	< 0.17	< 0.17	< 0.2	< 0.21	< 0.14
RADIUM 228 (pCi/L)	< 0.68	< 0.6	0.74	< 0.89	< 0.68

TABLE 4.2-7 Results for FMC November 2001 Special Groundwater Monitoring Event

ANALYTE	Wells Analyzed for Expanded Parameter List								
Routine Parameters	**Batiste Spring**	**TW-11S**	**TW-12S**	**TW-9S**	**Well-104**	**Well-110**	**Well-113**	**Well-115**	**Well-122**
Field Measurements									
PH (FLD)	7.36	7.62	6.96	7.1	7.52	6.7	7.47	7.56	6.89
SC (UMHOS/CM AT 25 C) (FLD)	704	540	845	2050	2120	1763	1175	1846	2590
TURBIDITY (NTU) (FLD)	0.4	9.8	5	3.4	0.9	0.6	0.5	0.4	0.3
WATER TEMPERATURE (C) (FLD)	12.5	12.7	14.4	15.9	14.4	17.8	12.1	11.3	19.1
General WQP									
POTASSIUM (K) TOTAL	6.43	3.9 B,J	20.2	98.5	267 L,J	37.7	22.1 L,J	10.3	195
SULFATE (SO4)	74.1	42.6	128	267	149	415	88.2	135	252
CHLORIDE (CL)	32.1	18.3	50.2	224	136	86.2	140	147	382
FLUORIDE (F)	0.48	0.57	0.7	0.07 B,J	4.2	0.44	0.46	< 0.1	0.07 B,J
TOTAL AMMONIA (NH3+NH4 AS N)	< 0.2	< 0.2	< 0.2 J	< 0.2	3.8 J	< 0.2	< 0.2 J	< 0.2	0.2 U
NITRATE (NO3-N)	3.5	2	4.9	15.5	22	3.4	7	1.4	32.7
ORTHOPHOSPHATE (PO4-P)	0.84 J,JU	0.03	3.2 J,J	1.1 J,JU	1.9 J,J	2.2 J,U	0.14 J,JU	1.6 J,JU	8.3 J,JU
PHOSPHORUS (P) TOTAL	1.9	1 U	3 J	3.6	3.7 J	4.8	0.3 J	6.1	9.2
Metals									
ARSENIC (AS) TOTAL	0.0063	0.0033 B,J	0.0185	0.0308	0.0663	0.0772	0.0281	0.269	0.0614
CADMIUM (CD) TOTAL	< 0.001	< 0.001	0.0013	0.00037 B,UJ	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001 U
SELENIUM (SE) TOTAL	< 0.005	< 0.005	0.007 U	0.0085 U	0.0048 B,UJ	0.055	0.0038 B,UJ	< 0.005	0.0041 B,U,J
Additional Parameters									
Metals									
ALUMINUM (AL) TOTAL	0.0492 B,UJ	0.044 B,UJ	0.0116 B,UJ	0.0375 B,UJ	0.0512 B,UJ	0.0679 B,UJ	0.0387 B,UJ	0.0529 B,UJ	0.0571 B,U,J
ANTIMONY (SB) TOTAL	< 0.01	< 0.01	0.003 B,J	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01 U
BARIUM (BA) TOTAL	0.0362 B,J	0.0612 B,J	0.0284 B,J	0.0842 B,J	0.227	0.0875 B,J	0.0575 B,J	0.12 B,J	0.224
BORON (B) TOTAL	0.165 B,UJ	0.121 B,UJ	0.189 B,J	0.644	1.85	0.399	0.72	2.51	0.792
CHROMIUM (CR) TOTAL	< 0.005	< 0.005	0.0013 B,J	< 0.005	< 0.005	0.0016 B,J	0.0029 B,J	< 0.005	< 0.005 U
COBALT (CO)TOTAL	0.0008 B,UJ	< 0.05	0.069 B,J	0.0133 B,J	0.0857	0.0011 B,UJ	0.005 B,J	0.0326 B,J	0.02 B,J
COPPER (CU) TOTAL	< 0.025	< 0.025	< 0.025	0.0011 B,UJ	0.0023 B,J	0.0015 B,UJ	< 0.025	0.0019 B,UJ	0.00089 B,U,J
LEAD (PB) TOTAL	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003 U
LITHIUM (LI) TOTAL	0.0468 J	0.0483 B,J	0.0673	0.0958	0.119	0.129	0.0466 B,J	0.0475 B,J	0.108
MANGANESE (MN) TOTAL	0.0018 B,UJ	0.0056 B,J	0.0033 B,UJ	0.84	2.01	0.00065 B,UJ	0.0014 B,UJ	0.67	1
MERCURY (HG) TOTAL	< 0.0002	< 0.0002	< 0.0002	< 0.0002	0.00022	< 0.0002	< 0.0002	< 0.0002	0.00013 B,U,J
MOLYBDENUM (MO) TOTAL	0.0026 B,UJ	0.0018 B,UJ	0.0032 B,UJ	0.0124 B,UJ	0.0225 B,J	0.0085 B,UJ	0.0015 B,UJ	0.029 B,J	0.0253 B,J
NICKEL (NI) TOTAL	< 0.04	< 0.04	0.009 B,J	< 0.04	0.0062 B,J	< 0.04	< 0.04	0.0034 B,J	0.0055 B,J
SILVER (AG) TOTAL	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005 U
THALLIUM (TL) TOTAL	< 0.01	0.0064 B,UJ	< 0.01	0.0061 B,UJ	< 0.01	0.007 B,UJ	< 0.01	0.0078 B,UJ	0.0061 B,U,J
VANADIUM (V) TOTAL	0.0037 B,UJ	0.0032 B,UJ	0.0072	0.0053 B,J	0.0134	0.0166	0.0088	0.018	0.0104
ZINC (ZN) TOTAL	0.0016 B,UJ	0.00077 B,UJ	0.0209	0.00037 B,UJ	0.0069 B,UJ	0.00036 B,UJ	0.0022 B,UJ	< 0.02	0.0018 B,U,J
Other									
CYANIDE (CN) TOTAL	< 0.01		< 0.01		0.082		0.082	0.13	0.051
Radiological									
GROSS ALPHA (pCi/l)	2.2 U	4.5 U		2.8 U		4.3 U		1 U	2.6 U
GROSS BETA (pCi/l)	7.3	7.1 U		76		31.9		6.5	140
RADIUM 226 (pCi/L)	0.14 U	-0.01 U		0.27		0.13 U		0.16 U	0.27
RADIUM 228 (pCi/L)	0.16 U	-0.2 U		0.69 U		0.77		0.4	0.64 U
CESIUM-137 (pCi/l)	3.3 U	-1 U		2.6 U		-1 U		-5.3 U	-1.4 U

TABLE 4.2-7 Results for FMC November 2001 Special Groundwater Monitoring Event

ANALYTE	Wells Analyzed for Expanded Parameter List								
Routine Parameters	**Well-123**	**Well-126**	**Well-127**	**Well-128**	**Well-131**	**Well-142**	**Well-146**	**Well-147**	**Well-148**
Field Measurements									
PH (FLD)	6.63	7.48	7.41	7.42	7.22	6.61	7.28	7.39	7.42
SC (UMHOS/CM AT 25 C) (FLD)	2850	856	1667	1483	1690	3640	928	1019	1089
TURBIDITY (NTU) (FLD)	0.3	0.6	0.5	0.4	30	0.7	0.8	0.4	0.6
WATER TEMPERATURE (C) (FLD)	17.5	16.8	14.6	12.5	13.9	15.4	20.1	17	16.4
General WQP									
POTASSIUM (K) TOTAL	31.4	9.49 L,J	14.2 L,J	16.4 L,J	13.7	24.3 L,J	49.5	12 L,J	12.9 L,J
SULFATE (SO4)	479	90.8	183	120	150	1260	94.1	63.7	91.1
CHLORIDE (CL)	383	92.8	268	229	174	108	96.8	153	153
FLUORIDE (F)	0.77	0.88	0.62	0.43	< 0.1	0.02 B,J	0.5	0.69	0.73
TOTAL AMMONIA (NH3+NH4 AS N)	5.2	< 0.2 J	< 0.2 J	< 0.2 J	< 0.2	< 0.2 J	< 0.2 J	< 0.2 J	< 0.2 J
NITRATE (NO3-N)	18.5	1.7	3.6	3.6	0.28	2.6	5.8	3.2	2.8
ORTHOPHOSPHATE (PO4-P)	1.3 J,JU	0.1 J,JU	< 0.1 BJ,JU	< 0.1 BJ,JU	5.2 J,J	< 0.1 J	0.16 J,U	0.019 BJ,JU	0.018 BJ,JU
PHOSPHORUS (P) TOTAL	3.1	< 0.1 J	0.1 J	0.3 J	29	0.2 J	0.3 J	< 0.1 J	0.1 J
Metals									
ARSENIC (AS) TOTAL	0.314	0.0077	0.0103	0.0182	0.0673	0.0124	0.0138	0.0034 B,J	0.0085
CADMIUM (CD) TOTAL	< 0.001 U	< 0.001	< 0.001	< 0.001	0.00027 B,U,J	< 0.001	< 0.001	< 0.001	< 0.001
SELENIUM (SE) TOTAL	0.196	0.0034 B,UJ	0.0068 U	0.0048 B,UJ	0.0042 B,U,J	0.0112 U	< 0.005	0.0068 U	< 0.005
Additional Parameters									
Metals									
ALUMINUM (AL) TOTAL	0.0523 B,U,J	0.0423 B,UJ	0.0498 B,UJ	0.047 B,UJ	0.899	0.0335 B,UJ	0.0151 B,UJ	0.0364 B,UJ	0.0322 B,UJ
ANTIMONY (SB) TOTAL	< 0.01 U	< 0.01	< 0.01	< 0.01	< 0.01	0.0022 B,J	< 0.01	< 0.01	< 0.01
BARIUM (BA) TOTAL	0.039 B,J	0.136 B,J	0.068 B,J	0.0743 B,J	0.108 B,J	0.0412 B,J	0.0927 B,J	0.228	0.139 B,J
BORON (B) TOTAL	0.765	0.202	0.381	0.564	2.42	0.438	0.235	0.167 B,J	0.343
CHROMIUM (CR) TOTAL	< 0.005 U	0.0022 B,J	0.0054	0.0036 B,J	0.0012 B,J	< 0.005	< 0.005	0.0039 B,J	0.004 B,J
COBALT (CO)TOTAL	0.0042 B,U,J	0.0016 B,UJ	0.0078 B,J	0.007 B,J	0.0406 B,J	< 0.05	0.002 B,J	< 0.05	0.0066 B,J
COPPER (CU) TOTAL	0.0014 B,U,J	< 0.025	< 0.025	< 0.025	0.0062 B,U,J	0.0011 B,J	< 0.025	< 0.025	< 0.025
LEAD (PB) TOTAL	< 0.003 U	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
LITHIUM (LI) TOTAL	0.196	0.0574	0.0788	0.0647	0.0485 B,J	0.0441 B,J	0.0634	0.0614	0.062
MANGANESE (MN) TOTAL	0.257	0.00029 B,UJ	< 0.015	< 0.015	2.55	0.0016 B,UJ	0.0094 B,J	< 0.015	0.00092 B,UJ
MERCURY (HG) TOTAL	< 0.0002 U	< 0.0002	< 0.0002	< 0.0002	< 0.0002 U	< 0.0002	< 0.0002	< 0.0002	< 0.0002
MOLYBDENUM (MO) TOTAL	0.024 B,J	0.0026 B,UJ	< 0.04	0.0015 B,UJ	0.0135 B,U,J	< 0.04	0.005 B,UJ	< 0.04	< 0.04
NICKEL (NI) TOTAL	0.0039 B,J	< 0.04	0.0023 B,J	< 0.04	0.0129 B,J	0.0014 B,J	< 0.04	< 0.04	< 0.04
SILVER (AG) TOTAL	< 0.005 U	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
THALLIUM (TL) TOTAL	0.0052 B,U,J	< 0.01	< 0.01	< 0.01	0.0052 B,U,J	< 0.01	< 0.01	< 0.01	< 0.01
VANADIUM (V) TOTAL	0.181	0.0057 B,J	0.0052 B,J	0.0087	0.0086	0.0039 B,J	0.0051 B,J	0.0035 B,J	0.0054 B,J
ZINC (ZN) TOTAL	0.0011 B,U,J	0.0089 B,UJ	0.0021 B,UJ	0.0011 B,UJ	0.0121 B,U,J	0.0054 B,UJ	0.0024 B,UJ	0.0079 B,UJ	0.0089 B,UJ
Other									
CYANIDE (CN) TOTAL	0.022	0.016	0.05	0.017	0.43			< 0.01	0.02
Radiological									
GROSS ALPHA (pCi/l)	-0.7 U				1.6 U				
GROSS BETA (pCi/l)	23.1				13.3				
RADIUM 226 (pCi/L)	0.01 U				0.3				
RADIUM 228 (pCi/L)	0.37 U				-0.1 U				
CESIUM-137 (pCi/l)	-7.5 U				0.2 U				

TABLE 4.2-7 Results for FMC November 2001 Special Groundwater Monitoring Event

ANALYTE	Wells Analyzed for Expanded Parameter List								
Routine Parameters	**Well-149**	**Well-154**	**Well-155**	**Well-157**	**Well-165**	**Well-168**	**Well-171**	**Well-172**	**Well-175**
Field Measurements									
PH (FLD)	7.5	7.53	7.01	7.25	7.43	7.31	7.58	7.5	7.43
SC (UMHOS/CM AT 25 C) (FLD)	775	771	3940	4680	1408	2290	1046	1065	1028
TURBIDITY (NTU) (FLD)	0.5	0.4	0.8	0.4	0.5	2.2	0.4	0.4	0.4
WATER TEMPERATURE (C) (FLD)	16.5	17.6	14.6	15.6	12.6	13	13.4	12.5	16
General WQP									
POTASSIUM (K) TOTAL	11 L,J	10.4 L,J	511	896	12.3 L,J	14.8 L,J	15.6 L,J	18.6 L,J	11.8 L,J
SULFATE (SO4)	49.8	38.1	330	213	146	654	70.8	65.9	63.2
CHLORIDE (CL)	84.5	85.9	319	299	211	136	168	134	143
FLUORIDE (F)	0.94	1.1	< 0.1	4.7	0.19	4.7	0.6	0.42	0.53
TOTAL AMMONIA (NH3+NH4 AS N)	< 0.2 J	< 0.2 J	1.2 ,U	3.3	< 0.2 J	0.3 J	< 0.2 J	< 0.2 J	< 0.2 J
NITRATE (NO3-N)	1.2	1	0.21	< 0.1	3.6	20.1	3	8.3	5.2
ORTHOPHOSPHATE (PO4-P)	0.074 BJ,JU	< 0.1 J	49.8 J,J	268 J,J	0.22 J,JU	0.05 BJ,JU	0.055 BJ,JU	0.22 J,U	0.032 BJ,JU
PHOSPHORUS (P) TOTAL	< 0.1 J	< 0.1 J	0.1	290	0.6 J	0.2 J	0.1 J	0.4 J	< 0.1 J
Metals									
ARSENIC (AS) TOTAL	0.0146	0.0062	0.186	0.173	0.0284	0.0262	0.02	0.0228	0.0063
CADMIUM (CD) TOTAL	< 0.001	< 0.001	< 0.001	< 0.001 U	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
SELENIUM (SE) TOTAL	0.0045 B,UJ	< 0.005	< 0.005 U	< 0.005 U	0.0082 U	0.0171 U	0.0035 B,UJ	0.0053 U	0.0047 B,UJ
Additional Parameters									
Metals									
ALUMINUM (AL) TOTAL	0.048 B,UJ	0.033 B,UJ	0.0935 B,U,J	0.125 B,U,J	0.0406 B,UJ	0.108 B,UJ	0.0398 B,UJ	0.0359 B,UJ	0.0435 B,UJ
ANTIMONY (SB) TOTAL	< 0.01	0.0033 B,UJ	< 0.01	< 0.01 U	< 0.01	< 0.01	0.0023 B,UJ	< 0.01	< 0.01
BARIUM (BA) TOTAL	0.0922 B,J	0.143 B,J	0.119 B,J	0.0218 B,J	0.044 B,J	0.0164 B,J	0.0758 B,J	0.106 B,J	0.185 B,J
BORON (B) TOTAL	0.209	0.173 B,J	2.25	2.76	0.458	2.39	0.208	0.498	0.172
CHROMIUM (CR) TOTAL	0.0027 B,J	0.0017 B,J	0.0019 B,J	0.0104	0.0037 B,J	0.003 B,J	0.0026 B,J	0.0072	0.004 B,J
COBALT (CO)TOTAL	< 0.05	< 0.05	0.0376 B,J	0.0145 B,J	0.013 B,J	0.036 B,J	0.0012 B,UJ	0.0045 B,UJ	< 0.05
COPPER (CU) TOTAL	< 0.025	< 0.025	0.0018 B,U,J	< 0.025 U	< 0.025	0.0023 B,J	< 0.025	< 0.025	< 0.025
LEAD (PB) TOTAL	< 0.003	< 0.003	< 0.003 U	< 0.003 U	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
LITHIUM (LI) TOTAL	0.0636	0.0575	0.18	0.125	0.0482 B,J	0.164	0.0374 B,J	0.0333 B,J	0.0509
MANGANESE (MN) TOTAL	0.0014 B,UJ	< 0.015	2.5	1.78	0.0177	0.206	< 0.015	0.0004 B,UJ	< 0.015
MERCURY (HG) TOTAL	0.00018 B,J	< 0.0002	< 0.0002 U	< 0.0002 U	0.00016 B,J	0.00012 B,J	< 0.0002	< 0.0002	< 0.0002
MOLYBDENUM (MO) TOTAL	0.0032 B,UJ	0.0026 B,UJ	0.0377 B,J	0.0428	0.0037 B,UJ	< 0.04	0.0036 B,UJ	0.0029 B,UJ	0.0014 B,UJ
NICKEL (NI) TOTAL	< 0.04	< 0.04	0.0367 B,J	0.0121 B,J	0.0013 B,J	0.0025 B,J	< 0.04	< 0.04	< 0.04
SILVER (AG) TOTAL	< 0.005	< 0.005	< 0.005 U	< 0.005 U	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
THALLIUM (TL) TOTAL	< 0.01	< 0.01	0.0064 B,U,J	< 0.01 U	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
VANADIUM (V) TOTAL	0.0053 B,J	0.0046 B,J	0.0039 B,J	< 0.007 U	0.0089	0.0064 B,J	0.0079	0.0072	0.0036 B,J
ZINC (ZN) TOTAL	0.0308	0.0041 B,UJ	< 0.02 U	< 0.02 U	0.0014 B,UJ	0.0064 B,UJ	0.0031 B,UJ	0.0027 B,UJ	0.0019 B,UJ
Other									
CYANIDE (CN) TOTAL	< 0.01	< 0.01	0.11	0.077	0.037	0.21	0.01	0.01	0.01
Radiological									
GROSS ALPHA (pCi/l)			-1.9 U	19					
GROSS BETA (pCi/l)			452	836					
RADIUM 226 (pCi/L)			0.071 U	0.42					
RADIUM 228 (pCi/L)			0.77	0.37 U					
CESIUM-137 (pCi/l)			-5.8 U	1 U					

TABLE 4.2-7 Results for FMC November 2001 Special Groundwater Monitoring Event

ANALYTE	Wells Analyzed for Expanded Parameter List							
	Well-176	Well-178	Well-183	Well-502	Well-515	Well-523	Well-524	Well-525
Routine Parameters								
Field Measurements								
PH (FLD)	7.4	7.29	7.61	7.65	7.44	7.57	7.69	7.73
SC (UMHOS/CM AT 25 C) (FLD)	1073	4230	571	677	1486	739	519	519
TURBIDITY (NTU) (FLD)	0.4	1	2.6	0.5	0.6	0.4	0.3	0.4
WATER TEMPERATURE (C) (FLD)	17.3	15.8	16.3	12.3	13.4	12.7	12.6	12.5
General WQP								
POTASSIUM (K) TOTAL	12.8 L,J	30 L,J	9.09	5.48	8.91	7.82	3.85 B,BJ	3.78 B,J
SULFATE (SO4)	66.4	470	22.4	69.5	149	42.1	40.2	42.4
CHLORIDE (CL)	129	1050	54.3	45	222	80.2	18	18.2
FLUORIDE (F)	0.58	0.21	0.48	0.74	0.6	0.37	0.55	0.58
TOTAL AMMONIA (NH3+NH4 AS N)	< 0.2 J	< 0.2 J	< 0.2	< 0.2 J	< 0.2 J	< 0.2	< 0.2	< 0.2
NITRATE (NO3-N)	4.1	5.4	0.85 ,J	4.7	3.3	2.8	2.1	2.2
ORTHOPHOSPHATE (PO4-P)	0.027 BJ,JU	0.03 BJ,JU	0.43 J,JU	< 0.1 J,JU	0.053 BJ,JU	0.027 BJ,JU	< 0.1	0.028 BJ,JU
PHOSPHORUS (P) TOTAL	< 0.1 J	< 0.1 J	0.8 U	< 0.1 J	< 0.1 J	0.9 U	0.9 U	1 U
Metals								
ARSENIC (AS) TOTAL	0.0046 B,J	0.0079	0.0181	0.0043 B,J	0.0053	0.0053	< 0.005	0.0027 B,J
CADMIUM (CD) TOTAL	< 0.001	< 0.001	< 0.001 U	< 0.001	< 0.001	< 0.001	0.00025 B,UJ	< 0.001
SELENIUM (SE) TOTAL	0.0079 U	0.0129 U	0.0042 B,U,J	< 0.005	0.0052 U	< 0.005	< 0.005	< 0.005
Additional Parameters								
Metals								
ALUMINUM (AL) TOTAL	0.373 B,UJ	0.109 B,UJ	0.101 B,U,J	0.0381 B,UJ	0.0297 B,UJ	0.0462 B,UJ	0.058 B,UJ	0.0558 B,UJ
ANTIMONY (SB) TOTAL	< 0.01	0.0027 B,UJ	< 0.01 U	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
BARIUM (BA) TOTAL	0.244	0.05 B,J	0.0978 B,J	0.0651 B,J	0.112 B,J	0.178 B,J	0.0652 B,J	0.0634 B,J
BORON (B) TOTAL	0.179 B,J	0.243	0.124 B,U,J	0.139 B,UJ	0.181 B,J	0.0995 B,UJ	0.147 B,UJ	0.142 B,UJ
CHROMIUM (CR) TOTAL	0.0036 B,J	0.0076	0.0018 B,J	0.0012 B,J	0.0015 B,J	< 0.005	< 0.005	< 0.005
COBALT (CO)TOTAL	< 0.05	0.0141 B,J	< 0.05 U	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
COPPER (CU) TOTAL	< 0.025	< 0.025	< 0.025 U	< 0.025	< 0.025	0.0012 B,UJ	< 0.025	< 0.025
LEAD (PB) TOTAL	< 0.003	< 0.003	< 0.003 U	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
LITHIUM (LI) TOTAL	0.0555	0.0753	0.0238 B,J	0.0505	0.0596	0.0406 B,J	0.0459 B,BJ	0.0456 B,J
MANGANESE (MN) TOTAL	< 0.015 B,UJ	0.0019 B,UJ	0.0029 B,J	< 0.015	< 0.015	0.00048 B,UJ	0.00026 B,UJ	0.00068 B,UJ
MERCURY (HG) TOTAL	< 0.0002	< 0.0002	< 0.0002 U	0.00013 B,J	< 0.0002	< 0.0002	< 0.0002	< 0.0002
MOLYBDENUM (MO) TOTAL	< 0.04	< 0.04	0.0074 B,U,J	< 0.04	< 0.04	0.0016	0.0014 B,UJ	< 0.04
NICKEL (NI) TOTAL	< 0.04	< 0.04	< 0.04 U	< 0.04	< 0.04	< 0.04 B,UJ	< 0.04	< 0.04
SILVER (AG) TOTAL	< 0.005	< 0.005	< 0.005 U	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
THALLIUM (TL) TOTAL	< 0.01	< 0.01	0.0051 B,U,J	< 0.01	< 0.01	0.006 B,UJ	< 0.01	0.0059 B,UJ
VANADIUM (V) TOTAL	0.003 B,J	0.0033 B,J	0.0066 B,J	0.0022 B,J	0.0023 B,J	0.0041 B,J	0.0036 B,UJ	0.0034 B,UJ
ZINC (ZN) TOTAL	0.01 B,UJ	0.0104 B,UJ	0.001 B,U,J	0.003 B,UJ	0.0033 B,UJ	0.00051 B,UJ	< 0.02	0.0014 B,UJ
Other								
CYANIDE (CN) TOTAL	< 0.01	0.11	< 0.01					
Radiological								
GROSS ALPHA (pCi/l)			5.5			4.2	0.7 U	2.3
GROSS BETA (pCi/l)			9.6			7	4.9	3.9
RADIUM 226 (pCi/L)			1.14 J			0.18 U	-0.02 U	0.14 U
RADIUM 228 (pCi/L)			0.32 U			0.34 U	0.45 U	0.22 U
CESIUM-137 (pCi/l)			1.7 U			-3.4 U	2.2 U	-7.6 U

TABLE 4.2-8 Results of FMC May 2002 Special Groundwater Monitoring Event

ANALYTE Routine Parameter	Deep Wells Analyzed May 2002 Well-109			Well-125		
Field Measurements						
OXYGEN (O) (FLD) DISSOLVED		5.96			5.22	
PH (FLD)		7.48			7.41	
SC (UMHOS/CM AT 25 C) (FLD)		576			553	
TURBIDITY (NTU) (FLD)		0.2			0.5	
WATER TEMPERATURE (C) (FLD)		14.9			17.9	
General WQP						
CALCIUM (CA) TOTAL		5.54			45.6	
MAGNESIUM (MG) TOTAL		16.6			12.6	
SODIUM (NA) TOTAL		33.6			50.3	
POTASSIUM (K) TOTAL		5.48			8.29	
BICARBONATE ALKALINITY AS HCO3		0.2			210	
SULFATE (SO4)		67.1			39.2	
CHLORIDE (CL)		24.2	J		27	J
FLUORIDE (F)		0.76			0.98	
TOTAL AMMONIA (NH3+NH4 AS N)	<	0.2		<	0.2	
NITRATE (NO3-N)		0.9			0.65	
ORTHOPHOSPHATE (PO4-P)		0.025	B,JU		0.035	B,JU
PHOSPHORUS (P) TOTAL	<	0.1		<	0.1	
Metals						
ARSENIC (AS) TOTAL		0.0052			0.0068	
CADMIUM (CD) TOTAL	<	0.002		<	0.002	
SELENIUM (SE) TOTAL		0.007			0.0059	
Expanded Parameter List						
Metals						
BARIUM (BA) TOTAL		0.0736	B,J		0.091	B,J
BORON (B) TOTAL		0.0912	B,J		0.121	B,J
LITHIUM (LI) TOTAL		0.0527			0.0547	
MANGANESE (MN) TOTAL		0.00061	B,UJ		0.00081	B,UJ

TABLE 4.2-9A Results for FMC June 2003 "Tesco Property" Groundwater Monitoring Event

ANALYTE	Wells Analyzed for June 2003 Expanded Parameter Lists					
	Well-522			Well-523		
Routine Parameters						
Field Measurements						
OXYGEN (O) (FLD) DISSOLVED					1.58	
PH (FLD)		7.4			7.51	
SC (UMHOS/CM AT 25 C) (FLD)		970			889	
TURBIDITY (NTU) (FLD)		0.6			0.3	
WATER TEMPERATURE (C) (FLD)		14.6			13.4	
General WQP						
POTASSIUM (K) TOT		11.5	J		8.92	J
SULFATE (SO4)		70.2			60.2	
CHLORIDE (CL)		126			115	
FLUORIDE (F)		0.53			0.48	
TOTAL AMMONIA (NH3+NH4 AS N)	<	0.2		<	0.2	
ORTHOPHOSPHATE (PO4-P)		0.03	B,UJ		0.53	U
Metals						
ARSENIC (AS) TOTAL		0.004	B,J		0.0035	B,J
CADMIUM (CD) TOTAL	<	0.001		<	0.001	
SELENIUM (SE) TOTAL	<	0.005		<	0.005	
Additional Parameter List						
Metals						
CHROMIUM (CR) TOTAL		0.0033	B,J		0.0019	B,J
LEAD (PB) TOTAL	<	0.003		<	0.003	
NICKEL (NI) TOTAL	<	0.04		<	0.04	
SILVER (AG) TOTAL	<	0.005		<	0.005	
ZINC (ZN) TOTAL		0.0048	B,J	<	0.02	
Other Inorganics						
CYANIDE (CN) TOTAL	<	0.01		<	0.01	
Organics						
PHENOL TOTAL	<	0.01		<	0.01	
Volatile/Semi-volatile compounds		(a)			(a)	

(a) None of the volatile or semivolatile compounds were detected, the full analytical list of organic compounds is shown on Table 4.2-9B.

TABLE 4.2-9B FMC June 2003 "Tesco Property" Monitoring Event
Organic Compound List

Organics

ETHYLBENZENE
STYRENE
CIS-1,3-DICHLOROPROPENE
TRANS-1,3-DICHLOROPROPENE
ACROLEIN
1,2-DICHLOROETHANE
ACRYLONITRILE
4-METHYL-2-PENTANONE (MIBK)
TOLUENE
CHLOROBENZENE
DIBROMOCHLOROMETHANE
TETRACHLOROETHENE
XYLENES (TOTAL)
M-P XYLENE
O-XYLENE
TRANS-1,2-DICHLOROETHENE
CARBON TETRACHLORIDE
ACETONE
CHLOROFORM
BENZENE
1,1,1-TRICHLOROETHANE
BROMOMETHANE
CHLOROETHANE
VINYL CHLORIDE
ACETONITRILE
METHYLENE CHLORIDE
CARBON DISULFIDE
BROMOFORM
BROMODICHLOROMETHANE
1,1-DICHLOROETHANE
1,1-DICHLOROETHENE
TRICHLOROFLUOROMETHANE
1,2-DICHLOROPROPANE
2-BUTANONE (MEK)
1,1,2-TRICHLOROETHANE
TRICHLOROETHENE
1,1,2,2-TETRACHLOROETHANE
4-NITROANILINE
4-NITROPHENOL
4-BROMOPHENYL PHENYL ETHER
2,4-DIMETHYLPHENOL
4-METHYLPHENOL/3-METHYLPHENOL
1,4-DICHLOROBENZENE
4-CHLOROANILINE
BIS(2-CHLOROETHYL) ETHER
BIS(2-CHLOROETHOXY)METHANE
BIS(2-ETHYLHEXYL) PHTHALATE
HEXACHLOROBENZENE
ANTHRACENE
1,2,4-TRICHLOROBENZENE
2,4-DICHLOROPHENOL
2,4-DINITROTOLUENE
PYRENE
DIBENZOFURAN
BENZO(GHI)PERYLENE
BENZO(B)FLUORANTHENE
FLUORANTHENE
BENZO(K)FLUORANTHENE
ACENAPHTHYLENE
CHRYSENE
BENZO(A)PYRENE
2,4-DINITROPHENOL
1,3-DICHLOROBENZENE
BENZO(A)ANTHRACENE
4-CHLORO-3-METHYLPHENOL
2,6-DINITROTOLUENE
N-NITROSO-DI-N-PROPYLAMINE
HEXACHLOROETHANE
4-CHLOROPHENYL PHENYL ETHER
HEXACHLOROCYCLOPENTADIENE
ISOPHORONE
ACENAPHTHENE
PHENANTHRENE
BUTYL BENZYL PHTHALATE
N-NITROSODIPHENYLAMINE
FLUORENE
HEXACHLOROBUTADIENE
PENTACHLOROPHENOL
2,4,6-TRICHLOROPHENOL
2-NITROANILINE
2-NITROPHENOL
NAPHTHALENE (SEMI-VOL)
2-METHYLNAPHTHALENE
2-CHLORONAPHTHALENE
3,3'-DICHLOROBENZIDINE
2-METHYLPHENOL
1,2-DICHLOROBENZENE
2-CHLOROPHENOL
2,4,5-TRICHLOROPHENOL
NITROBENZENE
3-NITROANILINE
1,2-DICHLOROETHENE
2-CHLOROETHYL VINYL ETHER
2-METHYL-4 6-DINITROPHENOL
CARBAZOLE
CHLOROMETHANE
CIS-1,2-DICHLOROETHENE
DIBENZ (A,H) ACRIDINE
DIETHYLPHTHALATE
DIMETHYLPHTHALATE
DI-N-BUTYLPHTHALATE
DI-N-OCTYLPHTHALATE
INDENO (1,2,3-CD) PYRENE

TABLE 4.2-10A Results of FMC May 2005 Special Groundwater Monitoring Event

ANALYTE	Wells Analyzed for May 2005 Expanded Parameter List											
	Well-106		Well-116		Well-143		Well-158		Well-167		Well-183	
Routine Parameters												
Field Measurements												
OXYGEN (O) (FLD) DISSOLVED	-6.15		-1.53		0.42		6.28		0.16		4.69	
PH (FLD)	7.19		7.14		6.39		7.01		7.06		7.44	
SC (UMHOS/CM AT 25 C) (FLD)	1060		1882		2770		1209		1401		737	
TURBIDITY (NTU) (FLD)	1.5		0.6		0.3		0.3		0.2		0.7	
WATER TEMPERATURE (C) (FLD)	16.1		15.4		14.3		16.4		14.3		15.9	
General WQP												
POTASSIUM (K) TOT	15.5		53.8		26.2		16.8	J	14.3	J	10.6	J
SULFATE (SO4)	166		146		502		270		135		71.2	
CHLORIDE (CL)	90		193		390		70.7		133		94.5	
FLUORIDE (F)	0.32		0.56		0.37		0.22		< 0.1		0.44	
TOTAL AMMONIA (NH3+NH4 AS N)	< 0.2		< 0.2		2.6		< 0.2		< 0.2		< 0.2	
NITRATE (NO3-N)	2		14.4		13.2		1.3		0.1		1	
ORTHOPHOSPHATE (PO4-P)	0.1	J	0.6	J	1.8	J	0.067	J	8.8		0.4	
Metals												
ARSENIC (AS) TOTAL	0.0042	J	0.0763		0.107		0.0137		0.0532		0.018	
CADMIUM (CD) TOTAL							< 0.001		< 0.001		< 0.001	
SELENIUM (SE) TOTAL	0.0037	J	0.0053		0.0757		< 0.005		< 0.005		0.0047	J
Additional Parameters												
Other												
PHENOL TOTAL	< 0.01		< 0.01		< 0.01		< 0.01		< 0.01		< 0.01	
Organics [a]												
CARBON DISULFIDE	< 0.001		< 0.001		< 0.001		< 0.001		0.0041		< 0.001	
DIMETHYLPHTHALATE	0.014		0.011		0.03		< 0.01		< 0.01		0.03	

[a] Only those organic compounds that were detected are shown, the full list of organic compounds that were analyzed is shown on Table 4.2-10B.

TABLE 4.2-10B FMC May 2005 Special Monitoring Event
Organic Compound List

Organics	
1,1,1-TRICHLOROETHANE	BENZYL ALCOHOL
1,1,2,2-TETRACHLOROETHANE	BIS (2-CHLOROISOPROPYL) ETHER
1,1,2-TRICHLOROETHANE	BIS(2-CHLOROETHOXY)METHANE
1,1-DICHLOROETHANE	BIS(2-CHLOROETHYL) ETHER
1,1-DICHLOROETHENE	BIS(2-ETHYLHEXYL) PHTHALATE
1,2,4-TRICHLOROBENZENE	BROMODICHLOROMETHANE
1,2-DICHLOROBENZENE	BROMOFORM
1,2-DICHLOROETHANE	BROMOMETHANE
1,2-DICHLOROETHENE	BUTYL BENZYL PHTHALATE
1,2-DICHLOROPROPANE	CARBON DISULFIDE
1,3-DICHLOROBENZENE	CARBON TETRACHLORIDE
1,4-DICHLOROBENZENE	CHLOROBENZENE
2,4,5-TRICHLOROPHENOL	CHLOROETHANE
2,4,6-TRICHLOROPHENOL	CHLOROFORM
2,4-DICHLOROPHENOL	CHLOROMETHANE
2,4-DIMETHYLPHENOL	CHRYSENE
2,4-DINITROPHENOL	CIS-1,3-DICHLOROPROPENE
2,4-DINITROTOLUENE	DIBENZ(A,H)ANTHRACENE
2,6-DINITROTOLUENE	DIBENZOFURAN
2-BUTANONE (MEK)	DIBROMOCHLOROMETHANE
2-CHLOROETHYL VINYL ETHER	DIETHYL PHTHALATE
2-CHLORONAPHTHALENE	DIMETHYL PHTHALATE
2-CHLOROPHENOL	DI-N-BUTYL PHTHALATE
2-HEXANONE	DI-N-OCTYL PHTHALATE
2-METHYLNAPHTHALENE	ETHYLBENZENE
2-METHYLPHENOL	FLUORANTHENE
2-NITROANILINE	FLUORENE
2-NITROPHENOL	HEXACHLOROBENZENE
3,3'-DICHLOROBENZIDINE	HEXACHLOROBUTADIENE
3-NITROANILINE	HEXACHLOROCYCLOPENTADIENE
4,6-DINITRO-2-METHYLPHENOL	HEXACHLOROETHANE
4-BROMOPHENYL PHENYL ETHER	INDENO(1,2,3-CD)PYRENE
4-CHLORO-3-METHYLPHENOL	ISOPHORONE
4-CHLOROANILINE	METHYLENE CHLORIDE
4-CHLOROPHENYL PHENYL ETHER	NAPHTHALENE
4-METHYL-2-PENTANONE (MIBK)	NITROBENZENE
4-METHYLPHENOL	N-NITROSODI-N-PROPYLAMINE
4-NITROANILINE	N-NITROSODIPHENYLAMINE
4-NITROPHENOL	PENTACHLOROPHENOL
ACENAPHTHENE	PHENANTHRENE
ACENAPHTHYLENE	PYRENE
ACETONE	STYRENE
ANTHRACENE	TETRACHLOROETHENE
BENZENE	TOLUENE
BENZO(A)ANTHRACENE	TRANS-1,2-DICHLOROETHENE
BENZO(A)PYRENE	TRANS-1,3-DICHLOROPROPENE
BENZO(B)FLUORANTHENE	TRICHLOROETHENE
BENZO(GHI)PERYLENE	VINYL ACETATE
BENZO(K)FLUORANTHENE	VINYL CHLORIDE
BENZOIC ACID	XYLENES (TOTAL)

TABLE 4.2-11A Results of FMC May 2008 Groundwater Monitoring Event - Expanded Parameter List

Parameter Routine Analytes	BATISTE SPRING	TW-11S	TW-12S	TW-9S	WELL-101
Field Measurements					
PH (FLD)	6.76	7.18	6.47	7.05	7.37
SC (UMHOS/CM AT 25 C) (FLD)	1004	845	1471	2277	915
OXIDATION REDUCTION POTENTIAL	-37.8	-138.1	-128	-135.1	-64.6
DISSOLVED OXYGEN	1.4	6.57	0.38	0.24	7.5
TURBIDITY (NTU) (FLD)	0.3	9.5	8.7	7.5	0.2
WATER TEMPERATURE (C) (FLD)	13.2	12.4	14.9	14.6	13.4
General WQP					
POTASSIUM (K) TOT	11.7 ,J	3.75 ,J	14.8 ,J	43.4 ,J	6.76 NE,J
SULFATE (SO4)	171	49.7	147	166	87.3
CHLORIDE (CL)	51.4	19.9	52.2	193	144
FLUORIDE (F)	0.4	0.8	1.3	0.1	0.4
TOTAL AMMONIA (NH3+NH4 AS N)	1.4	< 0.2	0.8	< 0.2	< 0.2
NITRATE (NO3-N)	7.1	1.6	6.7	10.4	2.3
ELEMENTAL PHOSPHORUS	< 0.00005	< 0.00005	< 0.00005	< 0.00005	
TOTAL PHOSPHORUS	17.6 ,J	< 0.5 ,J	22.3 ,J	2.42 ,J	< 0.5 NE,J
Metals					
ARSENIC (AS) TOTAL	0.0246	0.002	0.0203	0.0257	0.0125 B
CADMIUM (CD) TOTAL	0.00038 ,U				
SELENIUM (SE) TOTAL	0.0042	< 0.005	0.0051	0.0031 ,U	< 0.005
Special Parameters					
Metals					
ANTIMONY (SB) TOTAL	0.00096 ,U	< 0.005	< 0.005	< 0.05	< 0.005
BORON (B) TOTAL	0.2	< 0.5	0.205 ,J	0.432 ,J	< 0.5
MANGANESE (MN) TOTAL	0.0492 ,J	0.004 ,J	0.0464 ,J	0.455 ,J	< 0.002 E,J
MERCURY (HG) TOTAL	< 0.0002	< 0.0002	< 0.0002	< 0.0002	0.000083 B
URANIUM (U) TOTAL	0.00081	0.0029	0.0025	< 0.01	0.0031 B
VANADIUM (V) TOTAL	0.005 ,J	0.0026	0.0097	0.0038 ,U	< 0.01 B,J
Other Inorganics					
CYANIDE (CN) TOTAL	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Radiological					
GROSS ALPHA (pCi/l)	-0.6 ,U	2.7	2.1 ,U	2.2 ,U	5.4
RADIUM 226 (pCi/L)	0.15 ,U	0.078 ,M,U	0.13 ,U	0.14 ,U	0.3 ,Y
RADIUM 228 (pCi/L)	0.22 ,U	0.4	0.15 ,U	0.14 ,U	0.54 ,U,Y
Sum Ra-226+Ra-228	0.37	0.478	0.28	0.28	0.84

TABLE 4.2-11A Results of FMC May 2008 Groundwater Monitoring Event - Expanded Parameter List

Parameter Routine Analytes	WELL-102	WELL-108	WELL-110	WELL-111	WELL-112	WELL-122
Field Measurements						
PH (FLD)	7.35	7.07	6.79	7.03	7.55	6.92
SC (UMHOS/CM AT 25 C) (FLD)	834	2182	1958	2143	841	2653
OXIDATION REDUCTION POTENTIAL	-70.3	-8.9	-96.4	-98.8	6.1	17.3
DISSOLVED OXYGEN	7.24	4.18	1.82	0.43	5.82	0.27
TURBIDITY (NTU) (FLD)	4	0.4	0.4	0.8	0.3	0.4
WATER TEMPERATURE (C) (FLD)	13.8	19.1	17.3	15.2	14.4	17.6
General WQP						
POTASSIUM (K) TOT	6.7 NE,J	156	19.3 ,J	34.5 ,J	6.92 ,J	181
SULFATE (SO4)	56.5	242	197	166	88.6	323
CHLORIDE (CL)	133	354	94.4	176	82.4	367
FLUORIDE (F)	0.4	1	0.5	0.2	0.9	0.2
TOTAL AMMONIA (NH3+NH4 AS N)	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
NITRATE (NO3-N)	1.9	17.2	4.1	9.4	2.3	25.1
ELEMENTAL PHOSPHORUS		0.03	< 0.00005	< 0.00005		0.00101
TOTAL PHOSPHORUS	< 0.5 NE,J	1.03 N,J	2.77 ,J	4.31 ,J	0.0842 ,J	9.17 N,J
Metals						
ARSENIC (AS) TOTAL	0.0127 ,J	0.0186	0.0456	0.0228	0.0047	0.0635
CADMIUM (CD) TOTAL		< 0.0005				0.00016 BN,U
SELENIUM (SE) TOTAL	< 0.005	0.0087	0.0234	0.0039 ,U	0.0016	0.0083 BN
Special Parameters						
Metals						
ANTIMONY (SB) TOTAL	< 0.005	< 0.005	0.0073	< 0.05	0.0027 ,U	0.0028 BN,U
BORON (B) TOTAL	< 0.5	0.343 BN	0.26 ,J	0.419 ,J	0.256	1.03 N
MANGANESE (MN) TOTAL	0.0064 BE,J	0.487 E,J	< 0.002 ,J	0.302 ,J	< 0.002 ,J	1.01 ,J
MERCURY (HG) TOTAL	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
URANIUM (U) TOTAL	0.0028 B	0.00049 B	< 0.01	< 0.01	0.0025	< 0.001
VANADIUM (V) TOTAL	< 0.01 B,J	0.0049 BE,J	0.0124 ,U	0.0072 ,U	0.0043	0.0116 ,J
Other Inorganics						
CYANIDE (CN) TOTAL	< 0.01	0.019	< 0.01	0.019	< 0.01	0.031
Radiological						
GROSS ALPHA (pCi/l)	4.2	-1.3 ,U	4.1 ,U	3.1 ,U	0.2 ,U	3.2 ,U
RADIUM 226 (pCi/L)	0.19 ,Y	0.22 ,M,U	0.01 ,M,U	0.18	0.054 ,U,Y	0.33
RADIUM 228 (pCi/L)	0.43 ,U,Y	0.42	0.44 ,U	-0.12 ,U	-0.45 ,M,U	0.5 ,U
Sum Ra-226+Ra-228	0.62	0.64	0.45	0.06	-0.396	0.83

TABLE 4.2-11A Results of FMC May 2008 Groundwater Monitoring Event - Expanded Parameter List

Parameter Routine Analytes	WELL-123	WELL-127	WELL-134	WELL-136	WELL-139	WELL-143
Field Measurements						
PH (FLD)	6.67	7.36	6.73	5.41	6.9	5.98
SC (UMHOS/CM AT 25 C) (FLD)	3247	1750	2805	5820	4589	3191
OXIDATION REDUCTION POTENTIAL	82.5	41.3	99	33.7	62.2	114.4
DISSOLVED OXYGEN	0.3	3.73	0.24	0.51	1.13	0.31
TURBIDITY (NTU) (FLD)	0.4	0.4	1.2	0.3	0.3	0.4
WATER TEMPERATURE (C) (FLD)	18.1	14.2	16.9	15.3	12.8	14.5
General WQP						
POTASSIUM (K) TOT	19.9 ,J	11.2 ,J	153 E,J	33 E,J	26.8 E,J	16.5 NE,J
SULFATE (SO4)	383 NC,M	193	325	2600	938	587
CHLORIDE (CL)	189	322	287	144 J	792 J	484 J
FLUORIDE (F)	1.2	0.8	0.2	0.5	1.1	0.5
TOTAL AMMONIA (NH3+NH4 AS N)	3.6	< 0.2	0.5	1.8	< 0.2	2
NITRATE (NO3-N)	7.9	4.9	21.2	2.4	38.2	15.3
ELEMENTAL PHOSPHORUS	< 0.00005					
TOTAL PHOSPHORUS	0.823 ,J	0.125	19.8 NE,J	75.9 NE,J	< 0.5 NE,J	1.1 NE,J
Metals						
ARSENIC (AS) TOTAL	0.244	0.0053	0.0982 B	0.347	< 0.01	0.098 B,J
CADMIUM (CD) TOTAL	0.00012 B,U	< 0.0005				
SELENIUM (SE) TOTAL	0.141	0.0046	< 0.05	0.0332 B	0.0303 B	0.0653
Special Parameters						
Metals						
ANTIMONY (SB) TOTAL	< 0.005	< 0.005	< 0.005 ,U	< 0.005 ,U	< 0.005	< 0.005
BORON (B) TOTAL	0.744 N	0.45	0.897	0.819	0.9	0.25 B
MANGANESE (MN) TOTAL	0.122 N,J	< 0.002	2.34 E,J	1.06 E,J	< 0.002 E,J	0.349 E,J
MERCURY (HG) TOTAL	< 0.0002	< 0.0002	0.000068	< 0.0002	0.00018 B	0.000068 B
URANIUM (U) TOTAL	0.00089 B	0.0014	< 0.01	< 0.001	0.0066 B	0.008 B
VANADIUM (V) TOTAL	0.182 E,J	0.003	0.0138 B	0.0185 B	< 0.01	0.0619 B,J
Other Inorganics						
CYANIDE (CN) TOTAL	< 0.01	< 0.01	0.049	< 0.01	0.022	0.035
Radiological						
GROSS ALPHA (pCi/l)	5.4 ,U	2.1 ,U	1.5	8 ,U	7 ,U	13.2 ,U
RADIUM 226 (pCi/L)	0.008 ,U	0.145 ,Y	0.29	0.4	0.106 ,U,Y	0.14 ,U,Y
RADIUM 228 (pCi/L)	-0.04 ,U	0.42 ,U,Y	0.89	1.06	0.41 ,U,Y	0.21 ,U,Y
Sum Ra-226+Ra-228	-0.032	0.565	1.18	1.46	0.516	0.35

TABLE 4.2-11A Results of FMC May 2008 Groundwater Monitoring Event - Expanded Parameter List

Parameter Routine Analytes	WELL-145	WELL-146	WELL-147	WELL-149	WELL-156	WELL-161
Field Measurements						
PH (FLD)	5.44	7.02	7.4	7.53	7.04	6.29
SC (UMHOS/CM AT 25 C) (FLD)	5600	1882	1060	919	6096	4380
OXIDATION REDUCTION POTENTIAL	54.7	-95.2	87.1	53.8	-124.1	13.8
DISSOLVED OXYGEN	0.44	2.54	4.68	5.89	0.27	0.5
TURBIDITY (NTU) (FLD)	4.5	0.2	0.2	0.3	1	0.3
WATER TEMPERATURE (C) (FLD)	15.3	17.2	16.8	16	15.6	16.9
General WQP						
POTASSIUM (K) TOT	37.7 NE,J	38.9 ,J	9.4 ,J	8.84 ,J	888	18.8 E,J
SULFATE (SO4)	2400	138	63.8	55	212	1800
CHLORIDE (CL)	154 J	144	158	126	357	177
FLUORIDE (F)	0.5	0.5	0.9	1.2	< 0.1	0.1
TOTAL AMMONIA (NH3+NH4 AS N)	2.5	< 0.2	< 0.2	< 0.2	14	< 0.2
NITRATE (NO3-N)	4.5	6.9	3.8	1.7	< 0.1	5.4
ELEMENTAL PHOSPHORUS		< 0.00005			0.0000946	
TOTAL PHOSPHORUS	57.3 NE,J	1.29 ,J	0.0369	0.0624	464	< 0.5 NE,J
Metals						
ARSENIC (AS) TOTAL	0.298 ,J	0.0301	0.0033	0.0067	0.163	< 0.01
CADMIUM (CD) TOTAL			< 0.0005	< 0.0005	0.00023 ,U	
SELENIUM (SE) TOTAL	0.0608	0.0018 ,U	0.0034	0.002	0.003	0.0051
Special Parameters						
Metals						
ANTIMONY (SB) TOTAL	< 0.005	< 0.05	< 0.005	< 0.005	0.001 ,U	< 0.005
BORON (B) TOTAL	0.674	0.352 ,J	< 0.5	< 0.5	6.24	< 0.5
MANGANESE (MN) TOTAL	1.16 E,J	0.0421 ,J	< 0.002	< 0.002	1.24 ,J	0.0043 E,J
MERCURY (HG) TOTAL	0.000066 B	< 0.0002	< 0.0002	< 0.0002	< 0.0002	0.00028
URANIUM (U) TOTAL	< 0.001	< 0.01	0.0033	0.0021	< 0.001	0.257
VANADIUM (V) TOTAL	0.0147 B,J	0.0053 ,U	< 0.01	< 0.01	< 0.01 ,J	< 0.01
Other Inorganics						
CYANIDE (CN) TOTAL	< 0.01	0.011	< 0.01	< 0.01	0.063	< 0.01
Radiological						
GROSS ALPHA (pCi/l)	7 ,U	0.6 ,U	2 ,U	1.1 ,U	0.8 ,U	325
RADIUM 226 (pCi/L)	0.3	0.08 ,U	0.116 ,U,Y	0.049 ,U,Y	0.42	0.16 ,U
RADIUM 228 (pCi/L)	0.9	-0.26 ,U	0.4 ,U,Y	0.65 ,U,Y	0.61 ,U	0.41 ,U
Sum Ra-226+Ra-228	1.2	-0.18	0.516	0.699	1.03	0.57

TABLE 4.2-11A Results of FMC May 2008 Groundwater Monitoring Event - Expanded Parameter List

Parameter Routine Analytes	WELL-164	WELL-167	WELL-169	WELL-173	WELL-174	WELL-175
Field Measurements						
PH (FLD)	6.2	7.21	8.13	7.59	7.4	7.29
SC (UMHOS/CM AT 25 C) (FLD)	5417	1531	434	1165	1230	1056
OXIDATION REDUCTION POTENTIAL	2.1	24	114.4	-16.1	-20.6	36.4
DISSOLVED OXYGEN	0.34	0.27	8.08	6.65	5.13	5.38
TURBIDITY (NTU) (FLD)	0.2	0.6	2.1	0.9	0.5	0.5
WATER TEMPERATURE (C) (FLD)	16	14.5	14.4	16.7	16.7	16
General WQP						
POTASSIUM (K) TOT	14.9 E,J	10 ,J	6.48 E,J	10.6 ,J	9.52 ,J	8.67 ,J
SULFATE (SO4)	2260	139	27	54	91.7	62.4
CHLORIDE (CL)	192	128	36.7	236	211	147
FLUORIDE (F)	0.1	< 0.1	0.7	1	0.9	0.7
TOTAL AMMONIA (NH3+NH4 AS N)	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
NITRATE (NO3-N)	4.4	1.8	1.3	3.9	4.3	5.3
ELEMENTAL PHOSPHORUS						
TOTAL PHOSPHORUS	43.4 NE,J	7.14	< 0.5 NE,J	0.032 ,J	0.0351	0.0425
Metals						
ARSENIC (AS) TOTAL	0.227	0.0561	< 0.01	0.0028	< 0.01	0.0049
CADMIUM (CD) TOTAL		0.000045 ,U		< 0.0005 ,U	< 0.0005	< 0.0005
SELENIUM (SE) TOTAL	0.0144 B	0.0027	< 0.005	0.0052	0.0046	0.0032
Special Parameters						
Metals						
ANTIMONY (SB) TOTAL	< 0.005	< 0.005	< 0.005	< 0.005 ,U	< 0.005	< 0.005
BORON (B) TOTAL	0.608	3.23	< 0.5	0.204 ,J	< 0.5	< 0.5
MANGANESE (MN) TOTAL	0.0038 E,J	0.923	< 0.002 E,J	0.0015 ,U	< 0.002	< 0.002
MERCURY (HG) TOTAL	0.000062 B	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
URANIUM (U) TOTAL	0.0129	0.00044	0.0016	0.0016 ,J	0.0035	0.0043
VANADIUM (V) TOTAL	0.0165 B	0.0083	0.0109	< 0.01	< 0.01	< 0.01
Other Inorganics						
CYANIDE (CN) TOTAL	< 0.01	0.13	< 0.01	< 0.01	< 0.01	< 0.01
Radiological						
GROSS ALPHA (pCi/l)	36	2 ,U	0.7 ,M,U	4.3	5.4	4.8
RADIUM 226 (pCi/L)	0.57	0.27	0.18 ,U,Y	0.125 ,U,Y	0.24	0.17 ,Y
RADIUM 228 (pCi/L)	0.85	0.95	0.43 ,U,Y	0.6 ,U,Y	1.18	0.25 ,U,Y
Sum Ra-226+Ra-228	1.42	1.22	0.61	0.725	1.42	0.42

TABLE 4.2-11A Results of FMC May 2008 Groundwater Monitoring Event - Expanded Parameter List

Parameter Routine Analytes	WELL-183	WELL-189	WELL-501	WELL-502	WELL-515	WELL-516
Field Measurements						
PH (FLD)	7.31	5.83	7.32	7.28	7.52	7.63
SC (UMHOS/CM AT 25 C) (FLD)	1542	5837	967	1036	1206	754
OXIDATION REDUCTION POTENTIAL	-66.9	11.4	-113.3	-125.7	111	37.9
DISSOLVED OXYGEN	4.6	0.26	4.45	6.8	4.77	6.38
TURBIDITY (NTU) (FLD)	0.6	0.5	0.2	0.2	0.8	0.3
WATER TEMPERATURE (C) (FLD)	16.7	15.8	12.4	12.6	13.4	13.6
General WQP						
POTASSIUM (K) TOT	9.4 E,J	28.5 E,J	6.5 ,J	5.36 ,J	6.95 ,J	6.09 ,J
SULFATE (SO4)	98.9	2730	78.9	64.9	127	68.6
CHLORIDE (CL)	154	148	119	44.3	183	81
FLUORIDE (F)	0.5	0.5	0.6	0.9	0.7	0.7
TOTAL AMMONIA (NH3+NH4 AS N)	< 0.2	1.9	< 0.2	< 0.2	< 0.2	< 0.2
NITRATE (NO3-N)	1.6	2.7	4.2	2.5	2.8	2.1
ELEMENTAL PHOSPHORUS	< 0.00005			< 0.00005		
TOTAL PHOSPHORUS	0.0365 B,J	81.8 NE,J	< 0.5 ,J	< 0.5 ,J	< 0.5 ,J	< 0.5 ,J
Metals						
ARSENIC (AS) TOTAL	0.0144	0.36	0.0027	0.0026	0.0035	0.0038
CADMIUM (CD) TOTAL	< 0.0005					
SELENIUM (SE) TOTAL	0.0073	0.0341 B	0.0021	< 0.005	0.00091	0.0013
Special Parameters						
Metals						
ANTIMONY (SB) TOTAL	< 0.005	< 0.005 ,U	< 0.005	< 0.005	< 0.005	< 0.005
BORON (B) TOTAL	< 0.5 N	0.831	< 0.5	< 0.5	0.181	< 0.5
MANGANESE (MN) TOTAL	< 0.002 E,J	0.871 E,J	< 0.002 ,J	< 0.002 ,J	< 0.002 ,J	< 0.002 ,J
MERCURY (HG) TOTAL	< 0.0002	< 0.0002	0.0001	< 0.0002	< 0.0002	< 0.0002
URANIUM (U) TOTAL	0.0056	< 0.001	0.0033	0.0044	0.014	0.0027
VANADIUM (V) TOTAL	0.0042 BE,J	0.0186	0.0039	0.0022	< 0.01	0.0029
Other Inorganics						
CYANIDE (CN) TOTAL	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Radiological						
GROSS ALPHA (pCi/l)	5.2	4	0	3.3	15.8	2.8
RADIUM 226 (pCi/L)	0.008 ,U,Y	0.35	0.058 ,U	0.16 ,M	0.086 ,U	0.087 ,U
RADIUM 228 (pCi/L)	0.34 ,U,Y	0.98	0.02 ,U	0.07 ,U	0.35 ,U	0.43 ,U
Sum Ra-226+Ra-228	0.348	1.33	0.078	0.23	0.436	0.517

TABLE 4.2-11A Results of FMC May 2008 Groundwater Monitoring Event - Expanded Parameter List

Parameter Routine Analytes	WELL-517	WELL-523	WELL-524	WELL-525
Field Measurements				
PH (FLD)	6.93	7.5	7.69	7.73
SC (UMHOS/CM AT 25 C) (FLD)	2575	907	511	515
OXIDATION REDUCTION POTENTIAL	-95.9	7.9	-25.7	-23.2
DISSOLVED OXYGEN	2.69	4.02	6.81	7.89
TURBIDITY (NTU) (FLD)	0.3	0.3	0.2	0.3
WATER TEMPERATURE (C) (FLD)	15.9	13.4	12.4	11.8
General WQP				
POTASSIUM (K) TOT	100 ,J	7.41 ,J	3.57 ,J	3.58 ,J
SULFATE (SO4)	189	59	42.3	44.1
CHLORIDE (CL)	198	109	17.9	18.7
FLUORIDE (F)	0.6	0.6	0.7	0.8
TOTAL AMMONIA (NH3+NH4 AS N)	0.2	< 0.2	< 0.2	< 0.2
NITRATE (NO3-N)	11.1	4.5	1.5	1.6
ELEMENTAL PHOSPHORUS	< 0.00005			
TOTAL PHOSPHORUS	0.924 ,J	0.0341 ,J	0.034 ,J	0.0391 ,J
Metals				
ARSENIC (AS) TOTAL	0.0468	0.0036	0.0021	< 0.01
CADMIUM (CD) TOTAL				
SELENIUM (SE) TOTAL	0.0138	0.002	< 0.005	< 0.005
Special Parameters				
Metals				
ANTIMONY (SB) TOTAL	< 0.005	< 0.005	< 0.005	< 0.005
BORON (B) TOTAL	0.489 ,J	< 0.5	< 0.5	< 0.5
MANGANESE (MN) TOTAL	< 0.002 ,J	< 0.002 ,J	< 0.002 ,J	< 0.002 ,J
MERCURY (HG) TOTAL	< 0.0002	< 0.0002	< 0.0002	< 0.0002
URANIUM (U) TOTAL	0.0005	0.0034	0.0021	0.0023
VANADIUM (V) TOTAL	0.0148	0.0027	0.0032	0.0021
Other Inorganics				
CYANIDE (CN) TOTAL	< 0.01	< 0.01	< 0.01	< 0.01
Radiological				
GROSS ALPHA (pCi/l)	-1.1 ,U	5.7	2.7	2.2
RADIUM 226 (pCi/L)	0.06 ,U	0.085 ,U	0.11 ,U	0.095 ,U
RADIUM 228 (pCi/L)	0.16 ,U	0.32 ,U	0.25 ,U	0.4 ,U
Sum Ra-226+Ra-228	0.22	0.405	0.36	0.495

TABLE 4.2-11B Results of FMC May 2008 Groundwater Monitoring Event - Routine Parameter List

Parameter **Routine Analytes**	WELL-104		WELL-113		WELL-114		WELL-115		WELL-121		WELL-124		WELL-126	
Field Measurements														
PH (FLD)	7.57		7.03		7.02		7.07		6.89		7.49		7.66	
SC (UMHOS/CM AT 25 C) (FLD)	2034		1257		1708		2342		3593		1152		858	
OXIDATION REDUCTION POTENTIAL	21.5		-30.6		-5.8		1.4		-67.4		7		-4.3	
DISSOLVED OXYGEN	0.19		1.15		0.2		0.19		3.21		4.07		4.65	
TURBIDITY (NTU) (FLD)	0.3		3.1		0.7		0.7		0.4		0.2		0.6	
WATER TEMPERATURE (C) (FLD)	14.7		12.1		11.3		11.6		16.8		14.4		16.5	
General WQP														
POTASSIUM (K) TOT	239	,J	16.8	NE,J	16.4	NE,J	8.85	NE,J	81.5		12.7	,J	9.03	,J
POTASSIUM (K) DIS														
SULFATE (SO4)	144		96.4		111		184		256		88.7		87.7	
CHLORIDE (CL)	149		135		141		148		406		179		87.7	
FLUORIDE (F)	3.9		0.5		0.5		0.3		0.6		1		1.2	
TOTAL AMMONIA (NH3+NH4 AS N)	3.5		< 0.2		1.4		< 0.2		< 0.2		< 0.2		< 0.2	
NITRATE (NO3-N)	25.3	,J	9.5	,J	< 0.1	,J	25.7	,J	26.3		2.7	,J	2	,J
ELEMENTAL PHOSPHORUS									< 0.00005					
TOTAL PHOSPHORUS	2.1	,J	0.353	BNE,J	7.95	NE,J	2.9	NE,J	0.735	N	< 0.5	,J	< 0.5	,J
Metals														
ARSENIC (AS) TOTAL	0.0603	B	0.0211		0.116		0.242		< 0.1	N	< 0.1		< 0.1	
ARSENIC (AS) DIS														
CADMIUM (CD) TOTAL	< 0.005		< 0.005		< 0.005		< 0.005				< 0.005		< 0.005	
CADMIUM (CD) DIS														
SELENIUM (SE) TOTAL	< 0.05		< 0.05		< 0.05		< 0.05		0.0126	BN	< 0.05		< 0.05	
SELENIUM (SE) DIS														

TABLE 4.2-11B Results of FMC May 2008 Groundwater Monitoring Event - Routine Parameter List

Parameter **Routine Analytes**	WELL-128		WELL-131		WELL-142		WELL-148		WELL-154		WELL-155	
Field Measurements												
PH (FLD)	7.43		7.36		6.31		7.51		7.47		7.22	
SC (UMHOS/CM AT 25 C) (FLD)	1809		2065		3740		1149		1182		3153	
OXIDATION REDUCTION POTENTIAL	-5.3		-34.3		54.5		43.9		68.4		-55.7	
DISSOLVED OXYGEN	3.86		0.19		1.71		3.31		4.85		0.21	
TURBIDITY (NTU) (FLD)	0.2		46		0.3		0.3		0.3		0.5	
WATER TEMPERATURE (C) (FLD)	12.5		14		15.9		15.9		16.8		14.6	
General WQP												
POTASSIUM (K) TOT	17.4	,J	14	,J	20.5		10.6	NE,J	13.3	,J	494	
POTASSIUM (K) DIS			14									
SULFATE (SO4)	137		164		1270		84.4		50.1		260	
CHLORIDE (CL)	359		228		140		169		206		222	
FLUORIDE (F)	0.7		< 0.1		0.1		0.8		1.2		< 0.1	
TOTAL AMMONIA (NH3+NH4 AS N)	< 0.2		< 0.2		< 0.2		< 0.2		< 0.2		< 0.2	
NITRATE (NO3-N)	5.6	,J	< 0.1	,J	2.9		3	,J	2.6	,J	5.7	
ELEMENTAL PHOSPHORUS											< 0.00005	
TOTAL PHOSPHORUS	0.288	B,J	165	,J	2.86		< 0.5	NE,J	< 0.5	,J	43	
Metals												
ARSENIC (AS) TOTAL	0.0198	B	0.0719	B	0.0582	B	< 0.1		< 0.1		0.201	
ARSENIC (AS) DIS			< 0.1									
CADMIUM (CD) TOTAL	< 0.005		< 0.005				< 0.005		< 0.005			
CADMIUM (CD) DIS			< 0.005									
SELENIUM (SE) TOTAL	< 0.05		0.0052	B	0.0087	B	< 0.05		< 0.05		0.0053	
SELENIUM (SE) DIS			< 0.05									

TABLE 4.2-11B Results of FMC May 2008 Groundwater Monitoring Event - Routine Parameter List

Parameter **Routine Analytes**	WELL-157	WELL-158	WELL-165	WELL-166	WELL-168	WELL-171
Field Measurements						
PH (FLD)	6.79	6.84	7.31	6.94	7.3	7.46
SC (UMHOS/CM AT 25 C) (FLD)	3460	2169	2026	2115	1959	1254
OXIDATION REDUCTION POTENTIAL	-138.4	-63.6	18.1	-18.2	156.4	22.2
DISSOLVED OXYGEN	0.24	4.19	0.26	0.23	0.61	5.71
TURBIDITY (NTU) (FLD)	0.4	0.3	0.2	0.7	0.8	0.2
WATER TEMPERATURE (C) (FLD)	16.1	16.6	12.5	11.8	13.1	13.2
General WQP						
POTASSIUM (K) TOT	370	17.7	13.3 ,J	23.7 NE,J	10.6 NE,J	21 ,J
POTASSIUM (K) DIS						
SULFATE (SO4)	238	284	237	161	557	96
CHLORIDE (CL)	278	82.9	387	236	86.7	212
FLUORIDE (F)	0.5	0.4	0.3	0.7	5	0.8
TOTAL AMMONIA (NH3+NH4 AS N)	3.1	< 0.2	< 0.2	< 0.2	0.3	< 0.2
NITRATE (NO3-N)	< 0.1	1.6	4.5 ,J	19.4 ,J	14.7 ,J	4.5 ,J
ELEMENTAL PHOSPHORUS	< 0.00005	< 0.00005				
TOTAL PHOSPHORUS	284	< 0.5 N	0.652 ,J	0.57 NE,J	< 0.5 NE,J	< 0.5 ,J
Metals						
ARSENIC (AS) TOTAL	0.177	< 0.1 N	0.0261 B	< 0.1	0.0202 B	0.0267 B
ARSENIC (AS) DIS						
CADMIUM (CD) TOTAL			< 0.005	< 0.005	< 0.005	< 0.005
CADMIUM (CD) DIS						
SELENIUM (SE) TOTAL	< 0.05	< 0.05 N	0.0085 B	0.005 B	0.0335 B	< 0.05
SELENIUM (SE) DIS						

TABLE 4.2-11B Results of FMC May 2008 Groundwater Monitoring Event - Routine Parameter List

Parameter **Routine Analytes**	WELL-172		WELL-176		WELL-177		WELL-178		WELL-180		WELL-190	
Field Measurements												
PH (FLD)	7.37		7.27		7.42		7.17		7.39		6.57	
SC (UMHOS/CM AT 25 C) (FLD)	1242		1085		1144		4003		1771		1709	
OXIDATION REDUCTION POTENTIAL	16.1		115.4		83.3		67.7		29.4		6.4	
DISSOLVED OXYGEN	3.22		3.71		4.19		3.07		2.52		2.73	
TURBIDITY (NTU) (FLD)	0.1		0.2		0.4		0.5		0.3		1.7	
WATER TEMPERATURE (C) (FLD)	12.5		17.5		17.3		15.4		13.2		16.5	
General WQP												
POTASSIUM (K) TOT	22.2	,J	11.7	,J	11.4	,J	22	,J	28.2	,J	4.63	
POTASSIUM (K) DIS												
SULFATE (SO4)	84		66.4		68.9		560		174		243	
CHLORIDE (CL)	160		160		182		897		157		231	
FLUORIDE (F)	0.5		0.9		0.9		0.9		0.6		1.3	
TOTAL AMMONIA (NH3+NH4 AS N)	< 0.2		< 0.2		< 0.2		< 0.2		< 0.2		< 0.2	
NITRATE (NO3-N)	9.7	,J	4.5	,J	3.8	,J	4.9	,J	29.6	,J	8.4	
ELEMENTAL PHOSPHORUS												
TOTAL PHOSPHORUS	0.449	B,J	< 0.5	,J	< 0.5	,J	0.222	B,J	1.06	,J	0.543	
Metals												
ARSENIC (AS) TOTAL	0.0323	B	< 0.1		< 0.1		< 0.1		0.0453	B	0.0231	B
ARSENIC (AS) DIS												
CADMIUM (CD) TOTAL	< 0.005		< 0.005		< 0.005		< 0.005		< 0.005			
CADMIUM (CD) DIS												
SELENIUM (SE) TOTAL	< 0.05		0.0056	B	0.0065	B	0.0095	B	0.0121	B	0.0129	B
SELENIUM (SE) DIS												

TABLE 4.2-12 Summary of the Results for the Routine Groundwater Monitoring Programs from 4th Quarter 2006 through 2nd Quarter 2008

Routine Analytes	Southwestern and Western Up-Gradient Area			Western Ponds Area						
Parameters	**WELL-173**	**WELL-174**	**WELL-175**	**WELL-104**	**WELL-113**	**WELL-114**	**WELL-115**	**WELL-124**	**WELL-126**	**WELL-127**
Field Measurments										
Depth to Water (Feet)	55.3	49.7	46.3	90.2	71.6	74.3	73.6	52	59.8	62.1
pH (Field)	7.55	7.39	7.3	7.48	7.19	7.17	7.24	7.33	7.5	7.27
SC (UMHOS/CM)	1114	1224	1017	1964	1220	1647	2198	1119	840	1740
Turbidity (NTU)	1.31	0.486	0.343	0.371	0.771	0.543	0.457	0.243	0.443	0.329
Water Temperature (C)	16.7	16.8	16	14.3	11.9	11.1	11.5	14.3	16.4	14.4
General WQP										
Potassium	13.9	13	11.7	225	20.6	23.5	12.3	13.3	9.98	15.1
Sulfate	55.6	93	63.4	141	97.5	112	176	88.5	89.9	203
Chloride	225	220	150	150	137	143	153	176	87.6	329
Fluoride	0.853	0.783	0.559	3.84	0.449	0.866	0.23	0.814	0.955	0.571
Ammonia	0.2	0.2	0.2	3.4	0.171	1.51	0.175	0.2	0.2	0.2
Nitrate	3.84	4.39	5.54	24.5	9.69	0.095	22.7	2.73	2.03	5.06
Orthophosphate/ Total P	0.16	0.16	0.16	2.09	0.14	2.71	2.13	0.16	0.16	0.16
Metals										
Arsenic	0.004	0.004	0.006	0.049	0.026	0.122	0.257	0.022	0.021	0.007
Cadmium	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.002	0.002	0.001
Selenium	0.006	0.006	0.004	0.011	0.011	0.01	0.011	0.01	0.01	0.005

Notes:

Results are average for last four sampling events (4Q06 to 2Q08) for CERCLA/Calciner Ponds and average for last 7 sampling events (4Q06 to 2Q08) for RCRA ponds.

All values are presented in mg/L unless otherwise noted.

Non-detect results were included in the mean as equal to the detection limit.

--- Parameters that were not evaluated.

* Average Orthophosphate/ Total phosphorus value for well 131 was calculated from 10/26/1990 - 2Q08 due to significant outlier result.

** Average arsenic and selenium value for well 158 was calculated excluding the May 2008 undetected results at the 10x dilution detection limit of 0.1 and 0.05 mg/l respectively.

TABLE 4.2-12 Summary of the Results for the Routine Groundwater Monitoring Programs from 4th Quarter 2006 through 2nd Quarter 2008

Routine Analytes	**Western Ponds Area**										
Parameters	**WELL-128**	**WELL-131**	**WELL-134**	**WELL-139**	**WELL-147**	**WELL-148**	**WELL-149**	**WELL-154**	**WELL-155**	**WELL-156**	**WELL-157**
Field Measurments											
Depth to Water (Feet)	65.7	89.9	84.2	71.8	46.9	49.8	50.6	50	95.1	98.4	106
pH (Field)	7.24	7.24	6.73	6.92	7.35	7.37	7.42	7.4	7.32	7.15	6.92
SC (UMHOS/CM)	1789	1968	2805	4643	1045	1158	923	1127	2506	6331	2941
Turbidity (NTU)	0.257	47.7	1.2	0.45	0.271	0.286	0.286	0.343	0.657	0.886	0.457
Water Temperature (C)	12.5	13.8	16.9	12.8	16.9	15.9	16.1	16.9	14.6	15.4	16
General WQP											
Potassium	18.7	14.8	153	38.5	12.5	13.3	12.2	13.9	473	1305	325
Sulfate	136	160	325	1051	65.5	94.2	57.4	49.3	209	221	212
Chloride	367	230	287	886	163	178	132	206	197	348	213
Fluoride	0.48	0.1	0.2	0.583	0.734	0.736	0.971	0.96	0.125	0.105	0.456
Ammonia	0.2	0.2	0.5	0.175	0.2	0.2	0.2	0.2	0.171	13.9	2.36
Nitrate	5.64	0.093	21.2	35.5	3.93	3.36	1.83	2.54	2.92	0.086	0.228
Orthophosphate/ Total P	0.13	8.67*	19.80	0.74	0.16	0.16	0.16	0.16	39.39	278.00	117.03
Metals											
Arsenic	0.015	0.057	0.098	0.039	0.004	0.02	0.008	0.018	0.179	0.156	0.108
Cadmium	0.001	0.001	---	---	0.001	0.001	0.001	0.002	0.001	0.001	0.001
Selenium	0.012	0.004	0.05	0.038	0.006	0.011	0.004	0.011	0.007	0.004	0.011

TABLE 4.2-12 Summary of the Results for the Routine Groundwater Monitoring Programs from 4th Quarter 2006 through 2nd Quarter 2008

Routine Analytes	**Western Ponds Area**						
Parameters	**WELL-158**	**WELL-165**	**WELL-166**	**WELL-167**	**WELL-168**	**WELL-171**	**WELL-172**
Field Measurments							
Depth to Water (Feet)	99.2	67.6	74.2	94.5	77.8	55.7	53.8
pH (Field)	7.03	7.3	7.07	7.13	7.17	7.36	7.25
SC (UMHOS/CM)	1437	1543	2130	1483	1882	1208	1208
Turbidity (NTU)	0.471	0.243	0.514	0.943	0.943	0.214	0.2
Water Temperature (C)	16.5	12.3	11.5	14.4	13	13.1	12.4
General WQP							
Potassium	16.8	13.2	30.7	13.9	12.9	21.8	23.1
Sulfate	288	178	169	125	530	92.9	84.2
Chloride	80.5	282	217	122	94.2	212	159
Fluoride	0.241	0.221	0.631	0.3	4.78	0.608	0.507
Ammonia	0.171	0.171	0.186	0.171	0.25	0.2	0.2
Nitrate	1.54	3.87	20.2	2.75	14.6	4.55	9.79
Orthophosphate/ Total P	0.17	0.22	0.25	7.40	0.15	0.16	0.15
Metals							
Arsenic	0.011	0.025	0.032	0.053	0.025	0.019	0.023
Cadmium	0.001	0.001	0.002	0.001	0.002	0.002	0.002
Selenium	0.005	0.007	0.005	0.003	0.03	0.01	0.01

TABLE 4.2-12 Summary of the Results for the Routine Groundwater Monitoring Programs from 4th Quarter 2006 through 2nd Quarter 2008

Routine Analytes	Western Ponds Area					Central Plant Area				
Parameters	**WELL-176**	**WELL-177**	**WELL-178**	**WELL-180**	**WELL-183**	**WELL-108**	**WELL-121**	**WELL-122**	**WELL-123**	**WELL-143**
Field Measurments										
Depth to Water (Feet)	46.3	47.6	53.7	55.8	99.9	89.7	91.5	82.9	91.4	103
pH (Field)	7.32	7.38	7.12	7.28	7.46	7.09	7.04	6.86	6.82	6.37
SC (UMHOS/CM)	1038	1088	3576	1556	991	2148	2421	2504	1964	2888
Turbidity (NTU)	0.314	0.314	0.629	0.3	0.757	0.386	0.357	0.6	0.271	0.575
Water Temperature (C)	17.4	17.3	15.3	13.2	16.1	19.6	16.7	17.7	18.3	14.3
General WQP										
Potassium	12.7	12.6	25.6	35.8	11.6	124	72	126	26	24.2
Sulfate	66	68.7	603	142	93.4	242	256	300	361	554
Chloride	157	180	813	144	141	346	418	345	161	439
Fluoride	0.667	0.739	0.391	0.671	0.374	0.783	0.283	0.132	0.977	0.33
Ammonia	0.2	0.2	0.2	0.213	0.15	0.178	0.171	0.175	3.23	2.28
Nitrate	4.54	3.81	4.21	25.5	1.34	18.4	24.5	23.3	5.53	14.8
Orthophosphate/ Total P	0.16	0.16	0.12	0.31	0.24	1.04	1.05	17.80	0.87	1.18
Metals										
Arsenic	0.017	0.018	0.022	0.042	0.014	0.018	0.022	0.06	0.24	0.103
Cadmium	0.001	0.001	0.002	0.002	0.001	0.002	0.001	0.001	0.001	---
Selenium	0.004	0.004	0.008	0.008	0.007	0.01	0.012	0.009	0.154	0.072

TABLE 4.2-12 Summary of the Results for the Routine Groundwater Monitoring Programs from 4th Quarter 2006 through 2nd Quarter 2008

Routine Analytes	Joint-Fenceline Area						North FMC Plant Boundary		
Parameters	**WELL-136**	**WELL-142**	**WELL-161**	**WELL-164**	**WELL-189**	**WELL-190**	**WELL-110**	**WELL-111**	**WELL-146**
Field Measurments									
Depth to Water (Feet)	87.3	145	111	156	168	147	66.2	75.5	69.6
pH (Field)	5.91	6.41	6.39	6.17	5.99	6.67	6.86	7.1	7.11
SC (UMHOS/CM)	5542	3569	3980	5203	5547	1518	1429	1513	1294
Turbidity (NTU)	0.35	0.425	0.35	0.3	0.65	13.3	0.4	0.5	0.35
Water Temperature (C)	15.1	15.6	16.8	16	15.8	16.1	17.1	14.8	16.9
General WQP									
Potassium	54	25.8	26.4	24.1	49.7	4.65	25.4	49.5	46.3
Sulfate	2472	1240	1728	2163	2575	208	215	157	128
Chloride	140	131	169	180	139	215	89.8	170	132
Fluoride	0.468	0.139	0.086	0.084	0.413	0.985	0.435	0.105	0.378
Ammonia	2.12	0.26	0.225	0.2	1.88	0.2	0.15	0.15	0.15
Nitrate	3.05	2.88	5.58	4.68	3.78	7.18	3.8	8.98	6.13
Orthophosphate/ Total P	112.38	2.51	0.20	38.10	99.10	0.25	3.09	3.95	1.33
Metals									
Arsenic	0.326	0.047	0.006	0.209	0.338	0.015	0.048	0.024	0.029
Cadmium	---	---	---	---	---	---	---	---	---
Selenium	0.039	0.009	0.009	0.017	0.038	0.013	0.029	0.005	0.003

TABLE 4.2-12 Summary of the Results for the Routine Groundwater Monitoring Programs from 4th Quarter 2006 through 2nd Quarter 2008

Routine Analytes	Area North of Highway 30			Area North of I-86 and Batiste Spring			
Parameters	**WELL-523**	**TW-9S**	**TW-12S**	**WELL-515**	**WELL-524**	**WELL-525**	**BATISTE SP**
Field Measurments							
Depth to Water (Feet)	57.4	64.8	52.2	57.3	17.1	16.7	
pH (Field)	7.38	7.06	6.5	7.37	7.55	7.52	6.8
SC (UMHOS/CM)	893	1842	1125	1260	517	524	908
Turbidity (NTU)	0.2	8	8.5	0.475	0.325	0.35	0.357
Water Temperature (C)	13.4	14.4	14.4	13.3	12.4	12.1	13
General WQP							
Potassium	8.49	58.4	15.7	8.85	4.21	4.15	12
Sulfate	59.6	161	132	132	42.9	44.6	138
Chloride	108	187	46.2	197	18.5	19.2	43.8
Fluoride	0.5	0.1	1.1	0.683	0.675	0.718	0.354
Ammonia	0.2	0.2	0.7	0.15	0.15	0.133	1.4
Nitrate	4.5	9.95	6.1	2.75	1.88	1.95	5.99
Orthophosphate/ Total P	0.30	3.21	16.90	0.20	0.20	0.25	18.99
Metals							
Arsenic	0.004	0.027	0.017	0.005	0.004	0.006	0.022
Cadmium	---	---	---	---	---	---	0.001
Selenium	0.003	0.005	0.006	0.003	0.005	0.005	0.005

Table 4.2-13
Calciner Pond Groundwater Monitoring Results - 2007

STATION ID: 136		
CONSTITUENT	**Conc. Qual Qtr-2-2007**	**Conc. Qual Qtr-4-2007**
DEPTH TO WATER LEVEL (FEET)	87.26	87
OXYGEN (O) (FLD) DIS	0.98	0.64
PH (FLD)	6.05	6.01
SC (UMHOS/CM AT 25C) (FLD)	5361	5614
TURBIDITY (NTU) (FLD)	0.5	0.2
WATER TEMPERATURE (C) (FLD)	15.1	15.1
POTASSIUM (K) TOT	67.1 J	60
SULFATE (SO4)	2380	2490 J
CHLORIDE (CL)	112 ,J	144 J,J
FLUORIDE (F)	0.4	0.5
TOTAL AMMONIA (NH3+NH4 AS N)	2.7 ,J	2.1
NITRATE (NO3-N)	3.7	3.1
ORTHOPHOSPHATE (PO4-P)	108 ,J	166 ,J
ARSENIC (AS) TOT	0.312	0.324
SELENIUM (SE) TOT	0.0435	0.0354

STATION ID: 142		
CONSTITUENT	**Conc. Qual Qtr-2-2007**	**Conc. Qual Qtr-4-2007**
DEPTH TO WATER LEVEL (FEET)	144.55	144.74
OXYGEN (O) (FLD) DIS	1.74	1.66
PH (FLD)	6.46	6.36
SC (UMHOS/CM AT 25C) (FLD)	3427	3650
TURBIDITY (NTU) (FLD)	0.8	0.2
WATER TEMPERATURE (C) (FLD)	15.7	15.4
POTASSIUM (K) TOT	27.6 ,J	25.9
SULFATE (SO4)	1260	1210 J
CHLORIDE (CL)	108 ,J	140 ,J
FLUORIDE (F)	< 0.1	0.3
TOTAL AMMONIA (NH3+NH4 AS N)	< 0.2 ,J	0.7 ,U
NITRATE (NO3-N)	2.9	3
ORTHOPHOSPHATE (PO4-P)	2.9 ,J	3.6 ,J
ARSENIC (AS) TOT	0.043	0.0457
SELENIUM (SE) TOT	0.0118 ,U	0.0093 ,U,J

All results are in mg/l unless otherwise noted.

Qualifiers:
< - Measured Not Detected
U - Qualified Not Detected
J - Estimated

Table 4.2-13
Calciner Pond Groundwater Monitoring Results - 2007

STATION ID: 143		
CONSTITUENT	Conc. Qual Qtr-2-2007	Conc. Qual Qtr-4-2007
DEPTH TO WATER LEVEL (FEET)	102.86	102.72
OXYGEN (O) (FLD) DIS	0.6	0.32
PH (FLD)	6.45	6.46
SC (UMHOS/CM AT 25C) (FLD)	2686	3016
TURBIDITY (NTU) (FLD)	0.6	0.2
WATER TEMPERATURE (C) (FLD)	14.3	14.3
POTASSIUM (K) TOT	26.6 ,J	24.6
SULFATE (SO4)	538	568 ,J
CHLORIDE (CL)	410 ,J	454 J,J
FLUORIDE (F)	0.3	0.3
TOTAL AMMONIA (NH3+NH4 AS N)	2.4 ,J	2.5
NITRATE (NO3-N)	14.7	14.9
ORTHOPHOSPHATE (PO4-P)	2.4 ,J	< 0.1 ,J
ARSENIC (AS) TOT	0.107	0.1
SELENIUM (SE) TOT	0.0778	0.0695

STATION ID: 161		
CONSTITUENT	Conc. Qual Qtr-2-2007	Conc. Qual Qtr-4-2007
DEPTH TO WATER LEVEL (FEET)	111.08	111.05
OXYGEN (O) (FLD) DIS	0.59	0.75
PH (FLD)	6.44	6.34
SC (UMHOS/CM AT 25C) (FLD)	3676	4285
TURBIDITY (NTU) (FLD)	0.4	0.2
WATER TEMPERATURE (C) (FLD)	17.6	16.7
POTASSIUM (K) TOT	28.7 ,J	28
SULFATE (SO4)	1780	1690
CHLORIDE (CL)	154 ,J	170 ,J
FLUORIDE (F)	< 0.1	< 0.1
TOTAL AMMONIA (NH3+NH4 AS N)	< 0.2 ,J	0.5 ,U
NITRATE (NO3-N)	5.7	5.6
ORTHOPHOSPHATE (PO4-P)	< 0.1 ,J	< 0.1 ,J
ARSENIC (AS) TOT	< 0.005	0.0034 ,U,J
SELENIUM (SE) TOT	0.0107 ,U	0.011 ,U

All results are in mg/l unless otherwise noted.

Qualifiers:
< - Measured Not Detected
U - Qualified Not Detected
J - Estimated

Table 4.2-13
Calciner Pond Groundwater Monitoring Results - 2007

STATION ID: 164		
CONSTITUENT	Conc. Qual Qtr-2-2007	Conc. Qual Qtr-4-2007
DEPTH TO WATER LEVEL (FEET)	155.31	155.71
OXYGEN (O) (FLD) DIS	0.47	0.63
PH (FLD)	6.19	6.08
SC (UMHOS/CM AT 25C) (FLD)	4981	5284
TURBIDITY (NTU) (FLD)	0.4	0.2
WATER TEMPERATURE (C) (FLD)	16.1	16
POTASSIUM (K) TOT	27.2 ,J	26.4
SULFATE (SO4)	2160	2140
CHLORIDE (CL)	149 ,J	189 ,J
FLUORIDE (F)	0.1 ,J	< 0.1
TOTAL AMMONIA (NH3+NH4 AS N)	< 0.2 ,J	0.4 ,U
NITRATE (NO3-N)	4.7	4.8
ORTHOPHOSPHATE (PO4-P)	40.8 ,J	16.9 ,J
ARSENIC (AS) TOT	0.209	0.207
SELENIUM (SE) TOT	0.0187	0.0174 ,U

STATION ID: 189		
CONSTITUENT	Conc. Qual Qtr-2-2007	Conc. Qual Qtr-4-2007
DEPTH TO WATER LEVEL (FEET)	167.57	167.35
OXYGEN (O) (FLD) DIS	0.65	0.76
PH (FLD)	6.06	5.96
SC (UMHOS/CM AT 25C) (FLD)	5327	5660
TURBIDITY (NTU) (FLD)	1.2	0.3
WATER TEMPERATURE (C) (FLD)	16.2	15.9
POTASSIUM (K) TOT	56.9 ,J	52.3
SULFATE (SO4)	2560	2620 J
CHLORIDE (CL)	114 ,J	144 J,J
FLUORIDE (F)	0.3	0.4
TOTAL AMMONIA (NH3+NH4 AS N)	1.7 ,J	2.3
NITRATE (NO3-N)	4.4	3.5
ORTHOPHOSPHATE (PO4-P)	86.6 ,J	100 ,J
ARSENIC (AS) TOT	0.329	0.331
SELENIUM (SE) TOT	0.0437	0.0375

All results are in mg/l unless otherwise noted.

Qualifiers:
< - Measured Not Detected
U - Qualified Not Detected
J - Estimated

Table 4.2-13
Calciner Pond Groundwater Monitoring Results - 2007

STATION ID: 190		
CONSTITUENT	Conc. Qual Qtr-2-2007	Conc. Qual Qtr-4-2007
DEPTH TO WATER LEVEL (FEET)	147.14	147.04
OXYGEN (O) (FLD) DIS	3.19	2.55
PH (FLD)	6.73	6.63
SC (UMHOS/CM AT 25C) (FLD)	1286	1678
TURBIDITY (NTU) (FLD)	9.3	1.3
WATER TEMPERATURE (C) (FLD)	15.6	16.4
POTASSIUM (K) TOT	4.38 ,J	4.84 ,J
SULFATE (SO4)	161	229 J
CHLORIDE (CL)	199 ,J	230 ,JJ
FLUORIDE (F)	1	0.8
TOTAL AMMONIA (NH3+NH4 AS N)	< 0.2 ,J	0.4 ,U
NITRATE (NO3-N)	5.7	8
ORTHOPHOSPHATE (PO4-P)	0.22 ,J	< 0.1 ,J
ARSENIC (AS) TOT	0.0083	0.0172
SELENIUM (SE) TOT	0.0126 ,U	0.0138 ,U

All results are in mg/l unless otherwise noted.

Qualifiers:
< - Measured Not Detected
U - Qualified Not Detected
J - Estimated

TABLE 4.3-1 SUMMARY OF REPRESENTATIVE (BACKGROUND) GROUNDWATER WELLS FOR THE BANNOCK AND MICHAUD HYDROGEOCHEMICAL REGIMES DURING THE REMEDIAL INVESTIGATION AND POST-RI WELLS USEABLE TO SUPPLEMENT THE REPRESENTATIVE WELL NETWORKS

BANNOCK HYDROGEOCHEMICAL REGIME REPRESENTATIVE WELLS

Original RI Wells

Well	Location and Status during RI	Current Status[a]	Shallow / Deep	Screen Interval	Lithology	Analytical Data Period		As Min[b]	Detected As Max[c]	As Average[d]	Number of Results[e]	Number of Non-Detects[e]	% Non-Detects
Idaho Power	Production well for the Idaho Power Kinport Substation, south and significantly upgradient of FMC property	Remains upgradient of any potential source area; Not part of routine monitoring programs	Deep	Information not available	Information not available	4Q1990	4Q1993	0.0105	0.0204	0.0156	7	1	14.3%
PEI-1	Could not find boring log or well construction documentation, well located upgradient of any potential souce areas and south of the gypstack during the RI period	Abandoned, date unavailable	Shallow	Information not available	Information not available	4Q1990	3Q1992	0.002	0.0073	0.0048	4	1	25.0%
106	Installed 1990 during PSCS, PSCS/RI data showed no site-related impacts	Not part of routine monitoring programs	Shallow	125 - 135	Gravel (GP)	4Q1990	4Q1993	0.00341	0.00729	0.0048	9	3	33.3%
158	Installed 1993 during RI, RI data showed no site-related impacts	Routine RCRA monitoring program - Pond 8S upgradient well	Shallow	136 - 146	Sand with Silt (SP-SM)	3Q1993	2Q2007[f]	0.00869	0.01704	0.014	9	2	22.2%
301	Installed 1992 during RI as background well upgradeint to supplement well PEI-1, both 301 and PEI-1 were upgradient of the south extent of the gypstack during the RI period	Simplot property well - status of monitoring data not known	Shallow	170 - 180	Sand (SP)	2Q1992	4Q1993	0.002	0.01653	0.0077	8	5	62.5%
305	Installed 1992 during RI as background well upgradeint of any potential source areas	Simplot property well - currently (2006) included in Simplot monitoring program	Deep	280 - 300	Gravelly Sand (SP)	2Q1992	4Q1993	0.00163	0.0178	0.0054	10	9	90.0%

Post-RI Wells

Well	Location Description	Current Status	Shallow / Deep	Screen Interval	Lithology	Period Analytical Data		As Min	Detected As Max	As Average	Number of Results	Number of Non-Detects	% Non-Detects
169	Installed 1995 as background upgradient well for RCRA ponds area; located upgradient of any potential source areas	Remains upgradient of any potential source areas; Not part of routine monitoring programs	Shallow	111 - 116	Silty Gravel (GM)	4Q1995	3Q1997	0.0057	0.0121	0.0093	9	2	22.2%

TABLE 4.3-1 SUMMARY OF REPRESENTATIVE (BACKGROUND) GROUNDWATER WELLS FOR THE BANNOCK AND MICHAUD HYDROGEOCHEMICAL REGIMES DURING THE REMEDIAL INVESTIGATION AND POST-RI WELLS USEABLE TO SUPPLEMENT THE REPRESENTATIVE WELL NETWORKS

MICHAUD HYDROGEOCHEMICAL REGIME REPRESENTATIVE WELLS

Original RI Wells

Well	Location and Status during RI	Current Status	Shallow / Deep	Screen Interval	Lithology	Period Analytical Data		As Min	Detected As Max	As Average	Number of Results	Number of Non-Detects	% Non-Detects
TW-10S	Installed 1981 as background well upgradient of any operations or waste ponds	Abandoned July 1998	Shallow	90 - 98	Clayey silt with fine sand and gravel interbeds	1Q1990	4Q1993	0.0019	0.014	0.0068	10	4	40.0%
101	Installed 1990 during PSCS as a shallow aquifer background well upgradient of any operations or waste ponds	Remains upgradient of any potential source areas; Not part of routine monitoring programs	Shallow	87 - 97	Silt (ML) / Silty Sand with Gravel (SM)	4Q1990	4Q2001	0.00856	0.01751	0.013	33	4	12.1%
102	Installed 1990 during PSCS as a deep aquifer background well upgradient of any operations or waste ponds	Remains upgradient of any potential source areas; Not part of routine monitoring programs	Deep	136 - 146	Sand (SP) / Sand with Gravel (SP)	4Q1990	4Q1994	0.0089	0.01959	0.0128	10	1	10.0%
147	Installed 1992 during RI, at the time of the RI this well was upgradient of any potential source areas; RI data period pre-dates operation of Pond 16S	No longer upgradient of potential source areas after Pond 16S began operation in 1995; Routine RCRA monitoring program Pond 16S downgradient well	Shallow	71 - 80	Sandy Gravel (GW)	2Q1992	2Q2007[f]	0.0031	0.00801	0.0053	14	8	57.1%
514	Installed 1993 during RI as a shallow cross-gradient well to monitor northern properties, RI data showed no site-related impacts	Remains cross-gradient of any potential source areas; Not part of routine monitoring programs	Shallow	81 - 91	Sandy Gravel (GW)	3Q1993	2Q2002[f]	0.0038	0.0077	0.006	4	3	75.0%
515	Installed 1993 during RI as a shallow cross-gradient well to monitor northern properties, RI data showed no site-related impacts	Remains cross-gradient of any potential source areas, data continues to show no site-related impacts; Routine CERCLA monitoring program - northern sentry well	Shallow	71 - 81	Sandy Gravel (GW)	3Q1993	4Q2006	0.0021	0.0074	0.0048	25	8	32.0%

TABLE 4.3-1 SUMMARY OF REPRESENTATIVE (BACKGROUND) GROUNDWATER WELLS FOR THE BANNOCK AND MICHAUD HYDROGEOCHEMICAL REGIMES DURING THE REMEDIAL INVESTIGATION AND POST-RI WELLS USEABLE TO SUPPLEMENT THE REPRESENTATIVE WELL NETWORKS

MICHAUD HYDROGEOCHEMICAL REGIME REPRESENTATIVE WELLS

Post-RI Wells

Well	Location Description	Current Status	Shallow / Deep	Screen Interval	Lithology	Period Analytical Data		As Min	Detected As Max	As Average	Number of Results	Number of Non-Detects	% Non-Detects
173	Installed 1998 as upgradient well for Pond 17 and is also upgradient of any other potential source areas	Remains upgradient of any potential source areas; Routine RCRA monitoring program - Pond 17 upgradient well	Shallow	70 - 85	Clayey Silt (ML) / Sandy Silty Gravel (GM)	4Q1998	2Q2007	0.002	0.008	0.0042	43	11	25.6%
174	Installed 1998 as upgradient well for Pond 18 and is also upgradient of any other potential source areas	Remains upgradient of any potential source areas; Routine RCRA monitoring program - Pond 18 Cell A upgradient well	Shallow	75 - 85	Silty Gravel and Sand (GM)	4Q1998	2Q2007	0.0026	0.0073	0.0045	40	12	30.0%
175	Installed 1998 as upgradient well for Pond 18 and is also upgradient of any other potential source areas	Remains upgradient of any potential source areas; Routine RCRA monitoring program - Pond 18 Cell B upgradient well [g]	Shallow	72 - 82	Silty Gravel (GM)	4Q1998	2Q2007	0.0055	0.0165	0.0094	41	8	19.5%
179	Installed 1997 per EPA direction as upgradient water table well for Pond 17 and is also upgradient of any other potential source areas	Remains upgradient of any potential source areas; dropped from the Pond 17 monitoring program - not an aquifer well	Saturated aquitard	49 - 59	Silt (ML) / Clayey Silt (ML)	3Q1997	2Q1999	0.003	0.012	0.007	8	2	25.0%

NOTES:
[a] Current status is as of March 2008.
[b] Arsenic minimum is miminum value reported for total arsenic whether detected or non-detect.
[c] Detected arsenic maximum is maximum detected value reported for total arsenic (i.e., exclusive of non-detect values).
[d] Arsenic average is the average of total arsenic values using non-detected values at the reported detection limit.
[e] Number of Results and Number of Non-Detects is the number of reported total arsenic values within the Analytical Data Period and does not include dissolved arsenic results.
[f] The Analytical Data Period for wells 158, 147 and 514 is for the RI and post-RI period; however the summary of arsenic results (max, min, ave, n, etc.) is only for the RI period (data through 4Q1994).
[g] Pond 18 Cell B closure by removal was completed and certified in 2005, at that time no further monitoring of well 175 was required per the EPA-approved Pond 18 Closure Plan.

TABLE 4.3-2 Common Ion Chemistry for Representative Wells in the Michaud and Bannock Hydrogeochemical Regimes, Eastern Michaud Flats Site

ANALYTE	CALCIUM-CHLORIDE WATER CHEMISTRY												CALCIUM-BICARBONATE WATER CHEMISTRY							
	Michaud Hydrogeochemical Regime												Bannock Hydrogeochemical Regime							
	EMF Remedial Investigation Representative Wells [a]						Post RI Representative Wells [b]				Added		EMF Remedial Investigation Representative Wells [a]						Post RI Rep Well [b]	
	Well TW-10S Mean	Well 101 Mean	Well 102 Mean	Well 147 Mean	Well 514 Mean	Well 515 Mean	Well 173 Mean	Well 174 Mean	Well 175 Mean	Well 179 Mean	Well 516 Mean	Michaud 95th Percentile [c]	Idaho Power Mean	Well PEI-1 Mean	Well 106 Mean	Well 158 Mean	Well 301 Mean	Well 305 Mean	Well 169 Mean	Bannock 95th Percentile [c]
COMMON IONS																				
Alkalinity, bicarbonate	142	143	148	171	132	190	NA	NA	NA	NA	163	198	165	159	151	169	120	137	NA	171
Calcium	79	86	76	85	45	93	NA	NA	NA	NA	63	98	46	59	60	65	50	54	NA	69
Chloride	169	131	111	148	29	188	195	209	152	265	78	193	45	39	48	66	42	46	40	52
Magnesium	26	32	27	26	15	33	NA	NA	NA	NA	20	34	17	15	17	22	11	13	NA	19
Potassium	9.4	8.5	8	10.6	4.4	9.2	17.6	12.7	12.3	11.4	8.2	12.7	8.2	6.2	9.8	9.1	8.2	6.5	8.2	10.5
Sodium	52	33	29	56	21	86	NA	89	63	75	41	74	25	14	23	24	26	18	17	28
Sulfate	34	64	48	57	44	114	55	90	65	53	67	73	23	16	38	46	14	35	32	43
NUTRIENTS																				
Nitrate (NO3 as N)	4.45	1.76	1.69	2.29	0.65	2.02	3.39	4.01	5.33	5.56	1.97	5.52	1.45	0.81	1.02	1.03	0.66	1.03	1.38	1.6
Orthophosphate	0.02	0.02	0.02	0.02	0.03	0.03	0.06 [e]	0.06 [e]	0.05 [e]	0.09 [e]	0.08	0.06	0.03	0.11	0.04	0.03	0.05	0.04	0.04 [e]	0.13
Total phosphorus [d]	0.04	0.27 / 0.03	0.32 / 0.04	0.03	0.02	0.02	NA	NA	0.05 [f]	NA	0.06	0.33	0.05	0.05	0.1	0.23	0.06	0.04	NA	0.31

NOTES:

[a] Mean concentrations (rounded) for common ions for the EMF RI representative wells from Table 4.4-1 of the EMF RI Report (August 1996).

[b] Mean concentrations for common ions for Post-RI wells calculated from FEDS database, NA means no analytical results for analyte.

[c] 95th percentile concentrations (rounded) for common ions calculated for the EMF RI representative wells from Table 4.4-1 of the RI Report (August 1996).

[d] For wells 101 and 102 (two values), the first is the EMF RI mean from Table 4.4-1, the second value is the mean total phosphorus value for each well calculated without the first three results (excludes data from October 1990 to June 1991) for wells 101 and 102.

[e] Value calculated is average of all results using 1/2 detection limit for undetected results, routine detection limit for most post-RI orthophosphate analyses was 0.1 mg/l.

[f] Value is one-half of reported result for single sample = 0.1 U (undetected at 0.1 mg/l detection limit).

TABLE 4.3-3 Total Phosphorus Results and Means for Wells 101 and 102

Data taken from FEDS Database

Location	SampleDate	OrigSampleID	QCCategory	SampleType	AnalyteName	DOT	ResultValue	ResultUnits	Rejected	Detected	Qual_Val	Qual
101	02-Oct-90	HYD5945	Primary	GW	Phosphorus	TOT	3	mg/l	N	Y		
101	03-Apr-91	9104101	Primary	GW	Phosphorus	TOT	0.06	mg/l	N	Y	J	
101	17-Jun-91	9106201	Primary	GW	Phosphorus	TOT	0.1	mg/l	N	Y	J	
101	19-Sep-91	9109301	Primary	GW	Phosphorus	TOT	0.1	mg/l	N	Y		
101	09-Dec-91	9112401	Primary	GW	Phosphorus	TOT	0.064	mg/l	N	Y	J4	
101	16-Mar-92	9203101	Primary	GW	Phosphorus	TOT	0.04	mg/l	N	N	U	
101	16-Jun-92	9206203	Primary	GW	Phosphorus	TOT	0.04	mg/l	N	Y	C	
101	10-Sep-92	9209305	Primary	GW	Phosphorus	TOT	0.02	mg/l	N	N	UC	U
101	02-Dec-92	F212412	Primary	GW	Phosphorus	TOT	0.03	mg/l	N	N	C	U
101	03-Mar-93	F303115	Primary	GW	Phosphorus	TOT	0.02	mg/l	N	Y	C	
101	25-May-93	F306205	Primary	GW	Phosphorus	TOT	0.024	mg/l	N	Y	C	
101	27-Jul-93	F308307	Primary	GW	Phosphorus	TOT	0.02	mg/l	N	N	UC	U
101	01-Dec-93	312101	Primary	GW	Phosphorus	TOT	0.039	mg/l	N	Y	C	
101	09-Mar-94	403101	Primary	GW	Phosphorus	TOT	0.02	mg/l	N	N	UC	U
101	23-Jun-94	406101	Primary	GW	Phosphorus	TOT	0.031	mg/l	N	Y	C	
101	07-Sep-94	409101	Primary	GW	Phosphorus	TOT	0.023	mg/l	N	Y	C	
101	30-Nov-94	412101A	Primary	GW	Phosphorus	TOT	0.02	mg/l	N	N	UC	U
101	06-Mar-95	503101	Primary	GW	Phosphorus	TOT	0.02	mg/l	N	N	UC	U

EMF RI Mean (all results prior to 1994) 0.27

Mean (all results except 02-Oct-90) 0.039

Mean (excluding first 3 [10/2/90 - 6/17/91] results) 0.034

Location	SampleDate	OrigSampleID	QCCategory	SampleType	AnalyteName	DOT	ResultValue	ResultUnits	Rejected	Detected	Qual_Val	Qual
102	12-Oct-90	HYD5946	Primary	GW	Phosphorus	TOT	3	mg/l	N	Y		
102	02-Apr-91	9104100	Primary	GW	Phosphorus	TOT	0.41	mg/l	N	Y	J	
102	17-Jun-91	9106200	Primary	GW	Phosphorus	TOT	0.27	mg/l	N	Y		
102	21-Sep-91	9109300	Primary	GW	Phosphorus	TOT	0.08	mg/l	N	Y		
102	09-Dec-91	9112400	Primary	GW	Phosphorus	TOT	0.0453	mg/l	N	N	U	
102	16-Mar-92	9203100	Primary	GW	Phosphorus	TOT	0.047	mg/l	N	Y		
102	16-Jun-92	9206202	Primary	GW	Phosphorus	TOT	0.05	mg/l	N	Y	C	
102	10-Sep-92	9209304	Primary	GW	Phosphorus	TOT	0.02	mg/l	N	Y	C	
102	02-Dec-92	F212411	Primary	GW	Phosphorus	TOT	0.05	mg/l	N	N	C	U
102	03-Mar-93	F303113	Primary	GW	Phosphorus	TOT	0.04	mg/l	N	Y	C	
102	25-May-93	F306204	Primary	GW	Phosphorus	TOT	0.035	mg/l	N	Y	C	
102	27-Jul-93	F308305	Primary	GW	Phosphorus	TOT	0.02	mg/l	N	N	UC	U
102	01-Dec-93	312102	Primary	GW	Phosphorus	TOT	0.029	mg/l	N	Y	C	

EMF RI Mean (all results prior to 1994) 0.32

Mean (all results except 12-Oct-90) 0.091

Mean (excluding first 3 [10/12/90 - 6/17/91] results) 0.042

TABLE 4.3-4 Bannock Representative Well Dataset for 2008 Calculation

SITE CODE	SAMP DATE	SAMP #	Samp Type	AS_TOT	DETECTED	QUAL
WELL-169	9/14/1995	509169	Primary	0.0116	Y	AS
WELL-169	11/29/1995	512169A	Primary	0.0121	Y	N*AS,J
WELL-169	3/8/1996	603169	Primary	0.0071	Y	BAS
WELL-169	6/5/1996	606169	Primary	0.0072	Y	BNAS,J
WELL-169	9/23/1996	609169	Primary	0.011	Y	P
WELL-169	11/19/1996	611169	Primary	0.013	N	U
WELL-169	3/4/1997	703169	Primary	0.0065	Y	
WELL-169	5/13/1997	705169	Primary	0.0091	N	U,U
WELL-169	8/19/1997	708169A	Primary	0.0057	Y	
WELL-301	4/25/1992	SG301	Primary	0.008	N	B,H,UK
WELL-301	9/21/1992	9209402	Primary	0.0165	Y	H
WELL-301	12/17/1992	S212406	Primary	0.002	N	UH,UJ
WELL-301	3/14/1993	S303400	Primary	0.0037	Y	BH
WELL-301	8/7/1993	S308400	Primary	0.0063	N	BH,U
WELL-301	12/15/1993	312301	Primary	0.0141	Y	H
WELL-301	7/1/1994	406301	Primary	0.0031	N	U,UAS
WELL-301	12/9/1994	412301	Primary	0.0079	N	BNAS,UJ
WELL-305	4/29/1992	SG305	Primary	0.01	N	H,UK
WELL-305	9/19/1992	9209409	Primary	0.0178	Y	H
WELL-305	12/13/1992	S212404A	Primary	0.002	N	UH,W
WELL-305	12/13/1992	S212406A		0.0113	N	H,UJ
WELL-305	3/15/1993	S303430A	Primary	0.002	N	U,UH
WELL-305	8/8/1993	S308402	Primary	0.0016	N	BH,U
WELL-305	8/8/1993	S308405	Duplicate	0.0018	N	BH,U
WELL-305	12/10/1993	312305A	Primary	0.0025	N	BAS,U
WELL-305	7/1/1994	406305	Primary	0.0031	N	U,UAS
WELL-305	12/7/1994	412305	Primary	0.0024	N	BAS,U
WELL-305	6/6/1995	506305	Primary	0.005	N	U,U
WELL-305	12/6/1995	512305	Primary	0.004	N	UJ
WELL-305	3/10/1997	703305	Primary	0.006	N	U
WELL-305	3/11/1998	803305	Primary	0.006	N	UJ
WELL-305	8/20/1998	808305	Primary	0.0009	N	U
WELL-305	8/27/2003	308305	Primary	0.003	N	U
WELL-305	12/1/2003	312305	Primary	0.003	N	U

NOTE:
The well 305 sample # S212406A (12/13/1992) was excluded from the calculation, the FEDS database indicates this result is associated with a primary sample; however, the sample number suggests (but could not be verified) the sample/result was a duplicate of sample S212404A.

TABLE 4.3-5 Michaud Representative Well Dataset for 2008 Calculation

SITE CODE	SAMP DATE	SAMP #	Samp Type	AS_TOT	DETECTED	QUAL
WELL-101	10/2/1990	HYD5945	Primary	0.0117	Y	J-
WELL-101	6/16/1992	9206203	Primary	0.0161	Y	H,J
WELL-101	9/10/1992	9209305	Primary	0.0149	Y	H
WELL-101	12/2/1992	F212412	Primary	0.011	N	H,U
WELL-101	12/2/1992	F212480		0.0109	N	H,U
WELL-101	3/3/1993	F303115	Primary	0.0117	Y	H
WELL-101	5/25/1993	F306205	Primary	0.015	Y	H
WELL-101	7/27/1993	F308307	Primary	0.0135	Y	H
WELL-101	12/1/1993	312101	Primary	0.01009	Y	AS
WELL-101	3/9/1994	94-403101	Primary	0.0155	Y	AS
WELL-101	6/23/1994	406101	Primary	0.0089	Y	BAS
WELL-101	9/7/1994	409101	Primary	0.0104	Y	AS
WELL-101	11/30/1994	412101A	Primary	0.0158	Y	AS
WELL-101	3/6/1995	503101	Primary	0.0103	Y	AS
WELL-101	6/1/1995	506101	Primary	0.014	Y	AS
WELL-101	9/12/1995	509101	Primary	0.011	Y	AS
WELL-101	11/29/1995	512101	Primary	0.0175	Y	N*AS,J
WELL-101	3/7/1996	603101	Primary	0.0114	Y	AS
WELL-101	6/3/1996	606101	Primary	0.0109	N	NAS,UJ
WELL-101	6/3/1996	606600	Duplicate	0.0086	N	BNAS,UJ
WELL-101	9/23/1996	609101	Primary	0.015	Y	
WELL-101	11/22/1996	611101	Primary	0.016	N	U
WELL-101	3/4/1997	703101	Primary	0.011	Y	
WELL-101	5/16/1997	705101	Primary	0.014	Y	
WELL-101	10/6/1997	710101	Primary	0.012	Y	
WELL-101	5/11/1998	805101	Primary	0.014	Y	J
WELL-101	11/2/1998	811101	Primary	0.01	Y	
WELL-101	5/18/1999	905101	Primary	0.014	Y	
WELL-101	11/16/1999	911101	Primary	0.0157	Y	
WELL-101	5/18/2000	5101	Primary	0.0138	Y	
WELL-101	11/9/2000	11101	Primary	0.0142	Y	
WELL-101	5/1/2001	105101	Primary	0.0156	Y	
WELL-101	11/1/2001	111101	Primary	0.0135	Y	
WELL-102	10/12/1990	HYD5946	Primary	0.0115	Y	J-
WELL-102	6/16/1992	9206202	Primary	0.0089	N	B,H,U
WELL-102	9/10/1992	9209304	Primary	0.014	Y	H
WELL-102	12/2/1992	F212411	Primary	0.0125	N	H,U
WELL-102	3/3/1993	F303113	Primary	0.0137	Y	H
WELL-102	5/25/1993	F306204	Primary	0.0155	Y	H
WELL-102	7/27/1993	F308305	Primary	0.0129	Y	H
WELL-102	12/1/1993	312102	Primary	0.0104	Y	AS
WELL-102	6/23/1994	406102	Primary	0.0092	Y	BAS
WELL-102	11/30/1994	412102	Primary	0.0196	Y	AS
TW-10S	3/26/1990	TW-10S	Primary	0.014	Y	
TW-10S	11/6/1990	HYD5926	Primary	0.0054	Y	
TW-10S	11/6/1990	HYD5927	Duplicate	0.0049	Y	
TW-10S	6/20/1992	9206238	Primary	0.0067	N	B,H,U
TW-10S	9/9/1992	9209300	Primary	0.0063	N	BH,U
TW-10S	12/1/1992	F212400	Primary	0.006	N	BH,U
TW-10S	3/2/1993	F303105A	Primary	0.0038	Y	BH
TW-10S	7/27/1993	F308300	Primary	0.0047	N	BH,U
TW-10S	11/30/1993	312T10S	Primary	0.0019	Y	BAS

TABLE 4.3-5 Michaud Representative Well Dataset for 2008 Calculation

SITE CODE	SAMP DATE	SAMP #	Samp Type	AS_TOT	DETECTED	QUAL
WELL-173	11/10/1998	811173	Primary	0.0027	Y	B,J
WELL-173	2/25/1999	902173	Primary	0.0049	Y	B
WELL-173	5/21/1999	905173	Primary	0.0059	N	,UJ
WELL-173	8/19/1999	908173	Primary	0.005	Y	
WELL-173	11/3/1999	911173	Primary	0.0064	Y	
WELL-173	2/29/2000	3173	Primary	0.0046	N	B,UJ
WELL-173	5/15/2000	5173	Primary	0.0028	Y	B,J
WELL-173	5/15/2000	5600	Duplicate	0.0022	Y	B,J
WELL-173	8/24/2000	8173	Primary	0.004	Y	B,J
WELL-173	11/14/2000	11173	Primary	0.006	Y	
WELL-173	2/27/2001	102173A	Primary	0.0066	Y	
WELL-173	5/14/2001	105173	Primary	0.005	N	U
WELL-173	8/7/2001	108173	Primary	0.0034	Y	B,J
WELL-173	11/2/2001	111173	Primary	0.0038	Y	B,J
WELL-173	3/5/2002	203173	Primary	0.0042	Y	B,J
WELL-173	5/13/2002	205173	Primary	0.0033	Y	B,J
WELL-173	7/30/2002	207173	Primary	0.002	Y	B,J
WELL-173	11/4/2002	211173	Primary	0.0035	N	B,UJ
WELL-173	3/17/2003	303173	Primary	0.0077	N	U
WELL-173	5/19/2003	305173	Primary	0.0034	Y	B,J
WELL-173	8/19/2003	308173	Primary	0.0044	Y	B,J
WELL-173	11/18/2003	311173	Primary	0.0025	Y	B,J
WELL-173	3/23/2004	403173	Primary	0.0039	Y	B,J
WELL-173	5/18/2004	405173	Primary	0.0044	N	B,UJ
WELL-173	5/18/2004	405600	Duplicate	0.002	N	B,UJ
WELL-173	8/3/2004	408173	Primary	0.005	N	U
WELL-173	11/12/2004	411173	Primary	0.0029	Y	B,J
WELL-173	3/2/2005	503173	Primary	0.005	Y	
WELL-173	5/3/2005	0505173A	Primary	0.0033	Y	J
WELL-173	8/2/2005	508173	Primary	0.004	N	B,U,J
WELL-173	11/10/2005	511173	Primary	0.0044	Y	B,J
WELL-173	2/28/2006	602173	Primary	0.0026	Y	B,J
WELL-173	5/2/2006	605173	Primary	0.004	Y	B,J
WELL-173	8/8/2006	608173	Primary	0.008	N	,U
WELL-173	8/8/2006	608600	Duplicate	0.0077	N	,U
WELL-173	11/7/2006	611173	Primary	0.0047	Y	B,J
WELL-173	2/27/2007	702173	Primary	0.0036	Y	B,J
WELL-173	4/30/2007	705173	Primary	0.0039	Y	B,J
WELL-173	7/30/2007	708173	Primary	0.005	N	U
WELL-173	11/5/2007	711173	Primary	0.005	N	U
WELL-174	11/13/1998	811174	Primary	0.005	N	U
WELL-174	2/24/1999	902174A	Primary	0.0032	Y	B,J
WELL-174	5/24/1999	905174	Primary	0.0047	Y	B,J
WELL-174	8/17/1999	908174	Primary	0.0033	Y	B,J
WELL-174	11/3/1999	911174	Primary	0.0054	Y	
WELL-174	2/29/2000	3174	Primary	0.0044	N	B,UJ
WELL-174	5/15/2000	5174	Primary	0.0028	Y	B,J
WELL-174	8/21/2000	8174	Primary	0.005	N	U
WELL-174	11/14/2000	011174A	Primary	0.0054	Y	
WELL-174	2/27/2001	102174	Primary	0.0034	Y	B,J
WELL-174	5/14/2001	105174	Primary	0.0041	Y	B,J
WELL-174	8/6/2001	108174	Primary	0.0042	Y	B,J

TABLE 4.3-5 Michaud Representative Well Dataset for 2008 Calculation

SITE CODE	SAMP DATE	SAMP #	Samp Type	AS_TOT	DETECTED	QUAL
WELL-174	11/2/2001	111174	Primary	0.0031	Y	B,J
WELL-174	11/2/2001	111601	Duplicate	0.005	N	U
WELL-174	3/5/2002	203174	Primary	0.0042	Y	B,J
WELL-174	5/13/2002	205174	Primary	0.0035	Y	B,J
WELL-174	7/29/2002	207174	Primary	0.0049	Y	B,J
WELL-174	11/4/2002	211174	Primary	0.0036	N	B,UJ
WELL-174	3/17/2003	303174	Primary	0.0069	N	U
WELL-174	3/17/2003	303600	Duplicate	0.0073	N	U
WELL-174	5/19/2003	305174	Primary	0.0043	Y	B,J
WELL-174	8/19/2003	308174	Primary	0.004	Y	B,J
WELL-174	11/18/2003	311174	Primary	0.0045	Y	B,J
WELL-174	3/22/2004	403174	Primary	0.0059	Y	
WELL-174	5/18/2004	405174	Primary	0.0057	N	,U
WELL-174	8/3/2004	408174	Primary	0.005	N	U
WELL-174	11/11/2004	411174	Primary	0.0026	Y	B,J
WELL-174	2/28/2005	503174	Primary	0.0059	Y	
WELL-174	5/3/2005	505174	Primary	0.0037	Y	J
WELL-174	8/1/2005	508174	Primary	0.0056	N	U
WELL-174	11/8/2005	511174	Primary	0.0034	Y	B,J
WELL-174	2/28/2006	602174	Primary	0.0032	Y	B,J
WELL-174	5/2/2006	605174	Primary	0.0033	Y	B,J
WELL-174	5/2/2006	605600	Duplicate	0.0035	Y	B,J
WELL-174	8/8/2006	608174	Primary	0.0071	N	,U
WELL-174	11/6/2006	611174	Primary	0.0051	Y	
WELL-174	2/26/2007	702174	Primary	0.0039	Y	B,J
WELL-174	4/30/2007	705174	Primary	0.0043	Y	B,J
WELL-174	7/30/2007	708174	Primary	0.0021	Y	B,J
WELL-174	11/5/2007	711174	Primary	0.0031	Y	B,J
WELL-175	11/13/1998	811175	Primary	0.0055	Y	
WELL-175	2/24/1999	902175	Primary	0.008	Y	
WELL-175	5/24/1999	905175	Primary	0.0068	Y	
WELL-175	8/17/1999	908175	Primary	0.0083	Y	
WELL-175	8/17/1999	908600	Duplicate	0.0063	Y	
WELL-175	11/3/1999	911175	Primary	0.007	Y	
WELL-175	2/29/2000	003175A	Primary	0.006	N	,U
WELL-175	5/15/2000	5175	Primary	0.0054	Y	
WELL-175	8/22/2000	8175	Primary	0.0075	N	,U
WELL-175	11/14/2000	11175	Primary	0.0165	Y	
WELL-175	2/27/2001	102175	Primary	0.007	Y	
WELL-175	5/14/2001	105175	Primary	0.0066	Y	
WELL-175	8/6/2001	108175	Primary	0.0067	Y	
WELL-175	11/15/2001	111175	Primary	0.0063	Y	
WELL-175	3/5/2002	203175	Primary	0.0065	Y	
WELL-175	5/13/2002	205175	Primary	0.0074	Y	
WELL-175	7/29/2002	207175	Primary	0.0078	Y	
WELL-175	11/4/2002	211175	Primary	0.0054	N	U
WELL-175	3/17/2003	303175	Primary	0.0103	N	U
WELL-175	5/19/2003	305175	Primary	0.0076	Y	
WELL-175	5/19/2003	305600	Duplicate	0.0058	Y	
WELL-175	8/19/2003	308175	Primary	0.0098	Y	
WELL-175	11/18/2003	311175	Primary	0.0069	Y	
WELL-175	3/22/2004	403175	Primary	0.0085	Y	

TABLE 4.3-5 Michaud Representative Well Dataset for 2008 Calculation

SITE CODE	SAMP DATE	SAMP #	Samp Type	AS_TOT	DETECTED	QUAL
WELL-175	5/18/2004	405175	Primary	0.0076	N	,U
WELL-175	8/3/2004	408175	Primary	0.0071	Y	
WELL-175	11/11/2004	411175	Primary	0.0073	Y	
WELL-175	2/28/2005	503175	Primary	0.0067	Y	
WELL-175	2/28/2005	503600	Duplicate	0.008	Y	
WELL-175	5/3/2005	505175	Primary	0.0068	Y	
WELL-175	8/2/2005	508175	Primary	0.0086	N	U
WELL-175	11/8/2005	511175	Primary	0.0075	Y	
WELL-175	2/28/2006	602175	Primary	0.0058	Y	
WELL-175	5/2/2006	605175	Primary	0.0061	Y	
WELL-175	8/8/2006	608175	Primary	0.0116	N	,U
WELL-175	11/7/2006	611175	Primary	0.0078	Y	
WELL-175	2/26/2007	702175	Primary	0.0073	Y	
WELL-175	4/30/2007	705175	Primary	0.0072	Y	
WELL-175	7/30/2007	708175	Primary	0.0067	Y	
WELL-175	7/30/2007	708600	Duplicate	0.0041	Y	B,J
WELL-175	11/5/2007	711175	Primary	0.0034	Y	B,J
WELL-179	8/21/1997	708179	Primary	0.012	Y	J
WELL-179	11/18/1997	711179	Primary	0.0043	N	BUJ
WELL-179	2/25/1998	802179	Primary	0.008	N	U
WELL-179	5/18/1998	805179	Primary	0.006	Y	
WELL-179	8/12/1998	808179	Primary	0.0037	Y	B,J
WELL-179	11/12/1998	811179	Primary	0.0083	Y	
WELL-179	2/25/1999	902179	Primary	0.011	Y	
WELL-179	5/21/1999	905179	Primary	0.003	Y	B,J
WELL-514	8/11/1993	O308327	Primary	0.0063	N	BH,U
WELL-514	12/9/1993	312514	Primary	0.0062	N	BAS,U
WELL-514	3/13/1994	94-403514	Primary	0.0077	N	BAS,U
WELL-514	5/16/2002	205514	Primary	0.0038	Y	B,J
WELL-515	8/11/1993	O308328	Primary	0.0051	N	BH,U
WELL-515	12/9/1993	312515	Primary	0.0069	Y	BAS
WELL-515	3/13/1994	94-403515	Primary	0.0077	N	BAS,U
WELL-515	6/27/1994	406515	Primary	0.005	N	BAS,U
WELL-515	12/6/1994	412515	Primary	0.0049	Y	BAS
WELL-515	6/2/1995	506515	Primary	0.0038	N	U,UAS
WELL-515	12/2/1995	512515A	Primary	0.0031	Y	BAS,J
WELL-515	6/2/1996	606515	Primary	0.0058	N	BAS,UJ
WELL-515	11/23/1996	611515	Primary	0.0056	N	U
WELL-515	5/16/1997	705515	Primary	0.0021	N	UB
WELL-515	10/7/1997	710515	Primary	0.0035	Y	BJ
WELL-515	5/12/1998	805515	Primary	0.004	Y	B,J
WELL-515	11/3/1998	811515	Primary	0.003	Y	B,J
WELL-515	5/19/1999	905515	Primary	0.0059	Y	
WELL-515	11/17/1999	911515	Primary	0.005	Y	B,J
WELL-515	5/22/2000	5515	Primary	0.0043	Y	B,J
WELL-515	11/9/2000	11515	Primary	0.0052	Y	
WELL-515	5/1/2001	105515	Primary	0.0056	Y	
WELL-515	11/13/2001	111515	Primary	0.0053	Y	
WELL-515	5/16/2002	205515	Primary	0.0049	Y	B,J
WELL-515	11/7/2002	211515	Primary	0.0038	Y	B,J
WELL-515	6/3/2003	305515	Primary	0.0035	Y	B,J
WELL-515	11/21/2003	311515	Primary	0.0047	N	B,UJ

TABLE 4.3-5 Michaud Representative Well Dataset for 2008 Calculation

SITE CODE	SAMP DATE	SAMP #	Samp Type	AS_TOT	DETECTED	QUAL
WELL-515	5/20/2004	405515	Primary	0.0047	N	B,UJ
WELL-515	11/16/2004	411515	Primary	0.0054	Y	
WELL-515	5/16/2005	505515	Primary	0.0054	Y	
WELL-515	11/11/2005	511515	Primary	0.0046	N	B,U,J
WELL-515	5/16/2006	605515	Primary	0.0028	Y	B,J
WELL-515	11/13/2006	611515	Primary	0.0049	Y	B,J
WELL-515	5/4/2007	705515	Primary	0.0045	Y	B,J
WELL-515	11/13/2007	711515	Primary	0.0068	N	J,U
WELL-516	8/11/1993	O308329	Primary	0.0063	N	BH,U
WELL-516	12/9/1993	312516	Primary	0.0047	Y	BAS
WELL-516	3/13/1994	94-403516	Primary	0.0078	N	BAS,U
WELL-516	6/27/1994	406516	Primary	0.0072	N	BAS,U
WELL-516	12/6/1994	412516	Primary	0.0072	Y	BAS
WELL-516	11/13/2007	711516	Primary	0.005	N	J,U
WELL-147	5/12/1992	FG147	Primary	0.00899	N	BH,U
WELL-147	5/12/1992	FG147D	Duplicate	0.005	N	BH,U
WELL-147	6/15/1992	9206200A	Primary	0.0053	N	BH,U
WELL-147	9/9/1992	9209301	Primary	0.0045	N	BH,U
WELL-147	12/1/1992	F212404	Primary	0.00578	N	BH,U
WELL-147	3/2/1993	F303106	Primary	0.00493	Y	BH
WELL-147	5/25/1993	F306201	Primary	0.00625	Y	BH
WELL-147	7/27/1993	F308302	Primary	0.00495	N	BH,U
WELL-147	11/30/1993	312147	Primary	0.00362	Y	BAS
WELL-147	3/9/1994	403147	Primary	0.00543	Y	BAS
WELL-147	6/21/1994	406147	Primary	0.00355	Y	BAS
WELL-147	6/21/1994	406700	Duplicate	0.00468	Y	BAS
WELL-147	9/7/1994	409147	Primary	0.0031	N	UAS,U
WELL-147	11/30/1994	412147	Primary	0.00801	N	BAS,U
WELL-147	3/6/1995	503147	Primary	0.00486	Y	BAS
WELL-147	5/31/1995	506147	Primary	0.00797	Y	BAS
WELL-147	9/12/1995	509147	Primary	0.0028	N	U,UAS
WELL-147	11/29/1995	511147	Primary	0.01165	Y	N*AS,J
WELL-147	3/7/1996	603147	Primary	0.00837	Y	BAS
WELL-147	6/6/1996	606147	Primary	0.0031	N	UAS,U
WELL-147	9/26/1996	609601	Duplicate	0.007	Y	P
WELL-147	9/26/1996	609147	Primary	0.0058	Y	P
WELL-147	11/19/1996	611147	Primary	0.0044	N	B,U
WELL-147	3/4/1997	703147A	Primary	0.0025	Y	JB
WELL-147	5/13/1997	705600	Duplicate	0.0048	N	B,U
WELL-147	5/13/1997	705147	Primary	0.0055	N	U
WELL-147	8/18/1997	708147	Primary	0.0047	Y	B,J
WELL-147	11/17/1997	711147	Primary	0.0064	N	U
WELL-147	2/25/1998	802147	Primary	0.0042	N	B,UJ
WELL-147	5/14/1998	805147	Primary	0.0047	Y	B,J
WELL-147	8/10/1998	808147	Primary	0.0053	Y	
WELL-147	11/10/1998	811147	Primary	0.0031	Y	B,J
WELL-147	2/24/1999	902147A	Primary	0.0054	Y	
WELL-147	5/21/1999	905147	Primary	0.0062	N	,UJ
WELL-147	8/18/1999	908147	Primary	0.0033	Y	B,J
WELL-147	11/3/1999	911147	Primary	0.006	Y	
WELL-147	3/1/2000	003147	Primary	0.004	N	B,U
WELL-147	5/16/2000	005147	Primary	0.0027	Y	B,J

TABLE 4.3-5 Michaud Representative Well Dataset for 2008 Calculation

SITE CODE	SAMP DATE	SAMP #	Samp Type	AS_TOT	DETECTED	QUAL
WELL-147	8/22/2000	008147	Primary	0.005	N	B,UJ
WELL-147	11/13/2000	011147	Primary	0.0067	Y	
WELL-147	2/27/2001	102147	Primary	0.0052	Y	
WELL-147	5/14/2001	105147	Primary	0.0047	Y	B.J
WELL-147	8/7/2001	108147	Primary	0.0046	Y	B
WELL-147	11/14/2001	111147	Primary	0.0034	Y	B,J
WELL-147	3/4/2002	203147	Primary	0.005	Y	B,J
WELL-147	5/13/2002	205600	Duplicate	0.0048	N	B,UJ
WELL-147	5/13/2002	205147	Primary	0.0034	N	B,UJ
WELL-147	7/30/2002	207147	Primary	0.0085	N	U
WELL-147	11/5/2002	211147	Primary	0.0045	N	B,UJ
WELL-147	3/18/2003	303147	Primary	0.0082	N	U
WELL-147	5/20/2003	305147	Primary	0.0042	Y	B,J
WELL-147	8/19/2003	308147A	Primary	0.0055	Y	J
WELL-147	11/18/2003	311147	Primary	0.0069	Y	
WELL-147	3/23/2004	403147	Primary	0.006	Y	
WELL-147	5/18/2004	405147	Primary	0.0068	Y	
WELL-147	8/3/2004	408147	Primary	0.0051	Y	
WELL-147	11/16/2004	411147	Primary	0.0038	Y	B,J
WELL-147	3/2/2005	503147	Primary	0.0083	Y	
WELL-147	5/3/2005	505147	Primary	0.0053	Y	
WELL-147	8/2/2005	508147	Primary	0.0054	N	U
WELL-147	11/8/2005	511147	Primary	0.0039	Y	B,J
WELL-147	3/1/2006	602147	Primary	0.0045	Y	B,J
WELL-147	5/3/2006	605147	Primary	0.005	N	U
WELL-147	8/9/2006	608147	Primary	0.0076	N	,U
WELL-147	11/8/2006	611147	Primary	0.0049	Y	B
WELL-147	2/28/2007	702147	Primary	0.0061	Y	
WELL-147	5/2/07	705147	Primary	0.005	Y	
WELL-147	8/1/07	708147	Primary	0.0028	Y	J
WELL-147	11/7/07	711147	Primary	0.0029	Y	J

NOTE:
The well 101 sample # F212480 (12/2/1992) was excluded from the calculation, the FEDS database indicates this result is associated with a primary sample; however, the sample number suggests (but could not be verified) the sample/result was a duplicate of sample F212412.

The well 175 result for sample # 611175 (11/7/2006) was incorrectly entered into the FEDS database at 0.078 mg/l, per the original laboratory report the correct value is 0.0078 mg/l as shown and used in the 2008 calculation.

The well 101 sample # 611101 (11/22/1996) was excluded from the final ProUCL calculation due to its high order, nondetected value in the initial ProUCL calculation run.

Table 4.3-6 Bannock Representative Well Network - ProUCL Output File - 95% UPL

	Nonparametric Background Statistics for Data Sets with Non-Detects
User Selected Options	
From File	Bannock_ProUCL Ready.wst
Full Precision	OFF
Confidence Coefficient	95%
Coverage	90%
Different or Future K Values	1

Arsenic	
Total Number of Data	32
Number of Non-Detect Data	21
Number of Detected Data	11
Minimum Detected	0.0037
Maximum Detected	0.0178
Percent Non-Detects	65.63%
Minimum Non-detect	0.0009
Maximum Non-detect	0.013
Mean of Detected Data	0.0103
SD of Detected Data	0.00462
Mean of Log-Transformed Detected Data	-4.678
SD of Log-Transformed Detected Data	0.492
Data appear Normal at 5% Significance Level	
Nonparametric Background Statistics	
95% UTL with 90% Coverage	
Order Statistic	31
Achieved CC	0.966
UTL	0.0165
Largest Non-detect at Order	29
95% UPL	
95% UPL	0.017
Kaplan-Meier (KM) Method	
Mean	0.0061
SD	0.00405
Standard Error of Mean	0.0007617
95% UTL 90% Coverage	0.0132
95% KM Chebyshev UPL	0.024
95% KM UPL (t)	0.0131
90% KM Percentile (z)	0.0113
95% KM Percentile (z)	0.0128
99% KM Percentile (z)	0.0155

Note: UPL (or upper percentile for gamma distributed data)
represents a preferred estimate of BTV. For an Example:
KM-UPL may be used when multiple detection limits are present

Table 4.3-7 Michaud Representative Well Network - ProUCL Output File - 95% UPL

	Nonparametric Background Statistics for Data Sets with Non-Detects
User Selected Options	
From File	Michaud_ProUCL Ready.wst
Full Precision	OFF
Confidence Coefficient	95%
Coverage	90%
Different or Future K Values	1
Arsenic	
Total Number of Data	272
Number of Non-Detect Data	78
Number of Detected Data	194
Minimum Detected	0.0019
Maximum Detected	0.0196
Percent Non-Detects	28.68%
Minimum Non-detect	0.002
Maximum Non-detect	0.0125
Mean of Detected Data	0.00669
SD of Detected Data	0.00385
Mean of Log-Transformed Detected Data	-5.15
SD of Log-Transformed Detected Data	0.524
Data do not follow a Discernable Distribution (0.05)	
Nonparametric Background Statistics	
95% UTL with 90% Coverage	
Order Statistic	252
Achieved CC	0.945
UTL	0.0137
Largest Non-detect at Order	248
95% UPL	
95% UPL	0.0141
Kaplan-Meier (KM) Method	
Mean	0.00584
SD	0.00357
Standard Error of Mean	0.00022088
95% UTL 90% Coverage	0.0109
95% KM Chebyshev UPL	0.0214
95% KM UPL (t)	0.0117
90% KM Percentile (z)	0.0104
95% KM Percentile (z)	0.0117
99% KM Percentile (z)	0.0141
Note: UPL (or upper percentile for gamma distributed data)	
represents a preferred estimate of BTV. For an Example:	
KM-UPL may be used when multiple detection limits are present	

Table 4.3-8 Combined Representative Well Network - ProUCL Output File - 95% UPL

	Nonparametric Background Statistics for Data Sets with Non-Detects
User Selected Options	
From File	Combined_ProUCL Ready.wst
Full Precision	OFF
Confidence Coefficient	95%
Coverage	90%
Different or Future K Values	1
Arsenic	
Total Number of Data	304
Number of Non-Detect Data	99
Number of Detected Data	205
Minimum Detected	0.0019
Maximum Detected	0.0196
Percent Non-Detects	32.57%
Minimum Non-detect	0.0009
Maximum Non-detect	0.013
Mean of Detected Data	0.00688
SD of Detected Data	0.00397
Mean of Log-Transformed Detected Data	-5.125
SD of Log-Transformed Detected Data	0.532
Data do not follow a Discernable Distribution (0.05)	
Nonparametric Background Statistics	
95% UTL with 90% Coverage	
Order Statistic	281
Achieved CC	0.939
UTL	0.0137
Largest Non-detect at Order	278
95% UPL	
95% UPL	0.0142
Kaplan-Meier (KM) Method	
Mean	0.00576
SD	0.00371
Standard Error of Mean	0.00021786
95% UTL 90% Coverage	0.011
95% KM Chebyshev UPL	0.022
95% KM UPL (t)	0.0119
90% KM Percentile (z)	0.0105
95% KM Percentile (z)	0.0119
99% KM Percentile (z)	0.0144
Note: UPL (or upper percentile for gamma distributed data)	
represents a preferred estimate of BTV. For an Example:	
KM-UPL may be used when multiple detection limits are present	

Table 4.3-9 Bannock Representative Well Network - ProUCL Output - 95% KM UCL

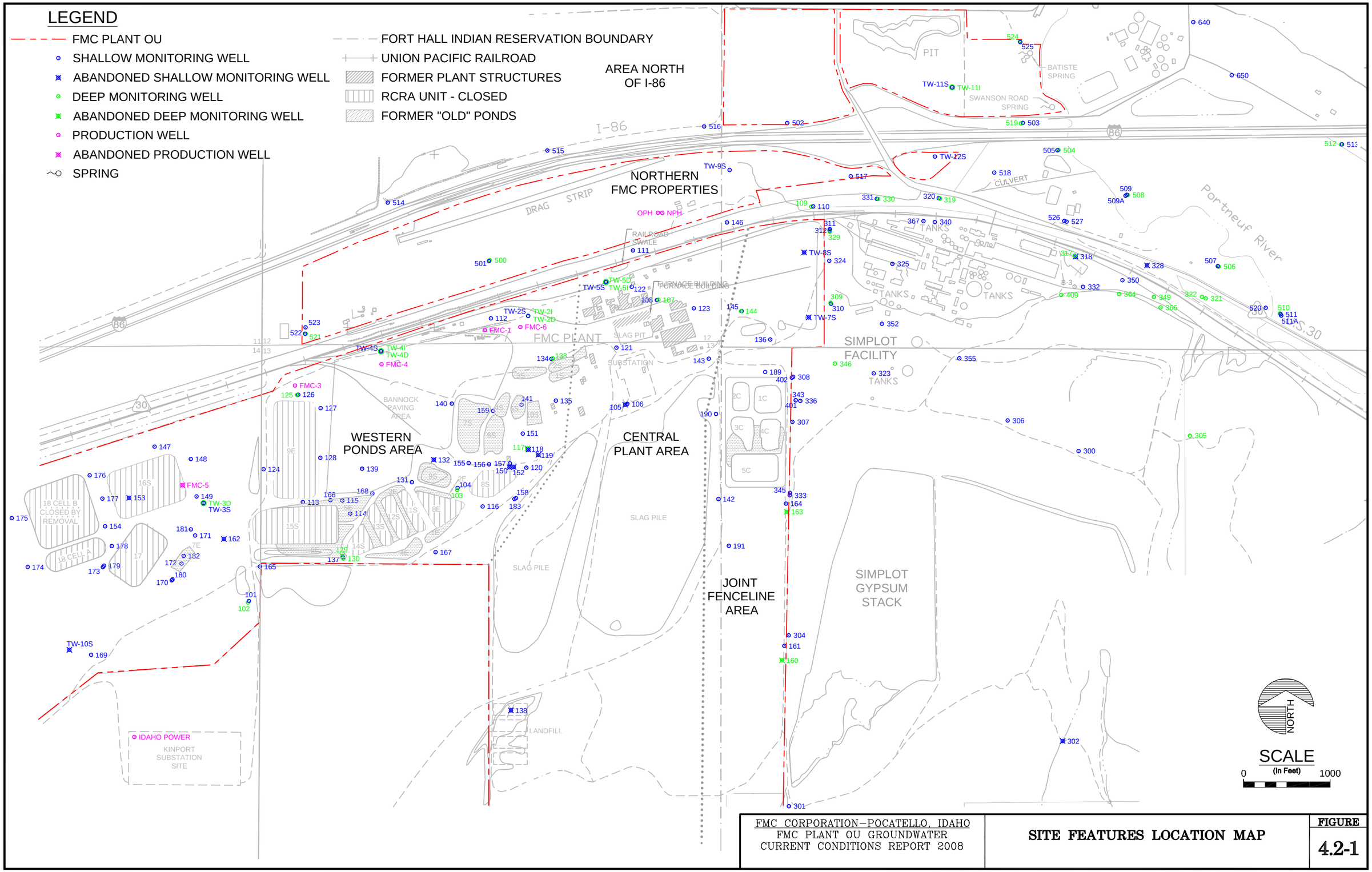
	General UCL Statistics for Data Sets with Non-Detects		
User Selected Options			
From File	Bannock_ProUCL Ready.wst		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operations	2000		
Bannock Arsenic			
General Statistics			
Number of Valid Data	32	Number of Detected Data	11
Number of Distinct Detected Data	11	Number of Non-Detect Data	21
		Percent Non-Detects	65.63%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0037	Minimum Detected	-5.599
Maximum Detected	0.0178	Maximum Detected	-4.029
Mean of Detected	0.0103	Mean of Detected	-4.678
SD of Detected	0.00462	SD of Detected	0.492
Minimum Non-Detect	0.0009	Minimum Non-Detect	-7.013
Maximum Non-Detect	0.013	Maximum Non-Detect	-4.343
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	29
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	3
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	90.63%
UCL Statistics			
Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.946	Shapiro Wilk Test Statistic	0.948
5% Shapiro Wilk Critical Value	0.85	5% Shapiro Wilk Critical Value	0.85
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.00512	Mean	-5.711
SD	0.00481	SD	0.983
95% DL/2 (t) UCL	0.00656	95% H-Stat (DL/2) UCL	0.00485
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.00505	Mean in Log Scale	-5.525
SD	0.00609	SD in Log Scale	0.707
95% MLE (t) UCL	0.00688	Mean in Original Scale	0.00526
95% MLE (Tiku) UCL	0.0131	SD in Original Scale	0.00456
		95% Percentile Bootstrap UCL	0.00657
		95% BCA Bootstrap UCL	0.00686
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	3.724	Data appear Normal at 5% Significance Level	
Theta Star	0.00277		
nu star	81.92		
A-D Test Statistic	0.291	Nonparametric Statistics	
5% A-D Critical Value	0.731	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.731	Mean	0.0061
5% K-S Critical Value	0.256	SD	0.00405
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	0.0007617
		95% KM (t) UCL	0.00739
Assuming Gamma Distribution		95% KM (z) UCL	0.00735
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.00742
Minimum	0.0037	95% KM (bootstrap t) UCL	0.00746
Maximum	0.0178	95% KM (BCA) UCL	0.00905
Mean	0.0104	95% KM (Percentile Bootstrap) UCL	0.00844
Median	0.0105	95% KM (Chebyshev) UCL	0.00942
SD	0.00265	97.5% KM (Chebyshev) UCL	0.0109
k star	12.84	99% KM (Chebyshev) UCL	0.0137
Theta star	0.0008108		
Nu star	821.8	Potential UCLs to Use	
AppChi2	756.3	95% KM (t) UCL	0.00739
95% Gamma Approximate UCL	0.0113	95% KM (Percentile Bootstrap) UCL	0.00844
95% Adjusted Gamma UCL	0.0114		
Note: DL/2 is not a recommended method.			

Table 4.3-10 Michaud Representative Well Network - ProUCL Output File - 95% KM UCL

	General UCL Statistics for Data Sets with Non-Detects		
User Selected Options			
From File	Michaud_ProUCL Ready.wst		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operations	2000		
Michaud Arsenic			
General Statistics			
Number of Valid Data	272	Number of Detected Data	194
Number of Distinct Detected Data	97	Number of Non-Detect Data	78
		Percent Non-Detects	28.68%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0019	Minimum Detected	-6.266
Maximum Detected	0.0196	Maximum Detected	-3.932
Mean of Detected	0.00669	Mean of Detected	-5.15
SD of Detected	0.00385	SD of Detected	0.524
Minimum Non-Detect	0.002	Minimum Non-Detect	-6.215
Maximum Non-Detect	0.0125	Maximum Non-Detect	-4.382
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	248
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	24
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	91.18%
UCL Statistics			
Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Lilliefors Test Statistic	0.168	Lilliefors Test Statistic	0.0865
5% Lilliefors Critical Value	0.0636	5% Lilliefors Critical Value	0.0636
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.00562	Mean	-5.361
SD	0.0037	SD	0.583
95% DL/2 (t) UCL	0.00599	95% H-Stat (DL/2) UCL	0.00577
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.0152	Mean in Log Scale	-5.288
SD	0.00146	SD in Log Scale	0.515
95% MLE (t) UCL	0.0154	Mean in Original Scale	0.00583
95% MLE (Tiku) UCL	0.0157	SD in Original Scale	0.00355
		95% Percentile Bootstrap UCL	0.00619
		95% BCA Bootstrap UCL	0.00621
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	3.604	Data do not follow a Discernable Distribution (0.05)	
Theta Star	0.00186		
nu star	1399		
A-D Test Statistic	4.202	Nonparametric Statistics	
5% A-D Critical Value	0.758	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.758	Mean	0.00584
5% K-S Critical Value	0.0655	SD	0.00357
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.0002209
		95% KM (t) UCL	0.0062
Assuming Gamma Distribution		95% KM (z) UCL	0.0062
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.0062
Minimum	1E-09	95% KM (bootstrap t) UCL	0.00623
Maximum	0.0196	95% KM (BCA) UCL	0.00622
Mean	0.00646	95% KM (Percentile Bootstrap) UCL	0.00621
Median	0.00565	95% KM (Chebyshev) UCL	0.0068
SD	0.00344	97.5% KM (Chebyshev) UCL	0.00722
k star	2.323	99% KM (Chebyshev) UCL	0.00803
Theta star	0.00278		
Nu star	1264	Potential UCLs to Use	
AppChi2	1182	95% KM (BCA) UCL	0.00622
95% Gamma Approximate UCL	0.0069		
95% Adjusted Gamma UCL	0.00691		
Note: DL/2 is not a recommended method.			

Table 4.3-11 Combined Representative Well Network - ProUCL Output File - 95% KM UCL

	General UCL Statistics for Data Sets with Non-Detects		
User Selected Options			
From File	Combined_ProUCL Ready.wst		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operations	2000		
Combined Arsenic			
General Statistics			
Number of Valid Data	304	Number of Detected Data	205
Number of Distinct Detected Data	102	Number of Non-Detect Data	99
		Percent Non-Detects	32.57%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0019	Minimum Detected	-6.266
Maximum Detected	0.0196	Maximum Detected	-3.932
Mean of Detected	0.00688	Mean of Detected	-5.125
SD of Detected	0.00397	SD of Detected	0.532
Minimum Non-Detect	0.0009	Minimum Non-Detect	-7.013
Maximum Non-Detect	0.013	Maximum Non-Detect	-4.343
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	278
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	26
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	91.45%
UCL Statistics			
Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Lilliefors Test Statistic	0.17	Lilliefors Test Statistic	0.0803
5% Lilliefors Critical Value	0.0619	5% Lilliefors Critical Value	0.0619
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.00556	Mean	-5.397
SD	0.00383	SD	0.644
95% DL/2 (t) UCL	0.00593	95% H-Stat (DL/2) UCL	0.00584
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.0156	Mean in Log Scale	-5.331
SD	0.00149	SD in Log Scale	0.564
95% MLE (t) UCL	0.0157	Mean in Original Scale	0.00573
95% MLE (Tiku) UCL	0.016	SD in Original Scale	0.0037
		95% Percentile Bootstrap UCL	0.00607
		95% BCA Bootstrap UCL	0.00608
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	3.531	Data do not follow a Discernable Distribution (0.05)	
Theta Star	0.00195		
nu star	1448		
A-D Test Statistic	4.281	Nonparametric Statistics	
5% A-D Critical Value	0.758	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.758	Mean	0.00576
5% K-S Critical Value	0.0634	SD	0.00371
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.0002179
		95% KM (t) UCL	0.00612
Assuming Gamma Distribution		95% KM (z) UCL	0.00612
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.00611
Minimum	1E-09	95% KM (bootstrap t) UCL	0.00612
Maximum	0.0196	95% KM (BCA) UCL	0.00615
Mean	0.00655	95% KM (Percentile Bootstrap) UCL	0.00612
Median	0.0059	95% KM (Chebyshev) UCL	0.00671
SD	0.00354	97.5% KM (Chebyshev) UCL	0.00712
k star	2.777	99% KM (Chebyshev) UCL	0.00793
Theta star	0.00236		
Nu star	1689	Potential UCLs to Use	
AppChi2	1594	95% KM (BCA) UCL	0.00615
95% Gamma Approximate UCL	0.00694		
95% Adjusted Gamma UCL	0.00694		
Note: DL/2 is not a recommended method.			



FMC CORPORATION–POCATELLO, IDAHO
FMC PLANT OU GROUNDWATER
CURRENT CONDITIONS REPORT 2008

SITE FEATURES LOCATION MAP

FIGURE
4.2-1

UPDATE TIME: 4:34PM
LT \HEL\031309\I:\Land Projects\1303b201\dwg\1303b201h071.dwg

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Figure 4.2-2A Potassium Concentrations at Pond 8S Wells

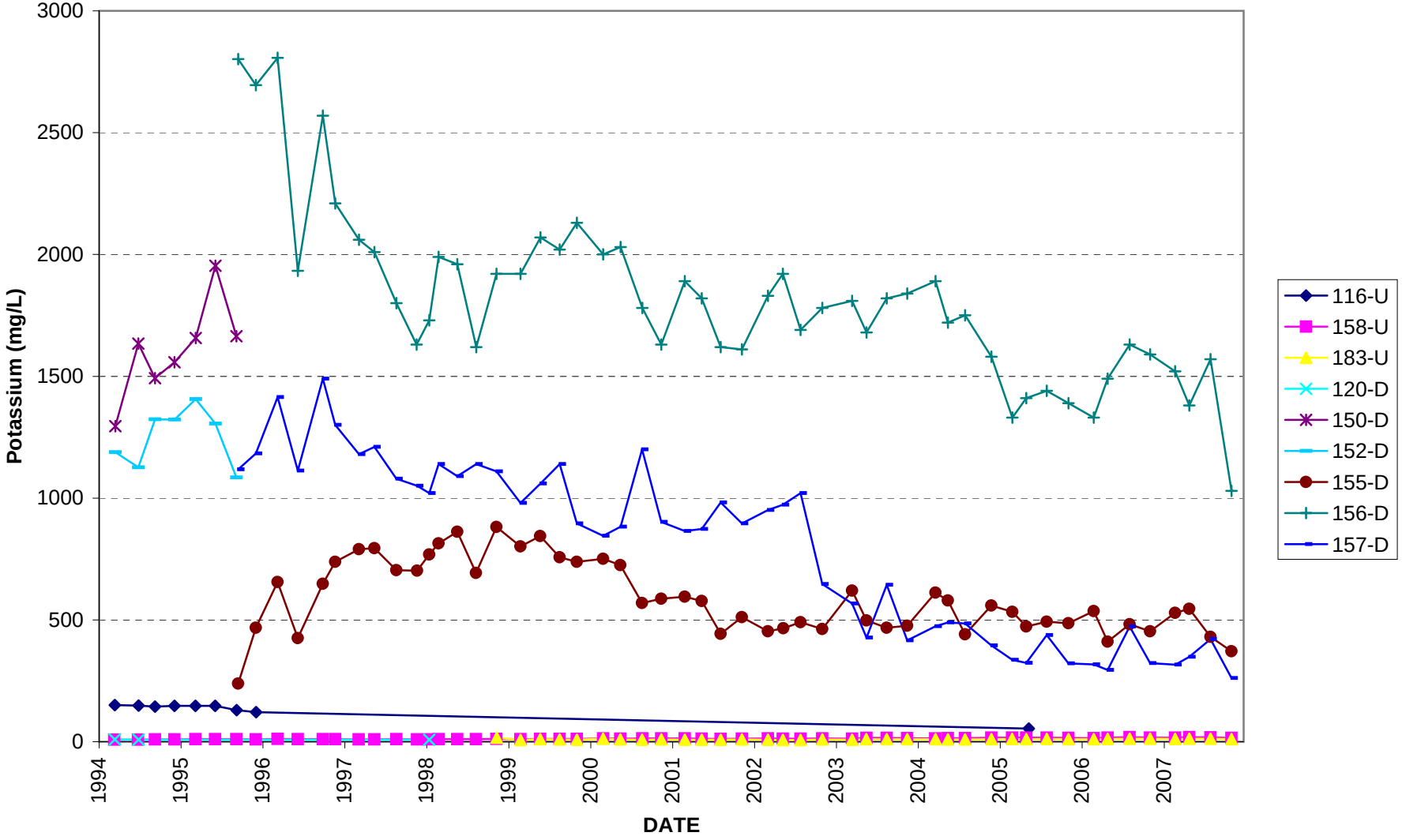


Figure 4.2-2B Chloride Concentrations at Pond 8S Wells

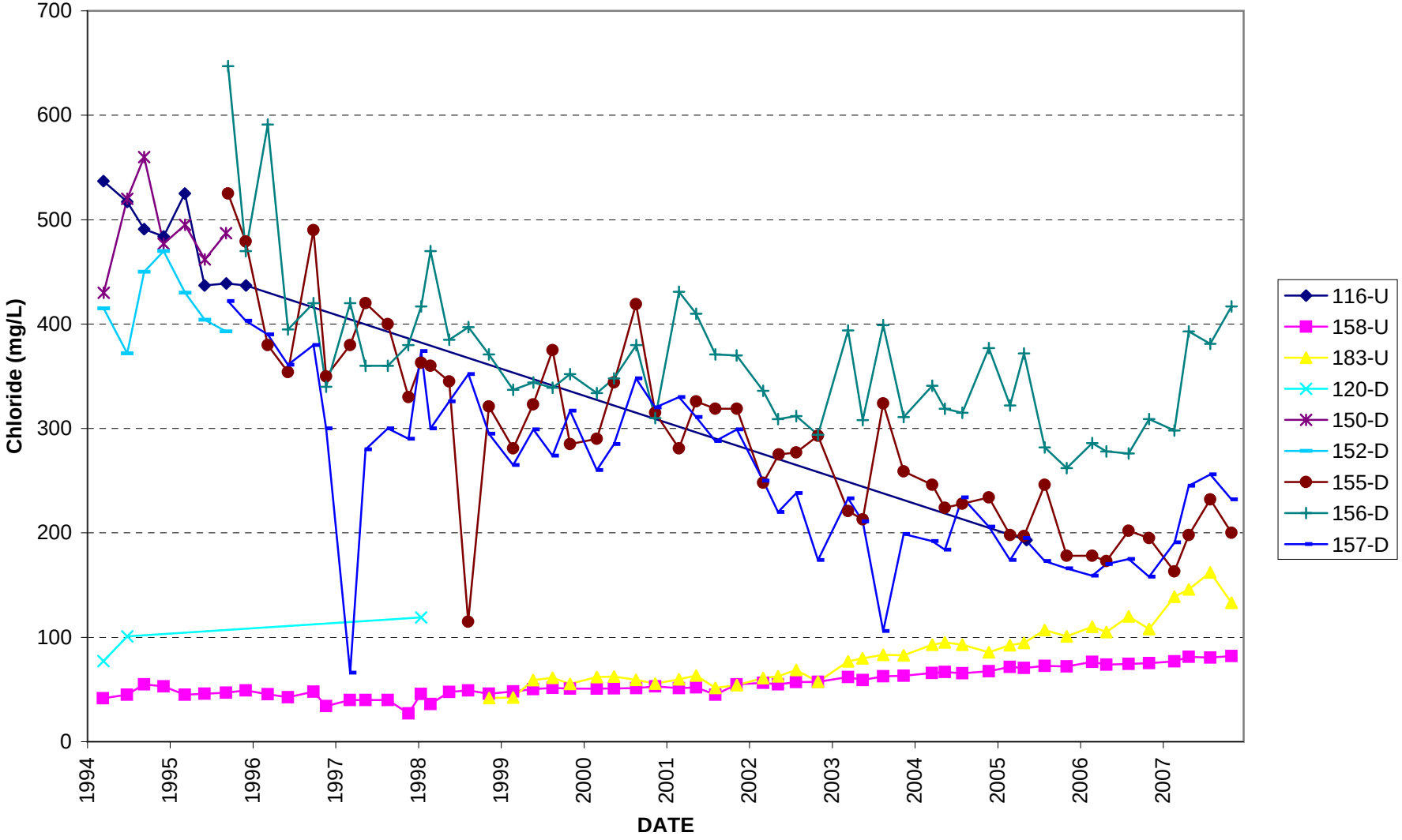


Figure 4.2-2C Sulfate Concentrations at Pond 8S Wells

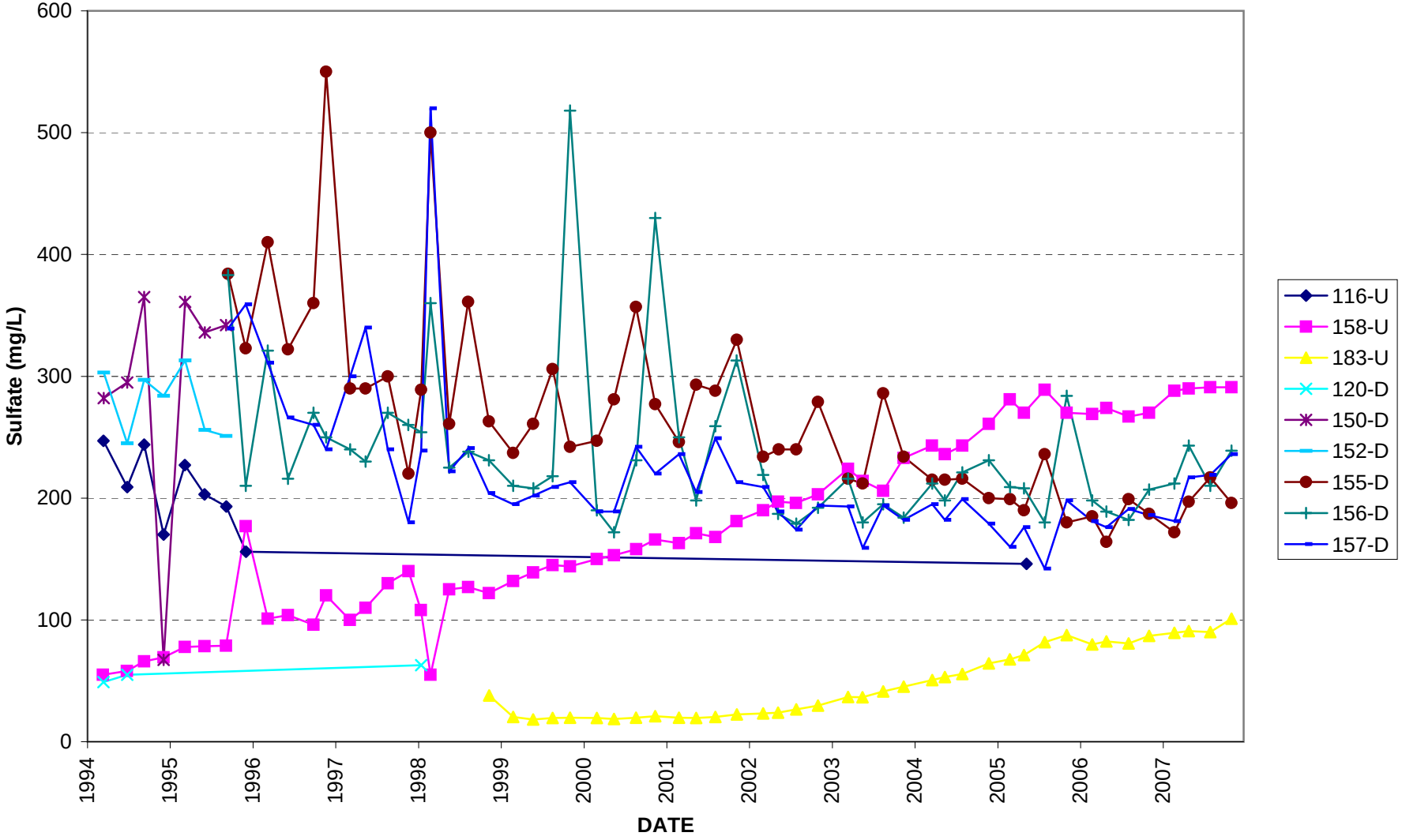


Figure 4.2-2D Arsenic Concentrations at Pond 8S Wells

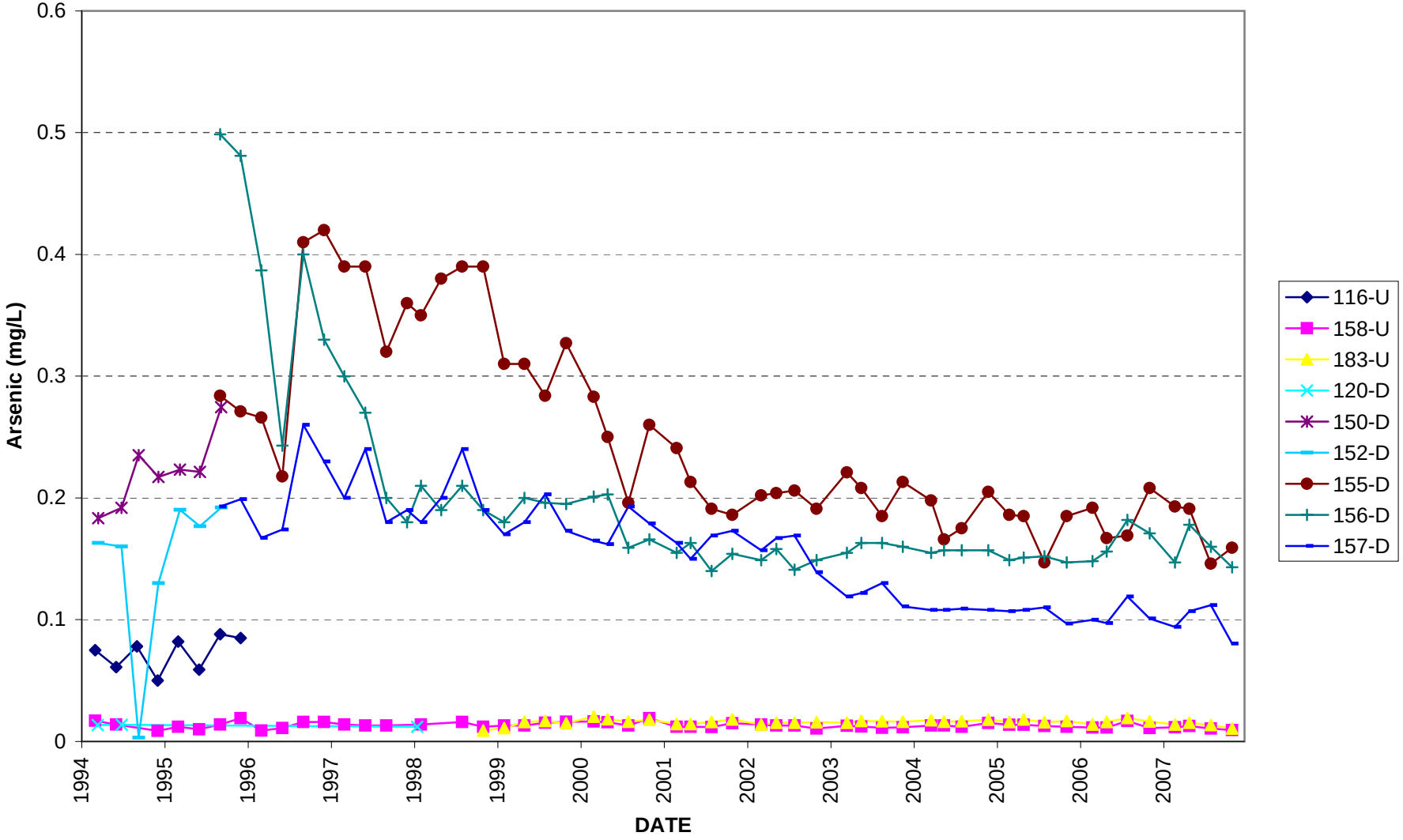


Figure 4.2-3A Potassium Concentrations at Pond 15S Wells

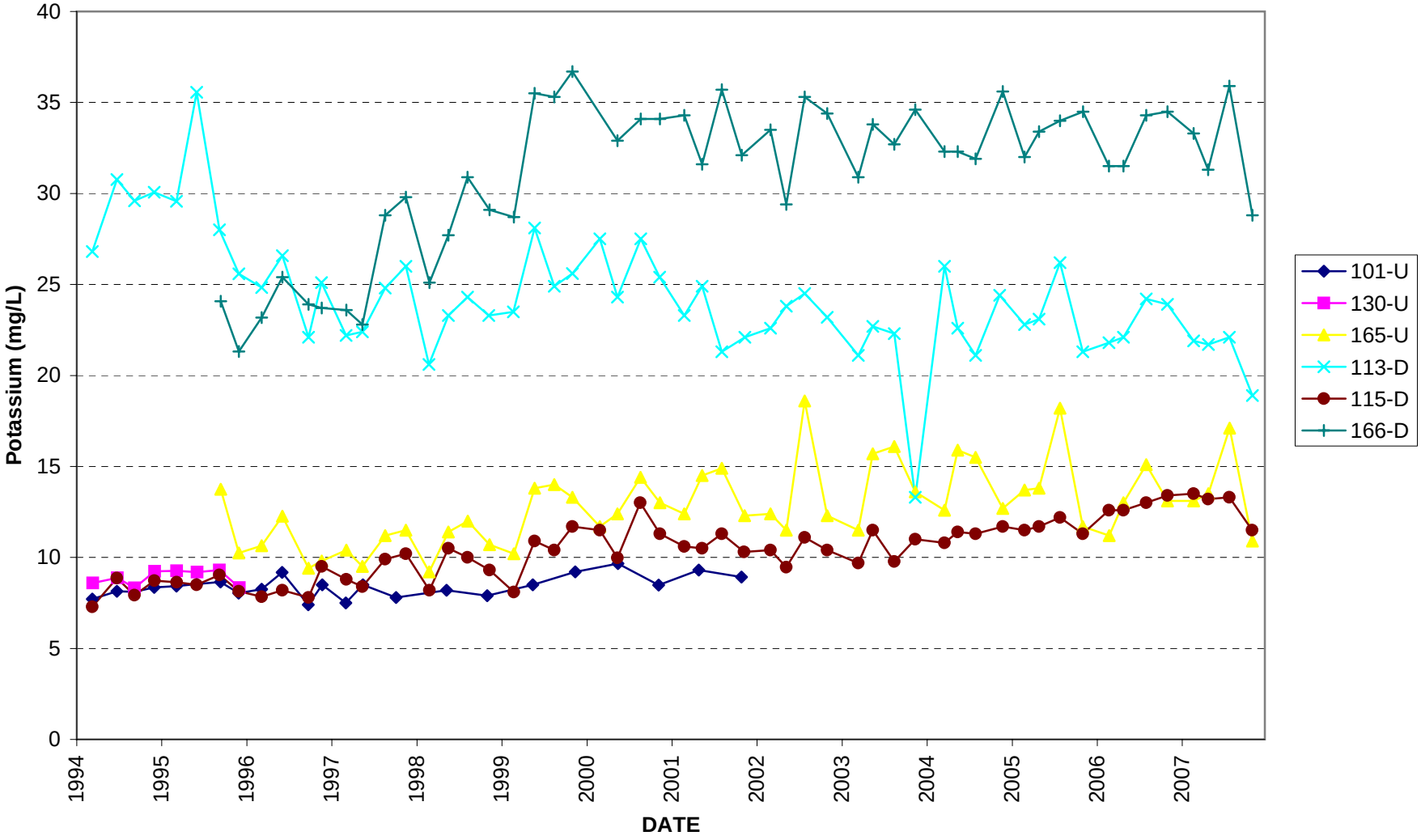


Figure 4.2-3B Chloride Concentrations at Pond 15S Wells

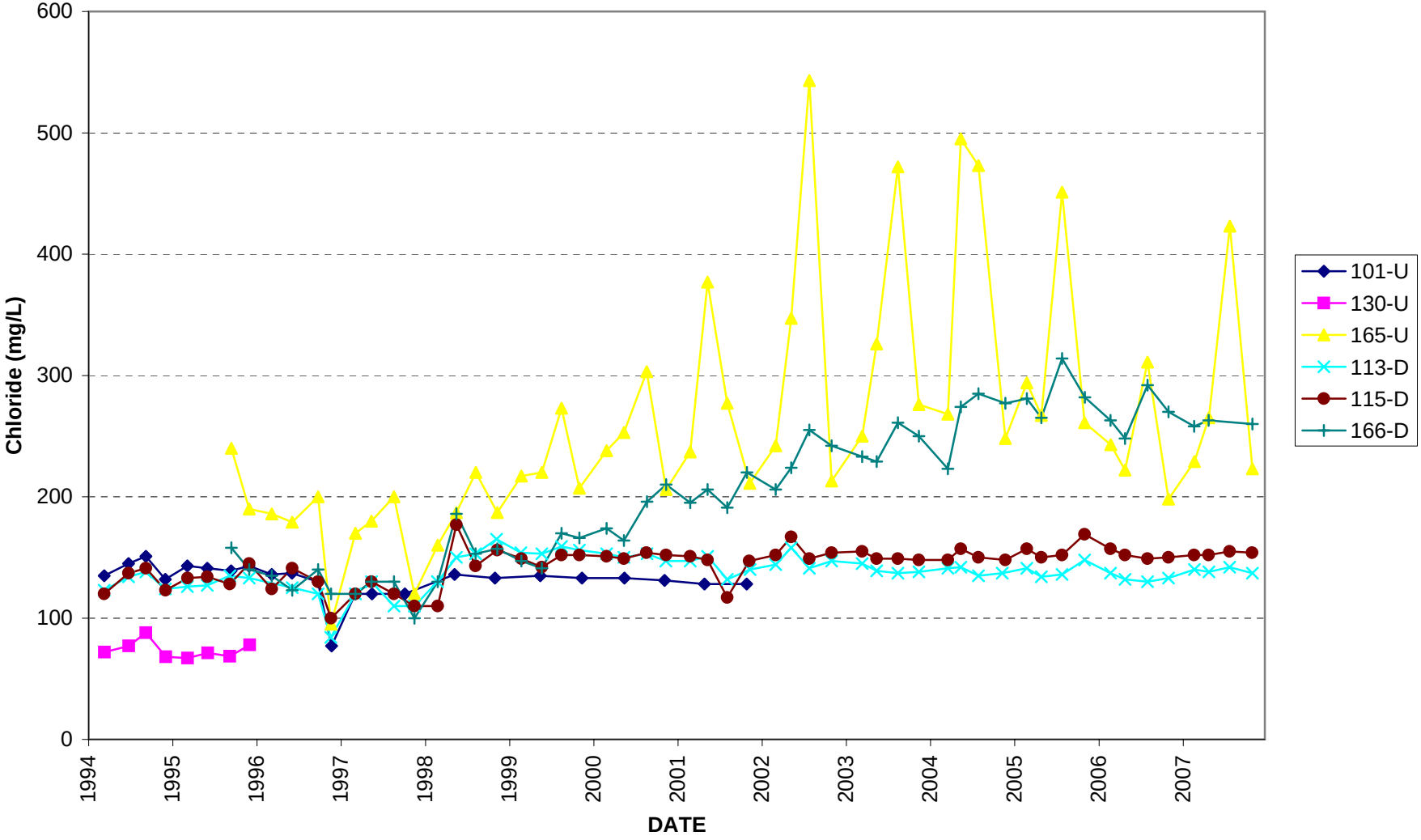


Figure 4.2-3C Sulfate Concentrations at Pond 15S Wells

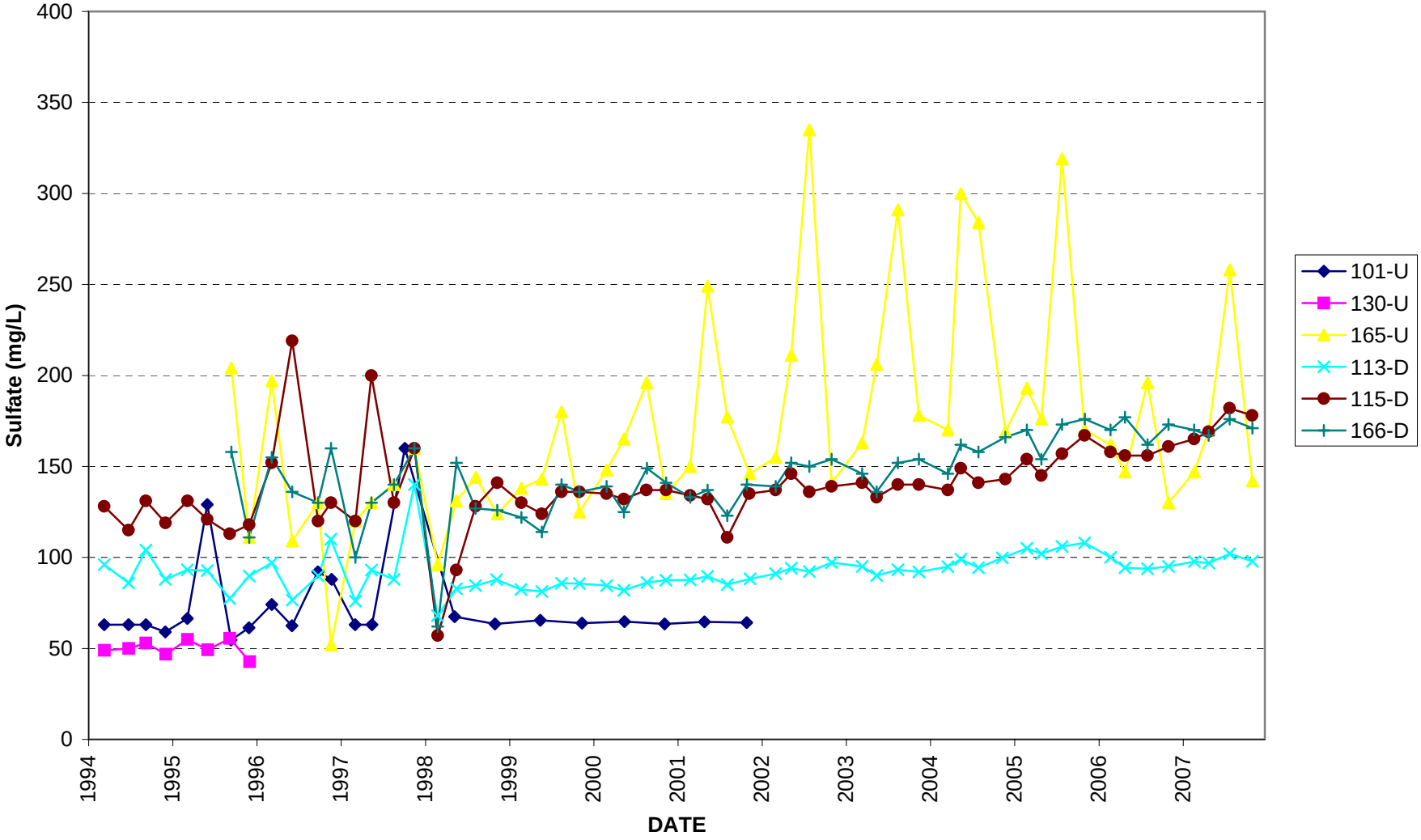


Figure 4.2-3D Arsenic Concentrations at Pond 15S Wells

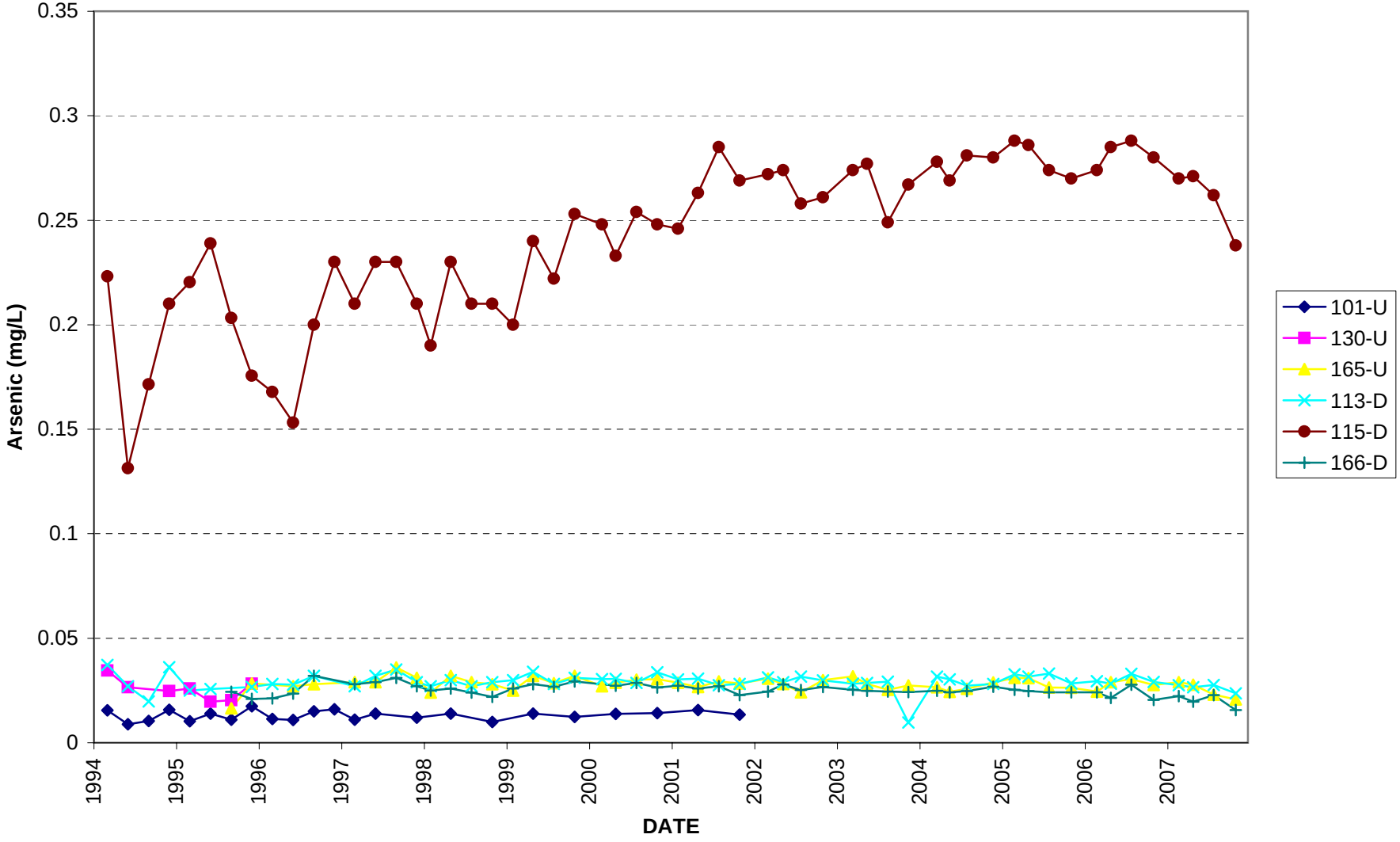


Figure 4.2-4A Potassium Concentrations at Phase IV ponds/Pond 8E Wells

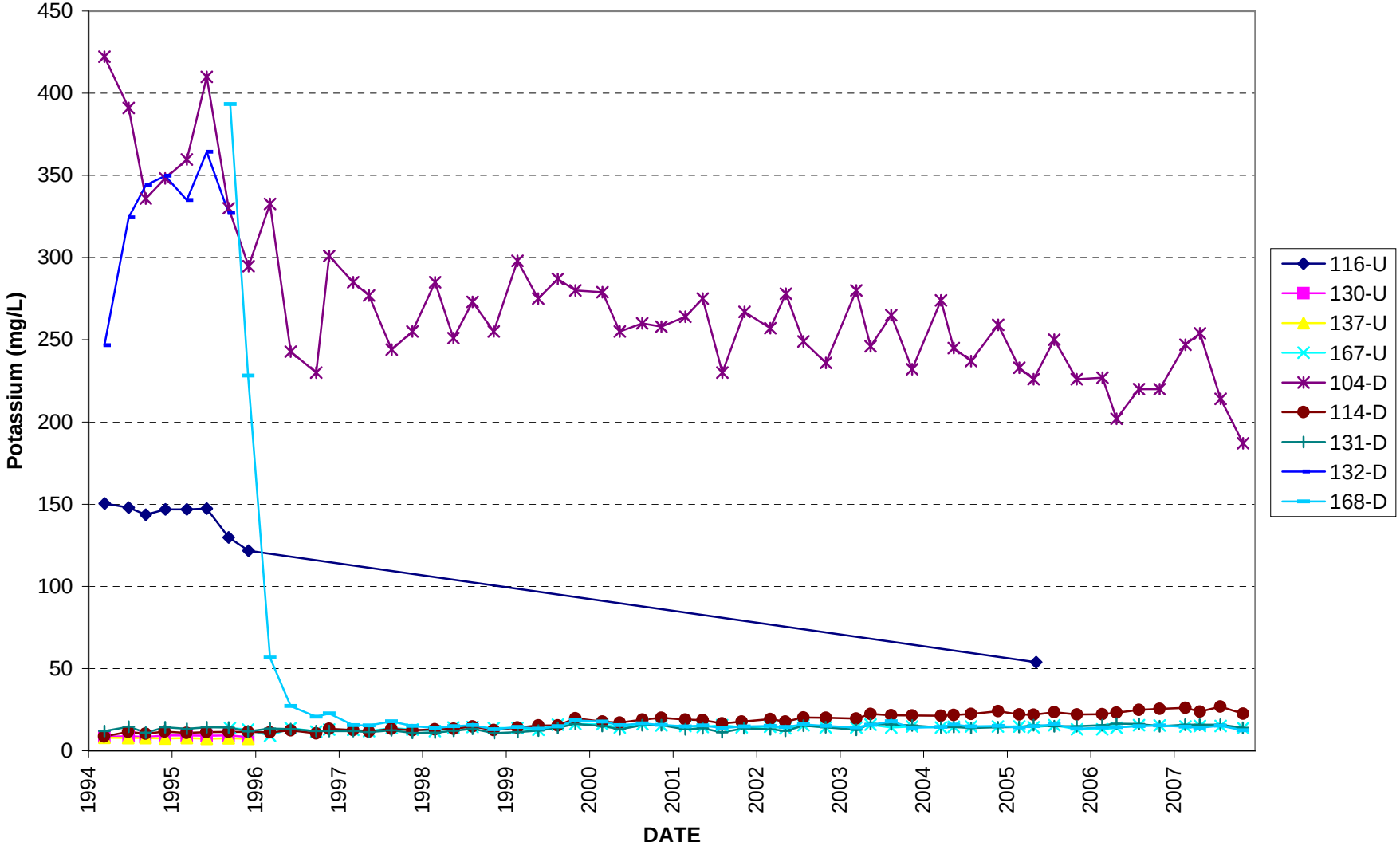


Figure 4.2-4B Chloride Concentrations at Phase IV ponds/Pond 8E Wells

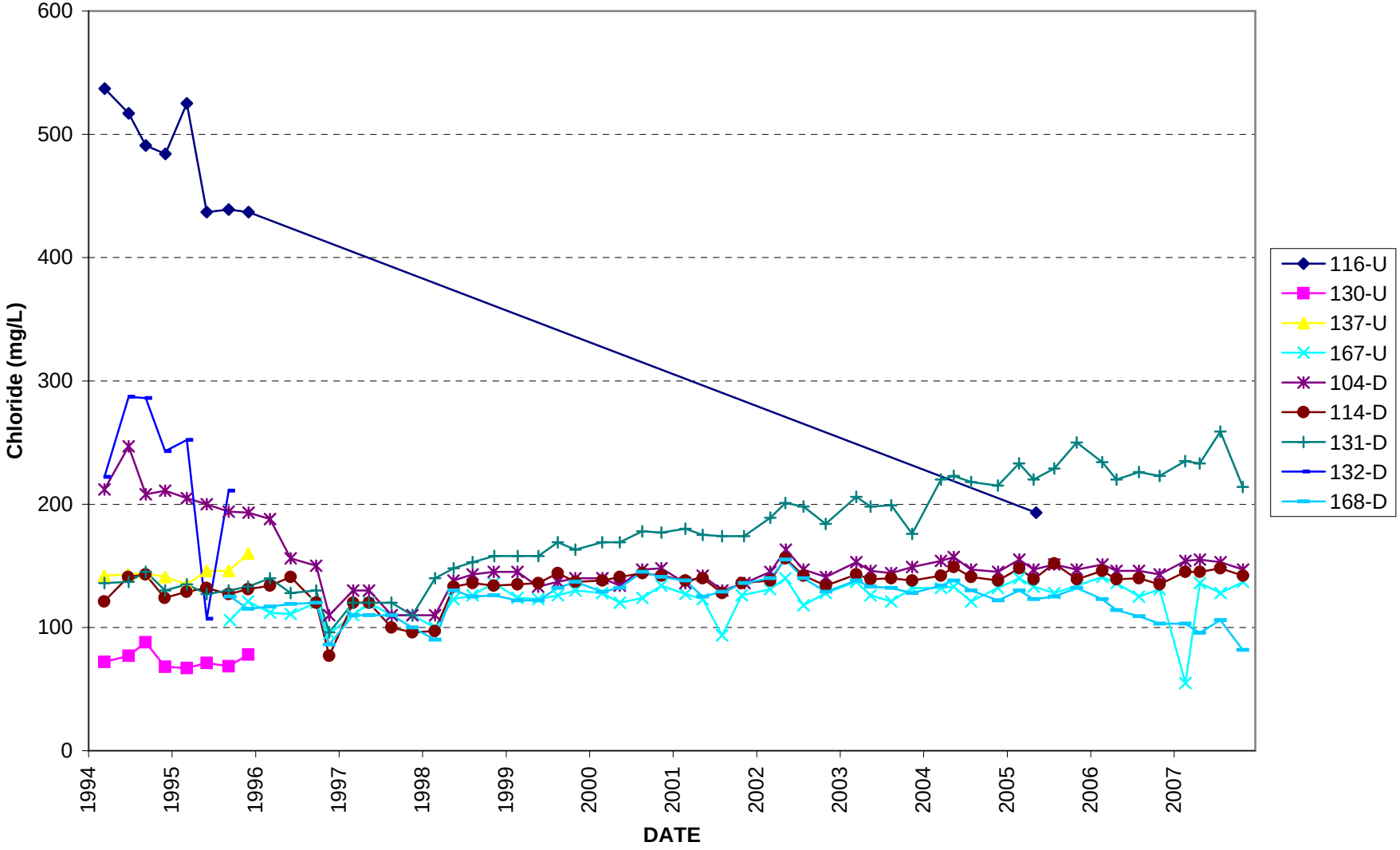


Figure 4.2-4C Sulfate Concentrations at Phase IV ponds/Pond 8E Wells

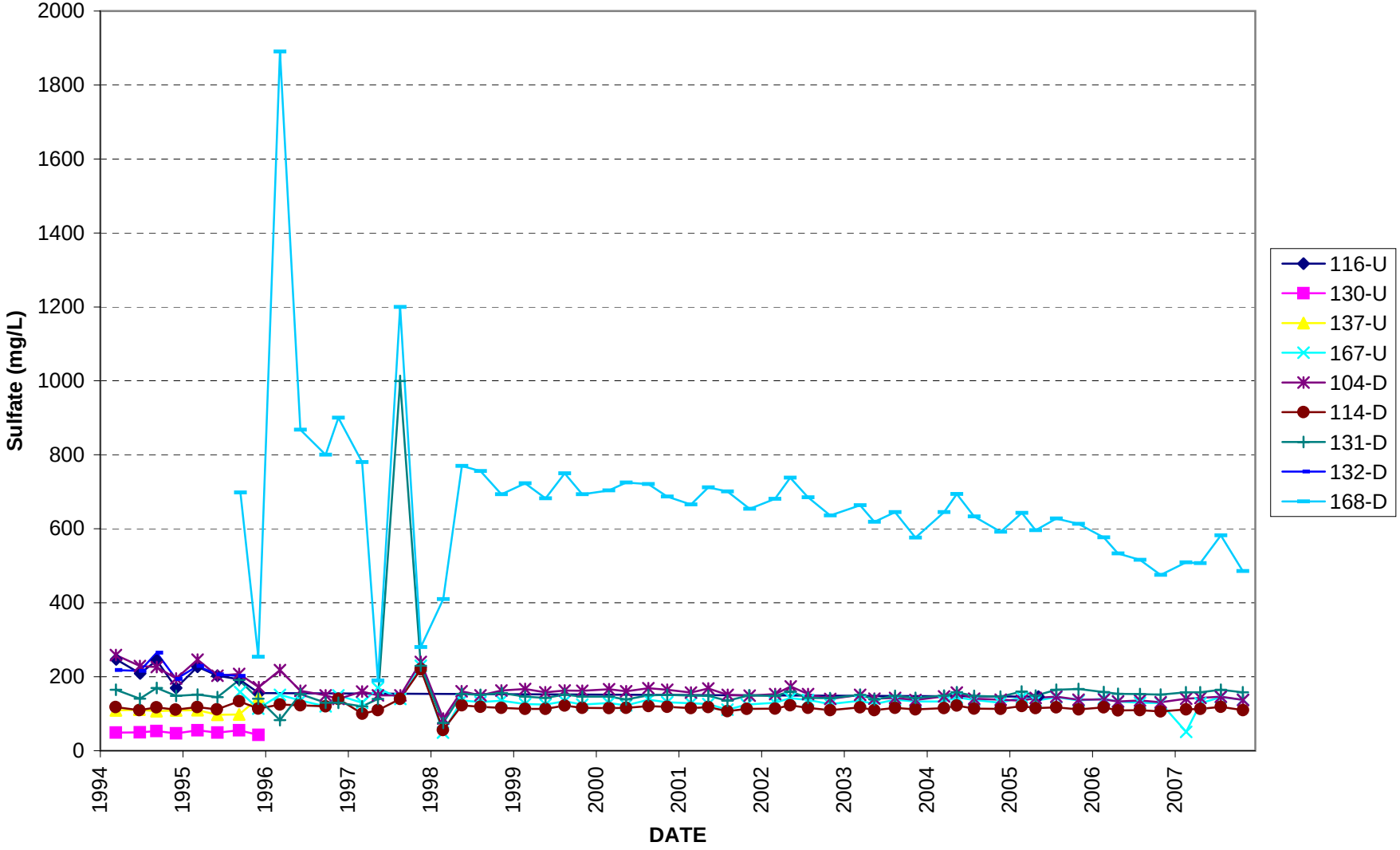


Figure 4.2-4D Arsenic Concentrations at Phase IV ponds/Pond 8E Wells

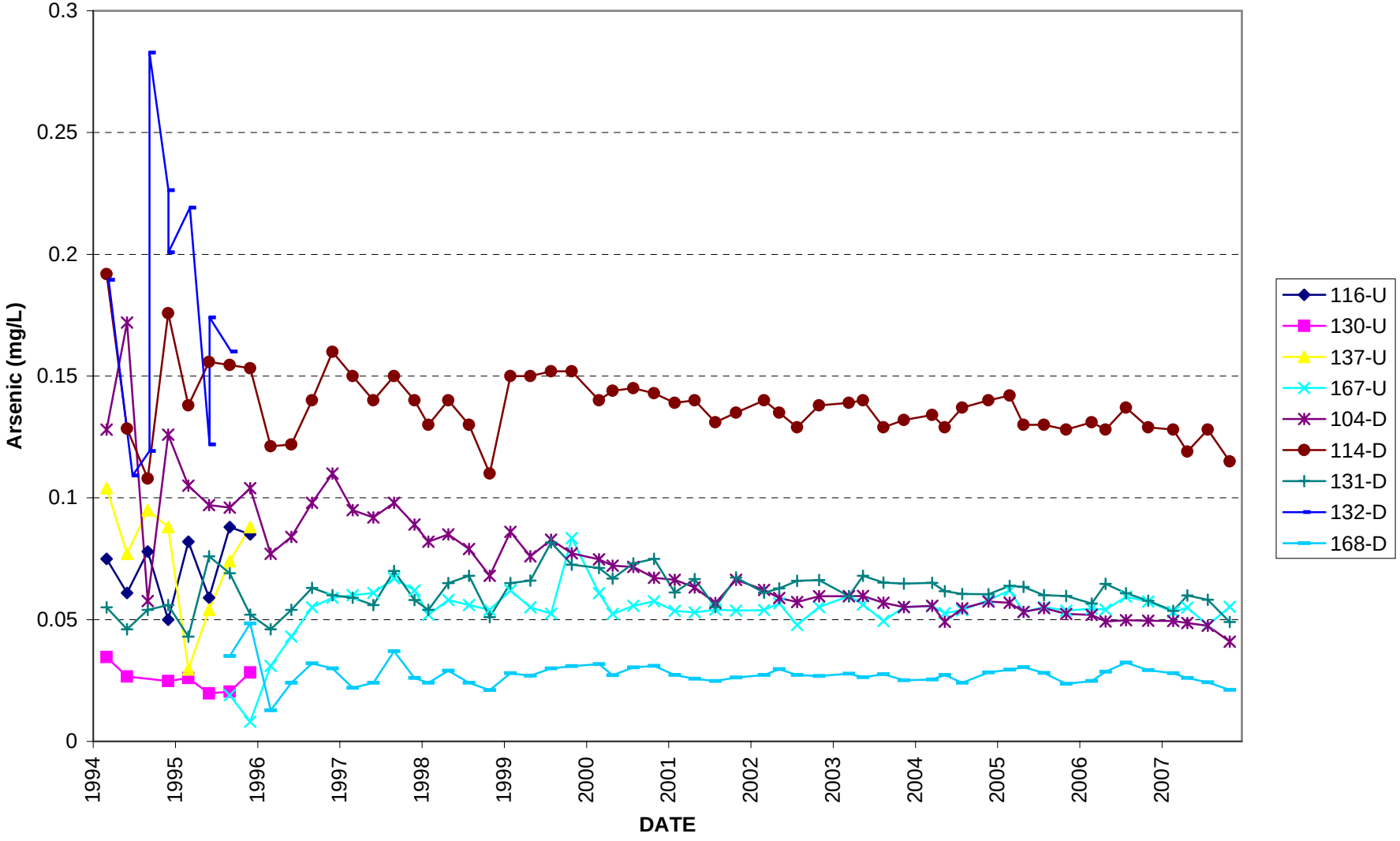


Figure 4.2-5A Potassium Concentrations at Pond 17 Wells

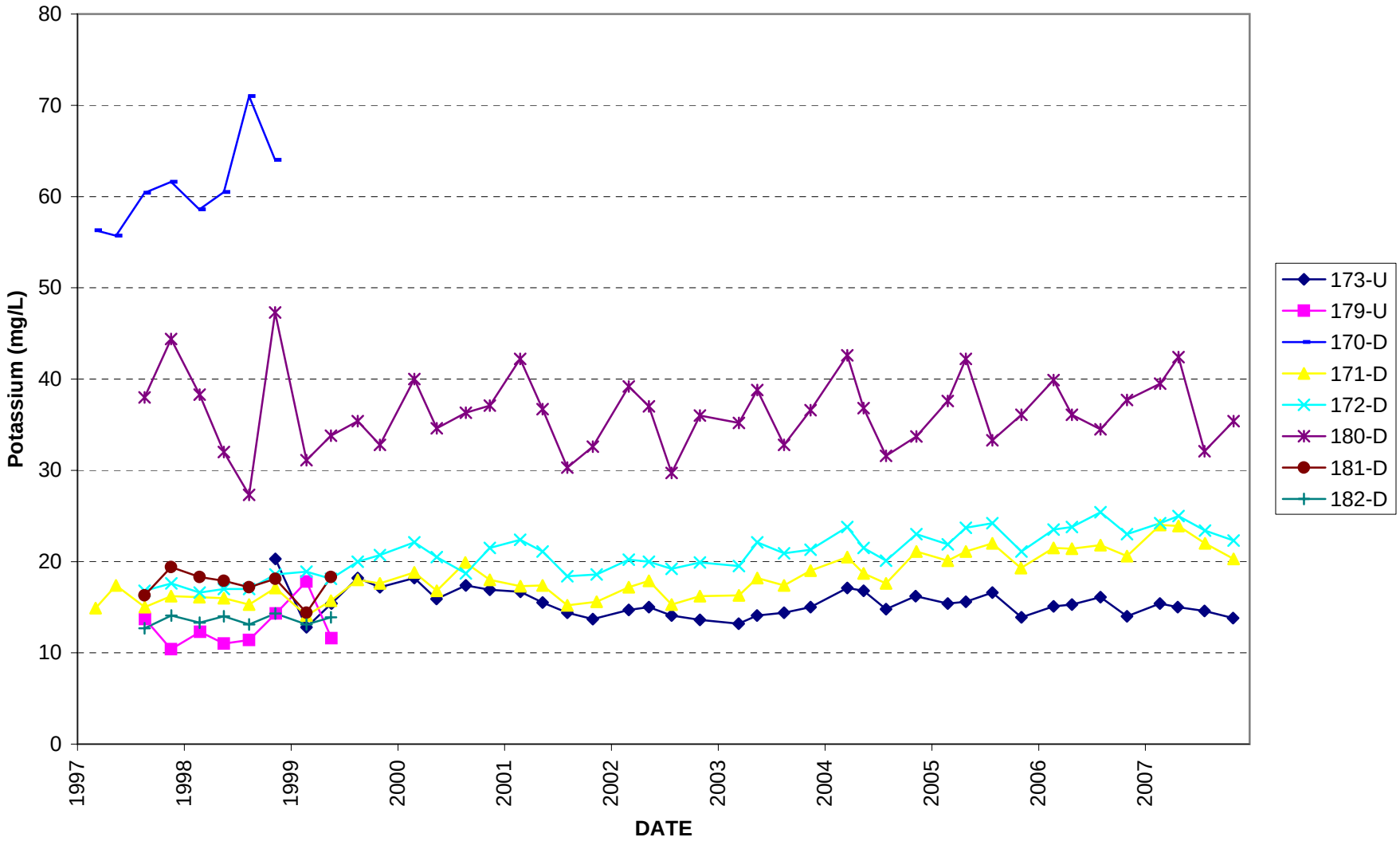


Figure 4.2-5B Chloride Concentrations at Pond 17 Wells

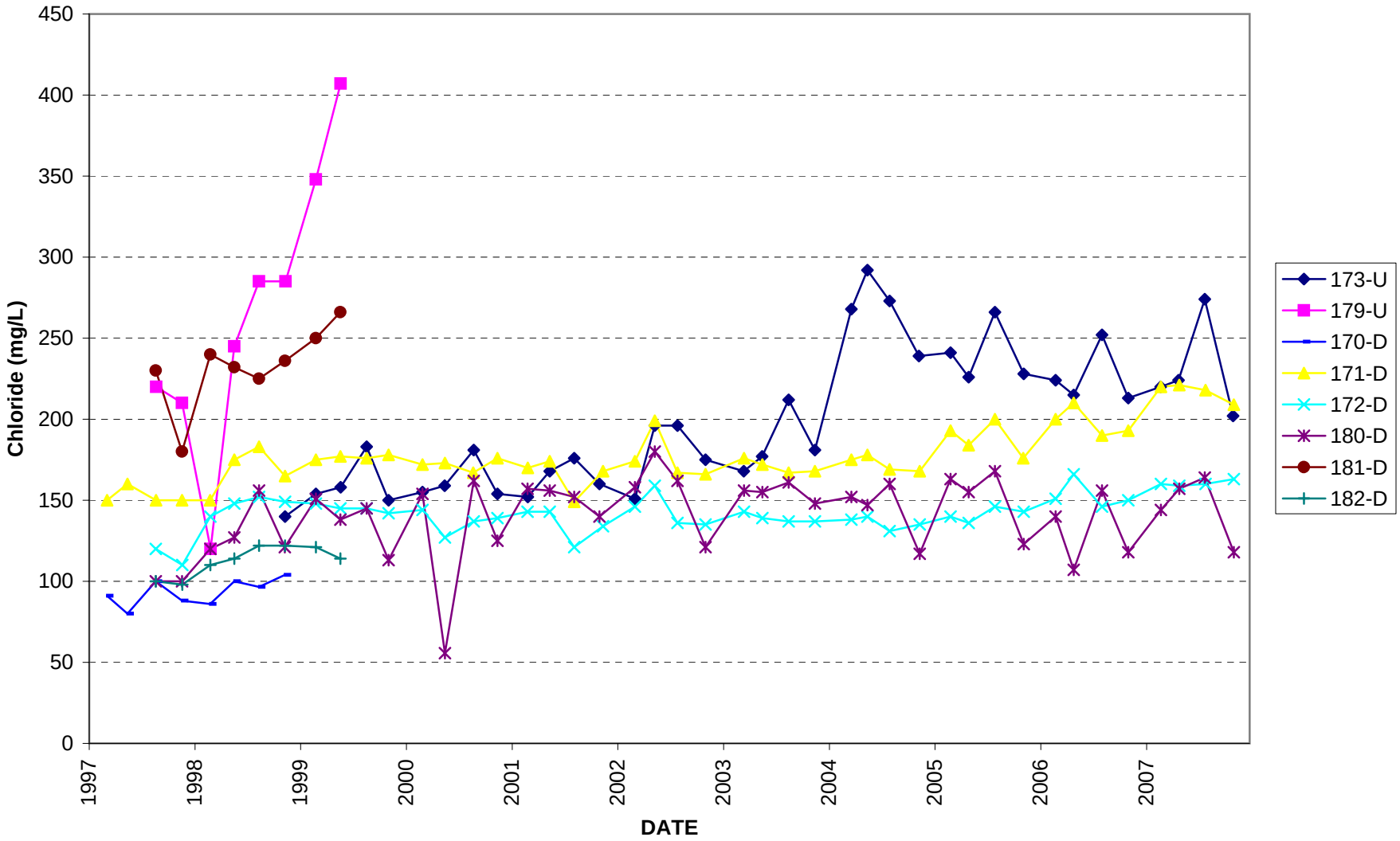


Figure 4.2-5C Sulfate Concentrations at Pond 17 Wells

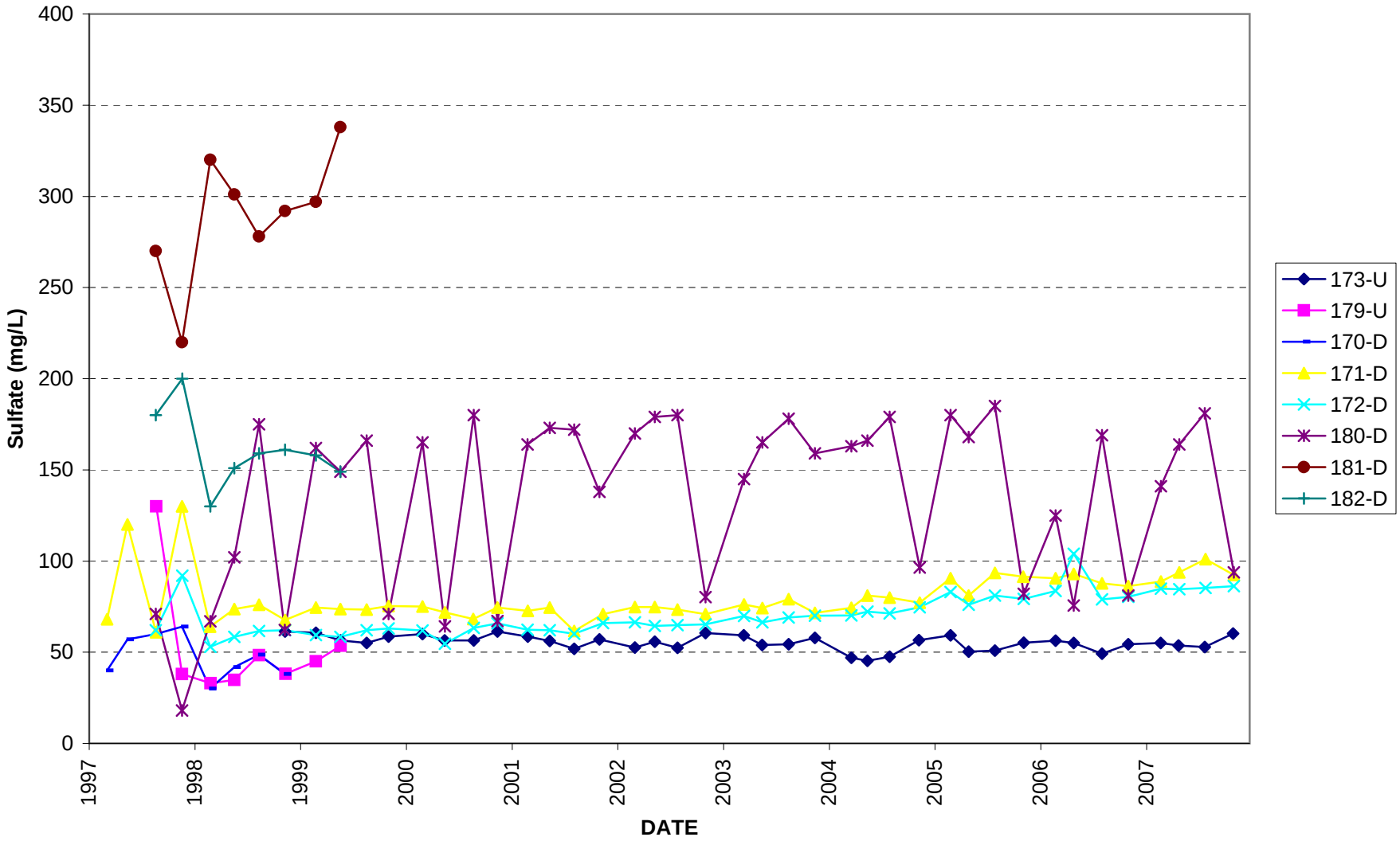
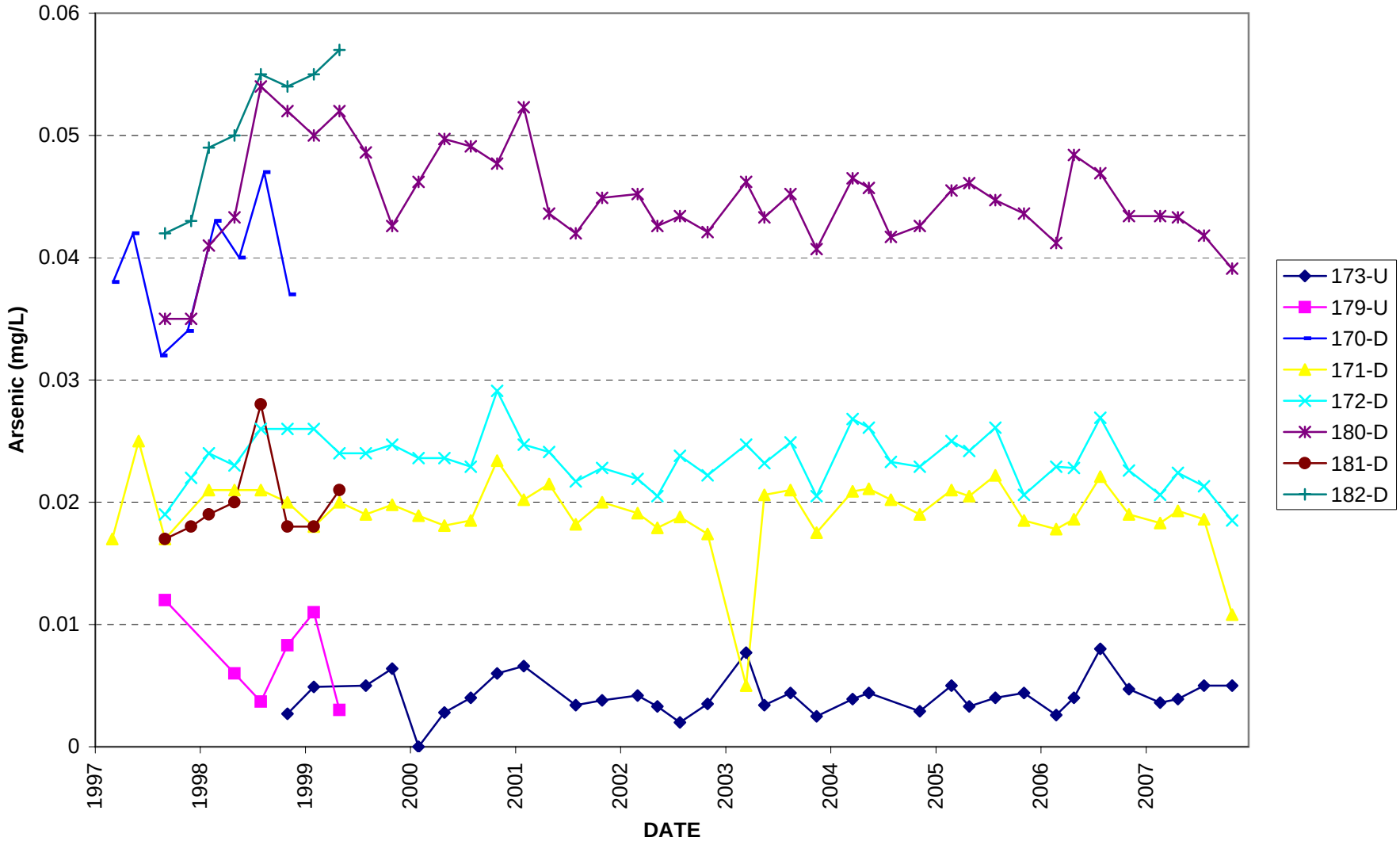
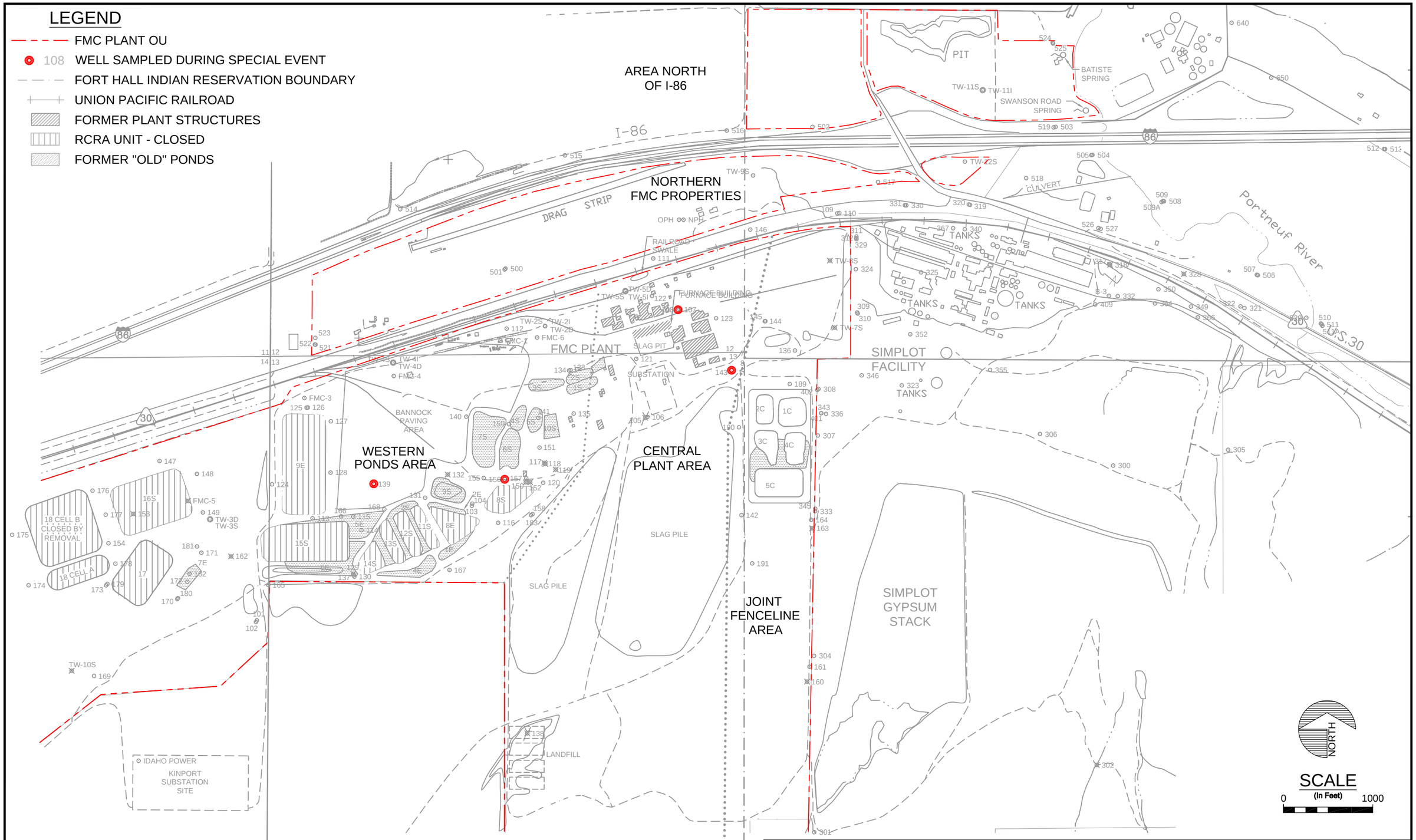


Figure 4.2-5D Arsenic Concentrations at Pond 17 Wells





FMC CORPORATION–POCATELLO, IDAHO
FMC PLANT OU GROUNDWATER
CURRENT CONDITIONS REPORT 2008

WELLS SAMPLED DURING NOVEMBER 1997 AND FEBRUARY 1998 SPECIAL MONITORING PROGRAM

FIGURE
4.2-6

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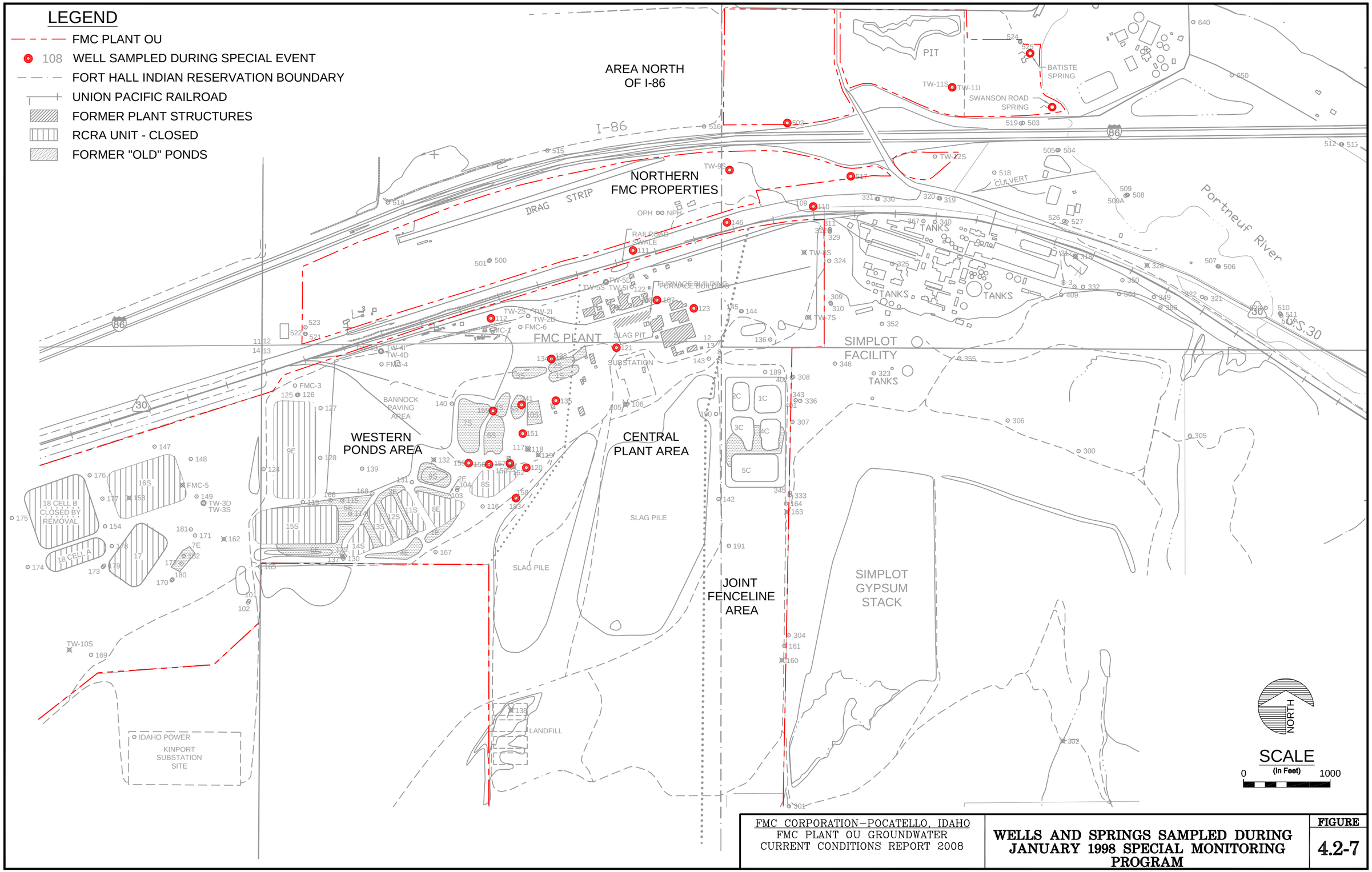
Consulting Scientists and Engineers



FMC CORPORATION–POCATELLO, IDAHO
FMC PLANT OU GROUNDWATER
CURRENT CONDITIONS REPORT 2008

WELLS AND SPRINGS SAMPLED DURING JANUARY 1998 SPECIAL MONITORING PROGRAM

FIGURE
4.2-7

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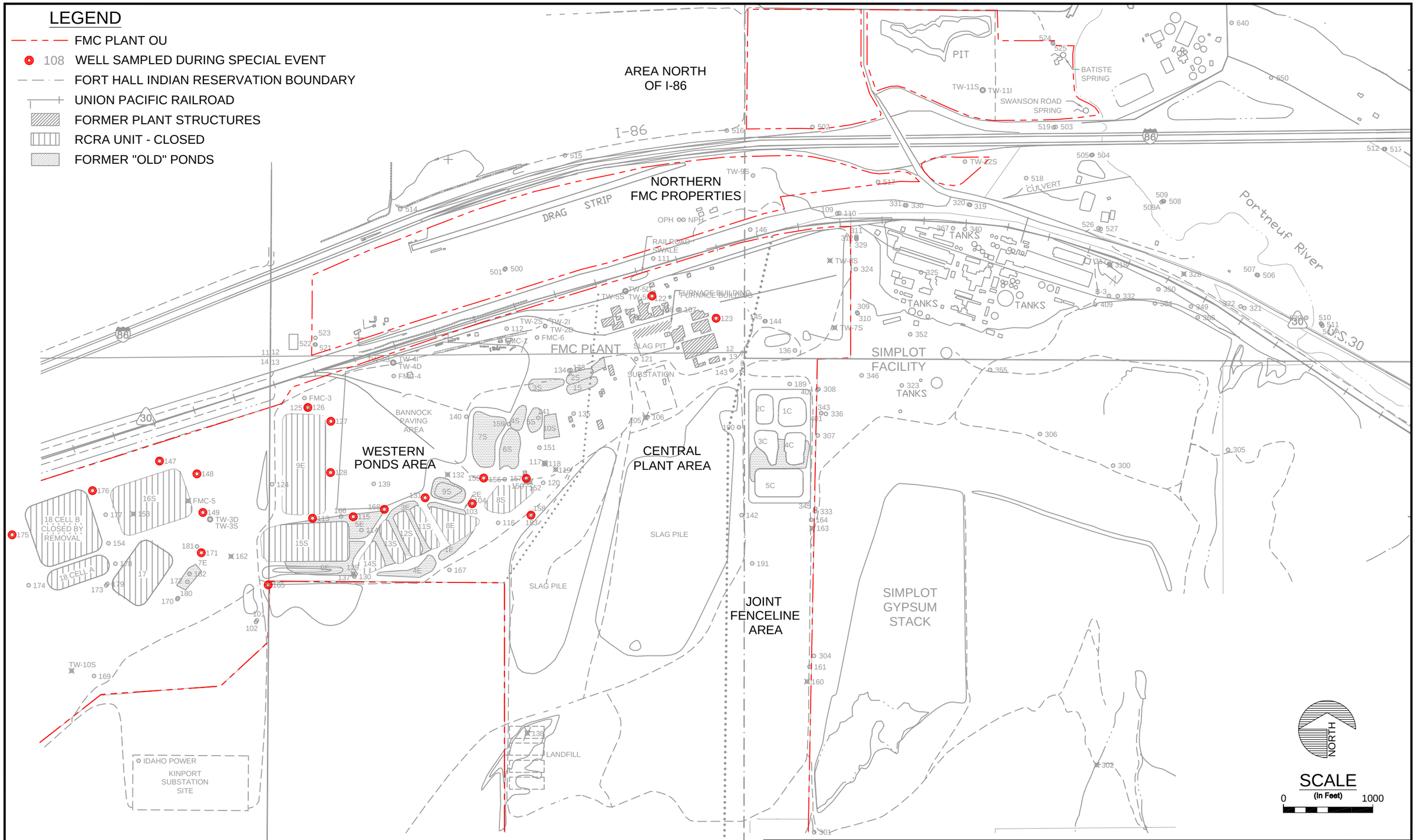

FMC CORPORATION–POCATELLO, IDAHO
FMC PLANT OU GROUNDWATER
CURRENT CONDITIONS REPORT 2008

WELLS SAMPLED DURING AUGUST 2000 SPECIAL MONITORING PROGRAM

FIGURE 4.2-8

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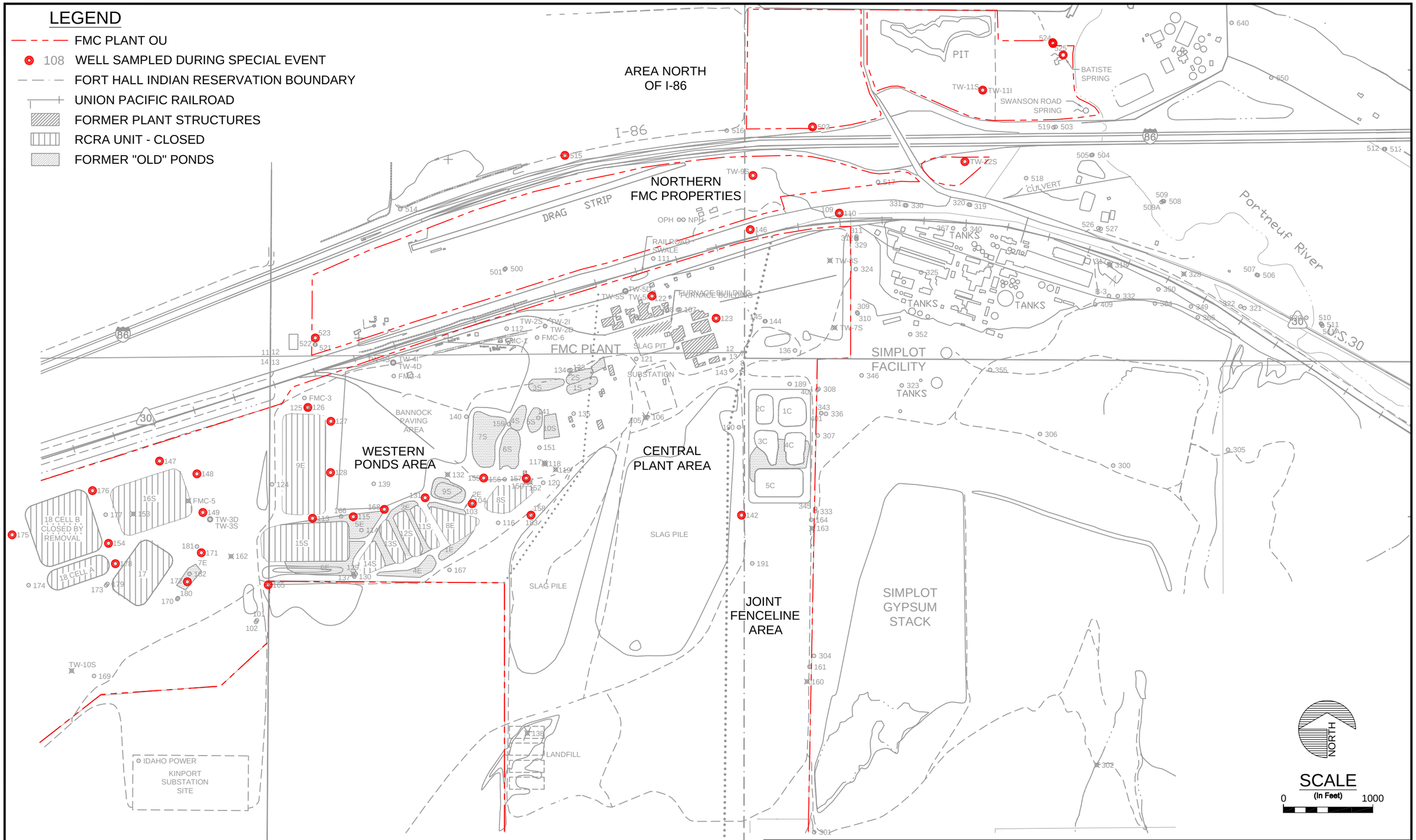

FMC CORPORATION–POCATELLO, IDAHO
FMC PLANT OU GROUNDWATER
CURRENT CONDITIONS REPORT 2008

WELLS SAMPLED DURING NOVEMBER 2001 SPECIAL MONITORING PROGRAM

FIGURE 4.2-9

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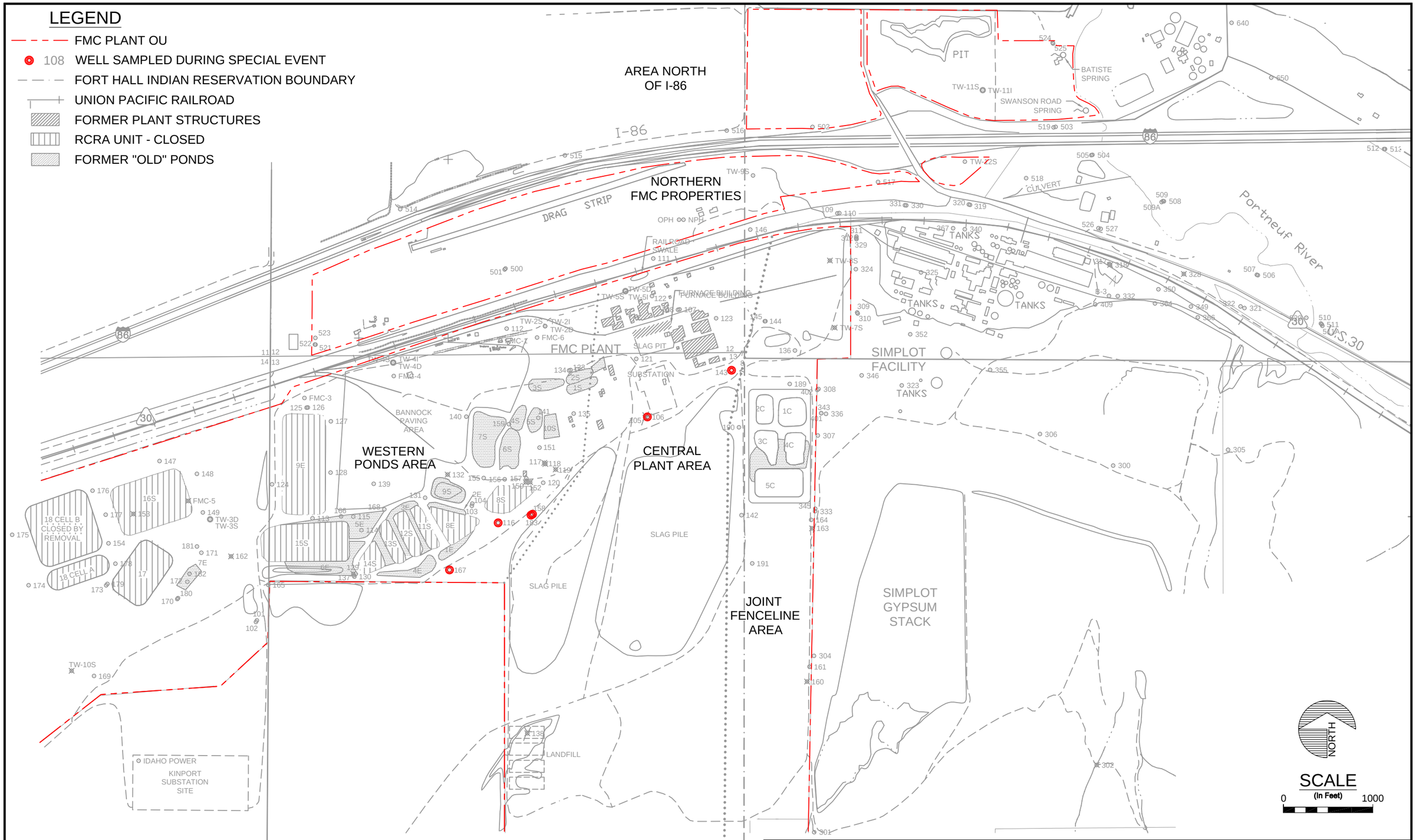
Consulting Scientists and Engineers



FMC CORPORATION–POCATELLO, IDAHO
FMC PLANT OU GROUNDWATER
CURRENT CONDITIONS REPORT 2008

WELLS SAMPLED DURING MAY 2005 SPECIAL MONITORING PROGRAM

FIGURE
4.2-10

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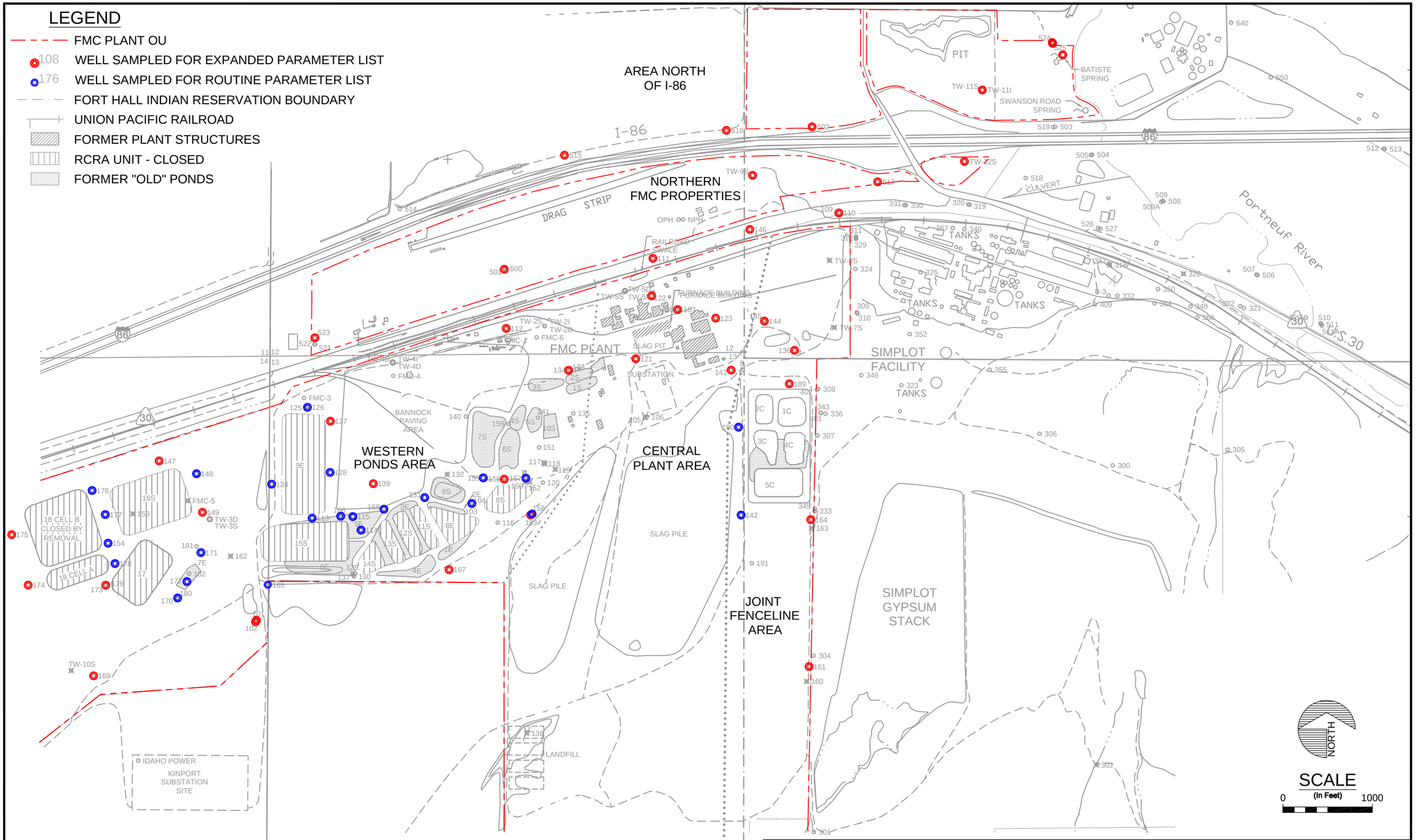
Consulting Scientists and Engineers



FMC CORPORATION–POCATELLO, IDAHO
FMC PLANT OU GROUNDWATER
CURRENT CONDITIONS REPORT 2008

WELLS AND SPRINGS SAMPLED DURING MAY 2008 SPECIAL MONITORING PROGRAM

FIGURE
4.2-11

UPDATE TIME: 4:46PM
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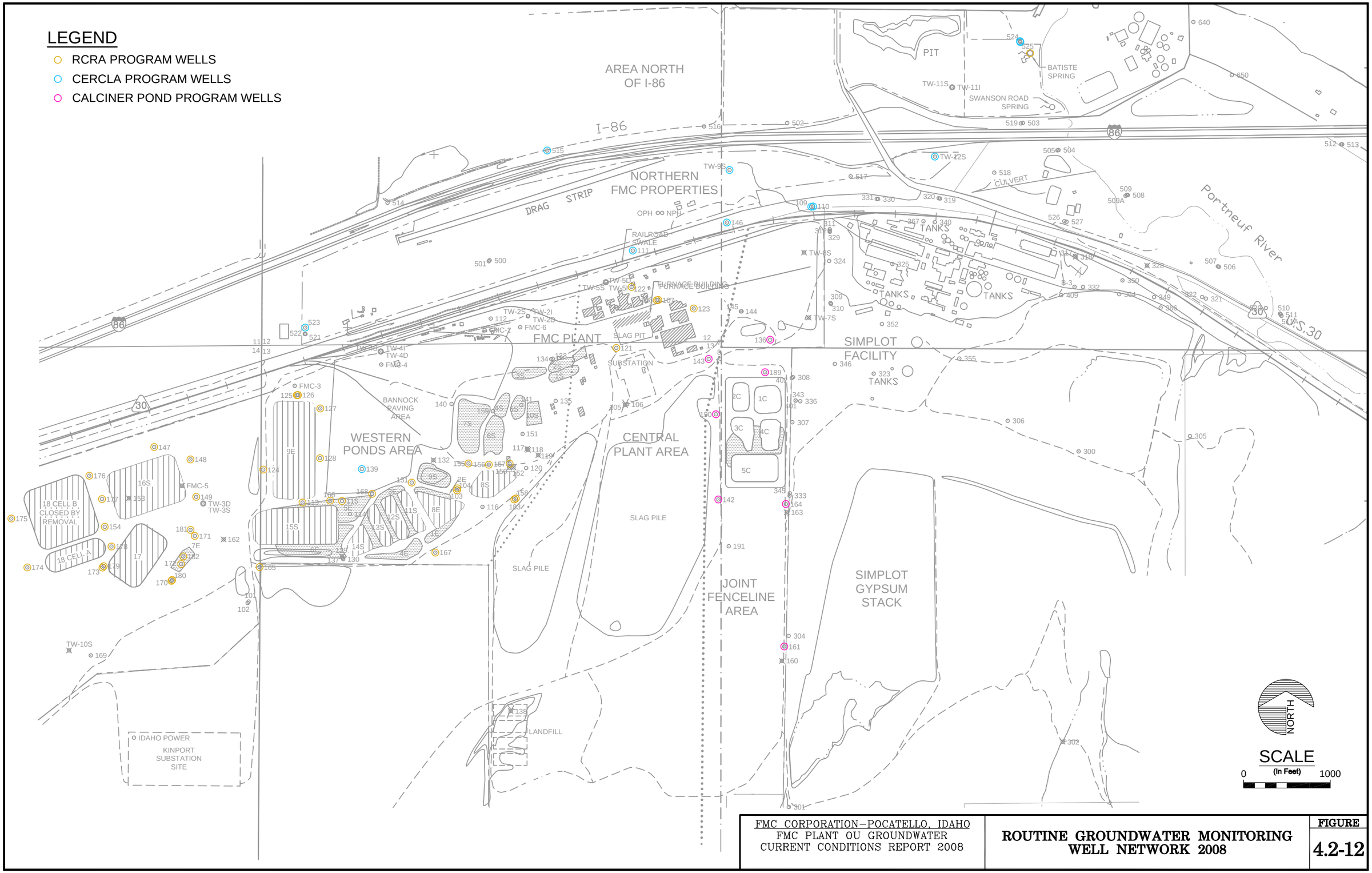
Consulting Scientists and Engineers



FMC CORPORATION–POCATELLO, IDAHO
FMC PLANT OU GROUNDWATER
CURRENT CONDITIONS REPORT 2008

ROUTINE GROUNDWATER MONITORING WELL NETWORK 2008

FIGURE
4.2-12

UPDATE TIME: 4:28PM
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Hydrometrics, Inc.
Consulting Scientists and Engineers

Figure 4.2-13A

Box Plot for Potassium (Data through 2007)

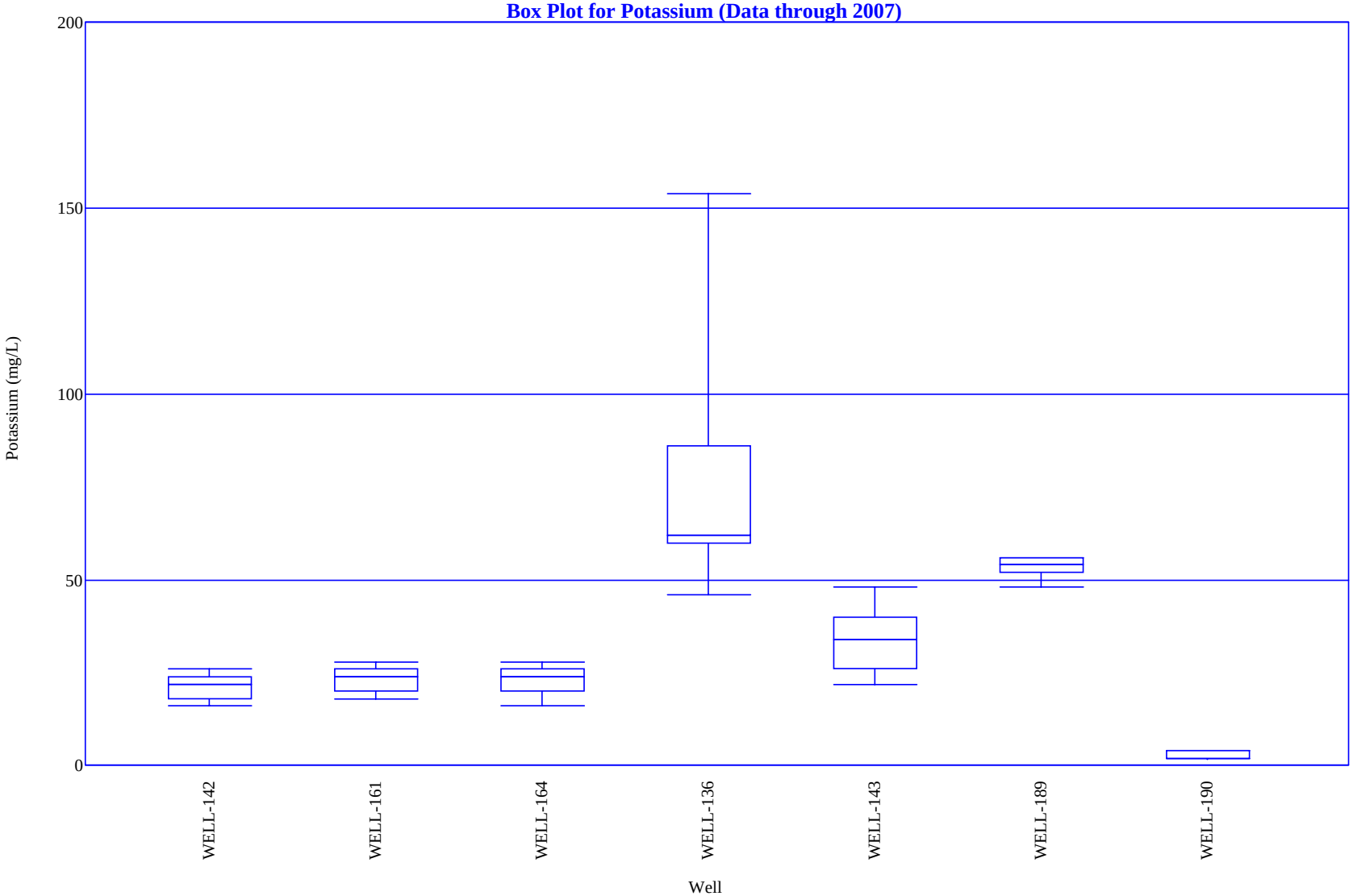


Figure 4.2-13B

Box Plot for Sulfate (Data through 2007)

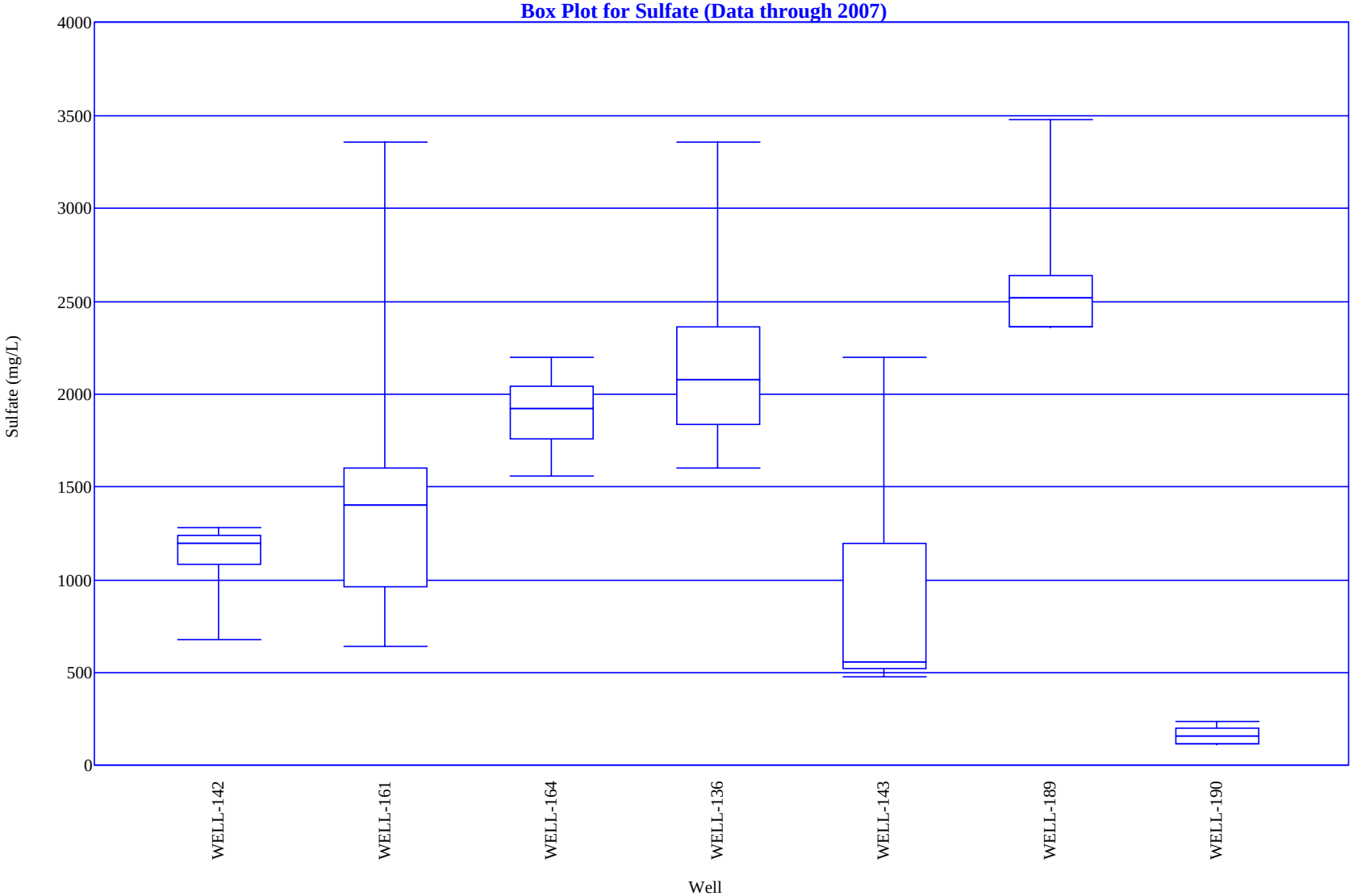


Figure 4.2-13C

Box Plot for Orthophosphate (Data through 2007)

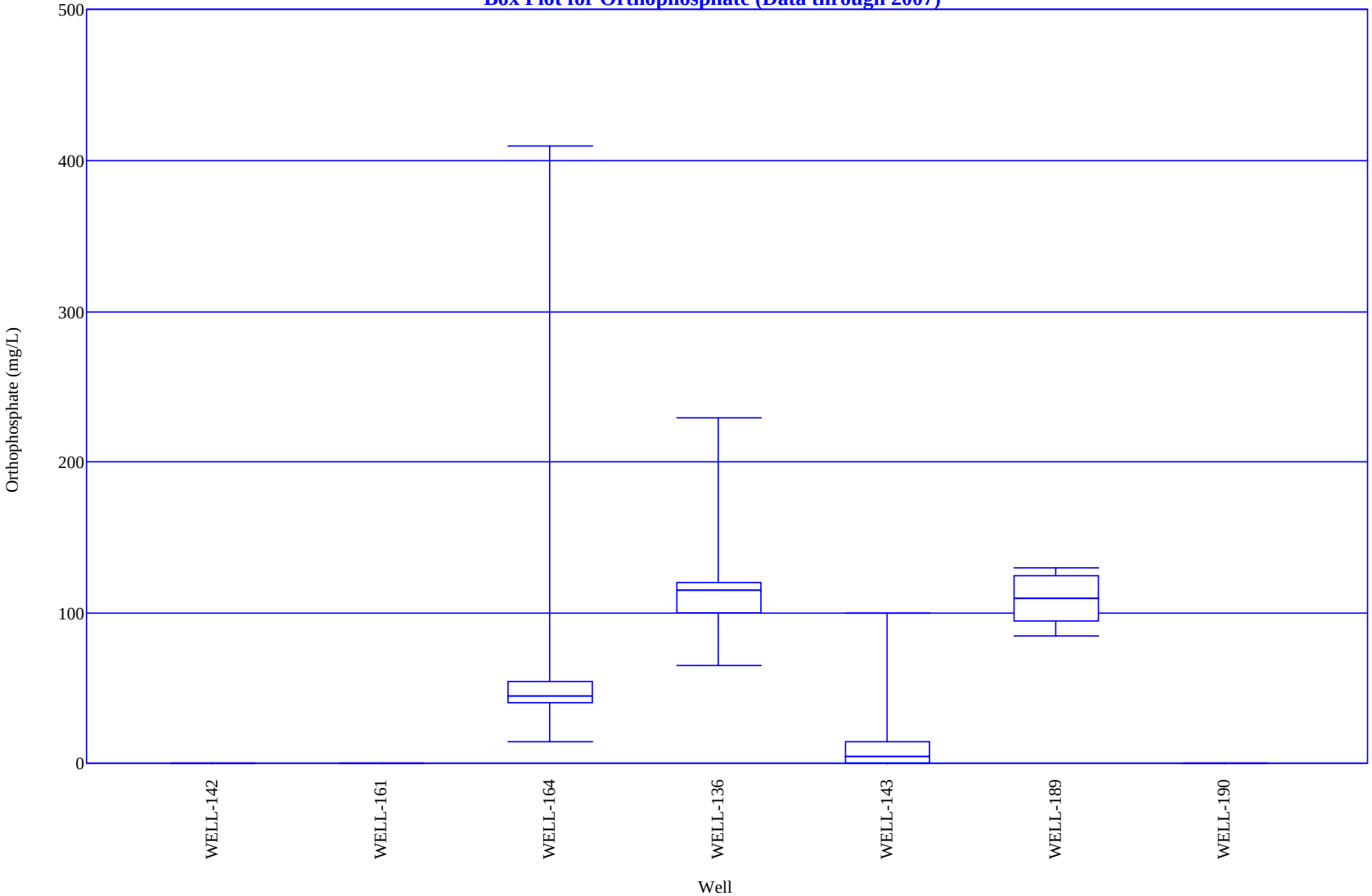


Figure 4.2-13D

Box Plot for Total Arsenic (Data through 2007)

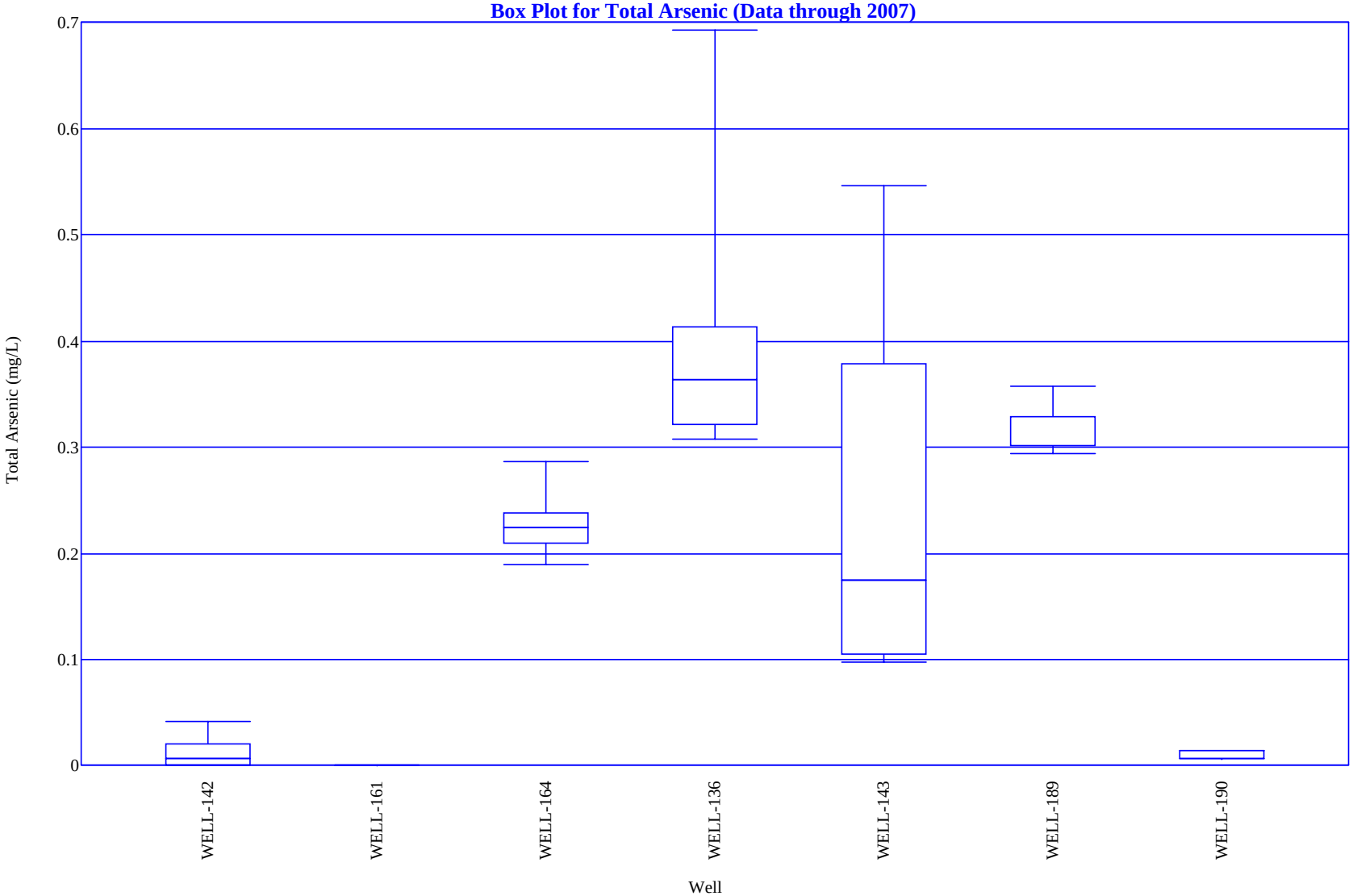
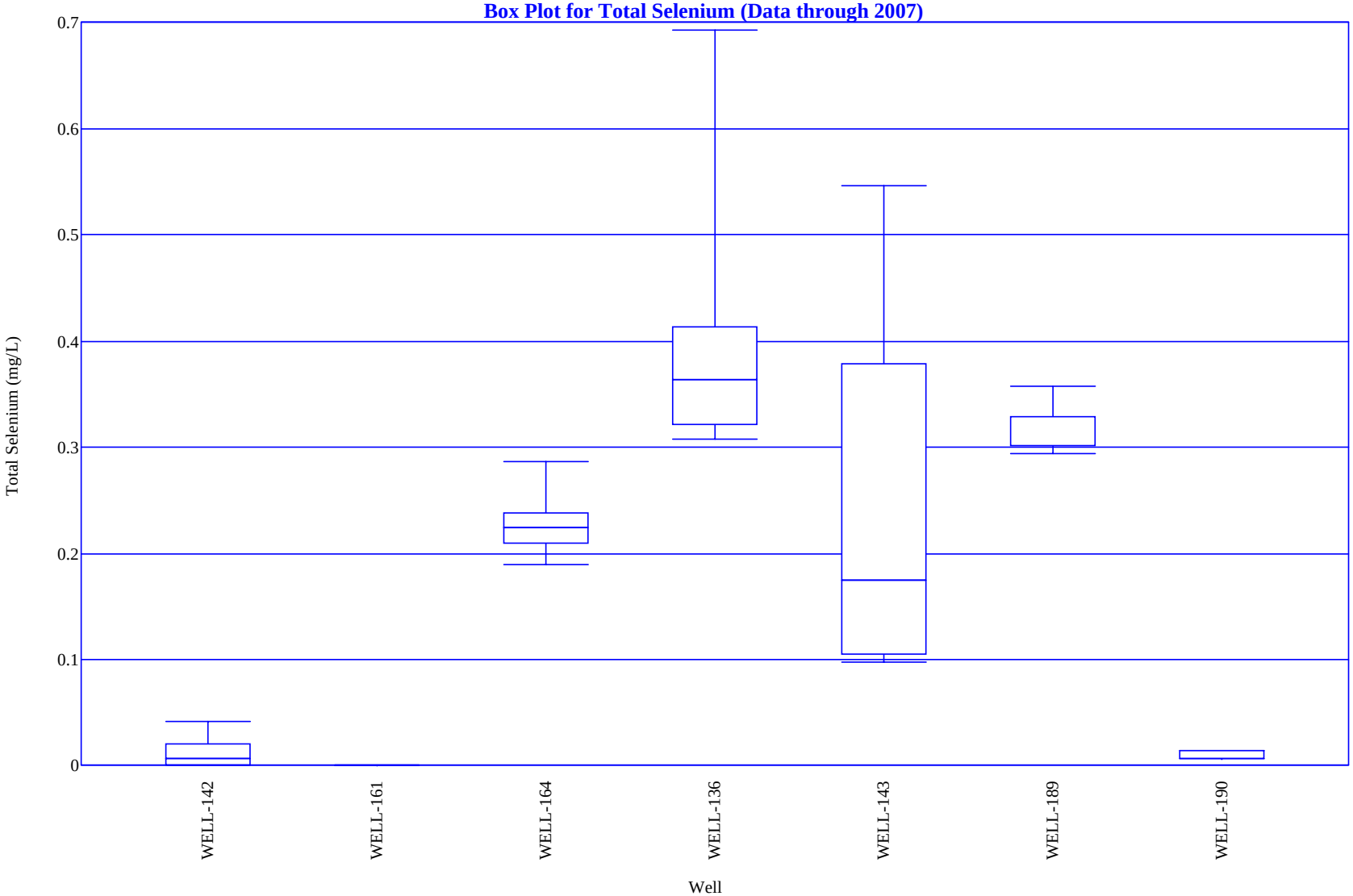
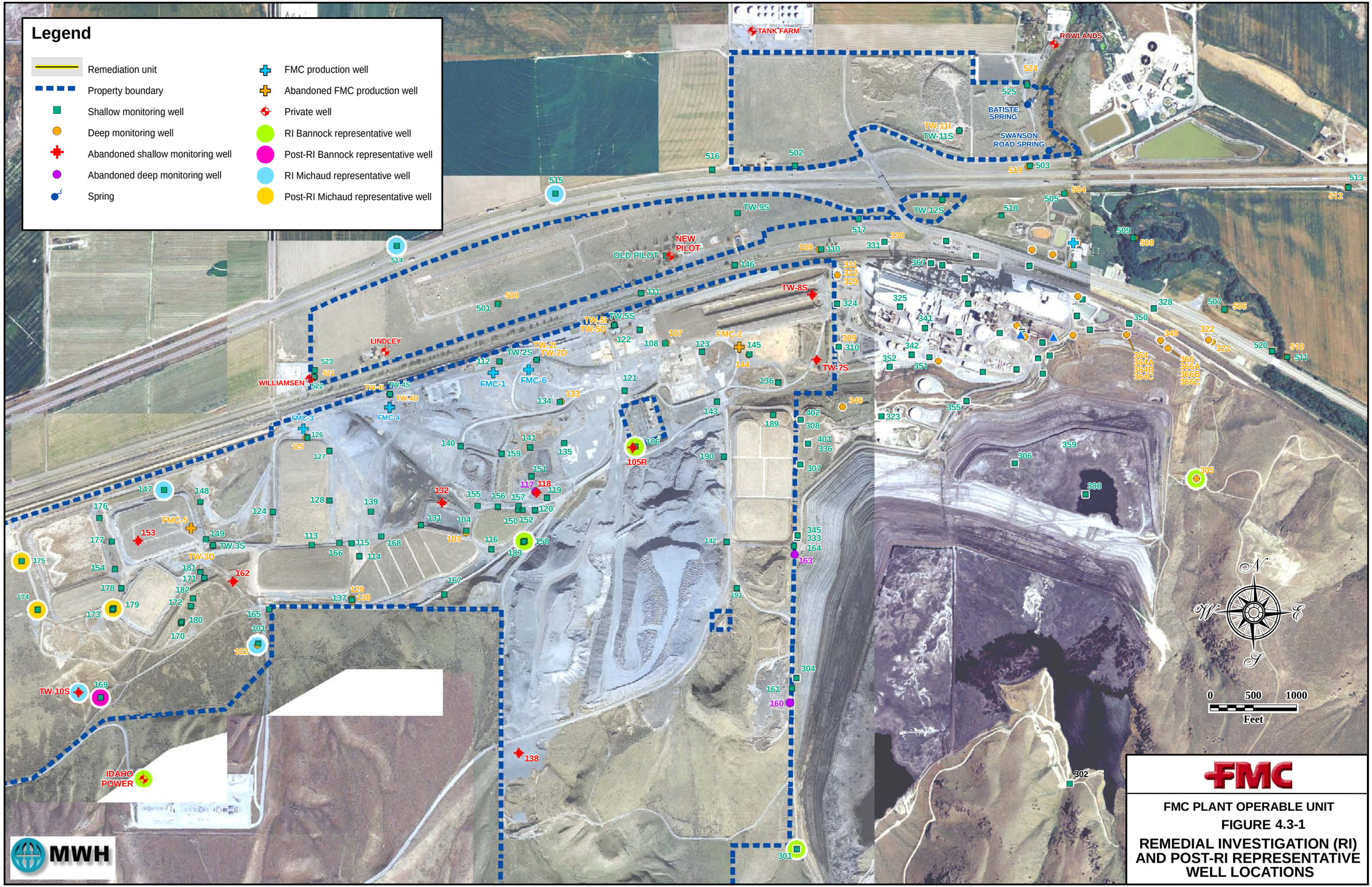


Figure 4.2-13E

Box Plot for Total Selenium (Data through 2007)





FILE Fig 1_FMC_RI_Post_WellLocations_7_3_08.mxd 7/3/08

Figure 4.3-2 Total Phosphorus and Orthophosphate at Wells 101 and 102

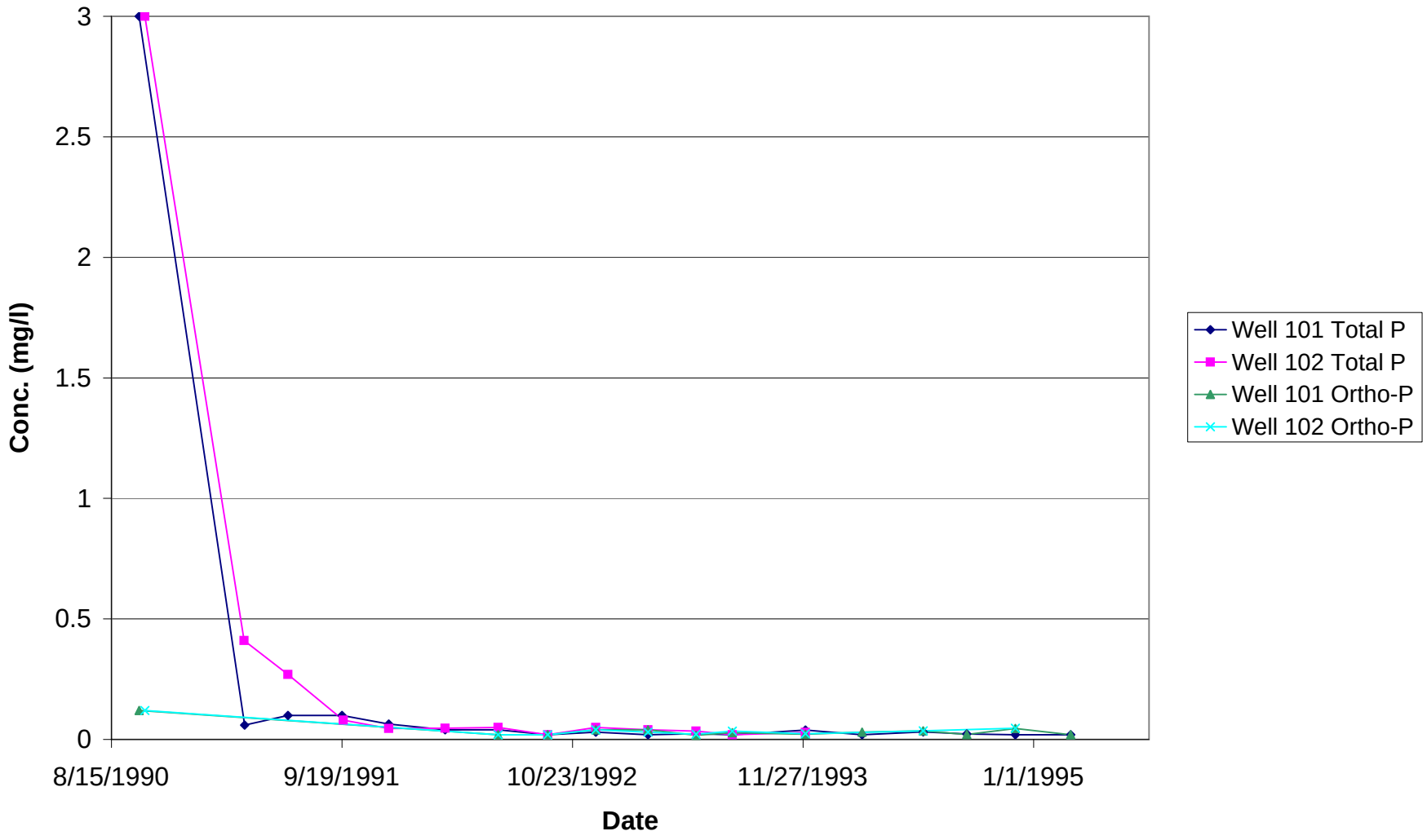
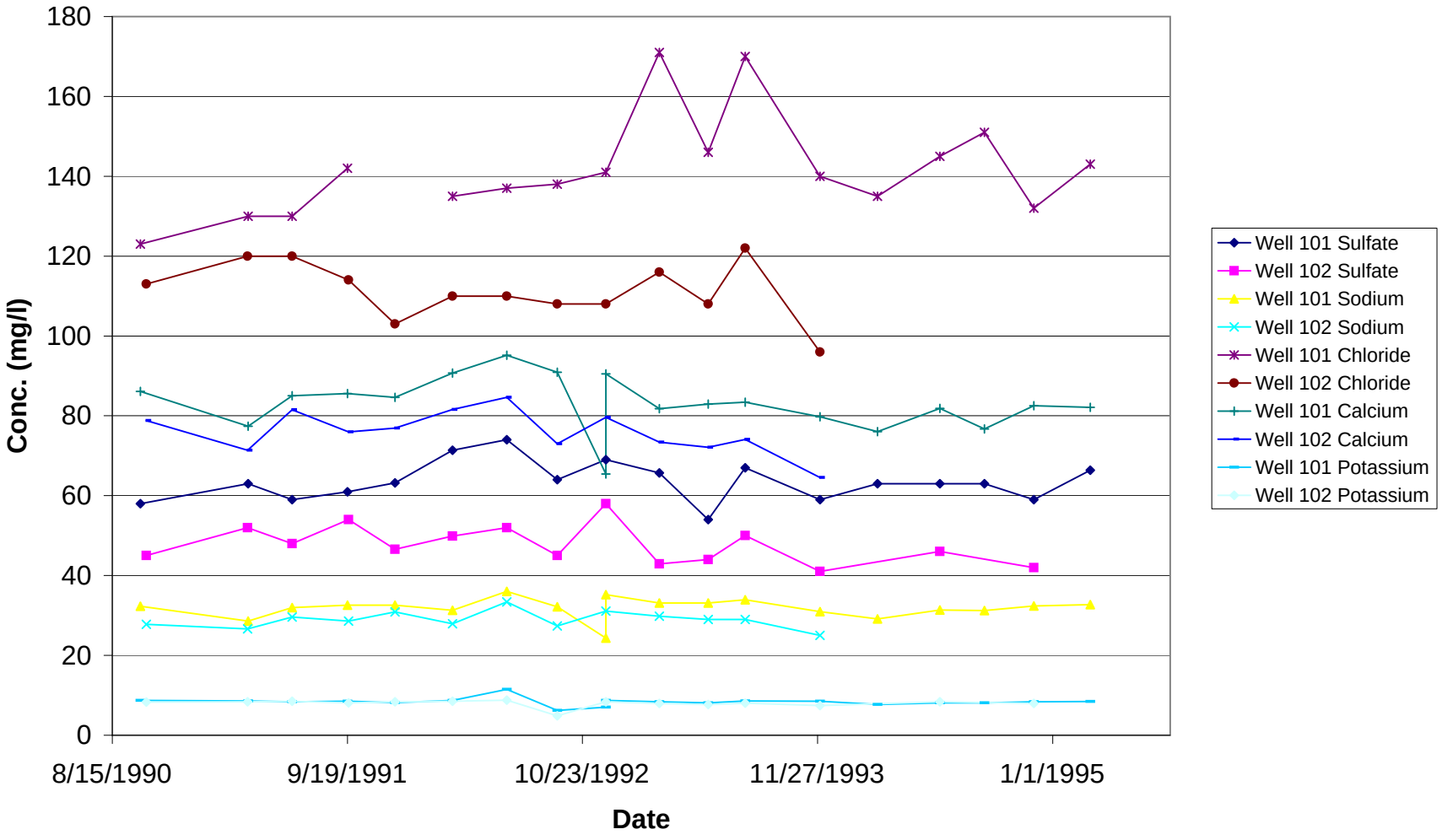


Figure 4.3-3 Common Ion Concentrations at Wells 101 and 102



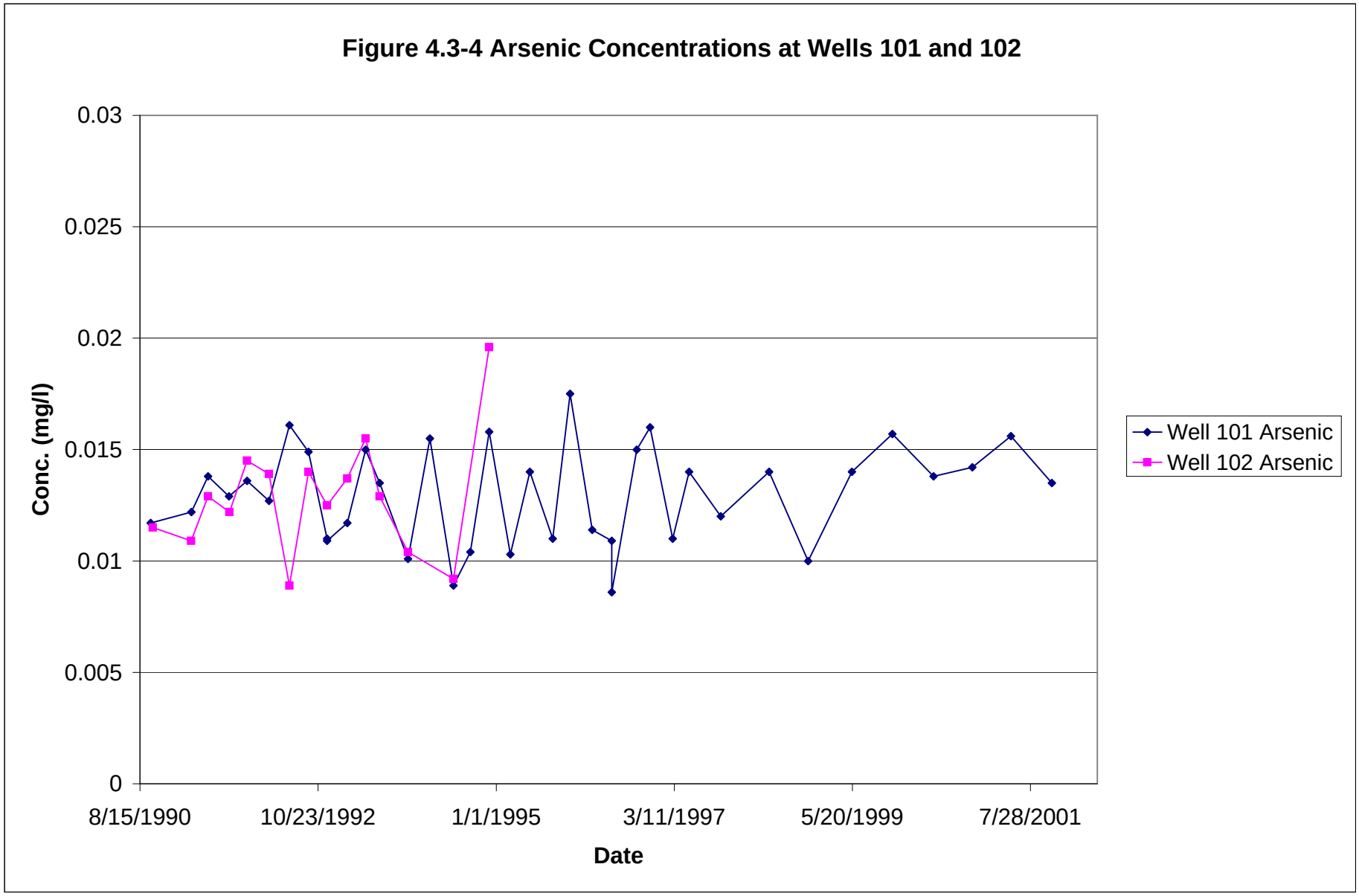
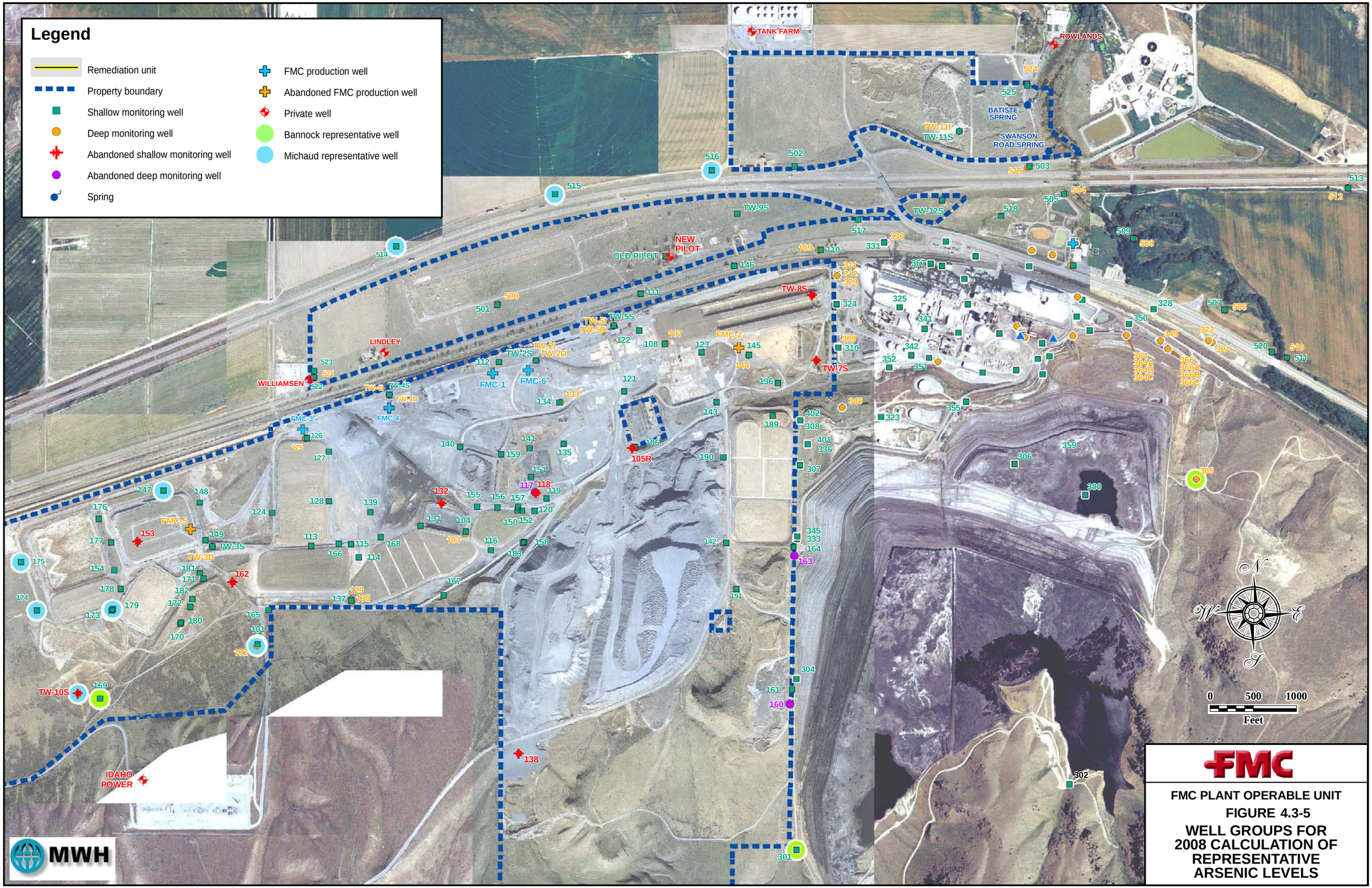


Figure 4.3-4 Arsenic Concentrations at Wells 101 and 102
0.03
0.025
0.02
0.015
0.01
0.005
0
Conc. (mg/l)
8/15/1990
10/23/1992
1/1/1995
3/11/1997
5/20/1999
7/28/2001
Date
Well 101 Arsenic
Well 102 Arsenic



FMC

FMC PLANT OPERABLE UNIT

FIGURE 4.3-5

WELL GROUPS FOR 2008 CALCULATION OF REPRESENTATIVE ARSENIC LEVELS

FILE Fig 2_FMC_Well Groups 08 Rep Arsenic_7_16_08.mxd 7/16/08

Section 5
ASSESSMENT OF GROUNDWATER QUALITY AND SOURCE AREAS

Section 4 of this report presented a summary of the EMF RI groundwater investigation and the results of the post-RI special groundwater studies and FMC's routine groundwater monitoring programs time sequentially, and with a focus on the findings for each individual event / program. This section presents an assessment of the groundwater quality at the FMC Plant OU based on the cumulative results and findings of the numerous groundwater investigations and monitoring programs. Stated another way, this section describes groundwater conditions on an area and site-wide basis independent of the regulatory program under which the groundwater data were generated. Section 5.1 provides an assessment of the groundwater quality and trends for four groundwater areas within the FMC Plant OU as follows:

- Western Ponds Area;
- Central Plant Area;
- Joint Fenceline / Calciner Ponds Area; and,
- Area North of Highway 30 and Interstate 86.

These four groundwater areas are similar to those delineated in the EMF RI. The groundwater areas remain relevant for the purpose of discussing groundwater quality, trends and source areas due to the fact that these areas are somewhat different with respect to groundwater constituents and/or are influenced by non-FMC groundwater impacts (e.g., Simplot facility impacts in the Joint Fenceline Area and Area North of Highway 30 and I-86). Figure 5.1-1 shows the groundwater areas and the FMC Plant Site RUs as delineated in the SRI Report (MWH, 2008).

Section 5.2 presents an evaluation of the identified and potential sources of groundwater impacts within the four groundwater areas.

Section 5.1 Groundwater Quality Assessment and Trends

Overall, the groundwater quality and the area of EMF-impacted groundwater are essentially the same as identified in Section 4.4 of the EMF RI and as summarized in Section 4.1 of this report. Figures 5.1-2 through 5.1-7 present updated groundwater concentration maps for arsenic, potassium, sulfate, nitrate, total phosphorus / orthophosphate and selenium, respectively, for the FMC Plant OU. These constituents were selected for the concentration maps as the primary indicator parameters, based on their prevalence above representative concentrations, to delineate the area of EMF-impacted groundwater.

The concentration maps primarily utilize the concentration averages for the plotted constituents from the period November 1996 through May 2008. The list of wells for which an average value was calculated and the average value posted on the concentration maps are provided on Table 4.2-12. The contouring was also guided by the recent (2001 to 2008) results from "non-routine" wells for which there are results for the contoured parameters, but insufficient data to calculate a meaningful current average. These "point values" are also posted on the concentration maps. The list of wells and point values that are posted on the concentration maps are provided on Table 5.1-1. Although the concentration contours are not "projected" into the Simplot OU, the arsenic, potassium, sulfate, nitrate, total phosphorus and selenium concentrations for the Simplot-monitored wells listed on Table 5.1-1 are also posted on the concentration maps. The Simplot well data was taken from Simplot's Second Quarter 2008 Groundwater Monitoring Report (Simplot, 2008c). As shown on Table 5.1-1, Simplot's May 2008 groundwater monitoring did not include analysis for ammonia so no data is posted for the relevant Simplot-monitored wells on Figures 5.1-5B (Ammonia Concentrations in Shallow Groundwater). The concentration maps provide a foundation for the assessment of groundwater quality and trends.

Concentration time-series (or trend) plots for the indicator parameters (arsenic, potassium, total phosphorus / orthophosphate, and sulfate) and the general indicator specific conductance were prepared for selected wells in the four groundwater areas within the FMC Plant OU. In addition to the trend plots, the Mann-Kendall test for trend was used to evaluate the presence or absence of statistically significant trends in the indicator parameters arsenic, potassium, total phosphorus / orthophosphate, and sulfate in the wells selected for trend plots. A total of thirty two (32) wells were selected for the trend plots and Mann-Kendall test for trend. These wells were selected using three primary criteria: 1) multiple wells distributed across each of the four groundwater areas were selected to provide broad spatial coverage across the entire FMC Plant OU; 2) wells with historically high concentrations of one or more groundwater constituent associated with identified source area s; and, 3) temporal continuity of monitoring data. In some cases, wells that were identified as meeting criteria 1 and 2 (e.g., wells 134, 140 and 145) were not selected due to the lack of temporally continuous data as these wells were not sampled / analyzed between 2001 and the May 2008 monitoring event. Figure 5.1-10 shows the wells that were selected for trend plots and the Mann-Kendall test for trend.

An assessment of the groundwater quality and trends are discussed for each of the four groundwater areas in Sections 5.1.1 through 5.1.4 below.

Section 5.1.1 Western Ponds Area

As described in Section 4, the nature of impacts to groundwater in the western ponds area can be summarized as elevated (i.e., greater than the representative level) concentrations of common ions, decreased pH, elevated concentrations of nutrients such as ammonia, nitrate and total phosphorus / orthophosphate, and metals such as arsenic and manganese.

Common Ions and Nutrients

As shown on Figures 5.1-3 and 5.1-4, potassium and sulfate concentrations exceed their representative levels in groundwater beneath and downgradient from the old phossy ponds (RU 22b). The area of elevated potassium and sulfate extends from the western extent at wells 170 and 178 in the area of old phossy pond 7E and along the southern set of wells proximal to or within the footprint of the old phossy ponds (e.g., wells 165, 167, 116 and 158). Maximum potassium concentrations (over 100 times the representative level) are associated with former unlined pond 8S as observed at well 156. Maximum sulfate concentrations (over 10 times the representative level) are observed at well 139 and appear to be associated with the old phossy ponds 3E through 6E.

As shown on Figure 5.1-5, nitrate concentrations exceed the representative level in shallow wells associated with the old phossy ponds area, but this exceedence occurs in a smaller area within the area of elevated common ions. The highest nitrate concentrations are observed at well 170 (old pond 7E) and well 139 (old ponds 3E through 6E). There is also an area of elevated nitrate that extends from western pond area well 134 to central plant area wells 121, 108 and 122. These wells are located north and east of former Pond 8S.

The average ammonia concentration at well 156, located immediately downgradient from former Pond 8S, is 13.9 mg/l while the average nitrate concentration is 0.09 mg/l. In general, the distribution of ammonia concentrations in the impacted wells is the inverse of the nitrate concentrations. As described above, several wells downgradient from former Pond 8S contain ammonia at elevated concentrations, with Wells 156 having the highest mean concentration. However, none of these wells have average nitrate concentrations in excess of the representative concentrations. Further downgradient, in the central plant area, ammonia concentrations decreased while nitrate concentrations increased. It appears that the ammonia associated with the reducing groundwater conditions at former Pond 8S may be oxidized to nitrate further downgradient.

As shown on Figure 5.1-6, total phosphorus / orthophosphate concentrations exceed the representative level in shallow wells associated with the old phossy pond area, but in smaller area within the area of elevated common ions. Maximum average total phosphorus / orthophosphate concentrations (39.4 to 278 mg/l) are associated with former unlined pond 8S, as observed at wells 155, 156 and 157 located immediately downgradient from pond 8S. Elevated total phosphorus / orthophosphate concentrations (average concentrations of 2.1 to 8.7 mg/l) are observed at wells 104, 114, 115, 131 and 167 and appear to be associated with the series of old phossy ponds 1E through 6E.

A fluoride concentration map was not prepared because fluoride concentrations exceed the representative level in relatively few wells in the western ponds area. The average fluoride concentrations exceeded the representative level in wells 104, 114, 124, 126, 149, 154 and 168 associated with the old phossy ponds. Overall, fluoride concentrations in the western ponds area have decreased significantly since the EMF RI.

Metals

As shown on Figure 5.1-2, arsenic concentrations exceed the representative level in groundwater beneath and downgradient from the old phossy ponds (RU 22b). The area of elevated arsenic concentrations is essentially coincident with the area of elevated potassium concentrations shown on Figure 5.1-3. The area of elevated arsenic extends from the western extent at wells 170 and 178 to 176 in the area north of old phossy pond 7E and along the southern set of wells proximal to or within the footprint of the old phossy ponds (e.g., wells 165, 167, 116 and 158). Maximum arsenic concentrations (greater than 0.1 mg/l) are associated with former unlined pond 8S, as observed at wells 155, 156 and 157. They also appear to be associated with the old phossy ponds 3E through 6E as observed at wells 114 and 115. The arsenic-impacted area associated with the old phossy pond area and pond 8S extends downgradient into the central plant area, generally in the area between and including well 121 (southern portion of the pond area plume) and well 111 (on the FMC Plant Site northern property line).

As shown on Figure 5.1-7, selenium concentrations exceed the representative level in shallow wells associated with the old phossy ponds area, but in a smaller area within the area of elevated arsenic. The highest selenium concentrations are observed at wells 168 and 139 (old ponds 3E through 6E). The selenium-impacted area associated with the old phossy pond area and pond 8S extends downgradient into the central plant area, generally in the area between and including wells 121 and 122, but does not extend as far north as well 111 (on the FMC Plant Site northern property line).

Manganese and boron concentrations exceed their representative levels in shallow wells associated with the old phossy ponds area, but in a smaller area within the area of elevated arsenic. The wells in which the manganese concentrations exceed the representative level are shown on Figure 5.1-8. In general, boron concentrations exceed the representative level in the same wells in which manganese is elevated. Maximum manganese and boron concentrations (manganese concentrations greater than 1.0 mg/l and boron concentrations greater than 2.0 mg/l) are associated with former unlined pond 8S, as observed at wells 155, 156, 157, 159 and 141, and also appear to be associated with the old phossy ponds 1E through 6E as observed at wells 167, 115, 131, 104, 168 and 140. The arsenic-impacted area associated with the old phossy pond area and pond 8S extends downgradient into the central plant area, generally in the area between and including well 121 (southern portion of the pond area plume) and well 111 (on the FMC Plant Site northern property line).

Based on the collective (EMF RI and post-RI) groundwater results as described in Section 4 of this report, aluminum, antimony, beryllium, cadmium, copper, lead, molybdenum, mercury, silver, thallium, vanadium, and zinc are not FMC-related groundwater constituents in the western pond area. Although the results for total uranium are from only a single monitoring event (May 2008), those results do not suggest that uranium is an FMC-related groundwater constituent in the western pond area.

Radiological Parameters

Based on the post-RI monitoring results, gross alpha activities exceeded the representative range in a few wells (wells 104 and 157 at pond 8S) within the western ponds area. None of the other wells, including pond 8S downgradient wells 155 and 156, exceed the representative range. Gross alpha and the alpha-emitting isotopes (uranium isotopes as discussed in Section 4) are not a significant component of impacted groundwater in the western pond area.

Elevated gross beta activities in the western pond area correlate with potassium concentrations (i.e., gross beta activities are commensurate with expected activities of potassium-40, a beta emitter, given its natural abundance) as described above in
Section 4.

Based on the post-RI results, radium-226 and radium-228 are not FMC-related groundwater constituent in the western pond area.

Organic Parameters

Based on the EMF RI and post-RI results, no significant concentrations of organic compounds have been detected in groundwater beneath the western pond area.

Other Inorganic Parameters

As described in Section 4.2, total cyanide has been detected in wells 104, 115, 131, 134, 139, 165, 167 and 168, associated with the old phossy pond area, and at the pond 8S wells 155, 156 and 157. As shown on Figure 5.1-9, cyanide concentrations are detected in shallow wells associated with the old phossy ponds area, but in a smaller area within the area of elevated common ions, nutrients and arsenic. Cyanide concentrations have exceeded the comparative value of 0.1 mg/l at western pond area wells 104 (0.15 mg/l [August 2000]), 115 (0.14 mg/l [August 2000]), 131 (0.43 mg/l [November 2001]), 139 (0.12 mg/l [November 1997]), 155 (0.13 mg/l [August 2000]), 156 (0.12 mg/l [November 1997]), 167 (0.13 mg/l [May 2008]), and 168 (0.34 mg/l [August 2000]).

Elemental phosphorus has not been detected in wells 112, 113, 120, 128, 131, 134, 135, 140, 141, 151, 159, 165, and 168 in the western pond area. Over the ten years of routine monitoring for elemental phosphorus at pond 8S, there have been sporadically reported detects at the upgradient and downgradient pond 8S wells as well as in rinseate blanks associated with the elemental phosphorus sampling and analysis events. A summary of the reported detected elemental phosphorus results for the pond 8S well and rinsate blanks is provided below:

Well / Sample	Total Number of Primary Results	Number of Reported Detects	Maximum Reported Detected Result (ug/l)	Maximum Reported Result Sample Date
155	22	5	0.17	5/03/2007
156	20	6	0.55	11/09/2005
157	20	7	0.15	11/12/2001
158	20	8	0.35	5/22/2003
183	19	11	0.32	5/21/2003
Rinsate Blank	21	9	0.19	11/09/2005

Note: Sample results are for the period January 1998 through May 2008.

In addition to the relatively low frequency of detections, there is no discernable temporal pattern to the reported detections for the pond 8S wells, except that the rinsate blanks associated with the November 2005 and May 2007 sampling events were reported as having detected elemental phosphorus. There were no rinsate blanks associated with the May 2003 event.

The elemental phosphorus analytical method (EPA method 7580) has an extremely low detection limit and FMC's current laboratory typically achieves a detection limit of 0.05 ug/l. The higher frequency of reported detections for the rinsate blank samples compared to the downgradient pond 8S wells 155, 156 and 157 and upgradient well 158 suggests that the reported results for the pond 8S wells may be laboratory artifacts. In any event, none of the reported results for the pond 8S wells have exceeded the comparative value of 0.73 ug/l for elemental phosphorus.

Groundwater Quality Trends

Concentration time-series (or trend) plots for the key indicator parameters (arsenic, potassium, total phosphorus / orthophosphate, and sulfate) and the general indicator specific conductance are provided in Appendix J. The trend plots show concentration trends through May 2008 for wells 127, 131, 139, 148, 155, 156, 157, 165, 166, and 172 in the western ponds area. Figure 5.1-10 shows the wells that were selected for trend plots and the Mann-Kendall test for trend as described below.

In addition to trend plots, the Mann-Kendall test for trend was used to evaluate the presence or absence of statistically significant trends in the indicator parameters arsenic, potassium, total phosphorus / orthophosphate, and sulfate in western ponds area wells. The Mann-Kendall test for trend is recommended as a robust non-parametric test for trends in data over time (Helsel and Hirsch, 2002; Gilbert, 1987). The test is suitable for data that do not follow a normal

distribution, and supports multiple observations per time period. The Mann-Kendall trend tests were conducted at the 95% confidence level. The test for trend was performed for two different time periods: 1) all data through May 2008 to evaluate potential ―longer term" trends that include the data prior to and during the EMF RI, and 2) monitoring year 2002 through May 2008 (―recent time period") to evaluate potential recent trends while also capturing sufficient data points for a meaningful test. The results of the Mann-Kendall trend tests for selected western pond area monitoring wells for all years through May 2008 and 2002 through May 2008 are shown on Tables 5.1-2A and B, respectively. The results are discussed below.

Well 172, located within the footprint of old pond 7E, shows an increasing trend for potassium and sulfate for both the longer term and recent time periods, and a decreasing trend for phosphorus (total P and orthophosphate) for the recent time period. However, note that as well 172 was installed in July 1997, the available longer term data set for this well is less than 5 years longer than the recent (2002 forward) data set.

Wells 148 and 127 that are near the northern fringe of the groundwater impact from the western pond area show an increasing trend for potassium and sulfate, a decreasing trend for arsenic, and well 127 shows a decreasing trend for phosphorus over the longer term. However, only sulfate at well 127 shows an increasing trend for the recent period.

Wells 165, 166 and 131, located proximal to or within the footprint of old phossy ponds, show an increasing trend for potassium and sulfate over the longer term. Wells 165 and 166 show a decreasing trend for arsenic, and well 166 shows a decreasing trend for phosphorus over the longer term. Well 131 shows an increasing phosphorus trend over the longer term. However, wells 131 and 166 show only an increasing trend for sulfate for the recent period. There is a decreasing recent trend for phosphorus at all three wells and a decreasing trend for arsenic at wells 166 and 131.

Well 139 is further downgradient from the old phossy ponds (compared to wells 166 and 131). The only significant trend is for sulfate over the longer term. There are no significant recent trends.

These trends suggest that solute from the old unlined phossy ponds 1E through 6E and unlined overflow pond 7E is still migrating from the saturated fine-grained (silt) horizon into underlying uppermost sand/gravel aquifer horizon and has reached a relatively steady state. The recent increasing trends for potassium at well 172 and sulfate at wells 172, 127, 166 and 131 may be related to the regional drought (below average precipitation) that generally persisted during the 2000 through 2006 period and resultant decrease in recharge and mixing from groundwater from the Bannock Range.

Pond 8S downgradient wells 155, 156 and 157 all show decreasing trends for all four parameters for the longer term. These wells also show decreasing or no trends for all four parameters for the recent period, with the sole exception of sulfate at well 156. Note that the Z-score for sulfate for well 156 is 1.99 compared to the critical Z-score of 1.97. This indicates that although the trend

is significant, it is not particularly –strong" and may quickly (within several quarters of monitoring) fall back to no trend as is the case at well 157.

The initial fill and removal of the standing hydraulic head from pond 8S was completed in 1994. Following placement of the initial fill and temporary cap in 1994, pond 8S was further dewatered to the extent practicable through a wickdrain and subgrade pumping system over the 1994 through 1996 period. The pond 8S final cover (cap) was constructed and completed in 1999. The trends at the pond 8S wells basically validate the EMF RI prediction that dewatering and capping would be effective in reducing pond solute and constituent migration to groundwater and a gradual improvement in groundwater quality downgradient from pond 8S.

Section 5.1.2 Central Plant Area

As described in Section 4, the nature of impacts to groundwater in the central plant area can be summarized as elevated (i.e., greater than the representative level) concentrations of common ions, decreased pH, elevated concentrations of nutrients such as nitrate and total phosphorus / orthophosphate, and metals such as arsenic and manganese.

Common Ions and Nutrients

As shown on Figures 5.1-3 and 5.1-4, potassium and sulfate concentrations exceed their representative levels in groundwater beneath the central plant area. The area of elevated potassium and sulfate extends from the western ponds area and migrates through the central plant area between and including wells 121 and 111. Elevated potassium and sulfate concentrations from the old phossy ponds and pond 8S migrate through the area of well 134 (average potassium concentration of 153 mg/l and average sulfate concentration of 325 mg/l) and well 121 upgradient from the slag pit (average potassium concentration of 72 mg/l and average sulfate concentration of 256 mg/l). Wells 108 and 122 are further downgradient from the western ponds area groundwater impact, and potassium and sulfate concentrations in the central plant area are elevated but slightly lower than the concentrations at well 134. Average potassium concentrations at wells 108 and 122 are 124 and 126 mg/l respectively, and average sulfate concentrations at wells 108 and 122 are 242 and 300 mg/l respectively.

Concentrations of potassium and sulfate decrease as impacted groundwater migrates through the central plant area toward the northeast. Average potassium concentrations at wells 111 and 146 (located at the northern boundary of the FMC Plant Site the area) are 49.5 and 46.3 mg/l respectively, and sulfate concentrations are 157 and 128 mg/l respectively.

As shown on Figure 5.1-5, nitrate concentrations exceed the representative level in shallow wells associated with the central plant area. The area of elevated nitrate extends from western pond area well 134 to central plant area wells 121, 108 and 122. These wells are located north and east of former pond 8S. The highest nitrate concentrations are observed at well 121 (upgradient from the slag pit) and well 122 (downgradient from the furnace building and phosphorus dock area). Ammonia concentrations are not elevated at wells 121, 108 and 122, indicating that

ammonia associated with the reducing groundwater conditions at the old phossy ponds and pond 8S is oxidized to nitrate further downgradient.

There is also an area of elevated nitrate and ammonia in the eastern portion of the central plant area at wells 143 and 123. Average ammonia and nitrate concentrations at well 143 are 2.28 and 14.8 mg/l respectively. Average ammonia and nitrate concentrations at well 123 are 3.23 and 5.53 mg/l respectively. The groundwater at these wells appears to be influenced by a source(s) with reduced nitrogen (ammonia) in the area of well 143. Source areas are discussed in Section 5.2 below.

Concentrations of nitrate and ammonia decrease as impacted groundwater migrates through the central plant area toward the northeast. Average total nitrate concentrations at wells 111 and 146 (located at the northern boundary of the FMC Plant Site the area) are 8.98 and 6.13 mg/l respectively, and ammonia concentrations are 0.15 mg/l at both wells.

As shown on Figure 5.1-6, total phosphorus / orthophosphate concentrations exceed the representative level in shallow wells associated with the central plant area. The area of elevated total phosphorus / orthophosphate extends from the western ponds area and migrates through the central plant area between and including wells 121 and 111. Elevated total phosphorus / orthophosphate concentrations from the old phossy ponds and pond 8S migrate through the area of well 134 (average total phosphorus / orthophosphate concentration of 19.8 mg/l) and well 121 upgradient from the slag pit (average total phosphorus / orthophosphate concentration of 1.05 mg/l). Wells 108 and 122 are further downgradient from the western ponds area groundwater impact, and total phosphorus / orthophosphate concentrations in the central plant area are elevated but slightly lower than the concentrations at well 134. Average total phosphorus / orthophosphate concentrations at wells 108 and 122 are 1.04 and 17.8 mg/l respectively.

Concentrations of total phosphorus / orthophosphate decrease as impacted groundwater migrates through the central plant area toward the northeast. Average total phosphorus / orthophosphate concentrations at wells 111 and 146 (located at the northern boundary of the FMC Plant Site the area) are 3.95 and 1.33 mg/l respectively.

The average fluoride concentrations do not exceed the representative level in any of the central plant area wells.

Metals

As shown on Figure 5.1-2, arsenic concentrations exceed the representative level in groundwater beneath and downgradient from the central plant area. The area of elevated arsenic concentrations is essentially coincident with the area of elevated potassium concentrations shown on Figure 5.1-3. The area of elevated arsenic extends from the western ponds area and migrates through the central plant area between and including wells 121 and 111. Elevated arsenic concentrations from the old phossy ponds and pond 8S migrate through the area of well 134 (average arsenic concentration of 0.098 mg/l) and well 121 (average arsenic concentration of

0.022 mg/l) both located upgradient from the slag pit. Wells 108 and 122 are further downgradient from the western ponds area groundwater impact, and are located in the central plant area. The arsenic concentrations there are elevated but slightly lower than the concentrations at well 134. Average arsenic concentrations at wells 108 and 122 are 0.018 and 0.06 mg/l respectively. Concentrations of arsenic decrease as impacted groundwater migrates through the central plant area toward the northeast. Average arsenic concentrations at wells 111 and 146 (located at the northern boundary of the FMC Plant Site the area) are 0.024 and 0.029 mg/l respectively.

As shown on Figure 5.1-7, selenium concentrations exceed the representative level in shallow wells in the central plant area, but in a smaller area within the area of elevated arsenic. The area of elevated selenium extends from the western ponds area through the central plant area between wells 121 and 111. Elevated selenium concentrations from the old phossy ponds and pond 8S migrate through the area of well 134 (average selenium concentration of 0.050 mg/l) and well 121 upgradient from the slag pit (average arsenic concentration of 0.012 mg/l). Wells 108 and 122 are further downgradient from the western ponds area groundwater impact and, as stated earlier, are in the central plant area. The selenium concentrations there are elevated but slightly lower than the concentrations at well 134. Average selenium concentrations at wells 108 and 122 are 0.010 and 0.009 mg/l respectively. Concentrations of selenium decrease as impacted groundwater migrates through the central plant area toward the northeast. Average selenium concentrations at wells 111 and 146 (located at the northern boundary of the FMC Plant Site the area) are 0.005 and 0.003 mg/l respectively and are below the representative concentration.

There is also an area of elevated selenium in the eastern portion of the central plant area at wells 143 and 123. Average selenium concentrations at well 143 are 0.072 and 0.154 mg/l respectively. The groundwater at these wells migrates northeast and merges with flow from the joint fenceline area. A discussion of the water quality migrating downgradient from the joint fenceline area is discussed in Section 5.1.3 below. Source areas are discussed in Section 5.2.

Manganese and boron concentrations exceed their representative levels in shallow wells associated with the central plant area. The wells in which the manganese concentrations have exceeded the representative level are shown on Figure 5.1-8. The area of elevated manganese and boron extends from the western ponds area through the central plant area between wells 121 and 111. Elevated manganese and boron concentrations from the old phossy ponds and pond 8S migrate through the area of well 134 (manganese concentration of 2.34 mg/l [May 2008]). Wells 108 and 122, further downgradient from the western ponds area and located in the central plant area, have manganese concentrations that are elevated but slightly lower than the concentrations at well 134. Manganese concentrations (May 2008) at wells 108 and 122 are 0.487 and 1.01 mg/l respectively. Concentrations of manganese decrease as impacted groundwater migrates through the central plant area toward the northeast. The manganese concentrations (May 2008) at well 111 is 0.302 mg/l. The May 2008 manganese concentration at well 146 is 0.0421 and is below the representative concentration.

There is also an area of elevated manganese in the eastern portion of the central plant area, at wells 143 and 123. The May 2008 manganese concentrations at wells 143 and 123 are 0.349 and 0.122 mg/l respectively. The May 2008 boron concentration at well 123 of 0.744 mg/l slightly exceeded the representative concentration. In addition, vanadium concentrations at well 123 have exceeded the representative concentration. The May 2008 vanadium result at well 123 was 0.182 mg/l, compared to the representative concentration of 0.1 mg/l. The groundwater at these wells migrates northeast and merges with flow from the joint fenceline area. A discussion of the water quality migrating downgradient from the joint fenceline area is discussed in Section 5.1.3 below. Source areas are discussed in Section 5.2.

Based on the collective (EMF RI and post-RI) groundwater results as described in Section 4 of this report, aluminum, antimony, beryllium, cadmium, copper, lead, molybdenum, mercury, silver, thallium and zinc are not FMC-related groundwater constituents in the central plant area. Although the results for total uranium are from only a single monitoring event (May 2008), those results do not suggest that uranium is an FMC-related groundwater constituent in the central plant area.

Radiological Parameters

Based on the EMF RI and post-RI monitoring results, gross alpha activities are not elevated above the representative range in the central plant area. During the May 2008 event, the gross alpha activity at well 143 in the eastern potion of the central pant area was reported at 13.2 pCi/l (May 2008) compared to the upper representative gross alpha activity of 7.97 pCi/l. Historically, the gross alpha activities measured at well 143 were below the representative range so this result appears anomalous. In addition, the radium-226 and total uranium results for May 2008 were 0.14 pCi/l and 0.008 mg/l respectively and were well below their representative ranges. The low radium and uranium results do not suggest that alpha-emitting isotopes would account for the reported gross alpha activity at well 143. Excluding the apparently anomalous May 2008 result for well 143, gross alpha and the alpha-emitting isotopes (uranium isotopes as discussed in Section 4) are not a significant component of impacted groundwater in the central plant area.

Elevated gross beta activities in the central plant area correlate with potassium concentrations (i.e., gross beta activities are commensurate with expected activities of potassium-40, a beta emitter, given its natural abundance) as described above in
Section 4.

Based on the post-RI results, radium-226 and radium-228 are not FMC-related groundwater constituent in the central plant area.

Organic Parameters

Based on the EMF RI and post-RI results, no significant concentrations of organic compounds have been detected in groundwater beneath the central plant area or elsewhere within the FMC Plant OU.

Other Inorganic Parameters

As described in Section 4.2 and shown on Figure 5.1-9, total cyanide has been detected in wells 108, 111, 122 and 146 in the central plant area, but at lower concentrations than observed at wells in the western ponds area. Cyanide concentrations at these wells range from 0.011 to 0.051 mg/l and are below the comparative value of 0.1 mg/l. Concentrations of cyanide decrease as western pond area-impacted groundwater migrates through the central plant area toward the northeast. Cyanide concentrations from May 2008 at wells 111 and 146, located at the northern boundary of the FMC Plant Site, were 0.019 and 0.011 mg/l respectively.

Total cyanide has also been detected at wells 143 and 123 in the eastern portion of the central plant area. The cyanide results for these wells range from 0.022 to 0.035 mg/l and are below the comparative value. The groundwater at these wells migrates northeast and merges with flow from the joint fenceline area. A discussion of the water quality migrating downgradient from the joint fenceline area is discussed in Section 5.1.3 below. Source areas are discussed in Section 5.2.

Based on the results described above, elemental phosphorus is not a groundwater constituent in the western ponds area and is not a component of the impacted groundwater migrating from the western pond area beneath the central plant area. However, elemental phosphorus has been routinely detected in wells 108 and 122, which are located downgradient from the furnace building and phosphorus dock (RU1) and slag pit (RU2) in the central plant area. Elemental phosphorus was not detected in the January 1998 and May 2008 sampling events at wells 110, 111 and 146, for which the detection limits were 0.02 ug/l and 0.05 ug/l respectively.

Over the ten years of routine monitoring for elemental phosphorus at the slag pit sump, there have also been sporadically reported detects at wells 121 and 123 as well as in rinseate blanks associated with the elemental phosphorus sampling and analysis events. A summary of the reported detected elemental phosphorus results for the slag pit sump wells and rinsate blanks is provided below:

Well / Sample	Total Number of Primary Results	Number of Reported Detects	Maximum Reported Detected Result (ug/l)	Maximum Reported Result Sample Date
108	22	19	258	11/19/2003
122	21	17	7.19	11/19/2003
123	20	13	0.88	11/19/2003
121	19	5	0.53	11/06/2002
Rinsate Blank	21	9	0.19	11/09/2005

Note: Sample results are for the period January 1998 through May 2008.

In addition to the relatively low frequency of detections at wells 121 and 123, there is no discernable temporal pattern to the reported detections for these wells. As described above, the elemental phosphorus analytical method (EPA method 7580) has an extremely low detection limit and FMC's current laboratory typically achieves a detection limit of 0.05 ug/l. The frequency of reported detections for the rinsate blank samples compared to wells 121 and 123 suggests that the reported results for the pond 8S wells may be laboratory artifacts. In any event, only the November 2002 result for well 123 exceeds the comparative value of 0.73 ug/l for elemental phosphorus. The May 2008 results for wells 121 and 123 were both undetected at 0.05 ug/l.

As described in the SRI Report for the FMC Plant OU (MWH, 2008), elemental phosphorus was encountered in the capillary fringe in an area extending downgradient from RU 1 (Furnace Building and Phosphorus Dock) and RU 2 (Slag Pit) in the vicinity of wells 108 and 122. The source of the elemental phosphorus in the subsurface and capillary fringe beneath and extending downgradient from RUs 1 and 2 is described in the SRI Report and discussed below in the Section 5.2. Elemental phosphorus trends at wells 108 and 122 are described in the subsection that follows.

Groundwater Quality Trends

Concentration time-series (or trend) plots for the key indicator parameters (arsenic, potassium, total phosphorus / orthophosphate, and sulfate) and the general indicator specific conductance are provided in Appendix J. The trend plots show concentration trends through May 2008 for wells 108, 111, 121, 122, 123, 143 and 146 in the central plant area. Figure 5.1-10 shows the wells that were selected for trend plots and the Mann-Kendall test for trend as described below.

The test for trend was performed for two different time periods: 1) all data through May 2008 to evaluate potential "longer term" trends that include the data prior to and during the EMF RI, and 2) monitoring year 2002 through May 2008 ("recent time period") to evaluate potential recent trends while also capturing sufficient data points for a meaningful test. The results of the Mann-Kendall trend tests for selected central plant area monitoring wells for all years through May 2008 and 2002 through May 2008 are shown on Tables 5.1-3A and B, respectively. The results are discussed below.

Well 121, located upgradient from the slag pit, shows a decreasing trend for arsenic for both the longer term and recent time periods, and an increasing trend for sulfate. The recent increasing trend for sulfate may relate to the trend for sulfate observed in the western ponds area as described above.

Well 108 shows a decreasing trend for arsenic for both the longer term and recent time periods and longer term decreasing trends for potassium and sulfate. The recent increasing trend for sulfate may relate to the same trend observed at upgradient well 121 and at the western ponds area. The longer term increasing trend for phosphorus is not apparent in the recent time period (no evidence of trend). Well 122 shows a longer term increasing trend for arsenic, phosphorus

and sulfate and a decreasing trend for potassium. However, only the decreasing potassium trend is apparent in the recent time period. The trends at well 122 (and well 146 downgradient from well 122) may be related to changes in precipitation / recharge patterns causing localized variations in groundwater flowpaths as the impacted groundwater from the western ponds area migrates through the central plant area.

Well 111, located at the northern FMC Plant Site boundary, shows a decreasing trend for arsenic, potassium and phosphorus in the longer term and a decreasing trend for arsenic potassium and sulfate in the recent period. Well 146, located at the northern FMC Plant Site boundary and downgradient from well 122, shows an increasing trend for arsenic and phosphorus, and a decreasing trend for potassium in the longer term. In the recent period, well 146 shows an increasing trend for arsenic and sulfate and a decreasing trend for phosphorus.

Wells 143 and 123, located in the eastern portion of the central plant area, show decreasing trends for all four of the tested parameters in the longer term and decreasing trends for arsenic, potassium and phosphorus in the recent time period. Groundwater at these wells migrates northeast and merges with flow from the joint fenceline area. A discussion of the water quality trends in the joint fenceline area is discussed in Section 5.1.3 below. Source areas are discussed in Section 5.2.

As described above, sampling and analysis of wells 108 and 122 for elemental phosphorus began in January 1998 and has continued as part of FMC‘s routine RCRA groundwater monitoring program. Time series plots for elemental phosphorus at wells 108 and 122 are shown on Figures 5.1-11 and 5.1-12 respectively. Elemental phosphorus concentrations at well 108 range from 0.00021 mg/l (May 2003) to 0.258 mg/l (November 2003) and generally indicate an increasing trend over the 2000 – 2007 time period. The May 2008 result (0.03 mg/l) may indicate a reversal of the apparent increasing trend. Elemental phosphorus concentrations at well 122 range from 0.00019 mg/l (November 2004) to 0.00719 mg/l (November 2003) and do not indicate a trend over the ten year period.

During the EMF RI, the tapping of molten slag (“pit run”) into the slag pit was identified as a significant source of thermal loading to the subsurface including shallow groundwater in the vicinity and downgradient from the slag pit. As shown on EMF RI Figure 4.4-12, the groundwater temperatures at wells 108, 122 and 123 downgradient from the slag pit and wells 146 at the northern boundary of the FMC Plant Site were significantly elevated compared to representative groundwater. The range of representative groundwater temperatures is 12 to 16.5 degrees Celsius (C). During the EMF RI, the groundwater temperature at well 108 was over 28 degrees C and wells 122 and 146 were over 20 degrees C. The groundwater thermal plume provided a useful “tracer” for evaluating groundwater flow patterns from the slag pit / furnace building area. As shown on EMF RI Figure 4.4-12 and described above in Section 2, groundwater flows from well 108 northeast through well 146 and then east through well 517.

FMC installed slag ladling on furnaces 1 and 4 during 1999 and completed the conversion on furnaces 2 and 3 in August 2000. The conversion to slag ladling eliminated the thermal load to

the subsurface at the slag pit and groundwater temperatures began a steadily decreasing trend as shown on Figure 5.1-13. As of May 2008, the groundwater temperature at well has decreased to 19.1 degrees C; wells 122 and 146 have decreased to below 18 degrees C, and well 517 north of highway 30 has decreased to within the representative temperature range. Not unexpectedly, the decreasing temperature trend at well 108 has flattened over the last several years as the groundwater temperature approaches the representative groundwater temperature range.

Elemental phosphorus at wells 108 and 122 and the potential implications of the groundwater temperature trend at these wells is discussed in greater detail in Section 5.2 below.

Section 5.1.3 Joint Fenceline / Calciner Ponds Area

As described in Section 4, the nature of impacts to groundwater in the joint fenceline area can be summarized as elevated (i.e., greater than the representative level) concentrations of common ions, decreased pH, elevated concentrations of nutrients such as ammonia, nitrate and total phosphorus / orthophosphate, and elevated levels of metals such as arsenic and selenium.

Common Ions and Nutrients

As shown on Figures 5.1-3 and 5.1-4, potassium and sulfate concentrations exceed their representative levels in groundwater beneath the joint fenceline area. The area of elevated potassium and sulfate extends from the southernmost upgradient well 161 at the FMC eastern property line to well 110 at the northern boundary of the FMC Plant Site. Elevated potassium concentrations (about 2 times the representative concentration) extend to well 142 to the west. Maximum potassium concentrations (about 4 times the representative level) are present at wells 189 and 136. Elevated sulfate concentrations extend to wells 142, 190 and 143 to the west. Maximum sulfate concentrations (over 25 times the representative level) are observed at wells 164 (on the eastern FMC property line and upgradient from the calciner ponds), 189 and 136. The sulfate concentration gradient decreases away from the eastern FMC property line toward the east, indicating that the primary source of sulfate in the joint fenceline area is the Simplot gypstack.

As shown on Figure 5.1-5, the nitrate concentrations at wells 161 and 190 exceed the representative concentration but by less than a factor of 2. These are the only wells in the joint fenceline area that exceed the representative concentration. Ammonia concentrations at wells 189 and 136 (average concentrations of 2.12 and 1.88 mg/l respectively) and the May 2008 result for well 145 (2.5 mg/l) exceed the representative concentration. These relatively low ammonia concentrations appear to oxidize to nitrate downgradient, as indicated by ammonia and nitrate concentrations at downgradient well 110 that are below representative concentrations.

As shown on Figure 5.1-6, total phosphorus / orthophosphate concentrations exceed their representative levels in groundwater beneath the joint fenceline area. The area of elevated total phosphorus / orthophosphate extends from near the southernmost upgradient well 161 at the FMC eastern property line to well 110 at the northern boundary of the FMC Plant Site. Elevated

total phosphorus / orthophosphate concentrations extend to wells 142 and 143 to the west. Maximum total phosphorus / orthophosphate concentrations (38 to over 100 mg/l) are observed at wells 164 (on the eastern FMC property line and upgradient from the calciner ponds), 189 and 136. The total phosphorus / orthophosphate concentration gradient decreases away from the eastern FMC property line toward the west, indicating that the primary source of total phosphorus / orthophosphate in the joint fenceline area is the Simplot gypstack.

The average fluoride concentration in well 190 slightly exceeds the representative level. No other joint fenceline area wells have exceeded the fluoride representative level.

Metals

As shown on Figure 5.1-2, arsenic concentrations exceed the representative level in groundwater beneath the joint fenceline area. The area of elevated arsenic extends from near the southernmost upgradient well 161 at the FMC eastern property line to well 110 at the northern boundary of the FMC Plant Site. Elevated arsenic concentrations extend to wells 142 and 143 to the west. Maximum arsenic concentrations (0.2 to 0.35 mg/l) are observed at wells 164 (on the eastern FMC property line and upgradient from the calciner ponds), 189 and 136. The arsenic concentration gradient decreases away from the eastern FMC property line toward the east, indicating that the primary source of total phosphorus / orthophosphate in the joint fenceline area is the Simplot gypstack.

As shown on Figure 5.1-7, selenium concentrations exceed the representative level in groundwater beneath the joint fenceline area. The area of elevated selenium extends from the southernmost upgradient well 161 at the FMC eastern property line to well 110 at the northern boundary of the FMC Plant Site. Elevated selenium concentrations extend to wells 142, 190 and 143 to the west. Maximum selenium concentrations are observed at well 189 and 136 (average concentrations of 0.038 and 0.039 mg/l respectively), but are lower than selenium consentrations observed at central plant area wells 143 and 123 (average concentrations of 0.072 and 0.154 mg/l respectively). Groundwater with elevated selenium concentrations extends through well 110 at the northern FMC Plant Site boundary as groundwater from the eastern portion of the central plant area (wells 143 and 123) and the joint fenceline area merge and flow toward the northeast. The selenium concentration gradient decreases away from the eastern FMC property line toward the east in the area of wells 161, 164 and 189. This indicates that the Simplot gypstack is a source but not the primary source of selenium in the joint fenceline area. A more detailed discussion of the source areas is presented in Section 5.2.

Manganese and boron concentrations exceed their representative levels at wells 189, 136 and 145 in groundwater beneath the joint fenceline area as shown on Figure 5.1-8. Boron concentrations exceed the representative level in the same wells in which manganese is elevated.

As described in Section 4.2.1, wells 161 and 164 located at the eastern FMC property line and upgradient from the calciner ponds (RU 14) were the only joint fenceline area wells with elevated uranium concentrations compared to the range of uranium concentrations in

representative wells. Well 161 is within about 100 feet of Simplot well 304 and well 164 is within about 100 feet of Simplot well 333. As summarized in Section 4.1 above, the gross alpha measured at well 304 during the EMF RI was 192 pCi/l and was attributed to uranium isotopes. This was due to the fact that radium-226 was not detected at a sufficient activity in this well to account for the observed gross alpha activity. Wells 161, 164 and 304 are downgradient from the gypstack at Simplot. The EMF RI report hypothesized that the gross alpha activity in Well 304 is related to the dissolution of uranium from rocks and gravels in the saturated zone due to a longer residence time of acidic seepage within this lower permeability region, rather than to migration of uranium isotopes from the gypstack. This hypothesis would also apply to the uranium results and elevated gross alpha (see discussion below) at wells 161 and 164. The uranium results for wells 161 and 164 and likely relationship to Simplot gypsum stack influences do not suggest that uranium is an FMC-related groundwater constituent in the joint fenceline area.

Based on the collective (EMF RI and post-RI) groundwater results as described in Section 4 of this report, aluminum, antimony, beryllium, cadmium, copper, lead, molybdenum, mercury, silver, thallium and zinc are not FMC-related groundwater constituents in the joint fenceline area.

Radiological Parameters

Based on the post-RI monitoring results, gross alpha activities exceeded the representative range in wells 161 and 164 in the joint fenceline area. None of the other wells exceed the representative range. As described in Section 4.2.1, wells 161 and 164, located at the eastern FMC property line and upgradient from the calciner ponds (RU 14), were also the only joint fenceline area wells with elevated uranium concentrations compared to the range of uranium concentrations in representative wells. Consistent with the EMF RI report hypothesis, the gross alpha activity in wells161 and 164 is likely related to the dissolution of uranium from rocks and gravels in the saturated zone due to a longer residence time of acidic seepage within this lower permeability region, rather than to migration of uranium isotopes from the gypstack. The gross alpha results for wells 161 and 164 and likely relationship to Simplot gypsum stack influences do not suggest that gross alpha (underlying alpha-emitting isotopes) is an FMC-related groundwater constituent in the joint fenceline area.

Elevated gross beta activities in the joint fenceline area correlate with potassium concentrations (i.e., gross beta activities are commensurate with expected activities of potassium-40, a beta emitter, given its natural abundance) as described above in
Section 4.

Based on the post-RI results, radium-226 and radium-228 are not FMC-related groundwater constituent in the joint fenceline / calciner ponds area.

Organic Parameters

Based on the EMF RI and post-RI results, no significant concentrations of organic compounds have been detected in groundwater beneath the joint fenceline / calciner ponds area.

Other Inorganic Parameters

As described in Section 4.2, total cyanide has not been detected in the joint fenceline area wells. Cyanide detected at central plant area wells 143 and 123 is not detected at downgradient well 110, where groundwater from the eastern portion of the central plant area and the joint fenceline area merge and flow toward the northeast. Similarly, elemental phosphorus has not been detected in the joint fenceline area wells. Based on the results, these constituents are not FMC-related groundwater constituents in the joint fenceline / calciner ponds area.

Groundwater Quality Trends

Concentration time-series (or trend) plots for the key indicator parameters (arsenic, potassium, total phosphorus / orthophosphate, and sulfate) and general indicator specific conductance are provided in Appendix J. The trend plots show concentration trends through May 2008 for wells 110, 136, 142, 161, 164, 189 and 190 in the joint fenceline / calciner pond area.

In addition to trend plots, the Mann-Kendall test for trend was used to evaluate the presence or absence of statistically significant trends in the indicator parameters arsenic, potassium, selenium, orthophosphate, and sulfate in both upgradient and downgradient wells in the joint fenceline / calciner ponds area. The Mann-Kendall trend tests were conducted at the 95% confidence level. The test for trend was performed for two different time periods: 1) all data through May 2008 to evaluate potential ―longer term" trends that include the data prior to and during the EMF RI, and 2) monitoring year 2002 through May 2008 (―recent time period") to evaluate potential recent trends while also capturing sufficient data points for a meaningful test. The results of the Mann-Kendall trend tests for selected joint fenceline area monitoring wells for all years through May 2008 and 2002 through May 2008 are shown on Tables 5.1-4A and B, respectively. Tables 5.1-4A and B also include the results of trend testing for the five tested parameters for central plant area well 143, because that well is within the calciner pond remedial action groundwater monitoring program. The results are discussed below.

Consistent with FMC's annual Calciner Ponds Remedial Action Groundwater Monitoring Report, the discussion of the trends for joint fenceline wells is presented in terms of wells that are upgradient and downgradient of the calciner ponds. As described in the EMF RI Report, the historic (―old") unlined calciner ponds and the calciner solids storage area ―A" were located within the footprint of the lined calciner ponds 1C through 5C that were remediated pursuant to the IDEQ-FMC Consent Order and IDEQ-approved Remedial Action Plan. The calciner ponds area is identified as RU 14 in the SRI Report. The old unlined calciner ponds were identified as a source of constituents to groundwater in the joint fenceline area as well as the Simplot gypsum

stack. A more detailed discussion of the source areas in the joint fenceline area is provided in Section 5.2.

The longer term trends can be summarized as follows:

Wells Upgradient from the Calciner Ponds Area

- Well 142 shows increasing trends in arsenic, potassium, total phosphorus /orthophosphate, and sulfate;
- Well 161 shows increasing trends in potassium and sulfate;
- Well 164 shows a decreasing arsenic trend, and increasing trends for potassium, total phosphorus /orthophosphate, and sulfate.

Downgradient Wells

- Well 136 shows decreasing trends in arsenic and potassium, and an increasing trend for sulfate;
- Well 143 shows decreasing trends for all five tested parameters (arsenic, potassium, selenium, total phosphorus /orthophosphate, and sulfate);
- Well 190 shows decreasing trends for total phosphorus /orthophosphate;
- Well 110 shows decreasing trends for arsenic, total phosphorus /orthophosphate, selenium and sulfate, and an increasing trend for potassium.

The recent period trends can be summarized as follows:

Wells Upgradient from the Calciner Ponds Area

- Well 142 shows an increasing trend for arsenic and total phosphorus / orthophosphate;
- Well 161 shows an increasing trend for sulfate;
- Well 164 shows a increasing arsenic trend for sulfate.

Downgradient Wells

- Well 143 shows decreasing trends for arsenic, potassium, selenium and total phosphorus /orthophosphate;

- Well 190 shows decreasing trends for total phosphorus /orthophosphate;

- Well 110 shows decreasing trends for all five tested parameters (arsenic, potassium, total phosphorus /orthophosphate, selenium and sulfate).

Downgradient well 189 did not show any statistically significant trends; however, the data set for this well and well 190 is limited to twelve data points, since they were not installed until 2003 (the longer term and recent data period are equal for wells 189 and 190). Thus the power of statistical testing to discern trends at these wells is thus also limited. As additional data are collected from wells 189 and 190, statistical power will increase. Nevertheless, the Mann-Kendall results of ―no significant trend" for groundwater constituents at these two wells appear to accurately describe the data sets, based on the trend plots in Appendix J.

The longer term trend evaluation for the calciner ponds area indicates that, with the exception of sulfate at well 136 and potassium at well 110, parameter concentrations in wells downgradient of the calciner ponds do not show an increasing trend, and in fact show decreasing trends in a number of cases. There are no short-term increasing trends in any of the downgradient calciner pond wells. Decreasing trends are evident for key calciner ponds indicator parameters such as potassium at both well 136 and well 143. The longer term increasing sulfate trend at well 136 tracks closely with similar trends at all three upgradient wells, suggesting that changes in sulfate concentration at this well are likely attributable to a source(s) other than the calciner ponds.

Increasing trends of sulfate, orthophosphate, potassium and arsenic in wells upgradient of the calciner ponds may indicate that the Simplot gypstack is contributing increasing levels of these constituents to groundwater upgradient of the calciner ponds over time. There is consequently a potential for these constituents to increase in concentration over time in samples collected from wells downgradient from the calciner ponds, and potentially reverse the currently stable or decreasing concentration trends in these downgradient wells. An evaluation of the source areas in the joint fenceline / calciner pond area is described in Section 5.2.3.

Section 5.1.4 Area North of Highway 30 and Interstate 86

As described in Section 4, the groundwater impacts in the area north of Highway 30 and Interstate 86 (I-86) can be summarized as elevated (i.e., greater than the representative level) concentrations of common ions, elevated concentrations of nutrients such as nitrate and total phosphorus / orthophosphate, and elevated levels of metals such as arsenic. The area north of Highway 30 and I-86 includes a series of wells that historically and currently are on the fringe or outside of the EMF-impacted groundwater area. These wells form a ―fence" of sentry wells to the north of the EMF site that extends from wells 523 and 501 (north of the western ponds area), to wells 516 and 502 (north of the central plant and joint fenceline areas), to well TW-11S (north of the Simplot plant) and to wells 524 and 525 north of Batiste Spring.

Common Ions and Nutrients

As shown on Figures 5.1-3 and 5.1-4, potassium and sulfate concentrations exceed their representative levels in groundwater in the area north of Highway 30 and I-86. As groundwater impacted by elevated potassium and sulfate from the western ponds area and joint fenceline area migrates northeast and downgradient from the northern boundary of the FMC Plant Site (e.g., wells 111, 146 and 110), groundwater flow lines merge and turn easterly in the area north of Highway 30. Potassium and sulfate concentrations at wells TW-9S, 517 and TW-12S exceed their representative concentrations in this area. The potassium concentrations at wells TW-9S and 517 are in the range from 50 to 100 mg/l (4 to 8 times the representative level) but decrease rapidly downgradient at well TW-12S, where the average potassium concentration is 15.7 mg/l. Sulfate concentrations at wells TW-9S, 517 and TW-12S are in the range of 150 to 200 mg/l and do not appear to decrease downgradient as observed for potassium concentrations at well TW-12S.

Potassium and sulfate concentrations do not exceed their representative concentrations in the northern sentry wells 523, 514, 516, 502 TW-11S, 524 and 525. Potassium concentrations at sentry wells 501 and 515 do not exceed the representative concentration. However, the sulfate concentration at well 501 (May 2008 result of 78.9 mg/l) slightly exceeds the representative concentration of 72.6 mg/l) and that at well 515 (average concentration of 132 mg/l) exceeds the representative concentration by a factor of about 1.8. The 2006 to May 2008 average sulfate concentration at well 515 is comparable to the EMF RI average of 113.5 mg/l. As described below, there is no long term or recent sulfate concentration trend at this well. Since none of the other key indicator parameters exceed their representative concentrations at well 515, the overall groundwater chemistry does not suggest this well is EMF-impacted. The elevated sulfate may reflect natural variability in representative sulfate levels or may be a result of agricultural practices on the parcels neighboring this well.

Potassium concentrations at Batiste Spring slightly (by less than a factor of 1.3) exceed the representative level. Sulfate concentrations at Batiste Spring exceed the representative level by a factor of about 1.9.

As shown on Figures 5.1-5, the nitrate concentrations exceed their representative levels in groundwater in the area north of Highway 30 and I-86. As groundwater impacted by elevated ammonia and nitrate from the western ponds area and joint fenceline area migrates northeast and downgradient from the northern boundary of the FMC Plant Site (e.g., wells 111, 146 and 110), groundwater flow lines merge and turn easterly in the area north of Highway 30. Nitrate concentrations at wells TW-9S, 517 and TW-12S exceed their representative concentrations in this area. The nitrate concentrations at wells TW-9S and 517 are in the range from 8 to 14 mg/l (1.4 to 2.5 times the representative level). Ammonia concentrations at the FMC Plant Site northern boundary wells 111, 146 and 110 and wells TW-9S and 517 are below the representative concentration.

At downgradient well TW-12S, nitrate and ammonia concentrations exceed their representative levels. Nitrate and ammonia concentrations at Batiste Spring also exceed their representative levels. As shown on EMF RI Figures 4.4-21 and 4.4-22, ammonia and nitrate concentrations were significantly elevated in groundwater in the area of Simplot well 320 (average ammonia concentration greater than 30 mg/l and nitrate concentration greater than 60 mg/l). Simplot well 320 is upgradient from well TW-12S. The elevated ammonia and nitrate concentrations observed at well TW-12S and at Batiste Spring are likely influenced by the Simplot source(s) impacting groundwater in the area of well 320.

Nitrate and ammonia concentrations do not exceed their representative concentrations in the northern sentry wells 523, 514, 501, 515, 516, 502 TW-11S, 524 and 525.

As shown on Figures 5.1-6, the total phosphorus / orthophosphate concentrations exceed their representative levels in groundwater in the area north of Highway 30 and I-86. As groundwater impacted by elevated total phosphorus / orthophosphate from the western ponds area and joint fenceline area migrates northeast and downgradient from the northern boundary of the FMC Plant Site (e.g., wells 111, 146 and 110), groundwater flow lines merge and turn easterly in the area north of Highway 30. Total phosphorus / orthophosphate concentrations at wells TW-9S, 517 and TW-12S exceed the representative concentration in this area. The total phosphorus / orthophosphate concentrations at wells TW-9S and 517 are in the range from less than 1 to 3 mg/l (2 to 9 times the representative level).

At downgradient well TW-12S, the average total phosphorus / orthophosphate concentration (16.9 mg/l) exceeds the representative levels. The average total phosphorus / orthophosphate at Batiste Spring (18.99 mg/l) also exceeds the representative level. These concentrations are significantly higher than the total phosphorus / orthophosphate levels in groundwater migrating from the FMC Plant Area northern boundary wells and observed at downgradient wells TW-9S and 517 north of Highway 30. Based on Figure 4-5 from the Simplot 2007 (Groundwater) Annual Report (Simplot, 2008), total phosphorus / orthophosphate concentrations are significantly elevated in groundwater in the area of Simplot wells 340 and 320 (November 2007 total phosphorus concentrations greater than 300 mg/l and greater than 50 mg/l respectively). The total phosphorus / orthophosphate concentrations observed at well TW-12S and at Batiste Spring are likely influenced by the Simplot source(s) impacting groundwater in the area of well 320.

Total phosphorus / orthophosphate concentrations do not exceed their representative concentrations in the northern sentry wells 523, 514, 501, 515, 516, 502 TW-11S, 524 and 525.

Metals

As shown on Figure 5.1-2, arsenic concentrations exceed their representative levels in groundwater in the area north of Highway 30 and I-86. As groundwater impacted by elevated arsenic from the western ponds area and joint fenceline area migrates northeast and downgradient from the northern boundary of the FMC Plant Site (e.g., wells 111, 146 and 110),

groundwater flow lines merge and turn easterly in the area north of Highway 30. Arsenic concentrations at wells TW-9S, 517 and TW-12S exceed the representative concentration in this area. The arsenic concentrations at wells TW-9S and 517 are in the range from 0.02 to 0.06 mg/l (1.4 to 4 times the representative level) but decrease downgradient at well TW-12S where the average potassium concentration is 0.017 mg/l. The average arsenic concentration at Batiste Spring (0.022 mg/l) exceeds the representative level.

Arsenic concentrations do not exceed the representative concentration in the northern sentry wells 523, 514, 501, 515, 516, 502 TW-11S, 524 and 525.

As shown on Figure 5.1-7, selenium concentrations exceed the representative level in groundwater in the area north of Highway 30, but not in the area north of I-86. As groundwater impacted by elevated selenium primarily from the eastern potion of the central plant area and joint fenceline area migrates northeast and downgradient from the northern boundary of the FMC Plant Site in the area of well 110, groundwater flow lines merge and turn easterly in the area north of Highway 30. Selenium concentrations at wells 517 and TW-12S exceed the representative concentration in this area. The selenium concentration at well 517 is 0.014 mg/l (May 2008), but decreases downgradient at well TW-12S, where the average selenium concentration is 0.006 mg/l compared to the representative levl of 0.005 mg/l. The May 2008 selenium result for Batiste Spring is 0.0042 and the average selenium concentration at Batiste Spring is 0.005 mg/l. These results do not exceed the representative level. The average selenium concentration at Batiste Spring is due largely to the high proportion of undetected selenium results at a 0.005 mg/l reporting limit.

Selenium concentrations do not exceed the representative concentration in the northern sentry wells 523, 514, 501, 515, 516, 502 TW-11S, 524 and 525.

Manganese and boron concentrations exceed their representative levels only at well TW-9S in groundwater beneath the area north of I-86, as shown on Figure 5.1-8. Manganese and boron concentrations do not exceed their representative concentrations at any of the other wells or Batiste Spring in the area north of Highway 30 and I-86.

As described in Section 4.2.1, the May 2008 total uranium result for well 515 (0.014 mg/l) appears anomalous compared to the range of uranium concentrations for the other representative wells (0.0016 to 0.0043 mg/l). The uranium result for well 515 may be related to naturally-occurring uranium associated with the underlying volcanic lithology of the Sunbeam and/or Starlight Formations and upward groundwater movement from the lower to the upper aquifer zone in the area of well 515. Note that the pH at well 515 (7.52 as measured May 2008) is not depressed compared to the representative groundwater pH range. The elevated uranium could also be related to the agricultural practices on the parcels neighboring this well. As described above, other than sulfate concentrations slightly higher than the representative level, all of the other indicator parameters indicate that well 515 is not impacted by EMF sources.

Based on the collective (EMF RI and post-RI) groundwater results as described in Section 4 of this report, aluminum, antimony, beryllium, cadmium, copper, lead, molybdenum, mercury, silver, thallium and zinc are not FMC-related groundwater constituents in the area north of Highway 30 and I-86.

Radiological Parameters

Based on the May 2008 monitoring results, gross alpha activities exceed the representative range only in well 515 in the area north of Highway 30 and I-86. None of the other wells or Batiste Spring in the area north of Highway 30 and I-86 exceed the representative range.

As described in Section 4.2.1, the gross alpha activity at well 515 appears to correlate with the uranium result that is also higher than the range for the other representative wells. The elevated gross alpha result for well 515 may be related to naturally-occurring uranium associated with the underlying volcanic lithology of the Sunbeam and/or Starlight Formations and upward groundwater movement from the lower to the upper aquifer zone in the area of well 515. The elevated gross alpha activity could also be related to the agricultural practices on the parcels neighboring this well. As described above, other than sulfate concentrations slightly higher than the representative level, all of the other indicator parameters indicate that well 515 is not impacted by EMF sources.

Elevated gross beta activities in the area north of Highway 30 and I-86 correlate with potassium concentrations (i.e., gross beta activities are commensurate with expected activities of potassium-40, a beta emitter, given its natural abundance) as described above in Section 4.

Based on the post-RI results, radium-226 and radium-228 are not FMC-related groundwater constituent in the area north of Highway 30 and I-86.

Organic Parameters

Based on the EMF RI and post-RI results, no significant concentrations of organic compounds have been detected in groundwater beneath the in the area north of Highway 30 and I-86.

Other Inorganic Parameters

Total cyanide has not been detected at wells or Batiste Spring in the area north of Highway 30 and I-86. Similarly, elemental phosphorus has not been detected at wells or Batiste Spring or Swanson Road Spring (the Spring at Batiste Road) in the area north of Highway 30 and I-86. Based on the results, these constituents are not FMC-related groundwater constituents in the area north of Highway 30 and I-86.

Groundwater Quality Trends

Concentration time-series (or trend) plots for the key indicator parameters (arsenic, potassium, total phosphorus / orthophosphate, and sulfate) and the general indicator specific conductance are provided in Appendix J. The trend plots show concentration trends through May 2008 for wells 501, 515, 516, TW-9S, TW-11S, 524 and 525 and Batiste Spring in the area north of Highway 30 and Interstate 86.

In addition to trend plots, the Mann-Kendall test for trend was used to evaluate the presence or absence of statistically significant trends in the indicator parameters arsenic, potassium, total phosphorus / orthophosphate, and sulfate in wells and Batiste Spring in the area north of Highway 30 and I-86. The Mann-Kendall trend tests were conducted at the 95% confidence level. The test for trend was performed for two different time periods: 1) all data through May 2008 to evaluate potential ―longer term" trends that include the data prior to and during the EMF RI and 2) monitoring year 2002 through May 2008 (―recent time period") to evaluate potential recent trends while also capturing sufficient data points for a meaningful test. The results of the Mann-Kendall trend tests for selected monitoring wells and Batiste Spring for all years through May 2008 and 2002 through May 2008 are shown on Tables 5.1-5A and B, respectively. The results are discussed below.

There is a longer term decreasing trend for potassium and total phosphorus / orthophosphate and an increasing trend for sulfate at well TW-9S. These trends are generally consistent with the longer terms trends at well 111 (FMC Plant Site northern boundary) that is upgradient from well TW-9S. The trends at well TW-9S may be related to changes in precipitation / recharge patterns, causing localized variations in groundwater flowpaths as the impacted groundwater from the western ponds area migrates through the area of well 111 and then to well TW-9S. Due to the discontinuation of routine monitoring at well TW-9S in 2001, there are not sufficient data to evaluate potential short term trends.

As expected, there are very few longer term trends at the northern sentry wells 501, 515, 516, TW-11S, 524 and 525. The apparent longer term increasing total phosphorus / orthophosphate trends at wells 515, TW-11S and 524 are artifacts due to undetected results at higher detection limits for the post-RI data. As shown below, the majority of the results for these wells are undetected and the detected results for these wells are below the representative concentration:

Well	Number of Results	Detected Results	Maximum Detected Result (mg/l)	EMF RI Detection Limit (mg/l)	Post RI Detection Limit (mg/l)
515	24	1	0.037 (12/1993)	0.02 – 0.04	0.1 – 0.5
TW-11S	26	6	0.04 (12/1991)	0.02 – 0.04	0.1 – 0.5
524	26	3	0.28 (5/2004)	0.02 – 0.04	0.1 – 0.14

There is also an apparent longer term decreasing sulfate trend at well 524 and 525; however, the historic and current sulfate results for these wells are below the representative concentration. The apparent sulfate trend may relate to variability in precipitation and recharge patterns in the Michaud aquifer.

There is no evidence of short term trends in wells 515, 524 and 525. Due to the discontinuation of routine monitoring at wells 501, 516 and TW-11S, there are not sufficient data to evaluate potential short term trends.

There is a longer term decreasing trend for arsenic and sulfate and an increasing total phosphorus / orthophosphate trend at Batiste Spring. As described above, the 4Q2006 to 2Q2008 average total phosphorus / orthophosphate at Batiste Spring is 18.99 mg/l compared to the EMF RI average of 1.9 mg/l (EMF RI Table 4.4-16). The average concentration at Batiste Spring is significantly higher than the total phosphorus / orthophosphate concentrations in groundwater migrating from the FMC Plant Area northern boundary wells (1 to 4 mg/l average at wells 111, 146 and 110) and observed at downgradient wells TW-9S and 517 (3.21 and 0.92 mg/l respectively) north of Highway 30. Based on Figure 4-5 from the Simplot 2007 (Groundwater) Annual Report (Simplot, 2008), total phosphorus / orthophosphate concentrations are significantly elevated in groundwater in the area of Simplot wells 340 and 320 (November 2007 total phosphorus concentrations greater than 300 mg/l and greater than 50 mg/l respectively). The total phosphorus / orthophosphate concentrations observed at well TW-12S and at Batiste Spring are likely influenced by the Simplot source(s) impacting groundwater in the area of well 320.

There is a recent increasing trend for arsenic, potassium and total phosphorus / orthophosphate at Batiste Spring. As shown on the time-series plots for Batiste Spring (Appendix J), arsenic, potassium, total phosphorus / orthophosphate and sulfate concentrations at Batiste Spring decreased during the 2000 to 2001 time period to near or below historic minimum levels. The concentrations remained at those relatively low concentrations until the 2003 to 2004 time period, when arsenic, potassium, total phosphorus / orthophosphate and to a lesser degree sulfate concentrations began to increase to pre-2000 levels. Based on the trend results and trend plot,

only the total phosphorus / orthophosphate concentration has increased significantly compared to historic levels at Batiste Spring.

The lower concentrations of arsenic, potassium, total phosphorus / orthophosphate and sulfate observed at Batiste Spring during the 2001 to 2004 time period may be related to long term precipitation and recharge patterns in the Bannock Range and Michaud Flats. As stated in the IDEQ report –Evaluation Of Water Quality Impacts Associated With FMC And Simplot Phosphate Ore Processing Facilities, Pocatello, Idaho" (IDEQ, 2004), –The source of water to Batiste Spring has changed over time, based on water quality and stable isotope data. Discharge at the spring currently appears to be from regional ground water, whereas underflow from the FMC and Simplot facilities supplied much of the water to the spring in the past. A significant decrease in area wide precipitation over the past several years may have caused this change in the ground water flow." Regional precipitation has been closer to average over the 2005 to 2007 period, and the groundwater flow pattern from the EMF facilities to Batiste Spring appears to have returned to those observed during the 1990s.

Section 5.2 Source Area Evaluation

This section presents an evaluation of the sources of groundwater impacts identified and discussed in Section 5.1 for the four groundwater areas within the FMC Plant OU as follows:

- Western Ponds Area;
- Central Plant Area;
- Joint Fenceline / Calciner Ponds Area; and,
- Area North of Highway 30 and Interstate 86.

The source evaluation is further broken down by FMC Plant Site RU within the western ponds area, the central plant area and the joint fenceline / calciner ponds area. Figure 5.1-1 shows the groundwater areas and RUs as delineated in the SRI Report (MWH, 2008).

The EMF RI Report (Bechtel, 1996), Remedial Investigation Update Memorandum for the FMC Plant OU (FMC, 2005) and the SRI for the FMC Plant OU (MWH, 2008) present the results of extensive sampling and analysis of the feedstocks, byproducts, co-products, waste materials and fill materials at the FMC Plant Site. These reports also present the results of extensive surface and subsurface soil sampling and analysis that has been performed at the FMC Plant Site. The results of these material and subsurface investigations are referenced and utilized in the source evaluations presented in this section, but are not reproduced herein.

The source evaluations focus on site-related constituents observed in groundwater at the monitoring wells within and downgradient from the potential or previously identified source

areas. Although the FMC monitoring well network was not designed nor intended to provide RU-by-RU upgradient and downgradient wells, these potential or previously identified source areas can be evaluated based on the groundwater chemistry observed in the site-wide well network.

Section 5.2.1 Western Ponds Area

As shown on Figure 5.1-1, the western ponds area includes the following RUs:

- RU 6 - Former Long-Term Phos Storage Tanks
- RU 12– Former RP&S Area and Mobile Shop (western portion only – the former LDR facility)
- RU 13 – Pond 8S Recovery Process and Metal Scrap Preparation Area
- RU 19– Slag Pile (included in central plant area), Bull Rock Pile (western portion only – the bull rock pile)
- RU 20 - Former Bannock Paving Area
- RU 21 – Other Onsite Railspurs (within Western Ponds Area)
- RU 22a – RCRA Ponds
- RU 22b – Old (phossy) Ponds
- RU 23 – Road Segments not within RU Boundaries (within Western Ponds Area)
- RU 24 – Plant Areas not within RU Boundaries (within Western Ponds Area)

5.2.1.1 RUs with Sustained Hydraulic Head – Western Ponds Area

As described in Section 4 and Section 5.1, the old unlined phossy ponds (RU 22b) and former unlined Pond 8S (within RU 22a) were identified as sources of constituents to groundwater. During the EMF RI, three samples of phossy pond influent (phossy wastewater and precipitator slurry) were analyzed for common ions and metals. The results from these samples are presented on EMF RI Table 4.2.3-3. Because the samples were not filtered, the results represent both dissolved-phase and solid-phase constituents. The range of results for phossy pond wastewater constituents that have been detected above representative concentrations in groundwater downgradient from these source areas is summarized below:

Constituent	Range of Results for EMF RI Phossy / Precipitator Pond Influent Samples (mg/l)
Potassium	2,890 - 9,890
Chloride	307 - 740
Sulfate	2 - 7,900
Phosphorus, total	1,370 - 7,680
Ammonia	29.7 – 39.6
Nitrate	0.39 – 0.6
Fluoride	436 – 1,510
Arsenic	0.0486 - 0.1454
Boron	0.001 – 0.114
Manganese	0.2 – 11.63
Selenium	0.2069 - 0.2292

During the Phase I and II EMF RI, the old phossy ponds area and Pond 8S were investigated including borings and soil sampling and analysis to groundwater. EMF RI borings were drilled within the footprint of the following old phossy ponds in RU 22b: former Pond 1E, former Pond 4E, former Pond 5E, former Pond 6E, and former Pond 7E; and around the perimeter of former Pond 8S within RU 22a. The EMF RI found that the analytical results for soil samples taken beneath the old phossy ponds indicated that with the exception of zinc, little to no migration of trace metals into the soils has occurred. There is evidence of the continued migration to depth of fluoride, total phosphorus, potassium, and to a lesser extent zinc. Note that the soil samples from these borings were analyzed for all of the EMF RI metals, but were not analyzed for chloride, sulfate, ammonia and nitrate. Based on the groundwater monitoring data, chloride, sulfate, ammonia and nitrate have migrated to depth and are old phossy pond-related constituents in groundwater.

Neither total cyanide nor elemental phosphorus were analyzed in the phossy pond influent samples during the EMF RI. However, FMC analyses of phossy water and precipitator slurry samples for total cyanide subsequent to the EMF RI identified total cyanide as a potential pond-related constituent. Elemental phosphorus was known to be present in the old phossy ponds, former Pond 8S and other RCRA ponds, a fact that is well documented in the EMF RI Report and FMC RCRA-related documents (e.g., RCRA Pond Closure Plans); however, no EPA-

approved analytical method was available at the time of the EMF RI. The EMF RI Report and the logs for the borings drilled in the old phossy ponds and around former Pond 8S do not indicate that visual evidence (smoking or burning) was encountered in any of the borings referenced above.

Total cyanide and elemental phosphorus were investigated in groundwater in the western ponds area as described in Section 4. As described in Section 5.1, total cyanide has been detected in groundwater impacted by the old phossy ponds (RU 22b) and former Pond 8S (RU 22a). The groundwater results for elemental phosphorus from wells within the identified pond-impacted groundwater area do not indicate that RUs 22a and 22b are a source of elemental phosphorus to groundwater in the western ponds area.

As described in Section 5.1, there is a delineated area of groundwater impact associated with RU 22b and former Pond 8S. Due to the commingling of impacted groundwater from the old phossy ponds and Pond 8S in the western ponds area, a determination of which individual old phossy ponds released more or less mass of constituents to the groundwater system is not possible. However, the highest concentrations of pond-related impacts to groundwater can be related to one or several of the old phossy ponds and former Pond 8S as shown on Figures 5.1-2 to 5.1-9.

Former Pond 8S

The highest concentrations of potassium, manganese, boron, ammonia and total phosphorus / orthophosphate in groundwater at the FMC Plant Site are encountered in wells downgradent from former Pond 8S. The average total phosphorus / orthophosphate concentration at Pond 8S downgradient wells 155, 156 and 157 ranges from 39.4 to 278 mg/l. The concentrations at wells 156 and 157 are higher than any other wells in the western ponds area and central plant area by over a factor of 5.9. As described in sections 4.2 and 5.1, former Pond 8S is also a source of arsenic, selenium, sulfate and total cyanide to groundwater beneath the western ponds area. The removal of free water, initial fill and temporary cover at Pond 8S was completed in 1994 and the final RCRA closure was completed in 1999. Groundwater quality downgradient from Pond 8S has improved and is expected to continue to improve as a result of the closure actions.

Former Ponds 3E, 4E, 5E and 6E

The highest concentrations of arsenic, sulfate, nitrate and total cyanide in groundwater at the western ponds and central plant area are encountered downgradient from former ponds 3E, 4E, 5E and 6E. The area of highest impact to groundwater from these former ponds is observed in wells 115, 166, 168, 131 and 139. Some of these wells are located within the footprint of former ponds 3E and 5E or are immediately downgradient from these ponds collectively. As described in sections 4.2 and 5.1, these former ponds are also a source of potassium, manganese, boron, selenium, sulfate, nitrate, total phosphorus / orthophosphate and total cyanide to groundwater beneath the western ponds area. As described below, multiple lines of evidence support FMC‘s hypothesis that the elevated concentrations observed at wells within the footprint and

downgradient from former ponds 3E, 4E, 5E and 6E are more likely related to historic releases from these former ponds than a current release from RCRA Pond 15S or the Phase IV ponds.

The groundwater conditions and trends observed at the wells downgradient from Pond 8S provide a useful model for groundwater impacts from a phossy water / precipitator slurry pond prior to and after removal of the hydraulic head and installation of a low permeability cover system. As described in Sections 4.2.2 and 5.1.1, groundwater downgradient from Pond 8S contains elevated levels of the indicator parameters arsenic, potassium and total phosphorus / orthophosphate. In addition, groundwater downgradient from Pond 8S also contains elevated ammonia, up to 25 mg/l prior to initiation of closure, and up to 15 mg/l in 2008; however, nitrate is not significantly elevated, up to 6 mg/l ,compared to the representative nitrate concentration of 5.5 mg/l (Table 4.2-1). The relationship between ammonia (reduced form of nitrogen) and nitrate (oxidized form of nitrogen) is expected given that the furnace production process was operated under highly reducing conditions. As shown on the inset table at the beginning of this section, analyses of the phossy pond / precipitator slurry influent showed ammonia concentrations of 20 to 40 mg/l compared to nitrate concentrations less than 1 mg/l.

As described in Section 5.1, the initial fill and removal of the standing hydraulic head from Pond 8S was completed in 1994. Since that time, downgradient wells 155, 156 and 157 all show decreasing trends for the arsenic, potassium and total phosphorus / orthophosphate over the longer term. Figures 5.2-1A through 5.2- 1E show time series plots for arsenic, potassium, ammonia, nitrate and total phosphorus / orthophosphate, respectively, at wells 150, 151, 152, 155, 156 and 157 immediately downgradient from Pond 8S. The ammonia and nitrate time series plots are included to further illustrate the relationship between ammonia and nitrate in groundwater downgradient from Pond 8S as described above and depicted on Figure 5.1-5B. These figures also show a vertical line corresponding to the completion of the initial fill and removal of the standing hydraulic head from Pond 8S in September 1994. Based on observations from Pond 8S, current or recent (within 10 to 15 years following dewatering) phossy pond impacts to groundwater would be expected to exhibit the following characteristics:

- Arsenic concentrations in the range of 0.05 to 0.5 mg/l;
- Potassium concentration in the range of 250 to over 1,000 mg/l;
- Total phosphorus / orthophosphate concentrations in the range of 10 to over 400 mg/l;
- Ammonia concentrations in the range of 1 to 15 mg/l ;
- Ammonia concentrations are consistently higher than nitrate concentrations;
- Over time and during migration in the groundwater system, oxidizing conditions are restored and the ammonia concentrations decrease with a corresponding increase in nitrate concentrations (i.e., conservation of the mass of nitrogen); and,

- Following dewatering and installation of a low permeability cover system, gradually decreasing concentrations of pond-related constituents in groundwater (e.g., arsenic, potassium, total phosphorus / orthophosphate).

The former unlined ponds 3E, 4E, 5E and 6E were removed from service and dried in 1980 and 1981, and were partially excavated for the construction of the Phase IV ponds in 1981 and Pond 15S in 1982 (EMF RI Report [Bechtel 1997], Appendix M). Portions of these former ponds were not covered by the Phase IV ponds and Pond 15S (Figure 5.1-1). The initial fill, dewatering and temporary cover phase of the RCRA closures of the Phase IV ponds and Pond 15S was completed during 1999 and the final cover and closures were completed in 2004.

Assuming that the source of groundwater impacts in these wells is either Pond 15S and/or the Phase IV ponds and these units were dewatered five years later than Pond 8S, the results from one or more of these wells would be expected to fit the Pond 8S model. Figures 5.2-2A through 5.2- 2E show time series plots for arsenic, potassium, ammonia, nitrate and total phosphorus / orthophosphate at wells 113, 114, 115, 131, 166 and 168 located downgradient from RCRA Pond 15S and the Phase IV ponds and also within the footprint of and downgradient from former pond 3E, 4E, 5E and 6E. These figures also show a vertical line corresponding to the completion of the initial fill and removal of the standing hydraulic head from Pond 15S and the Phase IV ponds in September 1999. The results from these wells deviate significantly from the Pond 8S model:

- Arsenic concentrations are below 0.15 mg/l in all of the wells with the exception of the concentration at well 115 of about 0.25 mg/l (May 2008) that is slightly higher the current (2008) range for the Pond 8S wells (0.1 to 0.2 mg/l);

- Potassium concentration range from 7 to 35 mg/l – more than one order of magnitude lower than the Pond 8S wells;

- Total phosphorus / orthophosphate concentrations range from 0.25 to 8 mg/l - – more than one order of magnitude lower than the Pond 8S wells;

- Ammonia concentrations are primarily non-detect (less than 0.2 mg/l) and in all wells are less than 2 mg/l.

- Nitrate concentrations range from less than 1 to 26 mg/l and are consistently higher than ammonia concentrations; and,

- Following dewatering and installation of a low permeability cover system at Pond 15S and the Phase IV ponds, most of the constituents (arsenic, potassium, nitrate and total phosphorus / orthophosphate) and wells show little or no trend and no decreasing trend as would be predicted based on the observed trends at Pond 8S after installation of the initial fill and cover. In fact, arsenic at well 115, potassium at wells 114 and 115, and nitrate at

wells 113, 115 and 166 appear to follow increasing trends after the dewatering and temporary cover was installed at Pond 15S and the Phase IV ponds in 1999.

Although the former ponds 3E, 4E, 5E and 6E were dewatered in 1980 and 1981, the portions of these ponds that are not overlain by the Pond 15S and Phase IV ponds are not covered by a low permeability cover system. The runoff from the RCRA covers at the Phase IV ponds and Pond 15S into the topographically lower areas to the south (portions of former ponds 4E and 6E), and to a lesser degree north (portions of former ponds 3E and 5E), may be creating artificially high infiltration through these old ponds and additional mobilization of pond-related constituents through the vadose zone into groundwater. FMC raised the potential for runoff from the RCRA pond covers into the surrounding ―old phossy pond" areas in its letter to EPA dated May 24, 1999. The interim stormwater management actions described in the May 24, 1999 letter were installed as proposed; however, those ―interim" measures were not designed nor could these measures 1) prevent precipitation and run-on to the old phossy pond areas from other surrounding areas (e.g., the roadway to the south of these former pond areas), or 2) remain in place after installation of the final cover systems at Pond 15S and the Phase IV ponds that was completed in 2004. A copy of the FMC May 24, 1999 letter is provided in Appendix L. Following the Agency-FMC meeting on December 16, 2008 to discuss preliminary comments on the GWCCR, this area of the site was discussed and FMC forwarded an annotated copy of the May 24, 1999 letter to the Agencies after the meeting. A copy of the annotated letter is also provided in Appendix L.

In summary, FMC believes the groundwater conditions observed at the wells downgradient from Pond 15S / the Phase IV ponds and the former ponds 3E, 4E, 5E and 6E are more likely attributable to the former ―old phossy" ponds based on these lines of evidence:

- The ranges of potassium and total phosphorus / orthophosphate concentrations in the wells downgradient from old ponds 3E – 6E are not consistent with groundwater impacted by a recent (within 10 to 15 years) phossy pond release to groundwater as observed at Pond 8S. Potassium, which is highly soluble and would not be attenuated in the vadose zone by sorption or precipitation, and total phosphorus / orthophosphate concentrations in these wells indicate an attenuated source of these mobile constituents that is ―older" than Pond 8S.

- Ammonia concentrations and ammonia to nitrate ratios in the wells downgradient from old ponds 3E – 6E are not consistent with groundwater impacted by a recent (within 10 to 15 years) phossy pond release to groundwater as observed at Pond 8S, rather the advanced oxidation of ammonia to nitrate in these wells indicates a source to groundwater ―older" than Pond 8S.

- Increasing indicator-parameter (arsenic, potassium and nitrate) concentration trends in several of the wells downgradient from the Pond 15S / Phase IV ponds area began after the initial fill, removal of standing hydraulic head and temporary cover installation at Pond 15S and the Phase IV ponds. These trends are inconsistent with the decreasing trends observed following the initial fill, dewatering and temporary cover at Pond 8S that

would have been predicted for Pond 15S or the Phase IV ponds if these units had been a source of groundwater impacts. As described above, these trends may be related to infiltration of precipitation and run-on from surrounding areas into the low-lying portions of former ponds 3E, 4E, 5E and 6E.

Former Pond 7E

As described in sections 4.2 and 5.1, former pond 7E is a source of arsenic, potassium, selenium, sulfate and nitrate to groundwater beneath the western ponds area. The area of highest impact to groundwater from former pond 7E is observed in wells 170/180, 171/181, 172/182 and 178 and appears to extend to the north to the area of well 148. The highest concentrations of pond-related constituents (with the exception of sulfate at well 178) are found in wells 170/180 and 172/182 that are located within the footprint of former pond 7E.

Former pond 7E was constructed in approximately 1969 by excavating a low-lying area and creating an earthen berm along the northern and western perimeters. This pond received phossy pond water for several years until 1981, when its use as an overflow area was discontinued. No pond sediments have been observed within the former pond 7E area. The eastern approximately 150 feet of the pond 7E area was excavated for the construction of Pond 15S in 1982 and Pond 9E in 1986 (EMF RI Report [Bechtel 1997], Appendix M). The former pond 7E northern/western berm still exists today. Wells 170/180 and 172/182 are in the vicinity of the former pond‘s low lying area. That area collects runoff from the surrounding areas, and may be creating artificially high infiltration through this pond area and additional mobilization of pond-related constituents through the vadose zone into groundwater.

Former Ponds 1E, 2E and the “S” Ponds

The former ponds 1E, 2E and the ~~“S~~-series” ponds (e.g., 0S, 1S, 2S, etc.) are located north and northeast of former Pond 8S and are part of RU22b. Pond-related constituents in groundwater are encountered in wells throughout the ~~“S~~” ponds area, but former or current impacts from these ponds are largely indiscernible due to the overriding influence of impacts from former pond 8S and from former ponds 3E, 4E, 5E and 6E as these plumes converge in the area of well 134 and former ponds 0S, 1S, 2S and 3S and migrate downgradient into the central plant area.

5.2.1.2 RUs without Sustained Hydraulic Head – Western Ponds Area

RU 13

As discussed in the SRI Report (MWH, 2008), former phossy pond sediments and plant fill materials were encountered in the subsurface in RU 13. As described above for the ~~“S~~” ponds, potential impacts to groundwater from these pond sediments / fill materials would be largely indiscernible due to the overriding influence of impacts from former pond 8S. As a practical

matter, the area of RU 13 where pond sediments are present in the subsurface should be considered as part of RU 22b.

RU 19

As described above, the majority of the wells located downgradient from RU 19 (bull rock pile area) including wells 104, 116, 120, 151 and 135 are impacted by former pond 8S and other old phossy ponds within RU22b. Wells 158 and 183 are located at the downgradient toe of the bull rock pile and upgradient from former pond 8S. However, these wells are in close enough proximity to former pond 8S (within about 100 feet) to be potentially affected by releases from that pond. The average concentrations of sulfate and selenium at well 183 are slightly higher than their representative concentrations, but none of the other indicator parameters (specific conductance, potassium, chloride, total phosphorus/orthophosphate and arsenic) are above their representative concentrations (Table 4.2-12). Similarly, the average concentrations of potassium and sulfate (and specific conductance) at well 158 are higher than their representative concentrations, but none of the other indicator parameters (chloride, total phosphorus/orthophosphate, arsenic and selenium) are above their representative concentrations.

As described in Section 4.7.3.3, entitled *Reference Area Investigation – Ore* of the SRI Report (MWH, 2008), ore-related constituents were not found to have leached into the subsurface at the ore handling area (RU 7). The bull rock pile consists of over-sized ore that was stockpiled in this area before FMC installed an ore crushing and screening system, and, as was the case at the ore handling area, no artificial hydraulic head was applied to his area. These findings indicate that the groundwater impacts observed at wells 158 and 183 are more likely related to former pond 8S and the old phossy ponds area than the bull rock pile.

Other RUs

Based on the results from the EMF RI and FMC Plant OU SRI subsurface investigations and the post-RI groundwater monitoring results, there is no evidence that RU 6 (Former Long-Term Phos Storage Tanks), RU 12 (western portion [former LDR facility]), – Former RP&S Area and Mobile Shop, RU 20 (former Bannock Paving Area), RU 21 (other onsite railspurs), RU 23 (road segments not within RU boundaries), or RU 24 (plant areas not within RU boundaries) are sources of site-related constituents to groundwater in the western ponds area.

Section 5.2.2 Central Plant Area

The central plant area includes the following RUs:

- RU 1 - Furnace Building, Phos Dock and Secondary Condenser
- RU 2 – Slag Pit

- RU 3 – Receiving, Stores, Paint Shop and P4 Decon building
- RU 4 – Office Buildings and Training Center
- RU 5 – Lab and Old Drainfield
- RU 7 (western half) – Shale Unload, Crushing and Stockpile
- RU 8 – Former Kiln Scrubber Ponds and Calciners
- RU 9 (western portion) – Silica Stockpiles and Former Kiln Scrubber Overflow Pond
- RU 11 – Equipment Area South of Calciners
- RU 12 (eastern portion) - Former RP&S Area and Mobile Shop
- RU 17 – Recyclable Material Landfill
- RU 18 – Plant Landfill
- RU 19 (slag pile) - Slag Pile, Bull Rock Pile (included in western ponds area)
- RU 21 – Other Onsite Railspurs (within Central Plant Area)
- RU 22c – Railroad Swale
- RU 23 – Road Segments not within RU Boundaries (within Central Plant Area)
- RU 24– Plant Areas not within RU Boundaries (within Central Plant Area)

5.2.2.1 RUs with Sustained Hydraulic Head – Central Plant Area

RUs 1 and 2

As described in Section 4.2.2 above, the slag pit sump within RU 2 was previously identified as a source of impacts to groundwater. An interim cover system was constructed over the slag pit sump in 1999 and the final RCRA closure was completed in 2005. Due to the migration of western ponds area impacted groundwater through the central plant area and the fact that the common ion, nutrient and metals constituents associated with the slag pit sump are the same as the phossy ponds, differentiating impacts solely attributable to the slag pit sump is not possible. Thus, the benefits of removing the hydraulic head and reducing infiltration by capping the slag

pit sump are also difficult to assess. The slag pit sump is a small feature within RUs 1 and 2 and is discussed below collectively with other sources in these RUs.

As described in the RI Update Memorandum for the FMC Plant OU (FMC, 2005) the Furnace Building, Phos Dock, and Secondary Condenser area (RU 1) and Slag Pit (RU 2) are considered together because of their proximity and because of the documented occurrence of P4 in the subsurface within the RU boundaries. In addition, these areas are former heat sources that likely affected the mobility of P4 in the subsurface. The following text, taken from the RI Update Memorandum, describes the conceptual model for releases and migration of P4 in the subsurface at RUs 1 and 2:

"Elemental phosphorus (P4) is a liquid at temperatures above 44 C and freezes (i.e., becomes solid) below that temperature and is essentially immobile in the subsurface. The P4 was maintained in a liquid during the majority of the manufacturing and handling processes at the plant. P4 was handled at temperatures typically in the range of 60 to 66 C while being transferred (i.e., displaced with water or pumped) between product vessels/tanks and for railcar loading. In the event of a P4 release, it would be released as a liquid, and migrate in the subsurface until it encountered soils with ambient temperatures less than 44 C. Once ambient soil temperatures fall below 44 C, P4 freezes and remains immobile as a solid. Soils beneath the slag pit and furnace building were heated to temperatures above 44 C from the intense heat source of continuous tapping of molten slag into the slag pit, until slag ladling was fully installed in 2000. FMC has documented P4 releases from certain specific areas and suspects that other historic releases of P4 have occurred in the former P4 working areas.

As noted above, when ambient temperatures exceed 44 C, elemental phosphorus is in a mobile, liquid state. In this state, it can seep through soil until it reaches areas with lower temperatures, at which time it solidifies and is no longer mobile as a liquid phase. The density of P4 in a liquid state is 1.7 grams per cubic centimeter (gm/cc). A P4 release from process equipment (all above the melting point) will migrate in a vertical, but tortuous path through the soil column. As long as there is a source of P4, and ambient temperatures remain above the melting point of P4, the P4 will continue migrating vertically to the water table. When the P4 encounters the groundwater, it will cool to below the melting point, and immobilize. As shown on Figure 5.1-13, the groundwater temperature at Well 108 exceeded 28 C, suggesting that groundwater with ambient temperatures of greater than 44 C could underlie the furnace building and slag pit (the most intense heat source).

Once the ambient temperatures fall below the P4 melting point, soluble concentrations of P4 would be transported by the groundwater. The solubility of P4 in water is 3 mg/l at 15 C, and if the water has an oxidizing Eh, the P4 will be converted to an oxidized phosphorus compound (orthophosphate). The maximum concentration of P4 observed in Well 108 was 0.258 mg/l (November 2003), well below the solubility limit of P4 in water."

This conceptual model was essentially validated during the SRI field investigation in 2007. That field investigation found evidence that P4 did migrate vertically through the soil column to

groundwater. It also found evidence that ambient groundwater temperatures of greater than 44 C probably did underlie the furnace building and slag pit, allowing horizontal migration of P4 at the groundwater interface (capillary fringe). However, the SRI findings modify the conceptual model with respect to the extent of downgradient migration of P4 in the capillary fringe.

As described in Section 4.2.3.2 of the SRI Report, P4 was visually detected in soils at the capillary fringe of the groundwater just north of RUs 1 and 2 at approximately 80 feet bgs. P4 was observed in soil collected at the capillary fringe just above the groundwater at approximately 83 feet bgs, as evidenced by smoking in borings RU1-CAP-SB004, RU1-CAP-SB005, and step-out boring RU1-CAP-SB004A. Refer to SRI Report Figure 4-1 for the location of these soil borings.

Seven additional borings were drilled to establish the maximum downgradient extent of P4 in the subsurface at any depth down to groundwater. P4 was not visually encountered in any of the borings down to groundwater, and none of the seven (7) borings reported analytical detections of P4. The sampled material ranged from silty sands to lean clays and exhibited very low hydraulic conductivity values, ranging from 2.3×10^{-6} to 1.2×10^{-8} cm/sec. The bulk dry density of the materials ranged from 80 to 96 pounds per cubic foot (pcf). Refer to SRI Report Figure 4-1 for the location of these soil borings.

The extent of P4 in the capillary fringe is described in the SRI Report and is not repeated here, except to note that the lateral extent of the capillary fringe impacted area was developed based on the SRI borings and the EMF RI findings that no P4 was reported in the soil column, including the capillary fringe, in the soil boring logs for wells 107, 108 and 122 and the SRI borings.

As described in Section 5.1, elemental phosphorus has been routinely detected at wells 108 and 122 downgradient from RUs 1 and 2. The maximum detected concentrations of P4 in groundwater at these wells is far below the maximum solubility of elemental phosphorus in water (3 mg/l at 15° C); therefore, elemental phosphorus detected in groundwater at wells 108 and 122 likely indicates low concentration dissolved P4 in groundwater outside the extent of the capillary fringe P4 area rather than dispersed solid-phase P4 within the capillary fringe ~~-s~~mear zone."

RUs 1 and 2 are clearly a source of elemental phosphorus to groundwater in the central plant area. However, these RUs do not appear to contribute discernable concentrations of other site-related constituents to groundwater. For example, total phosphorus / orthophosphate concentrations at wells 108, 122, 111 and 146 are lower than concentrations in the western ponds area impacted groundwater that migrates through the central plant area. The decreasing concentration gradient from well 134 (in the downgradient margin of the western ponds area) to downgradient wells 108 and 122 indicates attenuation of total phosphorus /orthophosphate as the western pond area plume migrates downgradient through the area of RUs 1 and 2.

The elemental phosphorus in groundwater at wells 108 and 122 is analytically quantitated as total phosphorus, so the total phosphorus results for well 108 of 1.56 mg/l (May 2008) and well

122 of 13.8 (May 2008) include the concentrations of elemental phosphorus of 0.03 and 0.001 mg/l (May 2008) respectively. The elemental phosphorus contribution to total phosphorus in groundwater is less than 2 percent at well 108 and less than 0.01 percent at well 122 for the May 2008 results. The maximum elemental phosphorus concentration measured at well 108 of 0.258 mg/l (November 2003) was less than 18 percent of the total phosphorus for that sampling event. The elemental phosphorus concentrations at these wells are essentially indiscernible from the total phosphorus / orthophosphate plume from the western ponds area. The fate of elemental phosphorus in groundwater at wells 108 and 122 is discussed in Section 6.

Similar to total phosphorus / orthophosphate, the arsenic, potassium, sulfate, nitrate, manganese, selenium and total cyanide concentrations follow a decreasing concentration gradient from well 134 (in the downgradient margin of the western ponds area) and well 121 (upgradient of RUs 1 and 2) to downgradient wells 108 and 122. This indicates an attenuation of these constituents as the western pond area plume migrates downgradient through the area of RUs 1 and 2. As described in Sections 4.2 and 5.1, nitrate concentrations initially increase downgradient from the western ponds area as ammonia oxidizes to nitrate in conjunction with the change in groundwater conditions from reducing near the ponds area sources to oxidizing conditions downgradient. Ammonia was undetected (0.2 mg/l detection limit) at wells 121, 108, 122, 111 and 146 during May 2008, indicating that ammonia contributed from the western ponds area sources have completely converted to nitrate as that groundwater flows beneath RUs 1 and 2.

RU 5

Based on the results from the SRI subsurface investigation and the EMF RI and post-RI groundwater monitoring results, there is no evidence that the Lab and Old Drainfield (historically an area of periodic applied hydraulic head) is a source of site-related constituents to groundwater in the central plant area.

RU 8 and 9

The former Kiln Scrubber Ponds and Calciners area (RU 8) and the Former Kiln Scrubber Overflow Pond (within RU 9) are considered together because the former kiln scrubber ponds and overflow pond and the calciner operation (calciners and calciner scrubber operations) are in close proximity, had similar source characteristic constituents, and groundwater beneath these RUs is influenced by other sources upgradient in the joint fenceline / calciner ponds area. The former kiln scrubber ponds and kiln scrubber overflow pond were operated with a sustained hydraulic head.

As described in the RI Update Memorandum, the former kiln scrubber ponds and the overflow pond were identified in the EMF RI as a potential source of contaminants to groundwater. However, no borings were drilled in this area during the EMF RI due to the presence of the operating calciners over the former kiln scrubber ponds. The kiln scrubber ponds were operated to clarify (settle solids) scrubber water from the former rotary kiln at the plant. The kiln scrubber overflow pond was operated as an overflow pond that received clarified water from the primary

settling ponds. All the kiln scrubber ponds were taken out of service in the late 1960's when the calciners were built in 1968. The concrete slab constructed for the calciners covered some of the area of the kiln scrubber ponds. The slab likely reduced infiltration of water through any remaining pond solids. However, some downward migration of metals may have occurred

during operation of the calciners, due to potential leaks in the subsurface piping and sumps associated with those units. The calciners ceased operation in 2001 with the plant shutdown.

As described in the SRI Report Section 4.8.3.2 entitled *Kiln Pond Delineation (RU 8 Cap)*, metals results for soil samples from several borings at the former kiln scrubber ponds and kiln scrubber overflow pond exceeded the soil to groundwater SSLs. Soil samples from the 5 to 7 feet bgs interval at boring RU8-CAP-SB013 located adjacent to the former kiln scrubber ponds and boring RU8-CAP-SB009 located adjacent to the former kiln scrubber overflow pond exceeded the soil to groundwater SSLs for arsenic and selenium. These results provided further evidence that the former kiln scrubber and overflow ponds were a likely source of contaminants to groundwater when they were under a sustained hydraulic head.

As described in Section 5.1, the selenium concentration at well 123 located downgradient from the former kiln scrubber ponds is the highest observed in groundwater at the FMC Plant OU wells. The selenium concentrations at well 143, located in close proximity to the southeast corner of the eastern former kiln scrubber pond, and at well 145, located downgradient from the former kiln scrubber overflow ponds, are also higher than the concentrations at wells located farther upgradient in the joint fenceline / calciner ponds area (Figure 5.1-7). In addition, based on the May 2008 groundwater results, the vanadium result for well 123 was higher than the representative level and the comparative value. Well 123 is the only well at the FMC Plant OU that has a vanadium concentration that exceeds the representative level. Nitrate is also elevated at well 143 compared to wells located farther upgradient in the joint fenceline / calciner ponds area (Figure 5.1-5). In addition, total cyanide has been detected at wells 143 and 123, but has not been detected at any other joint fenceline / calciner ponds area wells. The total cyanide concentrations at both wells were below the comparative value.

The concentrations of the other indicator parameters arsenic, potassium, sulfate, and total phosphorus / orthophosphate at wells 143, 123 and 145 are lower than their concentrations in upgradient wells in the joint fenceline / calciner ponds area. This indicates that these parameters are primarily associated with groundwater migrating from upgradient sources in that area, as described in Section 5.2.3.

As described in Section 5.1, there are longer-term decreasing trends in arsenic, potassium, total phosphorus / orthophosphate and sulfate concentrations at wells 143 and 123. Also, there is a longer-tern and recent decreasing trend in the selenium concentration at well 143. Selenium concentrations at well 123 were not tested for trend; however, as shown on Figure 5.2-5, the selenium concentration at well 123 has steadily decreased since the early to mid 1990s. Vanadium concentrations at well 123 have decreased slightly since monitoring began at this well in October 1990 as shown on Figure 5.2-5.

The former kiln scrubber ponds and former kiln scrubber overflow pond were likely sources of site-related constituents to groundwater. Due to joint fenceline / calciner pond area impacted groundwater migrating through the area of wells 143, 145 and possibly 123, it is not possible to isolate and quantify the groundwater impacts specific to the former kiln scrubber ponds and overflow pond. The selenium concentrations at wells 143, 123 and to a lesser extent well 145 indicate that the kiln scrubber ponds and overflow ponds were a primary source of this constituent to groundwater at the FMC Plant Site. However, the longer-term trends for selenium and the other primary indicator parameters indicate that the groundwater impacts from the former kiln scrubber ponds and overflow pond have been attenuating since monitoring of these wells began in the early 1990s.

RU 22c

The railroad swale was an area that received stormwater runoff from operating areas of the plant including the phos dock (RU 1). The railroad swale also received phossy water from spills in the RU 1 area. As a result of stormwater runoff events and phossy water spills, this area periodically was subject to an artificial hydraulic head. The liner that was installed over a portion of the railroad swale in 1993 would have decreased infiltration at the railroad swale after that date. As reported in the EMF RI Report Section 4.2, deeper soil samples from borings in the railroad swale did not indicate migration of site-related constituents to groundwater with the possible exception of total phosphorus / orthophosphate in a soil sample from 70 feet bgs. As described in the SRI Report Section 4.19.3.2, entitled *P4 Delineation (RU 22C Cap)*, elemental phosphorus was encountered in a trench at 10 ft bgs through the railroad swale that confirmed the presumed presence of P4 in the subsurface at the railroad swale.

Due to the migration of western ponds area impacted groundwater through the central plant area and the fact that the common ion, nutrient and metals constituents associated with potential releases from the railroad swale are the same as those from the phossy ponds, differentiating potential impacts solely attributable to the railroad swale is not possible. However, as shown on Figures 5.1-2 through 5.2-7, concentrations of indicator parameters do not increase in wells downgradient from the railroad swale (wells 111 and 146) compared to upgradient well TW-5S. Elemental phosphorus also has not been detected in well 111 and 146 downgradient from the railroad swale. Although the railroad swale may have been a source of groundwater impacts in the past as indicated by the EMF RI borings, there is currently no discernible contribution of site-related constituent from the railroad swale.

5.2.2.2 RUs without Sustained Hydraulic Head – Central Plant Area

RU 11

The Equipment Area South of Calciners was used for storage and staging of supplies and equipment. Joint fenceline area / calciner ponds impacted groundwater is encountered in well 143 at the eastern edge of RU 11 and in other wells downgradient from this area. However, as described in the SRI Report Section 4.11, metals, radionuclide and fluoride levels in underlying

native soils are not elevated above the soil to groundwater SSLs. The historic use of this area and SRI soil sampling results do not indicate that RU 11 is a likely source of site-related constituents to groundwater.

RU 17

The Recyclable Material Landfill history and the materials disposed there are described in the RI Update Memorandum and are not repeated here. This area was not operated with an artificial hydraulic head. Because there are no monitoring wells in the near vicinity of RU 17, an assessment specific to RU 17 as a potential source of constituents to groundwater is not possible. In addition, the monitoring wells located generally downgradient from RU 17, such as wells 106, 120, 158 and 183, are also downgradient from or within other potential or identified source areas (e.g., RU 14 and RU 22b). The potential groundwater impacts from RU 17 are discussed below collectively with RU 19 (slag pile) since these monitoring wells are also downgradient from the slag pile.

RU 18

The plant landfill history and the materials disposed there are described in the RI Update Memorandum and are not repeated here. The plant landfill was not subject to an artificial hydraulic head. As described in Section 4.3, two borings F027 and 138 were drilled at the FMC plant landfill to total depths of 140 and 168 feet bgs. These borings did not encounter groundwater in either the loess and alluvial sediments or the underlying volcanic bedrock. During the EMF RI, boring F027B was sampled and analyzed for the EMF RI organic and inorganic parameter lists. The soil samples taken from this borehole indicate little to no site-related impact with regard to inorganic or radiological parameters. A number of volatile organics were detected in these samples, in a random fashion. For the most part these organics appear to have been associated with laboratory-introduced contamination and there does not appear to be a clear association with site landfill activities. The results of the soil sampling and analysis from boring F027 are presented in the EMF RI Report Section 4.2.3.2. The results from boring F027 provide evidence that site-related constituents have not migrated into the subsurface. More importantly, the lack of groundwater beneath the plant landfill to a depth of at least 168 feet strongly indicates that the plant landfill is not and cannot be a source of groundwater impacts.

RU 19

The slag pile history and the materials disposed there are described in the RI Update Memorandum and SRI Report and are not repeated here. Similar to the discussion for the bull rock pile (RU 19) and the Recyclable Material Landfill (RU 17), because the majority of the wells located downgradient from RU 19 are impacted by other source areas, discerning potential impacts associated with the slag pile is complicated by identified impacts from the western ponds area and joint fenceline / calciner ponds area.

As described in Section 4.16.3.3, entitled *Reference Area – Slag (RU 20 REF)* of the SRI Report (MWH, 2008), slag-related constituents (metals, fluoride and radionuclides) were not found to have leached significantly into the subsurface at the slag reference area in RU 20. The slag pile consists primarily of slag (much greater by volume than the non-slag materials also located there, i.e., the old plant landfill and a number of buried railcars) and was not operated with an artificial hydraulic head. Therefore the findings of the RU 20 slag reference study are applicable to the slag pile. These findings do not indicate a potential for slag pile impacts to groundwater with respect to metals, fluoride or radionuclides. Potential slag pile impacts with respect to organic compounds are not an issue; as described in Sections 4 and 5.1, groundwater at the FMC Plant Site including wells downgradient from RU 19 has not been impacted by organic compounds.

Wells located downgradient from RU 19 including wells 167, 116, 120, and 135 are impacted by former pond 8S and other old phossy ponds within RU22b. Wells 158 and 183 are located downgradient of the bull rock pile and slag pile and upgradient from former pond 8S. However, these wells are in close enough proximity to former pond 8S (within about 100 feet of the pond area) to be potentially affected by releases from that pond. The average concentrations of sulfate and selenium at well 183 are slightly higher than their representative concentrations, but none of the other indicator parameters (specific conductance, potassium, chloride, total phosphorus/orthophosphate and arsenic) are above their representative concentrations (Table 4.2-12). Similarly, the average concentrations of potassium and sulfate (and specific conductance) at well 158 are higher than their representative concentrations, but none of the other indicator parameters (chloride, total phosphorus/orthophosphate, arsenic and selenium) are above their representative concentrations.

Well 143 is located downgradient of the slag pile, but it is also downgradient from and appears to be impacted by the former unlined calciner ponds (RU 14) and potentially other EMF-impacted groundwater in the joint fenceline / calciner ponds area. Any potential groundwater impact from the slag pile at well 143 cannot be differentiated from the joint fence line area / calciner pond impact observed at this well.

Well 106 is located immediately downgradient from the slag pile and is not downgradient from either the old phossy ponds (RU 22b) or the joint fenceline area / calciner ponds. Due to its location, well 106 is likely the best well for assessing potential groundwater impacts from the slag pile. The potassium and sulfate concentrations at well 106 slightly exceed the representative concentrations (Table 4.2-10A), but none of the other indicator parameters (chloride, total phosphorus/orthophosphate, arsenic and selenium) are above their representative concentrations.

Other RUs

Based on the results from the EMF RI and FMC Plant OU SRI subsurface investigations and the post-RI groundwater monitoring results, there is no evidence that RU 3 (Receiving, Stores, Paint Shop and P4 Decon building), RU 4 (Office Buildings and Training Center), RU 7 (western half – Shale Unload, Crushing and Stockpile), RU 12 (eastern portion - Former RP&S Area and Mobile Shop, RU 21 (other onsite railspurs), RU 23 (road segments not within RU boundaries),

or RU 24 (plant areas not within RU boundaries) are sources of site-related constituents to groundwater in the central plant area.

Section 5.2.3 Joint Fenceline / Calciner Ponds Area

The central plant area includes the following RUs:

- RU 7 (eastern half) – Shale Unload, Crushing and Stockpile
- RU 9 (eastern portion) – Silica Stockpiles and Former Kiln Scrubber Overflow Pond
- RU 10 – IWW Pond and Ditch
- RU 14 – Calciner Ponds
- RU 15 – Oversized Ore, Used Electrode, Baghouse Dust Area
- RU 16 – Calciner Solids Stockpile
- RU 23 – Road Segments not within RU Boundaries (within joint fenceline area)
- RU 24 – Plant Areas not within RU Boundaries (within joint fenceline area)

5.2.3.1 RUs with Sustained Hydraulic Head - Joint Fenceline Area

RU 9 (and 8)

The Former Kiln Scrubber Ponds and Former Kiln Scrubber Overflow Pond within RU 8 and 9 are discussed above under Section 5.2.2.1, *RUs with Sustained Hydraulic Head – Central Plant Area*. Based on the results from the SRI subsurface investigation and the post-RI groundwater monitoring results, there is no evidence that the Silica Stockpiles area within RU 9 is a source of site-related constituents to groundwater.

RU 10

The IWW ditch and pond were an unlined pond and ditch for cooling (IWW pond) and conveying (IWW ditch) non-contact cooling water from the furnaces and calciners. The IWW water was discharged to the Portneuf River under an NPDES permit. The pond and ditch were constructed in 1977 and operated with a sustained hydraulic head until the IWW discharge was permanently discontinued in August 2002.

Due to the commingling of EMF-impacted groundwater in the joint fenceline / calciner ponds area, discerning potential impacts attributable to the IWW pond and ditch is not possible. However, several lines of evidence were used to evaluate potential impacts to groundwater from the IWW pond and ditch.

As reported in the SRI Report Section 4.10.3.2 SFS (RU 10 SFS), the SRI soil sampling results for metals, fluoride and radionuclides were significantly below the soil to groundwater SSLs. These results are consistent with predicted results, based on the relatively low concentrations of site-related constituents in the IWW water discharged to the pond and ditch that in turn would have migrated vertically through the soil column to groundwater during operation of the IWW pond and ditch.

As shown on Figures 5.1-2 through 5.2-7, concentrations of indicator parameters are lower in well 110 downgradient from the IWW ditch and pond compared to upgradient wells 189 and 136. During their operation, the IWW pond and ditch were a likely source of infiltrating IWW water to groundwater. However, based on the low average concentrations of site-related constituents in IWW water, the infiltrating water may have actually served to dilute concentrations of EMF-related constituents migrating from upgradient sources in the joint fenceline / calciner ponds area. In any event, there is currently no discernible contribution of site-related constituents to groundwater from the IWW pond and ditch.

RU 14

As described in Section 1.3.3, the calciner ponds (Ponds 1C, 2C, 3C, 4C, and 5C) received treated calciner scrubber blowdown water and were operated with a sustained hydraulic head. Following plant shutdown in 2001, the calciner ponds were remediated under a IDEQ-FMC Consent Order. The remediation consisted of dewatering and placement of cover systems (caps) over the entire calciner pond area (RU 14). Calciner ponds 3C, 4C and 5C were originally installed over the former unlined calciner ponds and a former calciner solids stockpile area [referred to as the ―calciner pond sediment storage area ―A‘” in the EMF RI Report]. Therefore, the calciner ponds cover system encompasses the former unlined calciner ponds and former calciner pond sediment storage area ―A‘. The final cover construction was completed in November 2005. Due to the commingling of EMF-impacted groundwater in the joint fenceline / calciner ponds area, several lines-of-evidence approaches are utilized to differentiate the primary groundwater impact sources in this area.

IDEQ‘s report ―Evaluation of Water Quality Impacts Associated with FMC and Simplot Phosphate Ore Processing Facilities, Pocatello, Idaho” (IDEQ, 2004[a]) included an evaluation of the sulfate:chloride ratio in groundwater at the EMF site, including the joint fenceline area and areas downgradient of the plant sites. IDEQ‘s evaluation of the sulfate:chloride ratios was primarily focused on correlating reductions in orthophosphate due to mixing with unimpacted groundwater or due to mineral-precipitation of orthophosphate and/or sulfate as impacted groundwater migrates downgradient from source areas. The IDEQ report cited a sulfate:chloride

ratio on the order of 1 as representative of background or ambient conditions, where ion ratios are calculated from meq/L concentration values.

Based on IDEQ's work, an evaluation of EMF source area sulfate:chloride ratios was conducted to aid in assessing likely source impacts to groundwater in the joint fenceline / calciner pond area monitoring wells. Table 5.2-1 presents the sulfate and chloride concentrations and sulfate:chloride ratios measured in calciner pond water, calciner pond LCDRS water, gypsum stack water, groundwater wells immediately downgradient from the gypstack, and FMC ―phossy pond" water (the old ―phossy" ponds in the western ponds area). The data were taken from the RI Report and from post-RI samples of Calciner Pond LCDRS water, as reported in the Calciner Pond Remedial Action Plan (FMC, 2003).

As shown on Table Table 5.2-1, calciner pond water and LCDRS water have a sulfate:chloride ratio ranging from 1.56 to 4.54, with an average of 3.45. The gypsum stack water (single sample result) sulfate:chloride ratio was 20.41 and the average sulfate:chloride ratio for the gypstack wells (wells 300 and 306 are in the eastern portion of the Simplot plant, well 323 is within the joint fenceline area as defined in the RI) was 14.92. There are several mechanisms that could account for a lower sulfate:chloride ratio in groundwater compared to the source water: 1) mixing (dilution) with lower concentration water, 2) precipitation or sorption of sulfate, while also assuming chloride is conservative (i.e., is not attenuated by precipitation or sorption in the aquifer matrix), or 3) mixing with water higher in chloride concentrations and lower in sulfate than the source water. However, the only way to increase the sulfate:chloride ratio above the source water is to mix it with higher sulfate:chloride ratio water, again assuming chloride is conservative. Thus, wells impacted solely by the calciner ponds would be predicted to have a sulfate:chloride ratio of 5 or lower.

The sulfate:chloride ratios for the 2007 calciner ponds groundwater data were plotted on a site map depicting the general groundwater flow direction (Figure 5.2-3). As shown on Figure 5.2-3, the upgradient calciner ponds monitoring wells located along the eastern FMC fenceline adjacent to the gypsum stack show ion ratios consistent with gypsum stack influence. The average sulfate:chloride ratio observed at well 161 in 2007 was 7.9, with a ratio of 9.5 observed at well 164. Upgradient well 142 shows some apparent influence from gypsum stack-related groundwater, with a lower but still elevated average sulfate:chloride ratio of 7.5. Downgradient wells 190 and 143 show little if any evidence of gypsum stack influence, with average sulfate:chloride ratios of 0.7 and 0.9, respectively. Finally, downgradient wells 136 (average ratio of 14.2) and 189 (15) were within the range for gypstack wells (11.87 – 19.46). The data values shown on Figure 5.2-3 demonstrate that this increase in the sulfate:chloride ratio from upgradient groundwater (represented by wells 164 and 161) is due to higher sulfate concentrations, rather than lower chloride concentrations.

The sulfate:chloride ratio comparison provides additional evidence to support the general groundwater flow direction inferred by the potentiometric data, as shown on Figures 2.2-1 and 2.2-2. Upgradient of the calciner ponds, groundwater flow trends towards the northwest, implying flow from the gypsum stack area to wells 161 and 164, with a noticeable but lesser

influence on well 142. Wells 190 and 143 show lower ratios, indicating little gypsum stack influence to date. Downgradient wells 136 and 189 show ratios similar to but slightly higher than upgradient wells. The relative influence of gypsum stack-related groundwater on the calciner ponds monitoring well network may vary with seasonal or longer-term changes in groundwater elevations and flow directions.

An evaluation of EMF source area potassium concentrations, potassium:chloride ratios, and selenium concentrations was also conducted to assess source impacts from the calciner ponds area to the joint fenceline / calciner pond area monitoring wells. Table 5.2-2 presents the potassium and chloride concentrations, potassium:chloride ratios, and selenium concentrations measured in calciner pond water, calciner pond LCDRS water, gypsum stack water, and groundwater wells immediately downgradient from the gypstack. The data were taken from the RI Report and from post-RI samples of calciner pond LCDRS water as reported in the RAP (FMC, 2003). As shown on Table 5.2-2, calciner pond water and LCDRS water have a potassium:chloride ratio ranging from 2.4 to 4.7 (excluding Pond 1C LCDRS water) with an average of 2.7. Potassium concentrations ranged from 15,200 to 29,010 mg/L (again excluding Pond 1C LCDRS water) for calciner pond source water. The gypsum stack water (single sample result) potassium:chloride ratio was 1 and the average potassium:chloride ratio for the gypstack wells (wells 300 and 306 are in the eastern portion of the Simplot plant, well 323 is within the joint fenceline area as defined in the RI) was 0.2. The potassium concentration for the gypsum stack water was 176 mg/L and the gypsum stack impacted wells ranged from 15 to 30 mg/L. Selenium concentrations for the calciner pond water and LCDRS water averaged 8.52 mg/L, while the concentration for the gypsum stack water was 0.0451 mg/L and the gypsum stack impacted wells averaged 0.0078 mg/L.

Potential impacts from the calciner ponds area, either from the former unlined ponds and/or the lined calciner ponds subject to the Calciner Pond Remedial Action, could be discriminated from gypsum stack impacts based on potassium concentrations greater than approximately 40 mg/L, potassium:chloride ratios greater than approximately 0.2, and selenium concentrations greater then approximately 0.02 mg/L.

The potassium concentrations and potassium:chloride ratios for the 2007 calciner ponds groundwater data were plotted on a site map depicting the general groundwater flow direction (Figure 5.2-4). As shown on Figure 5.2-4, the upgradient calciner ponds monitoring wells located along the eastern FMC fenceline adjacent to the gypsum stack show ion ratios consistent with gypsum stack influence. The average potassium:chloride ratio observed at well 161 in was 0.16, with a ratio of 0.15 observed at well 164. Upgradient well 142 shows some apparent influence from gypsum stack-related groundwater with an average potassium:chloride ratio of 0.2. Downgradient wells 190 and 143 show little if any evidence of calciner pond area influence, with average potassium:chloride ratios of 0.02 and 0.05, respectively.

During 2007, downgradient wells 136 (potassium concentration average 63.6 mg/L, average K:Cl ratio of 0.46 and average selenium concentration of 0.0394 mg/L) and 189 (potassium concentration average 54.6 mg/L, average K:Cl ratio of 0.39 and average selenium concentration

of 0.0406 mg/L) indicate an influence from the calciner pond area in addition to the Simplot gypsum stack impact to groundwater in the joint fenceline / calciner pond area..

The decreasing potassium and selenium trends in well 143, decreasing potassium trend in well 136 and stable potassium and selenium trends in well 189 indicate that the calciner pond remedial action has been effective in reducing migration of constituents from the old unlined calciner ponds (beneath the lined calciner ponds 3C-5C) and potential releases from the calciner ponds area to groundwater. Although the potassium and selenium concentrations are expected to continue to decrease over time, the concentrations are not expected to decrease to levels below that predicted for Simplot gypsum stack impacted groundwater at wells 189 and 136.

In addition, based on the increasing trend of gypsum stack related constituents in wells upgradient from the calciner ponds area, the concentrations for those constituents in wells downgradient from the calciner ponds will likely increase in the future and potentially reverse the current decreasing or stable trends in the downgradient wells.

RU 16

The calciner solids stockpile area (RU 16) was not operated with an applied hydraulic head (i.e., was not operated as a pond). However, the calciner solids that were placed in the southern portion of the stockpile area during plant operation frequently contained a high enough moisture content that the calciner solids flowed when unloaded onto the stockpile. The fluid associated with these calciner solids is essentially calciner pond water as described above for the calciner ponds (RU 14). Although evaporative concentration would have occurred as the calciner pond water was evaporated and the calciner solids were solar dried in former calciner pond 5C (RU 14) prior to hauling and placement at the stockpile area (RU 16), the calciner pond water constituents and common ion ratios would not change appreciably.

Due to the Simplot gypsum stack impacted groundwater at wells 161, 164 and 142 downgradient from the calciner solids stockpile area, discerning potential impacts solely attributable to RU 16 is not possible. However, several lines of evidence were used to evaluate potential impacts to groundwater from the calciner solids stockpile area.

As described in the SRI Report Section 4.14.3.3, entitled *Leaching Potential RU 16 (RU 16 SIA 1)*, selenium, manganese, cadmium and thallium were detected in subsurface soil samples at concentrations that exceed the soil to groundwater soil screening levels (SSLs) at borings RU16-SIA1-SB006, SB007 and SB008. These borings, located in the southern portion of the calciner solids stockpile area, were advanced to groundwater. Groundwater was encountered at a depth of 157 to 158 feet bgs at these borings. These results indicate that the calciner solids stockpile area is a potential source of calciner sediment related constituents to groundwater.

As described above, the arsenic, potassium, sulfate, and total phosphorus / orthophosphate concentrations, and sulfate:chloride and potassium:chloride ratios observed at wells 161, 164 and 142 are consistent with a primary impact to groundwater from the Simplot gypsum stack. The

average selenium concentration at well 161 is at the upper range of the predicted groundwater concentration indicative of a Simplot gypsum stack impact, and the average nitrate concentration

at well 161 is slightly higher than the representative concentration. Manganese concentrations at these wells are all below the representative concentration.

Well 191 is also located downgradient from the calciner solids stockpile area. Although FMC does not routinely monitor this well, FMC did collect a sample from well 191 when the well was installed in 2003. Simplot routinely monitors this well. The August 2003 results (Table 4.2-2) and Simplot's March 2008 results (Simplot, 2008b) for well 191 are summarized below:

Parameter	FMC August 2003 Results (mg/l)	Simplot March 2008 Results (mg/l)
Potassium	13.2 J	10.96
Sulfate	396	391
Chloride	499 J	447
Ammonia	0.20 U	NA
Orthophosphate / Total P	0.53	0.1 U
Arsenic	0.0077	0.005
Cadmium	0.001 U	NA
Selenium	0.0249	NA
Fluoride	0.25	NA

U means the parameter was not detected, J means the result is an estimate.

NA means the parameter was not analyzed.

The August 2003 potassium, chloride, sulfate and selenium results were higher than their representative concentrations, indicating an EMF site impact to groundwater at well 191. The Simplot March 2008 results for chloride and sulfate are higher than the representative levels. Although the sulfate concentration at well 191 could be indicative of a gypsum stack impact, the chloride concentration (greater than 400 mg/l) is higher than predicted for a gypsum stack impact. The sulfate:chloride ratio for well 191 is 1. The August 2003 selenium concentration 0.0249 mg/l) is also higher than the value (0.02 mg/l) predicted for a gypsum stack impact.

Collectively, the results from well 191 are indicative of a groundwater impact associated with the calciner sediments located at the calciner solids storage area rather than the Simplot gypsum

stack. The calciner solids at RU 16 have dried from further evaporation at the storage area and no longer contain excess moisture that would be expected to migrate through the subsurface to groundwater. However, the lack of longer-term data from well 191 does not allow for an evaluation of concentration trends. Thus the data from this well do not provide the basis for assessing the current contribution of site-related constituents to groundwater from the calciner solids storage area.

5.2.3.2 RUs without Sustained Hydraulic Head - Joint Fenceline Area

Based on the results from the EMF RI and FMC Plant OU SRI subsurface investigations and the post-RI groundwater monitoring results, there is no evidence that RU 7 (eastern half – Shale Unload, Crushing and Stockpile), RU 15 (Oversized Ore, Used Electrode, Baghouse Dust Area), RU 23 (road segments not within RU boundaries), or RU 24 (plant areas not within RU boundaries) are sources of site-related constituents to groundwater in the joint fenceline / calciner ponds area.

Section 5.2.4 Area North of Highway 30 and Interstate 86

There were no FMC process operations in the area north of Highway 30 and I-86; therefore, there are no FMC sources in that area to evaluate for potential impacts to groundwater. As discussed in Section 5.1, groundwater quality in the area north of Highway 30 and I-86 is influenced by FMC-impacted groundwater from the FMC Plant Site migrating to the northeast and east, Simplot-impacted groundwater from the Simplot Don Plant migrating north and northeast, and groundwater from the Michaud aquifer merging and mixing prior to EMF-impacted groundwater discharge to the Portneuf River in the area between Swanson Road Spring (aka the Spring at Batiste Road) and Batiste Spring. Groundwater fate and transport is described in greater detail in Section 6.

Section 5.2.5 Summary

A summary of the identified sources and associated groundwater constituents for the source areas is presented on Table 5.2-3. As described above, due to the migration of site-impacted groundwater from the western ponds area through the central plant area and multiple sources in the joint fenceline / calciner ponds area including the Simplot gypstack, the evaluation of groundwater constituents attributable to the source areas focuses on those contaminants that can be distinguished from other sources—based on their higher concentrations compared to upgradient groundwater, or based on the fact that the constituents are unique in groundwater at that source area. Table 5.2-3 should not be interpreted to exclude potential contribution of constituents that are already present in groundwater migrating through the source area. For example, the former unlined calciner ponds, calciner sediment storage area _A‘ and calciner ponds area could be a source of arsenic to groundwater; however, any arsenic contribution from RU 14 cannot be distinguished from the Simplot gypsum stack arsenic impact.

Similarly, based on the operation of the IWW pond and ditch (RU 10) and the Railroad Swale (RU 22c) with a sustained hydraulic head, liquid from these areas likely migrated to groundwater. These areas may have been historic sources of constituents to groundwater. However, there is currently no discernable contribution to site-impacted groundwater from these areas.

Based on the collective EMF RI and SRI investigations and post-RI groundwater monitoring, there is no evidence that the other RUs (or portions of those RUs not identified as source areas) are sources of groundwater impacts at the FMC Plant OU.

Table 5.2-3
Summary of Identified Sources and Associated Groundwater Constituents at the FMC Plant OU

Areas / RUs Identified as Primary Source Areas	Groundwater Constituents Attributable to Source Area	Monitoring Wells Indicative of Impact from Identified Source Area
Pond 8S within RU 22a (RCRA Ponds)	Metals: Arsenic, manganese, boron, selenium Common ions: Potassium, chloride, sulfate Nutrients: Ammonia, nitrate, total phosphorus / orthophosphate Fluoride Total cyanide	104, 116, 158, 155, 156, 157, 151, 159, 141, 134
Old "Phossy" Ponds (RU 22b) and portions of RU 13 with identified "phossy" pond solids in fill materials	Metals: Arsenic, manganese, boron, selenium Common ions: Potassium, chloride, sulfate Nutrients: Ammonia, nitrate, total phosphorus / orthophosphate Fluoride Total cyanide	165, 137, 167, 113, 114, 115, 166, 168, 131, 104, 139, 140 170, 171, 172
Furnace Building, Phos Dock and Secondary Condenser (RU 1) and Slag Pit (RU 2)	Elemental phosphorus	108, 122
Former Kiln Scrubber Ponds and Calciners (RU 8) and Former Kiln Scrubber Overflow Pond (RU 9)	Metals: Selenium, vanadium Nutrients: Ammonia, nitrate Fluoride Total cyanide	143, 145, 123
Former Unlined Calciner Ponds, Calciner Sediment Storage Area "A", Calciner Ponds (RU 14)	Metals: Arsenic, manganese, boron, selenium Common ions: Potassium, chloride Fluoride	189, 136, 145
Calciner Solids Storage Area (RU 16)	Metals: Selenium Common ions: Potassium, chloride, sulfate	191
Slag Pile (RU 19)	Common ions: Potassium, sulfate	106

Table 5.1-1 List of Wells and "Point Values" Posted on Figures 5.1-2 to 5.1-7

FMC Monitoring Data

Well	As	Date	K	Date	SO4	Date	NO3	Date	NH3	Date	Total / Ortho-P	Date	Se	Date
101	12.5	May-08	6.8	May-08	87.3	May-08	2.3	May-08	< 0.2	May-08	< 0.5	May-08	< 0.005	May-08
106	0.0042	May-05	15.5	May-05	166	May-05	2	May-05	< 0.2	May-05	0.1	May-05	0.0037	May-05
112	0.0047	May-08	7	May-08	88.6	May-08	2.3	May-08	< 0.2	May-08	0.08	May-08	0.0016	May-08
116	0.0763	May-05	54	May-05	146	May-05	14.4	May-05	< 0.2	May-05	0.6	May-05	0.0053	May-05
140	0.0225	Nov-01	84	Nov-01	1060	Nov-01	8	Nov-01	< 0.2	Nov-01	< 0.16	Nov-01	0.0914	Nov-01
145	0.298	May-08	38	May-08	2400	May-08	4.5	May-08	2.5	May-08	57.3	May-08	0.0608	May-08
151	0.0307	Nov-01	57	Nov-01	177	Nov-01	0.4	Nov-01	< 0.2	Nov-01	7.6	Nov-01	< 0.005	Nov-01
159	0.093	Nov-01	37	Nov-01	166	Nov-01	0.1	Nov-01	1.9	Nov-01	14.1	Nov-01	< 0.005	Nov-01
169	< 0.01	May-08	6.5	May-08	27	May-08	1.3	May-08	< 0.2	May-08	< 0.5	May-08	< 0.005	May-08
501	0.0027	May-08	6.5	May-08	79	May-08	4.2	May-08	< 0.2	May-08	< 0.5	May-08	0.0021	May-08
502	0.0026	May-08	5.4	May-08	65	May-08	2.5	May-08	< 0.2	May-08	< 0.1	Nov-01	< 0.005	May-08
514	0.0038	May-02	4	May-02	43	May-02	0.6	May-02	< 0.2	May-02	< 0.1	Nov-01	< 0.005	May-02
516	0.0038	May-08	6	May-08	67	May-08	2.1	May-08	< 0.2	May-08	< 0.5	May-08	0.0013	May-08
517	0.0468	May-08	100	May-08	189	May-08	11.1	May-08	0.2	May-08	0.9	May-08	0.0138	May-08
TW-9S	0.0257	May-08	43.4	May-08	166	May-08	10.4	May-08	< 0.2	May-08	2.42	May-08	< 0.0031	May-08
TW-11S	0.002	May-08	3.8	May-08	49.7	May-08	1.6	May-08	< 0.2	May-08	< 0.5	May-08	< 0.005	May-08
TW-12S	0.0203	May-08	14.8	May-08	147	May-08	6.7	May-08	0.8	May-08	22.3	May-08	0.0051	May-08
Old Pilot	0.0242	Nov-01	57	Nov-01	189	Nov-01	10.3	Nov-01	< 0.2	Nov-01	2.7	Nov-01	< 0.0055	Nov-01

Simplot Monitoring Data [a]

Well	As	Date	K	Date	SO4	Date	NO3	Date	NH3	Date	Total / Ortho-P	Date	Se	Date
191	0.004	Jun-08	11.9	Jun-08	493	Jun-08	22.8	Jun-08	NA	--	< 0.15	Jun-08	0.0259	Jun-08
307	0.424	Jun-08	48.7	Jun-08	2860	Jun-08	2.2	Jun-08	NA	--	132	Jun-08	0.0156	Jun-08
308	0.394	Jun-08	45.5	Jun-08	2610	Jun-08	1.9	Jun-08	NA	--	120	Jun-08	0.0173	Jun-08
310	0.193	Jun-08	34	Jun-08	1300	Jun-08	2.4	Jun-08	NA	--	30	Jun-08	0.0116	Jun-08
312	0.158	Jun-08	49.4	Jun-08	946	Jun-08	7.8	Jun-08	NA	--	22	Jun-08	0.0605	Jun-08
320	0.101	Jun-08	33	Jun-08	1140	Jun-08	91	Jun-08	NA	--	98	Jun-08	0.0095	Jun-08
331	0.133	Jun-08	37.6	Jun-08	988	Jun-08	46.3	Jun-08	NA	--	19.5	Jun-08	0.0385	Jun-08
333	0.365	Jun-08	43.5	Jun-08	3190	Jun-08	1.4	Jun-08	NA	--	148	Jun-08	0.0108	Jun-08
336	0.477	Jun-08	57.6	Jun-08	2260	Jun-08	3.7	Jun-08	NA	--	124	Jun-08	0.0143	Jun-08
503	0.0159	Jun-08	8.8	Jun-08	187	Jun-08	2.85	Jun-08	NA	--	4.4	Jun-08	< 0.002	Jun-08
505	0.0057	Jun-08	7.3	Jun-08	107	Jun-08	2.66	Jun-08	NA	--	0.44	Jun-08	< 0.002	Jun-08
518	0.016	Jun-08	9.76	Jun-08	223	Jun-08	2.83	Jun-08	NA	--	4.1	Jun-08	0.0025	Jun-08
BRS (Swanson Rd Spring)	0.0088	Jun-08	8.12	Jun-08	163	Jun-08	2.66	Jun-08	NA	--	2.35	Jun-08	< 0.002	Jun-08

[a] Results from Simplot's Second Quarter 2008 Groundwater Monitoring Report, NA means the parameter was not analyzed/reported.

Table 5.1 - 2A Longer Term Mann-Kendall Trend Test Results
for Selected Wells in the
WESTERN PONDS AREA
(All Available Data through 2Q2008)

Site	Statistic	Arsenic (Total)	Potassium	Phosphorus	Sulfate
127	Trend	Decreasing	Increasing	Decreasing	Increasing
	Z-score	-2.62	5.01	-4.52	5.75
	p-value	0.0088	0.0000	0.0000	0.0000
131	Trend	None	Increasing	Increasing	Increasing
	Z-score	0.341	3.09	2.05	2.12
	p-value	0.7331	0.0020	0.0404	0.0340
139	Trend	None	None	None	Increasing
	Z-score	0.374	1.24	0.68	4.23
	p-value	0.7084	0.2150	0.4965	0.0000
148	Trend	Decreasing	Increasing	None	Increasing
	Z-score	-1.98	4.79	-0.82	4.22
	p-value	0.0477	0.0000	0.4122	0.0000
155	Trend	Decreasing	Decreasing	Decreasing	Decreasing
	Z-score	-7.11	-4.00	-3.04	-6.54
	p-value	0.0000	0.0001	0.0024	0.0000
156	Trend	Decreasing	Decreasing	Decreasing	Decreasing
	Z-score	-5.05	-6.968	-3.383	-2.925
	p-value	0.0000	0.0000	0.0007	0.0034
157	Trend	Decreasing	Decreasing	Decreasing	Decreasing
	Z-score	-7.37	-8.03	-4.68	-4.49
	p-value	0.0000	0.0000	0.0000	0.0000
165	Trend	Decreasing	Increasing	None	Increasing
	Z-score	-2.91	3.52	-0.648	3.55
	p-value	0.0036	0.0004	0.5170	0.0004
166	Trend	Decreasing	Increasing	Decreasing	Increasing
	Z-score	-4.36	2.97	-2.06	5.62
	p-value	0.0000	0.0030	0.0394	0.0000
172	Trend	None	Increasing	None	Increasing
	Z-score	-1.01	5.76	-0.689	7.04
	p-value	0.3125	0.0000	0.4908	0.0000

NOTES: Two-sided test for trend performed at 95% confidence level ($\alpha = 0.05$).
Critical Z-score = 1.97 (if $|Z| > 1.97$, then $p < 0.05$ and trend is significant).

Table 5.1 - 2B Recent Period Mann-Kendall Trend Test Results
for Selected Wells in the
WESTERN PONDS AREA
(Based on Recent Data -- 2002 through 2Q2008)

Site	Statistic	Arsenic (Total)	Potassium	Phosphorus	Sulfate
127	Trend	None	None	None	Increasing
	Z-score	-1.15	1.3	-1.66	3.16
	p-value	0.2501	0.1936	0.0969	0.0016
131	Trend	Decreasing	None	Decreasing	Increasing
	Z-score	-3.13	1.26	-2.14	3.25
	p-value	0.0017	0.2077	0.0324	0.0012
139	Trend	None	None	None	None
	Z-score	0.629	0.00	0.107	1.36
	p-value	0.5293	1.0000	0.9148	0.1738
148	Trend	None	None	None	None
	Z-score	0.309	0.662	-1.68	1.19
	p-value	0.7573	0.5080	0.0930	0.2340
155	Trend	Decreasing	None	Decreasing	Decreasing
	Z-score	-2.38	-0.375	-3.11	-2.54
	p-value	0.0173	0.7077	0.0019	0.0111
156	Trend	None	Decreasing	Decreasing	Increasing
	Z-score	0.111	-4.28	-2.73	1.99
	p-value	0.9116	0.0000	0.0063	0.0467
157	Trend	Decreasing	Decreasing	None	None
	Z-score	-3.62	-4.54	-1.94	1.57
	p-value	0.0003	0.0000	0.0524	0.1164
165	Trend	None	None	Decreasing	None
	Z-score	-1.63	-0.419	-2.37	-1.19
	p-value	0.1031	0.6752	0.0178	0.2340
166	Trend	Decreasing	None	Decreasing	Increasing
	Z-score	-3.07	-1.35	-2.16	3.74
	p-value	0.0021	0.1770	0.0308	0.0002
172	Trend	None	Increasing	Decreasing	Increasing
	Z-score	-0.11	3.15	-2.67	5.62
	p-value	0.9124	0.0016	0.0076	0.0000

NOTES: Two-sided test for trend performed at 95% confidence level ($\alpha = 0.05$).
Critical Z-score = 1.97 (if $|Z| > 1.97$, then $p < 0.05$ and trend is significant).

Table 5.1 - 3A Longer Term Mann-Kendall Trend Test Results
for Selected Wells in the
CENTRAL PLANT AREA
(All Available Data through 2Q2008)

Site	Statistic	Arsenic (Total)	Potassium	Phosphorus	Sulfate
108	Trend	Decreasing	Decreasing	Increasing	Decreasing
	Z-score	-6.18	-6.14	3.93	-2.28
	p-value	0.0000	0.0000	0.0001	0.0229
111	Trend	Decreasing	Decreasing	Decreasing	None
	Z-score	-6.07	-7.74	-4.96	-0.499
	p-value	0.0000	0.0000	0.0000	0.62
121	Trend	Decreasing	Decreasing	None	None
	Z-score	-5.6	-5.59	-0.183	-0.311
	p-value	0.0000	0.0000	0.8548	0.7558
122	Trend	Increasing	Decreasing	Increasing	Increasing
	Z-score	3.66	-8.41	4.72	6.74
	p-value	0.0003	0.0000	0.0000	0.0000
123	Trend	Decreasing	Decreasing	Decreasing	Decreasing
	Z-score	-8.66	-5.38	-7.482	-8.289
	p-value	0.0000	0.0000	0.0000	0.0000
143	Trend	Decreasing	Decreasing	Decreasing	Decreasing
	Z-score	-6.72	-5.01	-5.23	-4.02
	p-value	0.0000	0.0000	0.0000	0.0001
146	Trend	Increasing	Decreasing	Increasing	None
	Z-score	2.57	-4.72	4.27	-1.43
	p-value	0.0102	0.0000	0.0000	0.1524

NOTES: Two-sided test for trend performed at 95% confidence level ($\alpha = 0.05$).
Critical Z-score = 1.97 (if $|Z| > 1.97$, then $p < 0.05$ and trend is significant).

Table 5.1 - 3B Recent Period Mann-Kendall Trend Test Results
for Selected Wells in the
CENTRAL PLANT AREA
(Based on Recent Data -- 2002 through 2Q2008)

Site	Statistic	Arsenic (Total)	Potassium	Phosphorus	Sulfate
108	Trend	Decreasing	None	None	Increasing
	Z-score	-3.62	-1.68	-0.309	3.62
	p-value	0.0003	0.0932	0.7573	0.0003
111	Trend	Decreasing	Decreasing	None	Decreasing
	Z-score	-3.97	-3.735	-1.776	-2.989
	p-value	0.0001	0.0002	0.0757	0.0028
121	Trend	Decreasing	None	None	Increasing
	Z-score	-2.54	-0.992	-1.75	5.89
	p-value	0.0111	0.3212	0.0801	0.0000
122	Trend	None	Decreasing	None	None
	Z-score	1.04	-4.39	1.68	1.77
	p-value	0.2983	0.0000	0.0937	0.0774
123	Trend	Decreasing	Decreasing	Decreasing	Decreasing
	Z-score	-4.3	-2.96	-3.16	-4.23
	p-value	0.0000	0.0031	0.0016	0.0000
143	Trend	Decreasing	Decreasing	Decreasing	None
	Z-score	-3.86	-2.32	-2.02	1.28
	p-value	0.0001	0.0203	0.0434	0.2005
146	Trend	Increasing	None	Decreasing	Increasing
	Z-score	4.16	-0.367	2.81	2.76
	p-value	0.0000	0.7136	0.0049	0.0059

NOTES: Two-sided test for trend performed at 95% confidence level ($\alpha = 0.05$).
Critical Z-score = 1.97 (if $|Z| > 1.97$, then $p < 0.05$ and trend is significant).

TABLE 5.1-4A

Mann-Kendall Trend Test Results for Joint Fence Line / Calciner Ponds Area Wells

All Available Data through May 2008

Site		Statistic	Arsenic (Total)	Potassium	Phosphorus	Selenium (Total)	Sulfate
Upgradient Wells	142	Trend	Increasing	Increasing	Increasing	None	Increasing
		Z-score	6.72	5.07	6.73	1.13	5.55
		p-value	0.0000	0.0000	0.0000	0.26	0.00
	161	Trend	None	Increasing	None	None	Increasing
		Z-score	1.15	4.52	2.09	-0.820	6.89
		p-value	0.25	0.0000	0.04	0.41	0.0000
	164	Trend	Decreasing	Increasing	Increasing	None	Increasing
		Z-score	-3.93	2.96	2.03	-0.050	5.77
		p-value	0.0001	0.0031	0.0424	0.96	0.0000
Downgradient Wells	110	Trend	Decreasing	Increasing	Decreasing	Decreasing	Decreasing
		Z-score	-6.13	3.71	-2.03	-4.56	-5.60
		p-value	0.0000	0.0002	0.0424	0.0000	0.0000
	136	Trend	Decreasing	Decreasing	None	None	Increasing
		Z-score	-5.57	-4.66	-0.846	-1.96	6.35
		p-value	0.0000	0.0000	0.40	0.05	0.0000
	143	Trend	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing
		Z-score	-6.72	-5.01	-5.23	-6.74	-4.02
		p-value	0.0000	0.0000	0.0000	0.0000	0.0001
	189	Trend	None	None	None	None	None
		Z-score	1.33	-1.09	-1.17	0.934	1.64
		p-value	0.18	0.28	0.24	0.35	0.10
	190	Trend	None	None	Decreasing	None	None
		Z-score	-0.311	1.09	-2.18	0.703	1.09
		p-value	0.76	0.28	0.03	0.48	0.28

NOTES: Two-sided test for trend performed at 95% confidence level ($\alpha = 0.05$).
Critical Z-score = 1.97 (if $|Z| > 1.97$, then $p < 0.05$ and trend is significant).

TABLE 5.1-4B

Mann-Kendall Trend Test Results for Joint Fence Line / Calciner Ponds Area Wells

Recent Data: 2002 through May 2008

Site		Statistic	Arsenic (Total)	Potassium	Phosphorus	Selenium (Total)	Sulfate
Upgradient Wells	142	Trend	Increasing	None	Increasing	None	None
		Z-score	4.70	0.733	3.42	0.183	-0.736
		p-value	0.0000	0.4636	0.0006	0.85	0.46
	161	Trend	None	None	None	None	Increasing
		Z-score	1.76	0.429	-1.40	-0.549	2.81
		p-value	0.0784	0.6679	0.1627	0.58	0.0049
	164	Trend	None	None	None	None	Increasing
		Z-score	-1.34	0.429	-0.793	0.00	2.57
		p-value	0.1802	0.6679	0.4278	1.00	0.0102
Downgradient Wells	110	Trend	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing
		Z-score	-4.33	-2.62	-2.57	-4.09	-3.72
		p-value	0.0000	0.0087	0.0103	0.0000	0.0002
	136	Trend	None	None	None	None	None
		Z-score	-1.59	-0.244	-0.489	0.244	0.611
		p-value	0.1118	0.8072	0.6248	0.81	0.5412
	143	Trend	Decreasing	Decreasing	Decreasing	Decreasing	None
		Z-score	-3.86	-2.32	-2.02	-2.99	1.28
		p-value	0.0001	0.0203	0.0434	0.003	0.2005
	189	Trend	None	None	None	None	None
		Z-score	1.33	-1.09	-1.17	0.934	1.64
		p-value	0.18	0.28	0.24	0.35	0.10
	190	Trend	None	None	Decreasing	None	None
		Z-score	-0.311	1.09	-2.18	0.703	1.09
		p-value	0.76	0.28	0.03	0.48	0.28

NOTES: Two-sided test for trend performed at 95% confidence level ($\alpha = 0.05$).
Critical Z-score = 1.97 (if $|Z| > 1.97$, then $p < 0.05$ and trend is significant).

Table 5.1 - 5A Longer Term Mann-Kendall Trend Test Results
for Selected Wells in the
AREA NORTH OF HIGHWAY 30 AND INTERSTATE 86
(All Available Data through 2Q2008)

Site	Statistic	Arsenic (Total)	Potassium	Phosphorus	Sulfate
501	Trend	None	None	None	None
	Z-score	-1.72	0.735	0.201	0.191
	p-value	0.0854	0.4623	0.8407	0.8485
515	Trend	None	None	Increasing	None
	Z-score	0.843	0.017	2.50	1.12
	p-value	0.3992	0.99	0.0124	0.2614
516	Trend	None	None	None	None
	Z-score	-1.04	-1.5	1.34	0.751
	p-value	0.2983	0.1336	0.1802	0.4527
TW-9S	Trend	None	Decreasing	Decreasing	Increasing
	Z-score	-0.032	-2.91	-2.67	4.04
	p-value	0.9745	0.0036	0.0076	0.0001
TW-11S	Trend	None	None	Increasing	None
	Z-score	-0.755	0.457	3.37	0.946
	p-value	0.4502	0.6477	0.0008	0.3441
524	Trend	None	None	Increasing	Decreasing
	Z-score	0.66	-0.64	3.46	-2.65
	p-value	0.5125	0.52	0.0005	0.0081
525	Trend	None	None	None	Decreasing
	Z-score	0.127	-0.582	1.209	-2.61
	p-value	0.8989	0.56	0.2267	0.0091
Batiste Spring	Trend	Decreasing	None	Increasing	Decreasing
	Z-score	-2.18	-1.28	2.21	-2.15
	p-value	0.0293	0.20	0.0271	0.0316

NOTES: Two-sided test for trend performed at 95% confidence level ($\alpha = 0.05$).
Critical Z-score = 1.97 (if $|Z| > 1.97$, then $p < 0.05$ and trend is significant).

Table 5.1 - 5B Recent Period Mann-Kendall Trend Test Results
for Selected Wells in the
AREA NORTH OF HIGHWAY 30 AND INTERSTATE 86
(Based on Recent Data -- 2002 through 2Q2008)

Site	Statistic	Arsenic (Total)	Potassium	Phosphorus	Sulfate
501	Trend				
	Z-score	Insufficient Data			
	p-value				
515	Trend	None	None	None	None
	Z-score	0.00	0.793	0.736	-0.863
	p-value	1.0000	0.4278	0.4617	0.3881
516	Trend				
	Z-score	Insufficient Data			
	p-value				
TW-9S	Trend				
	Z-score	Insufficient Data			
	p-value				
TW-11S	Trend				
	Z-score	Insufficient Data			
	p-value				
524	Trend	None	None	None	None
	Z-score	-1.43	1.59	0.379	0.978
	p-value	0.1527	0.1121	0.7047	0.3281
525	Trend	None	None	None	None
	Z-score	1.18	1.22	1.94	0.915
	p-value	0.2380	0.2217	0.0530	0.3602
Batiste Spring	Trend	Increasing	Increasing	Increasing	None
	Z-score	2.18	2.12	4.54	1.81
	p-value	0.0293	0.0343	0.0000	0.0708

NOTES: Two-sided test for trend performed at 95% confidence level ($\alpha = 0.05$).
Critical Z-score = 1.97 (if $|Z| > 1.97$, then $p < 0.05$ and trend is significant).

TABLE 5.2-1 EMF POTENTIAL SOURCE AREA SULFATE AND CHLORIDE CONCENTRATIONS AND RATIOS

Calciner Ponds[1]	**SO4 (mg/L)**	**Cl (mg/L)**	**SO4 (meq/L)**	**Cl (meq/L)**	**SO4/CL**
Calciner Pond Water					
TWW-FSWCPW01	19,800	3,750	412.24	105.78	3.90
RWW-Cal Pond 2C	36,400	7,750	757.86	218.62	3.47
RWW-2C Decant	35,700	5,810	743.29	163.89	4.54
Calciner Pond LCDRS Water					
1C	8,050	3,800	167.60	107.19	1.56
3C	27,900	5,710	580.89	161.07	3.61
5C	45,300	9,440	943.16	266.29	3.54
Average, Calciner Pond & LCDRS Water	28,933	6,043	602.39	170.47	**3.45**
Gypstack[2]					
Gypsum Slurry Liquid - SGSFEF01	4,480	162	93.28	4.57	**20.41**
Well 300	2,500	95	52.05	2.67	19.46
Well 306	1,898	118	39.52	3.33	11.87
Well 323	1,778	98	37.02	2.76	13.42
Average, Gypstack wells	2,059	104	42.86	2.92	**14.92**
FMC Phossy Ponds[2]					
Discharge to Pond 8E	33	740	0.69	20.87	**0.03**

Notes:

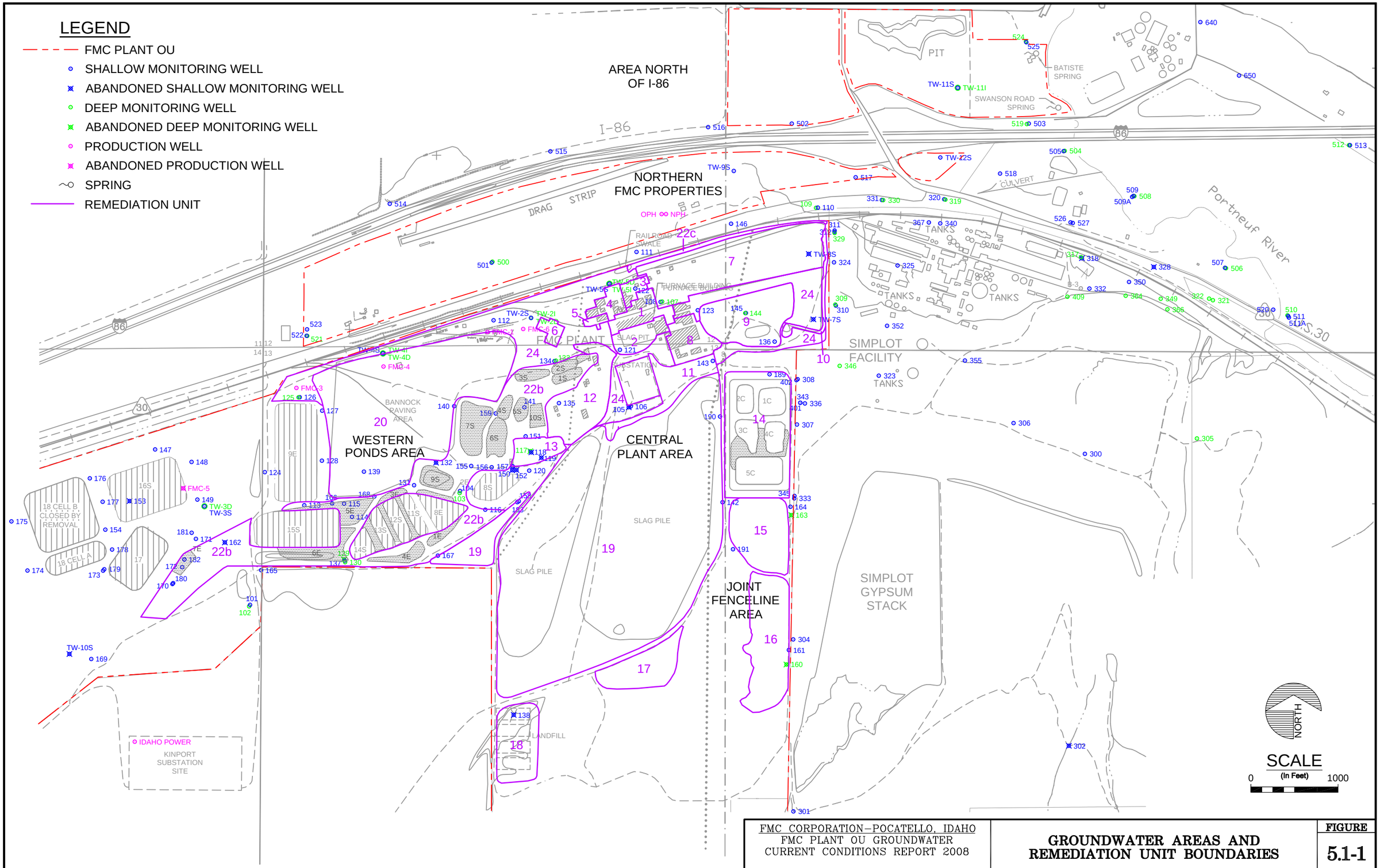
1. **Data from Bechtel, 1996 and FMC, 2003 [b].**
2. **Data from Bechtel, 1996.**

TABLE 5.2-2 EMF POTENTIAL SOURCE AREA POTASSIUM AND CHLORIDE CONCENTRATIONS AND RATIOS AND SELENIUM CONCENTRATIONS

Calciner Ponds[1]	**K (mg/L)**	**K (meq/L)**	**Cl (mg/L)**	**Cl (meq/L)**	**K/Cl**	**Se (mg/L)**
Calciner Pond Water						
TWW-FSWCPW01	19,330	494	3,750	105.8	4.7	2.785
RWW-Cal Pond 2C	29,010	742	7,750	218.6	3.4	19.735
RWW-2C Decant	20,400	522	5,810	163.9	3.2	27.1
Calciner Pond LCDRS Water						
1C	365	9	3,800	107.2	0.1	0.0579
3C	15,200	389	5,710	161.1	2.4	0.427
5C	25,200	645	9,440	266.3	2.4	0.997
Average, Calciner Pond & LCDRS Water	**18,251**	467	6,043	170.5	**2.7**	**8.52**
Gypstack[2]						
Gypsum Slurry Liquid - SGSFEF01	176	4.5	162	4.6	1	0.0451
Well 300	15.3	0.4	95	2. 7	0.1	0.0099
Well 306	30	0.8	118	3.3	0.2	0.0081
Well 323	27	0.7	98	2.8	0.2	0.0054
Average, Gypstack wells	**24.1**	0.6	104	2.9	**0.2**	**0.0078**

Notes:

1. **Data from Bechtel, 1996 and FMC, 2003 [b].**
2. **Data from Bechtel, 1996.**



FMC CORPORATION–POCATELLO, IDAHO
FMC PLANT OU GROUNDWATER
CURRENT CONDITIONS REPORT 2008

GROUNDWATER AREAS AND REMEDIATION UNIT BOUNDARIES

FIGURE
5.1-1

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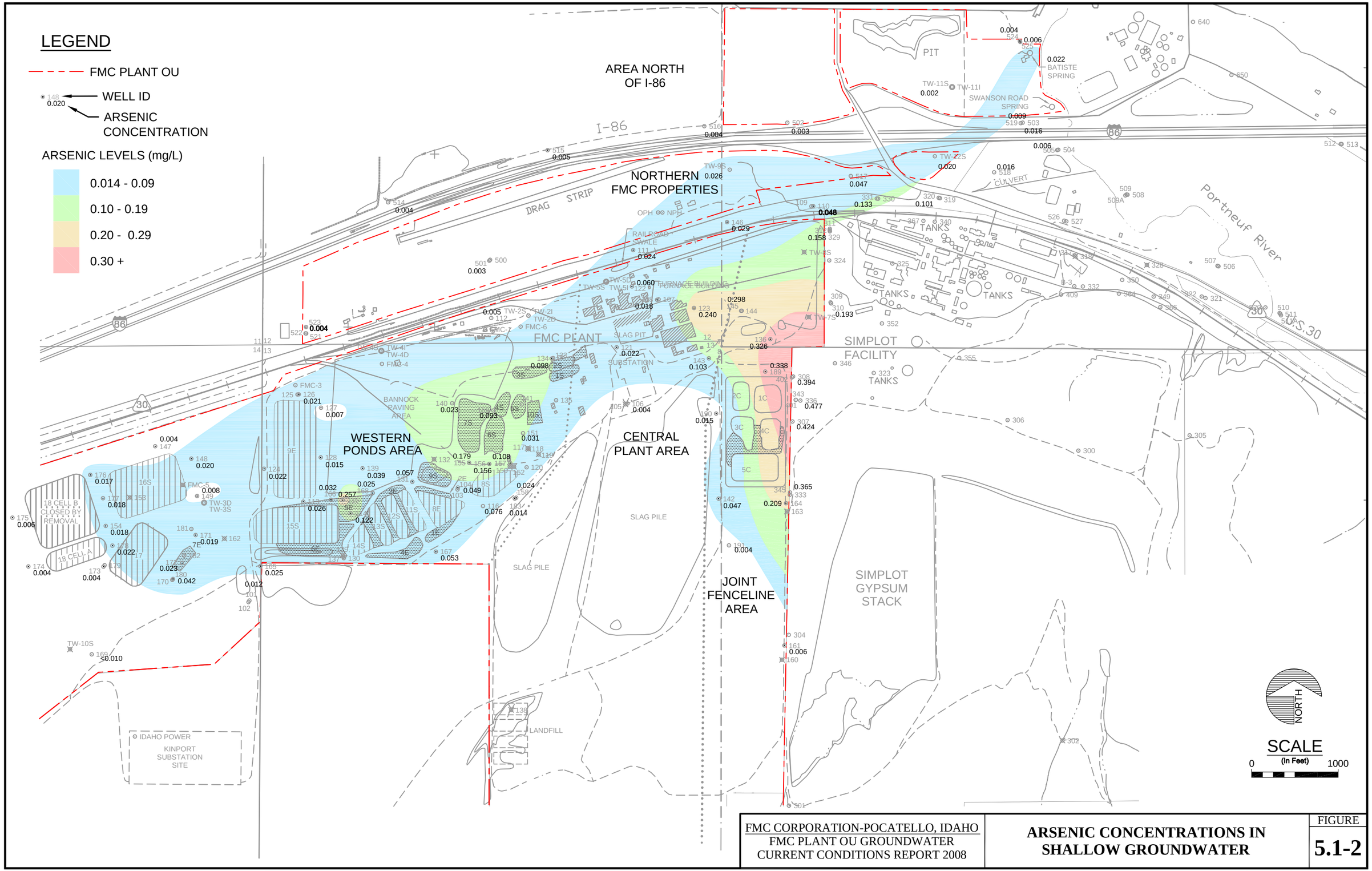

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CURRENT CONDITIONS REPORT 2008

ARSENIC CONCENTRATIONS IN SHALLOW GROUNDWATER

FIGURE
5.1-2

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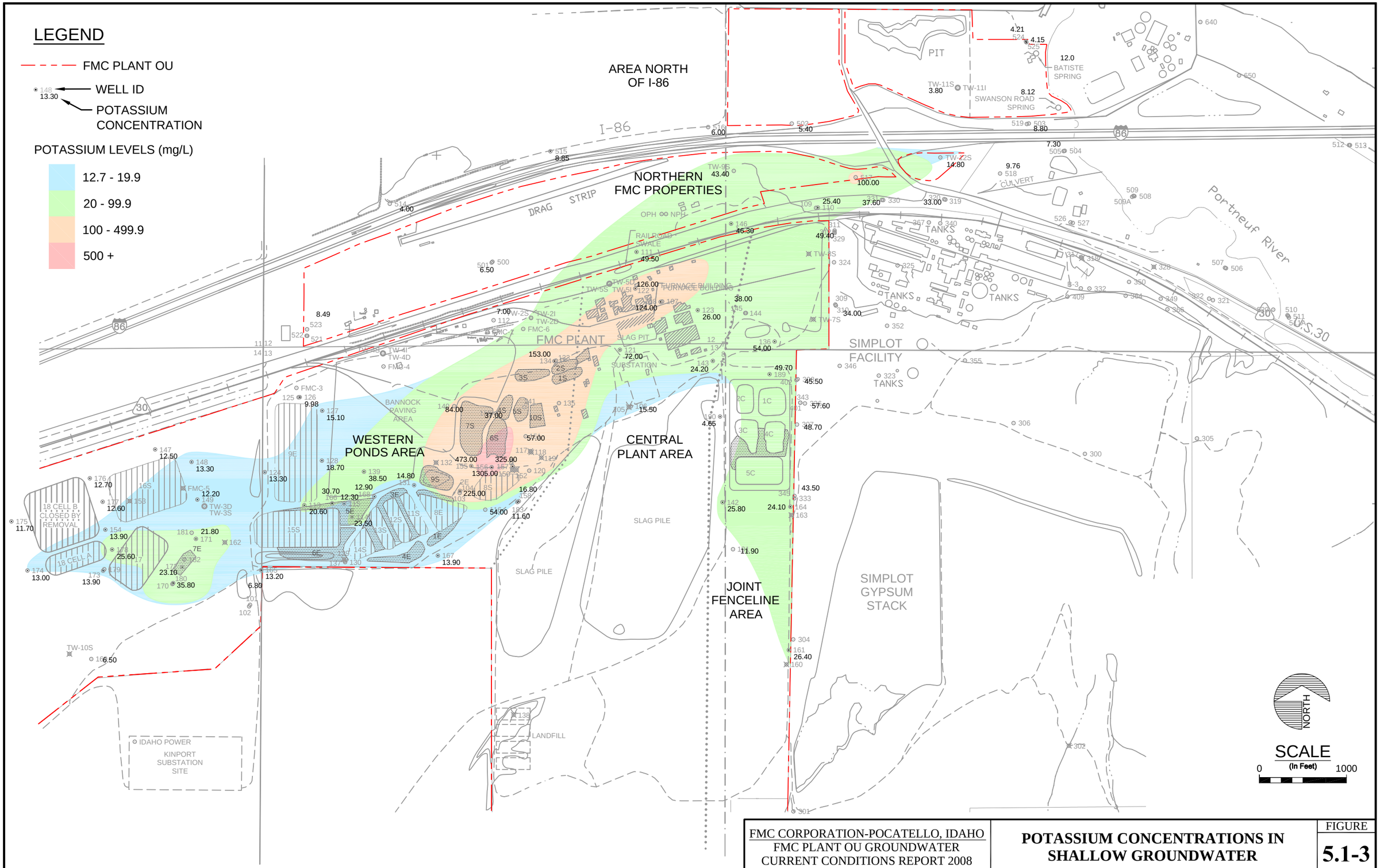

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FMC PLANT OU GROUNDWATER
CURRENT CONDITIONS REPORT 2008

POTASSIUM CONCENTRATIONS IN SHALLOW GROUNDWATER

FIGURE
5.1-3

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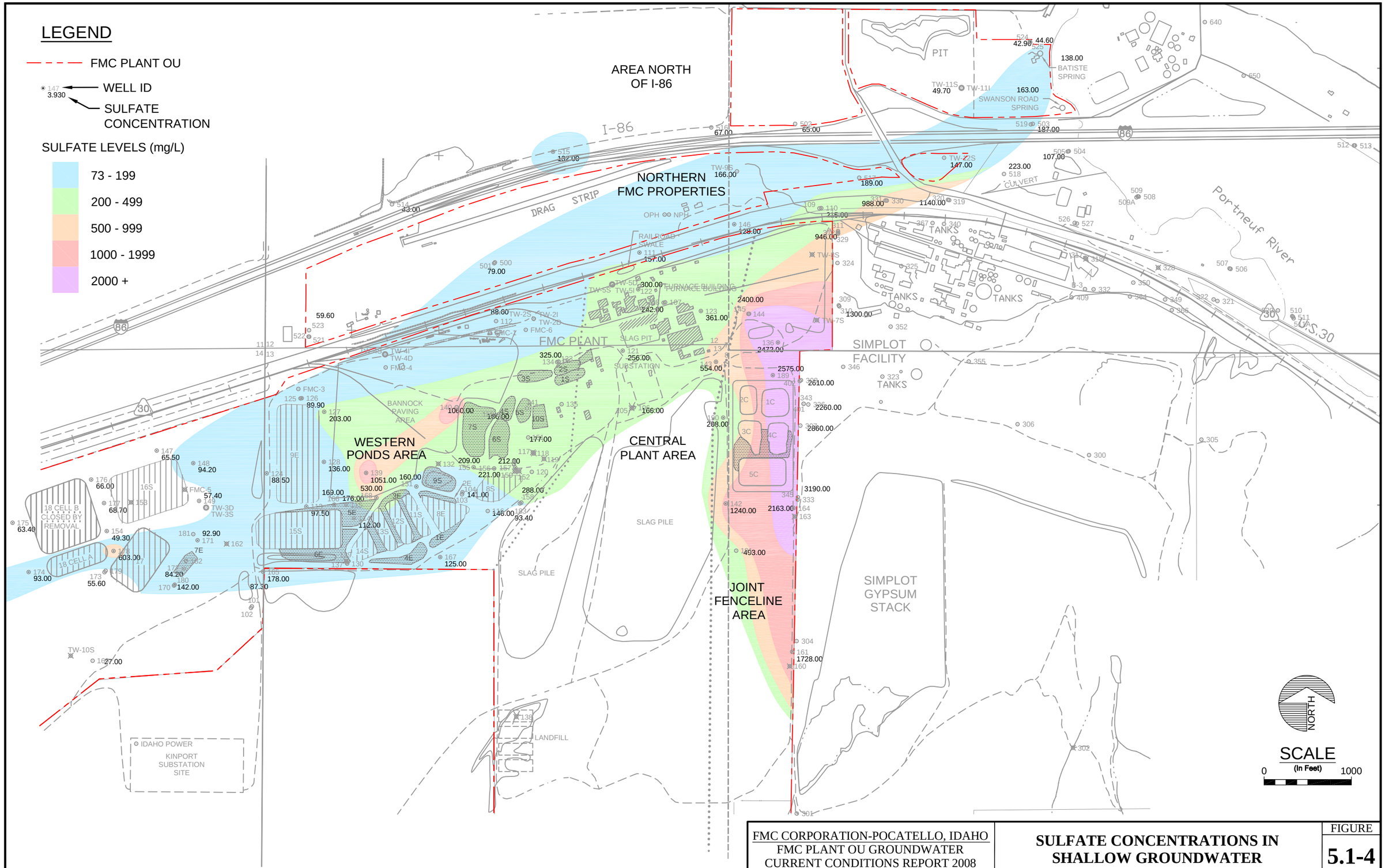

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CURRENT CONDITIONS REPORT 2008

SULFATE CONCENTRATIONS IN SHALLOW GROUNDWATER

FIGURE
5.1-4

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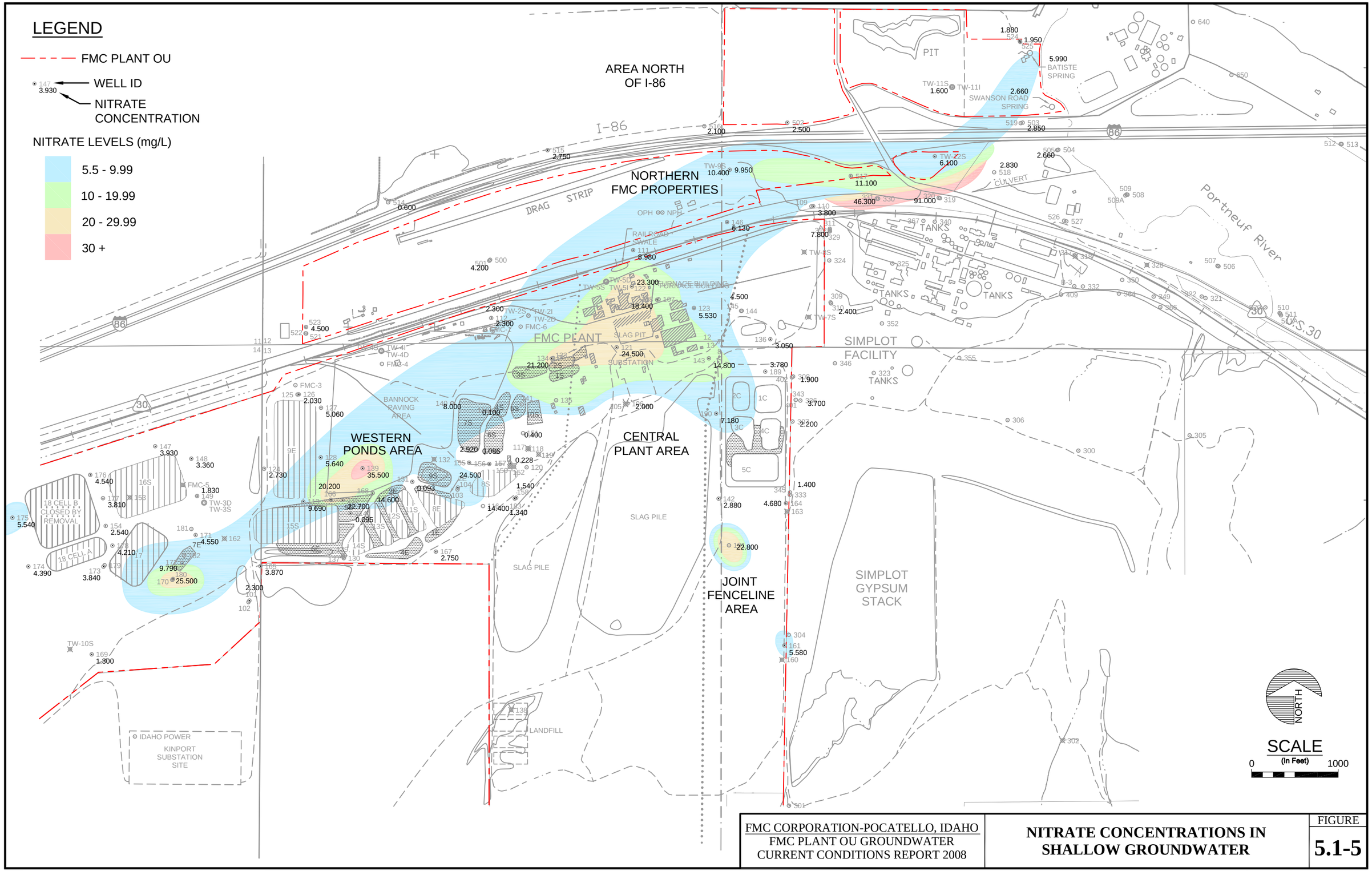

FMC CORPORATION-POCATELLO, IDAHO
FMC PLANT OU GROUNDWATER
CURRENT CONDITIONS REPORT 2008

NITRATE CONCENTRATIONS IN SHALLOW GROUNDWATER

FIGURE
5.1-5

UPDATE TIME: 2:05 PM
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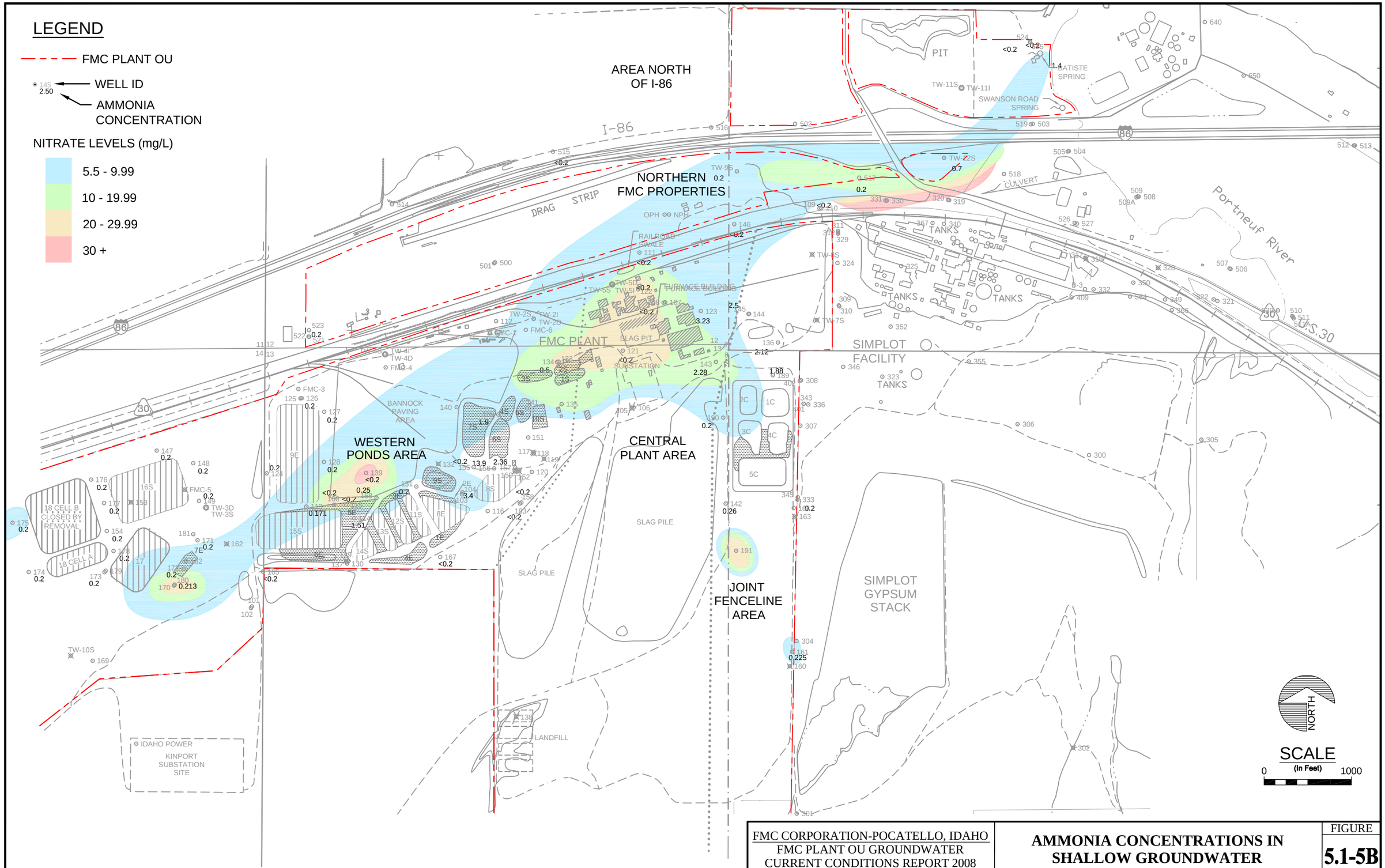

FMC CORPORATION-POCATELLO, IDAHO
FMC PLANT OU GROUNDWATER
CURRENT CONDITIONS REPORT 2008

AMMONIA CONCENTRATIONS IN SHALLOW GROUNDWATER

FIGURE
5.1-5B

UPDATE TIME: 2:05 PM
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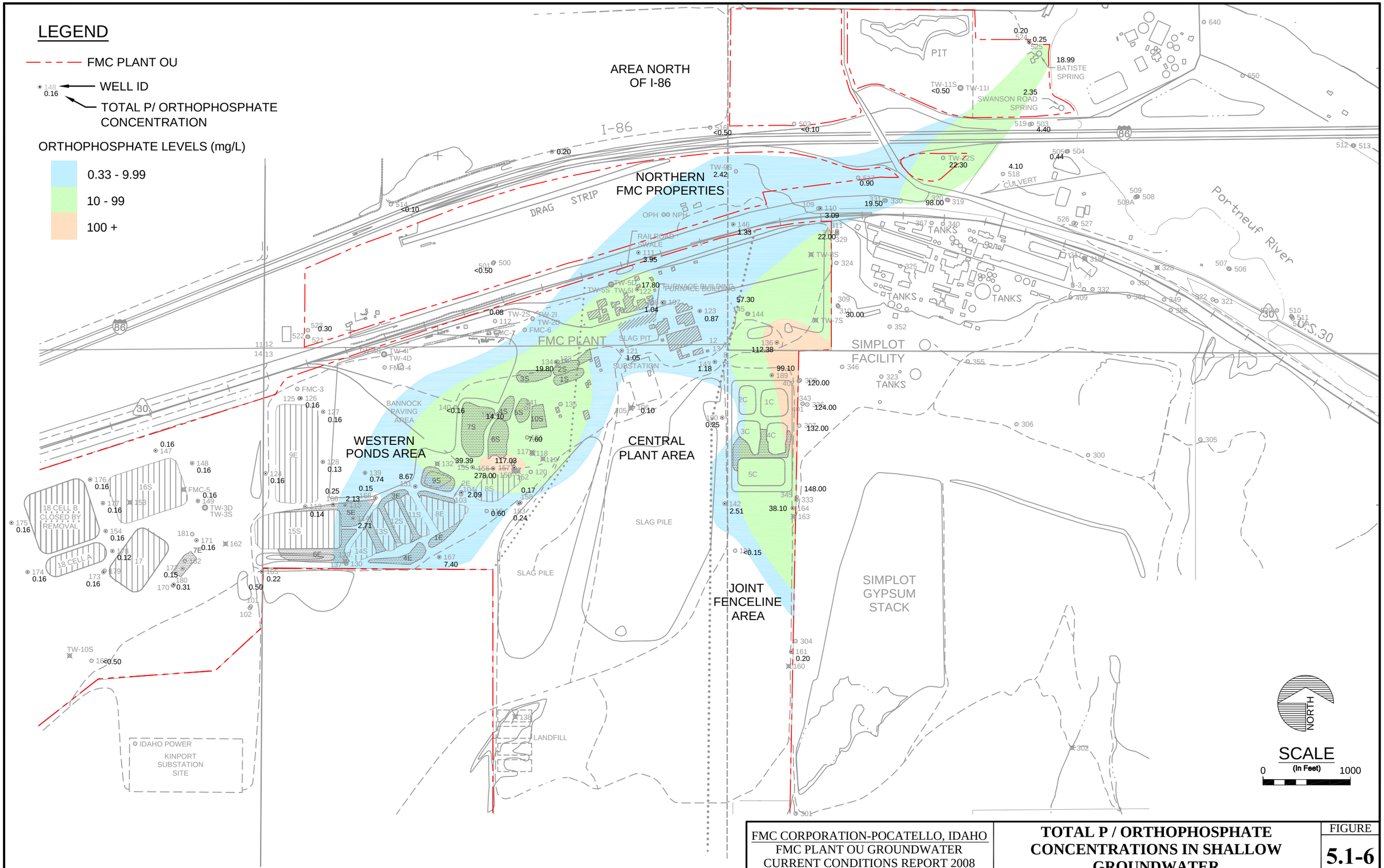

FMC CORPORATION-POCATELLO, IDAHO
FMC PLANT OU GROUNDWATER
CURRENT CONDITIONS REPORT 2008

TOTAL P / ORTHOPHOSPHATE CONCENTRATIONS IN SHALLOW GROUNDWATER

FIGURE
5.1-6

UPDATE TIME: 2:28 PM
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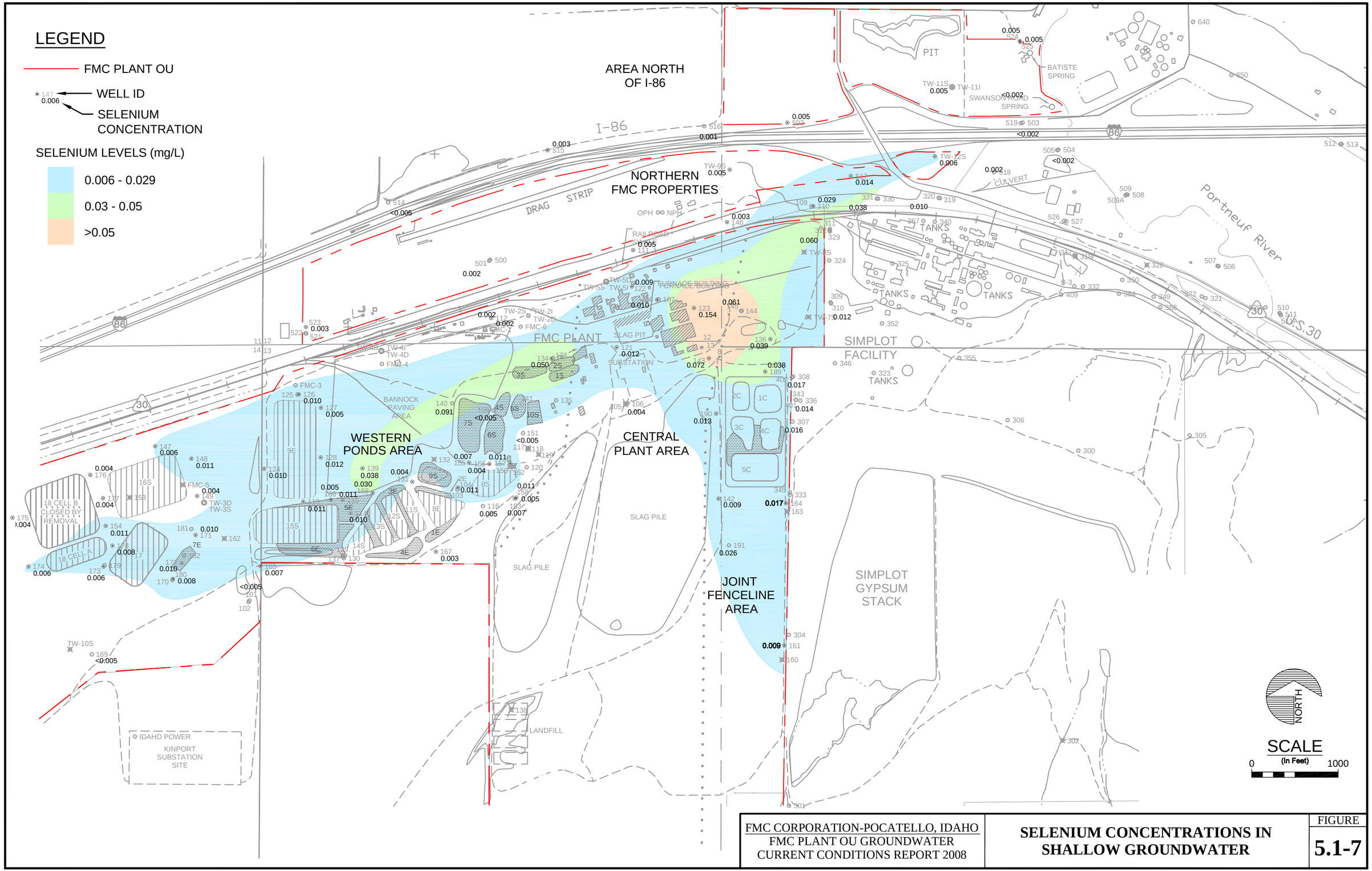

FMC CORPORATION-POCATELLO, IDAHO
FMC PLANT OU GROUNDWATER
CURRENT CONDITIONS REPORT 2008

SELENIUM CONCENTRATIONS IN SHALLOW GROUNDWATER

FIGURE
5.1-7

UPDATE TIME: 8:17 AM
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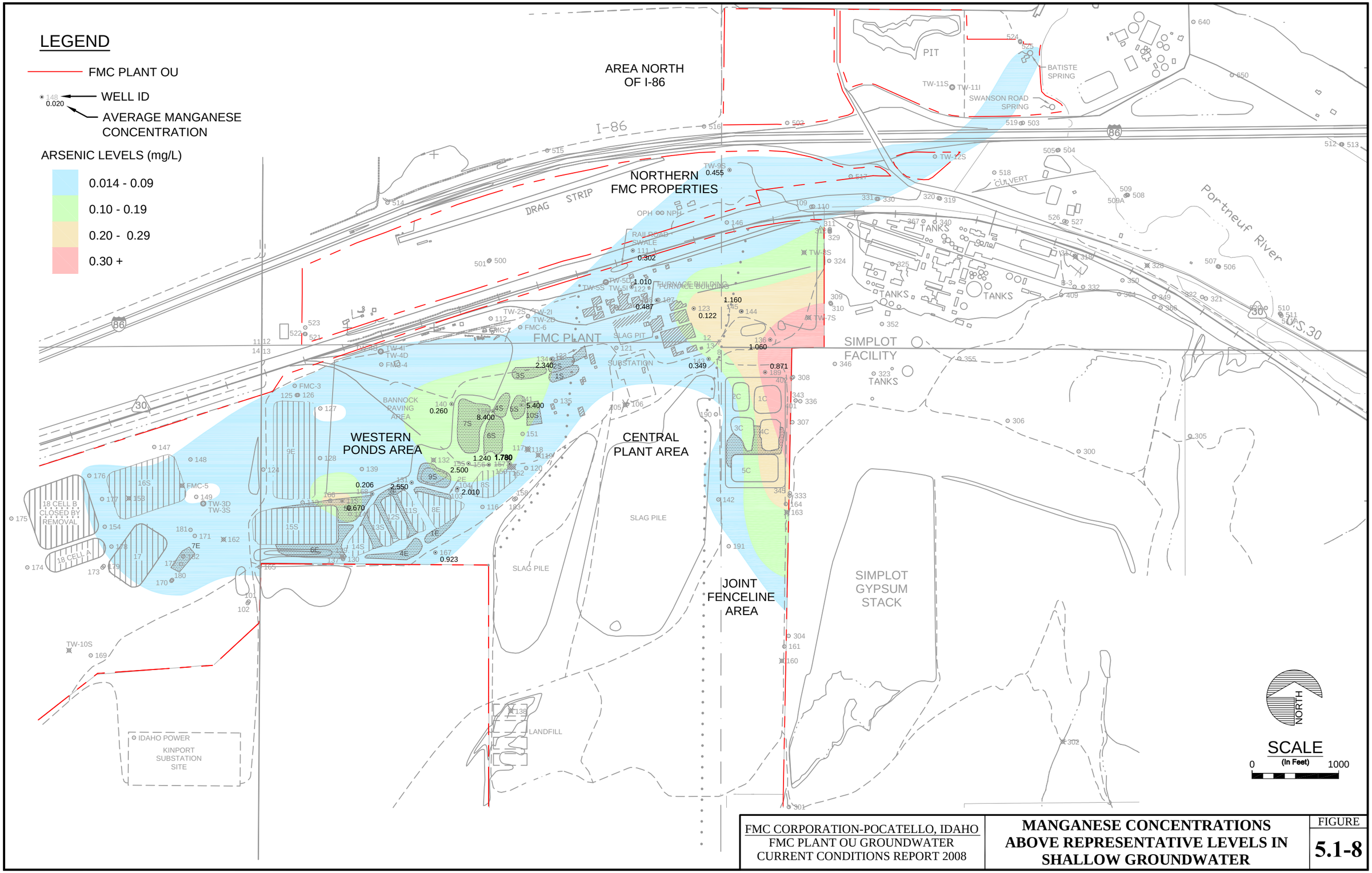

FMC CORPORATION-POCATELLO, IDAHO FMC PLANT OU GROUNDWATER CURRENT CONDITIONS REPORT 2008	MANGANESE CONCENTRATIONS ABOVE REPRESENTATIVE LEVELS IN SHALLOW GROUNDWATER	FIGURE 5.1-8

UPDATE TIME: 8:14 AM
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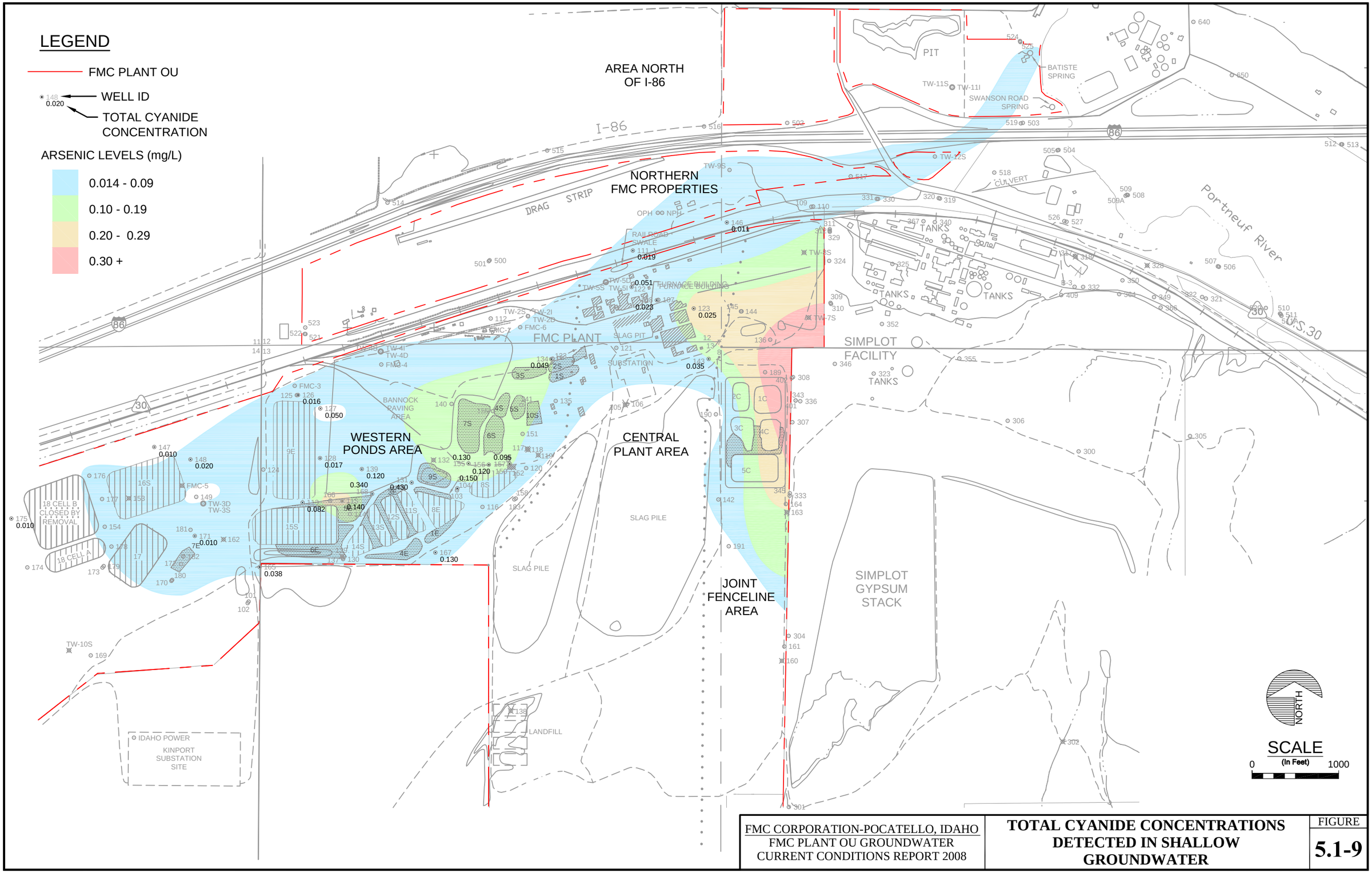

FMC CORPORATION-POCATELLO, IDAHO
FMC PLANT OU GROUNDWATER
CURRENT CONDITIONS REPORT 2008

TOTAL CYANIDE CONCENTRATIONS DETECTED IN SHALLOW GROUNDWATER

FIGURE
5.1-9

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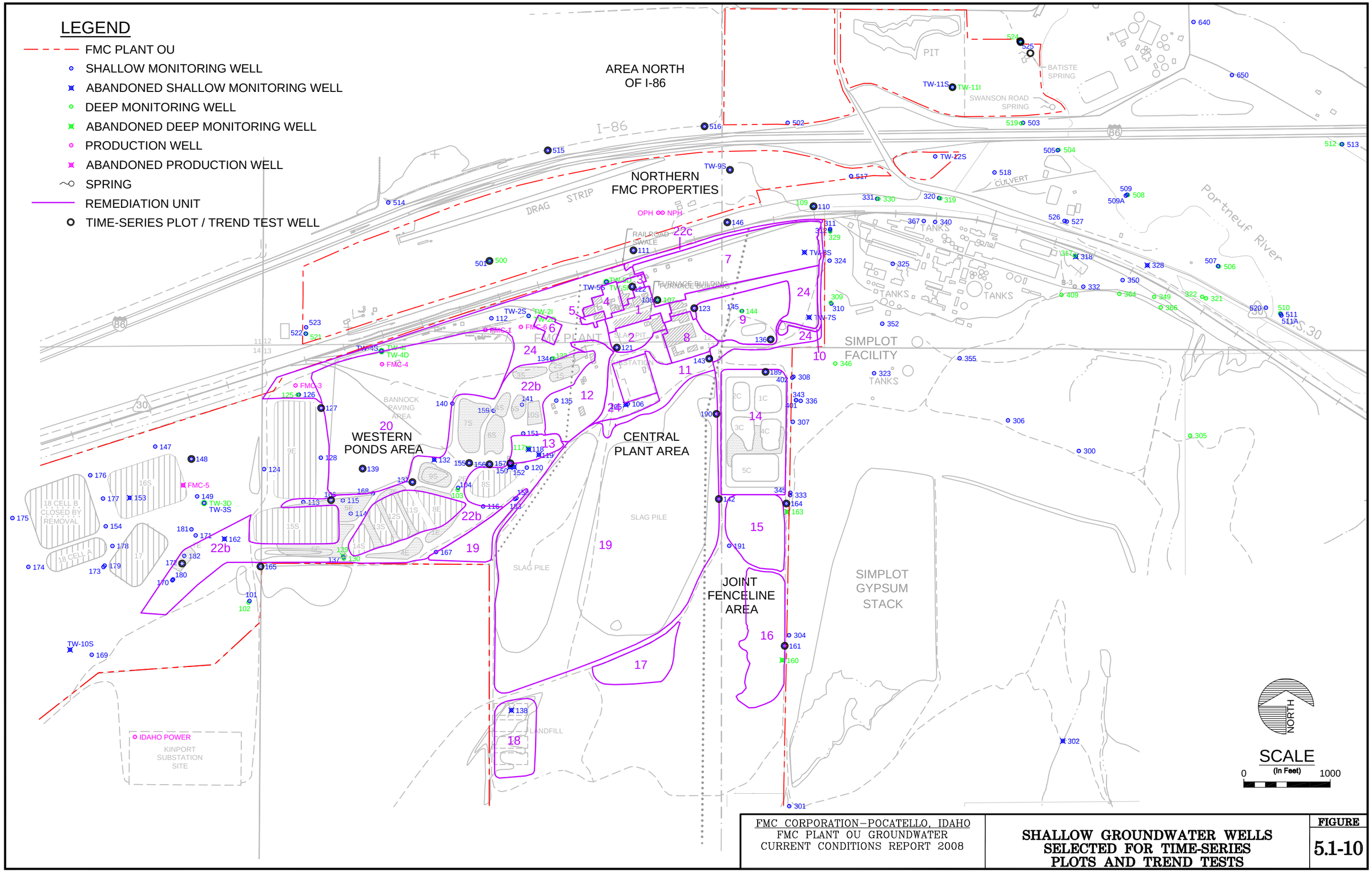

FMC CORPORATION–POCATELLO, IDAHO
FMC PLANT OU GROUNDWATER
CURRENT CONDITIONS REPORT 2008

SHALLOW GROUNDWATER WELLS SELECTED FOR TIME-SERIES PLOTS AND TREND TESTS

FIGURE
5.1-10

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Figure 5.1-11 Elemental Phosphorus at Well 108

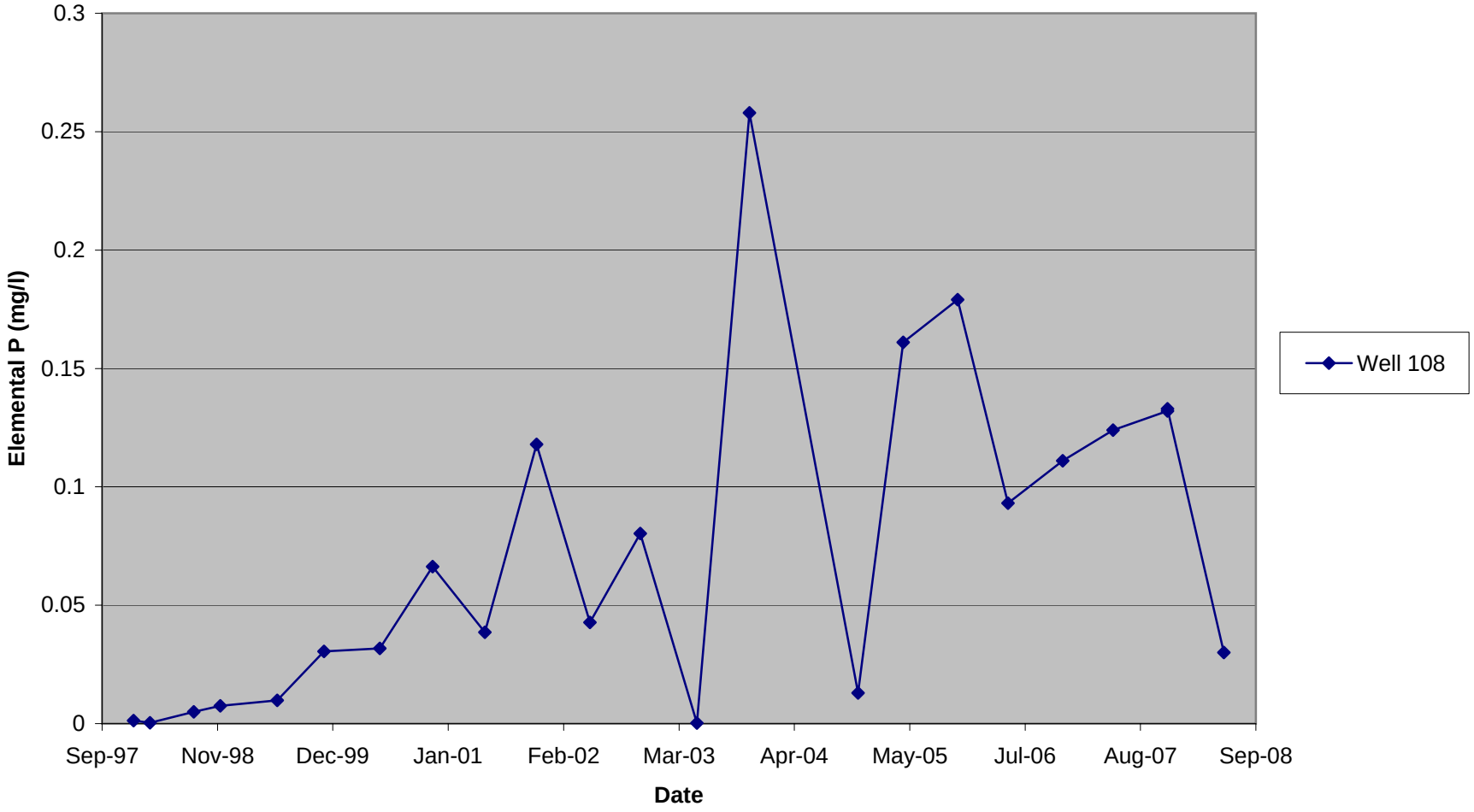


Figure 5.1-12 Elemental Phosphorus at Well 122

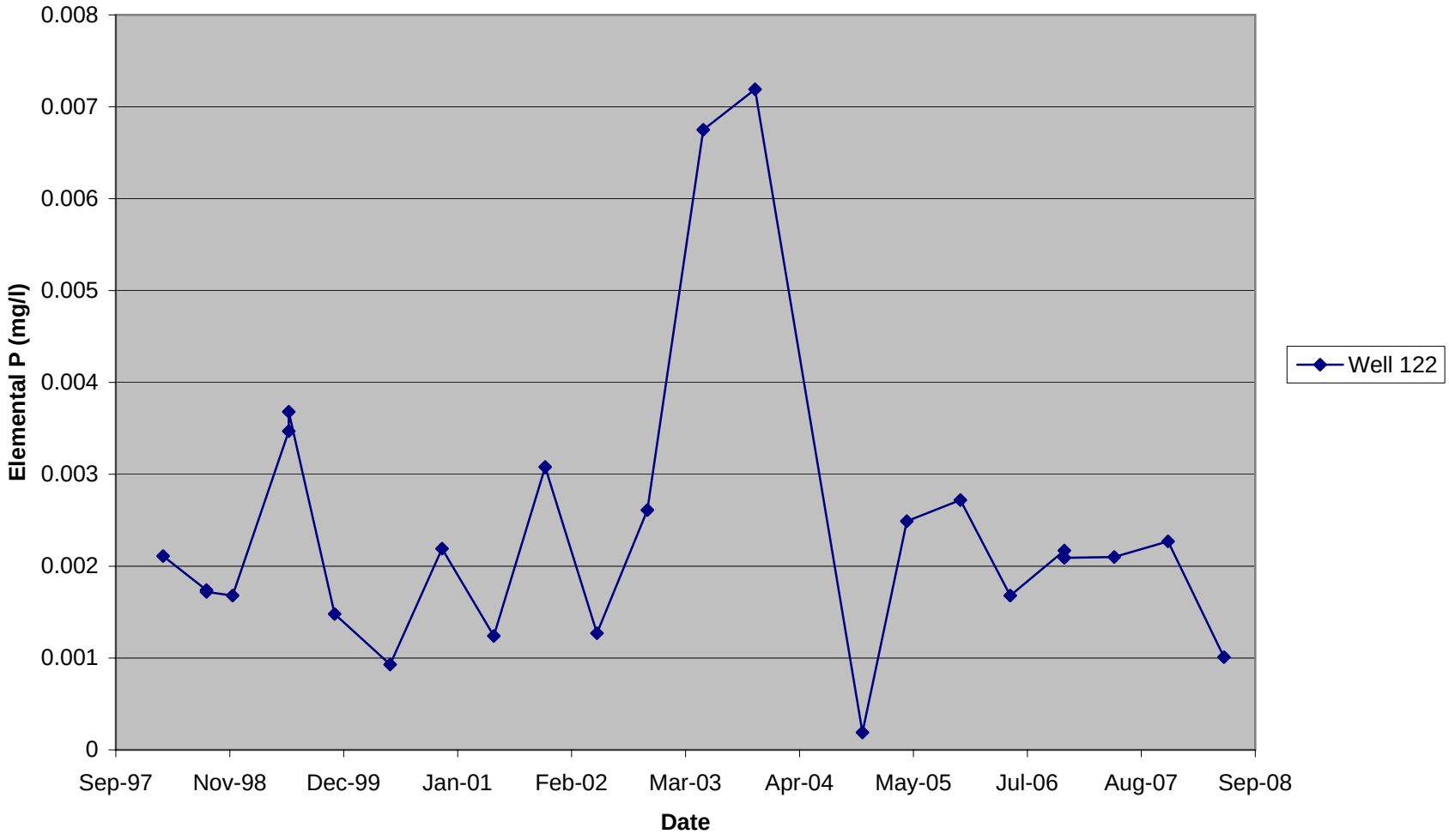


Figure 5.1- 13 Groundwater Temperature at Central Plant Area Wells

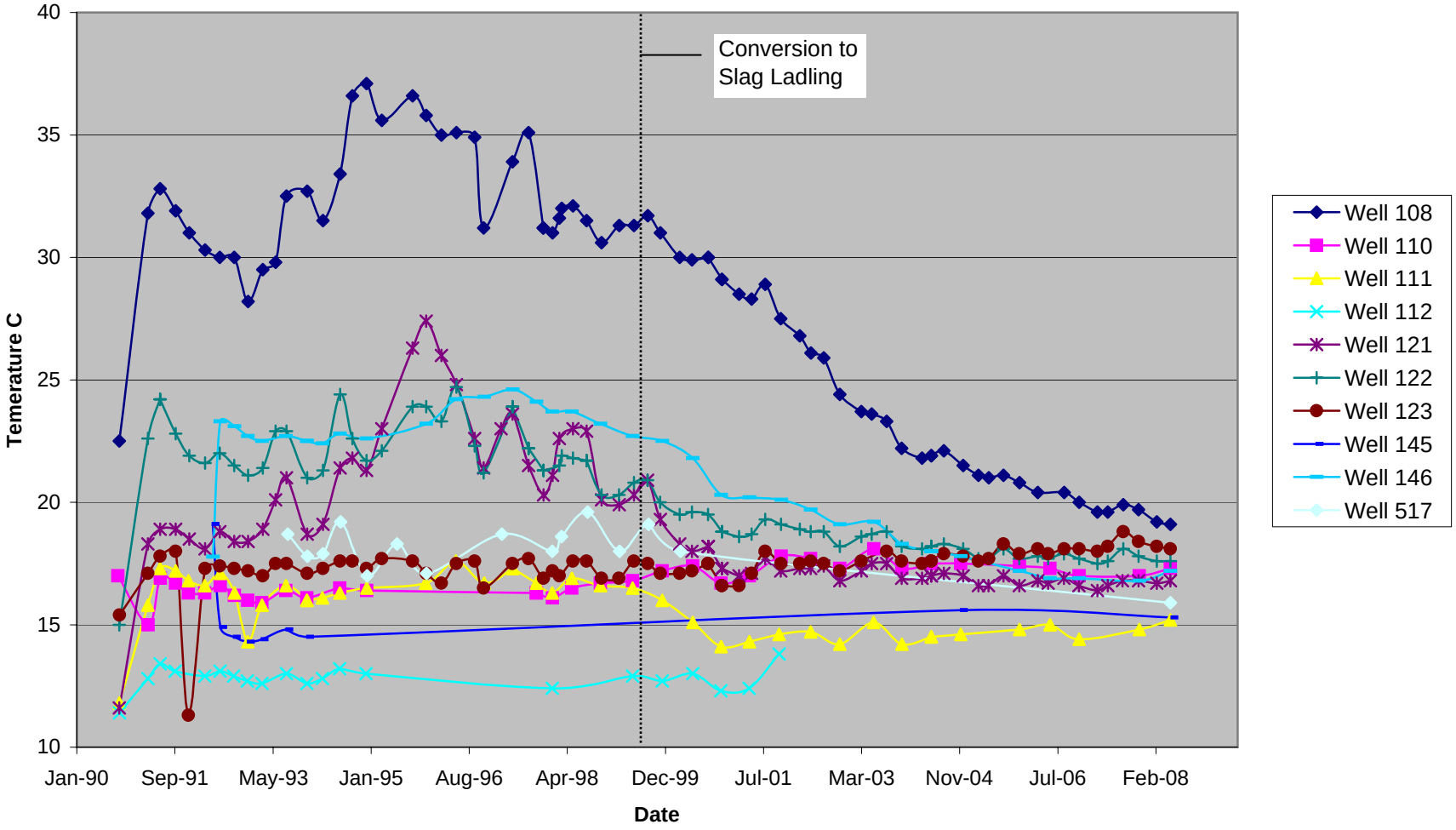


Figure 5.2-1A Arsenic Concentrations - Pond 8S Downgradient Wells

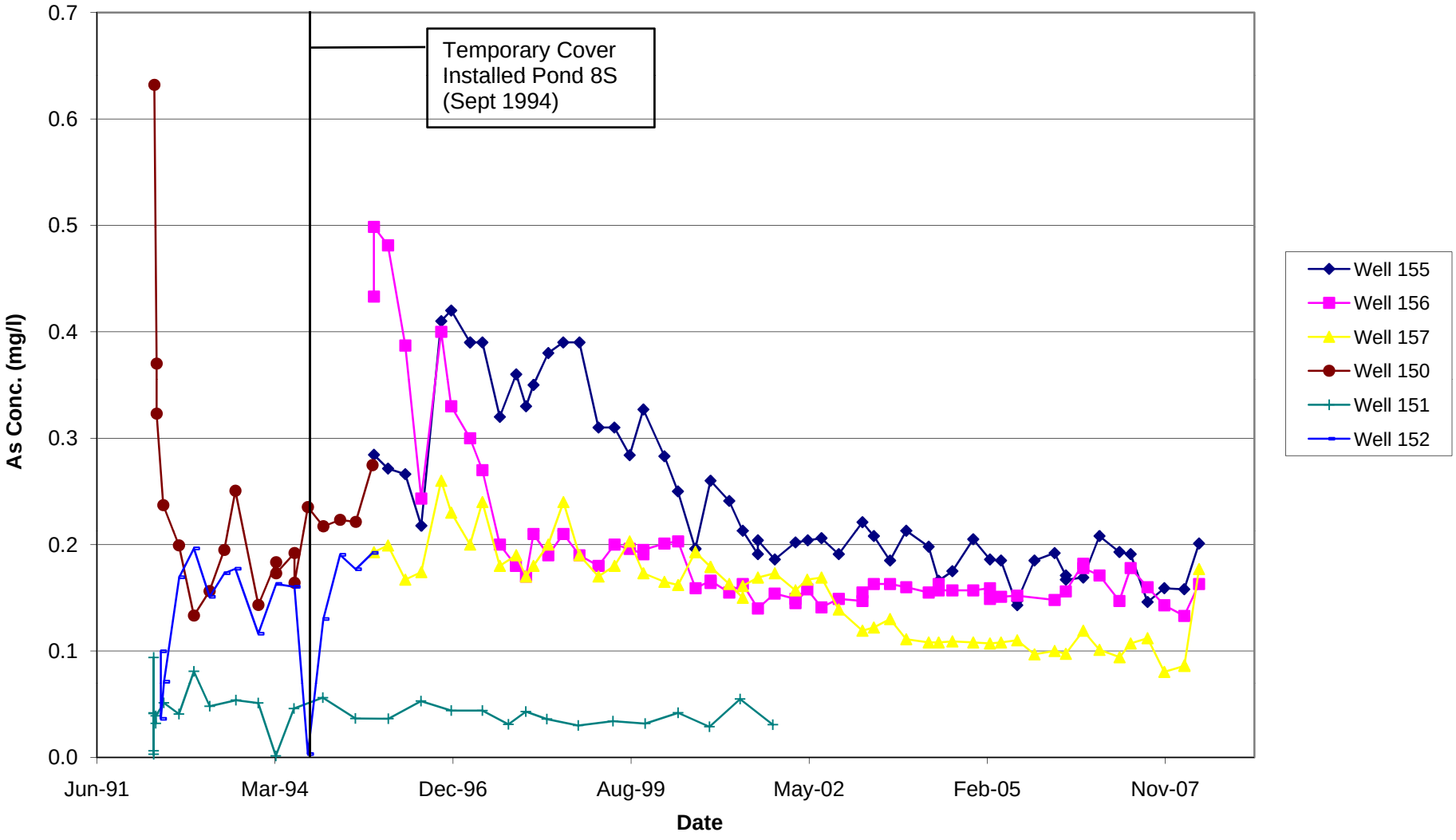


Figure 5.2-1B Potassium Concentrations - Pond 8S Downgradient Wells

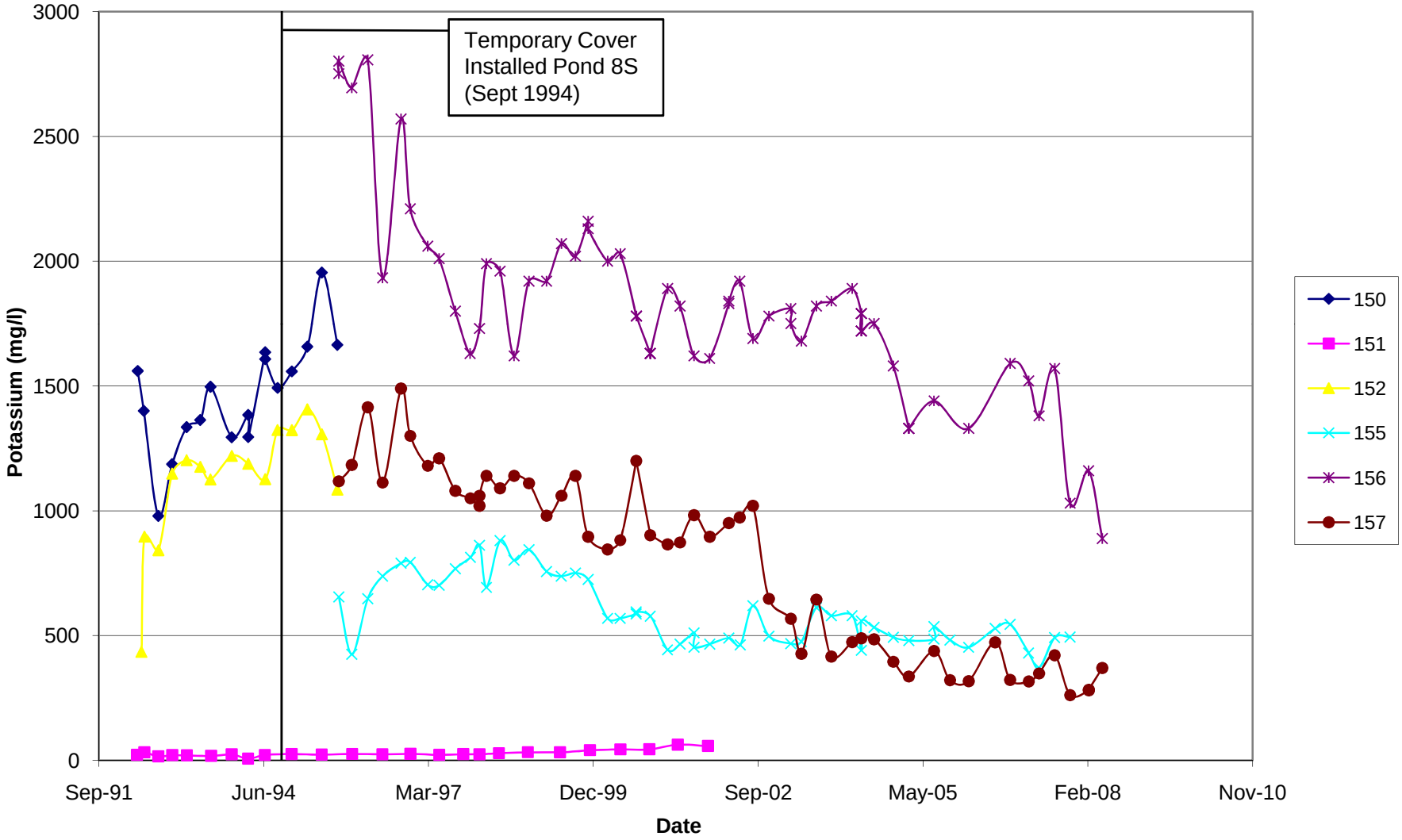


Figure 5.2-1C Ammonia Concentrations - Pond 8S Downgradient Wells

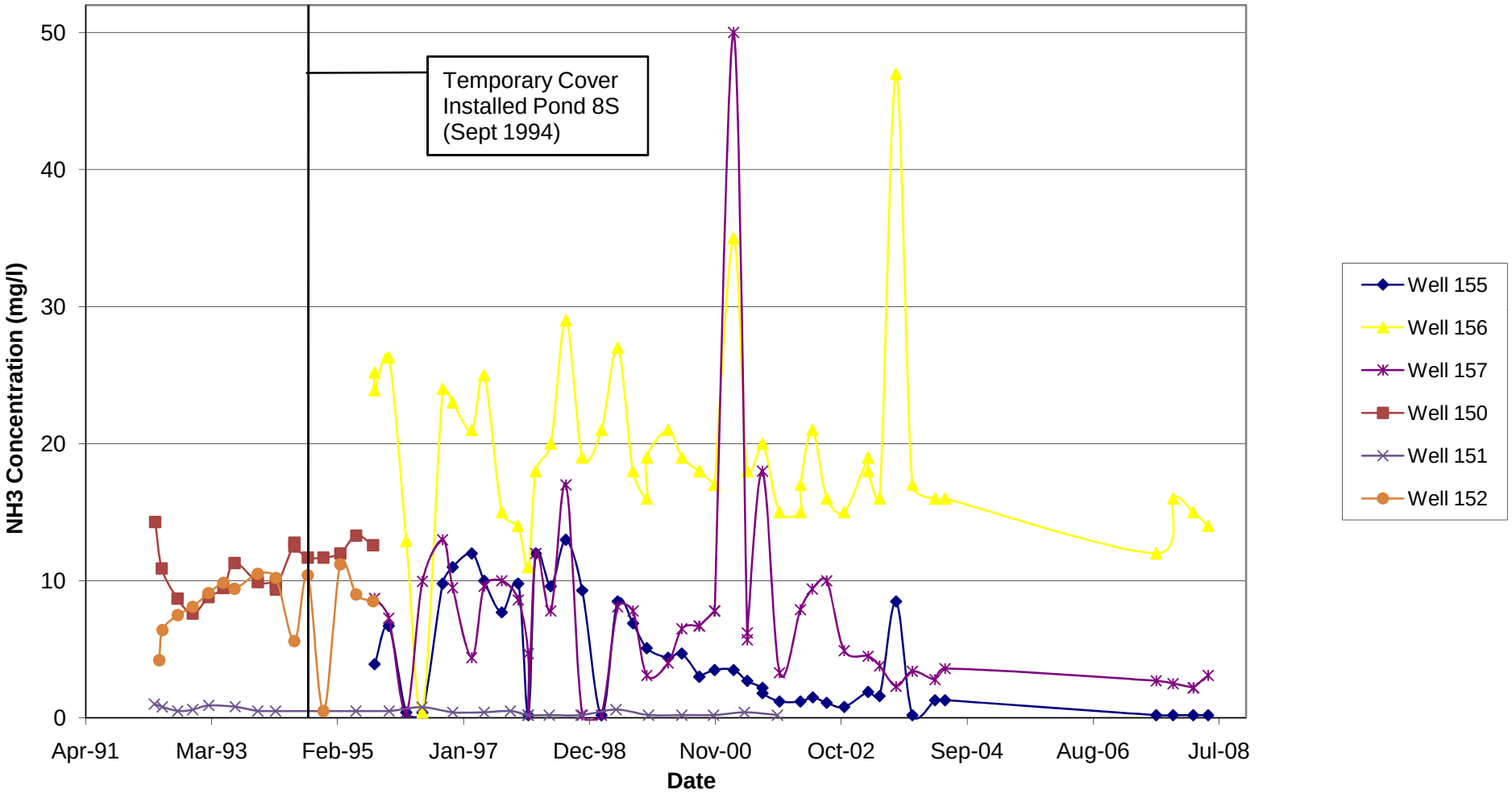


Figure 5.2-1D Nitrate Concentrations - Pond 8S Downgradient Wells

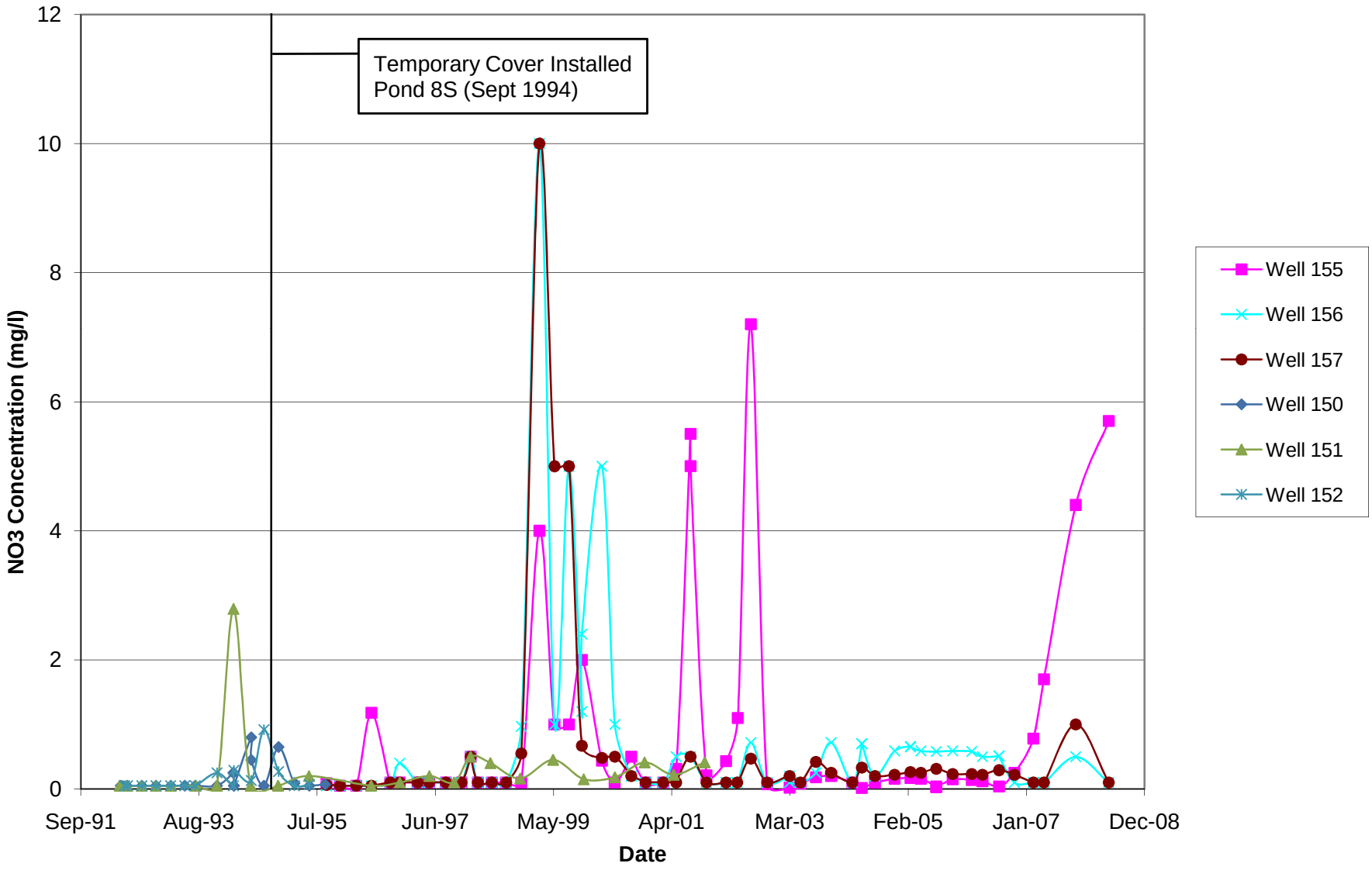


Figure 5.2-1E Total P / Orthophosphate Concentrations - Pond 8S Downgradient Wells

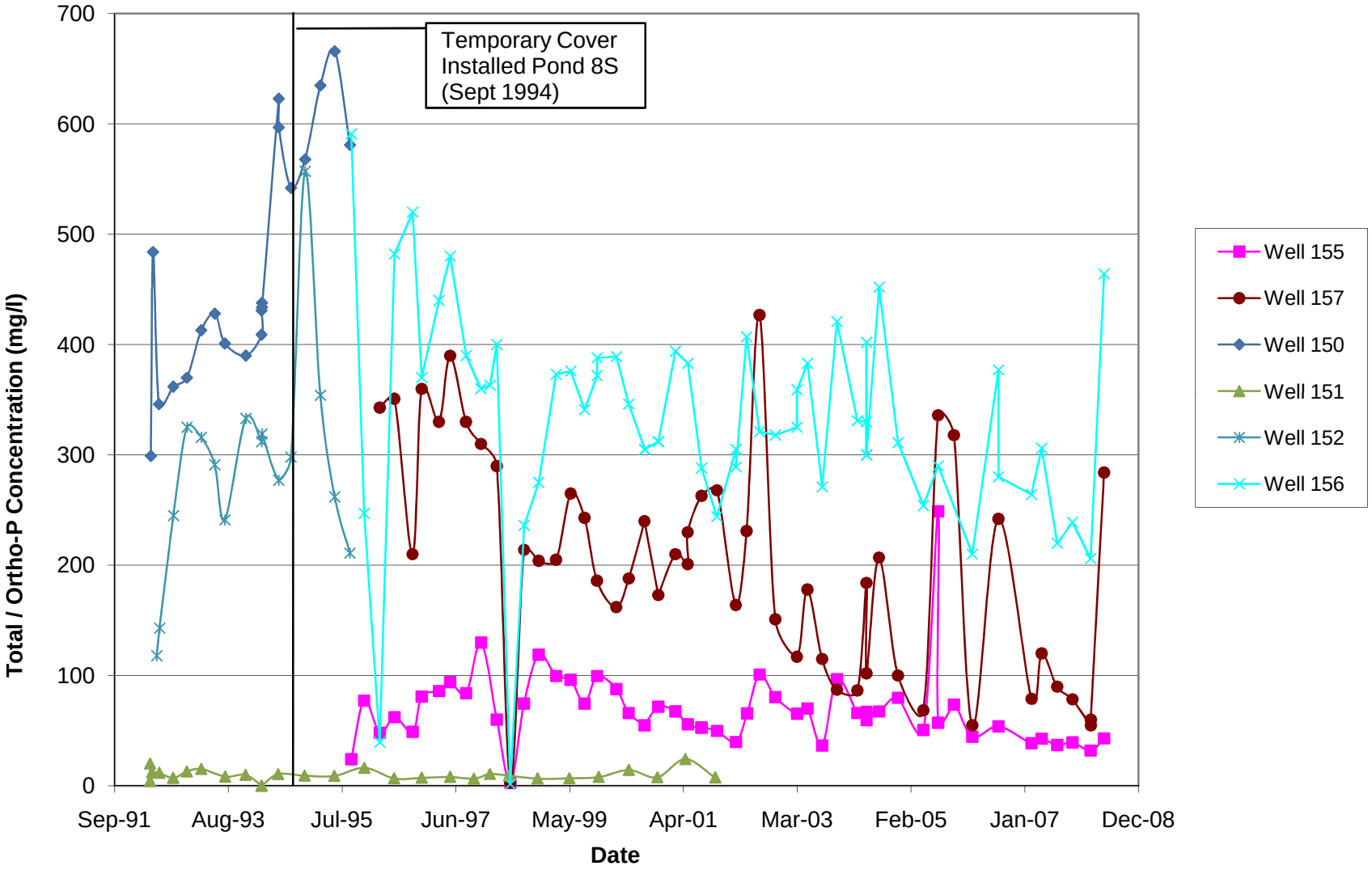


Figure 5.2-2A Arsenic Concentrations - Former Ponds 3E, 4E, 5E and 6E Downgradient Wells

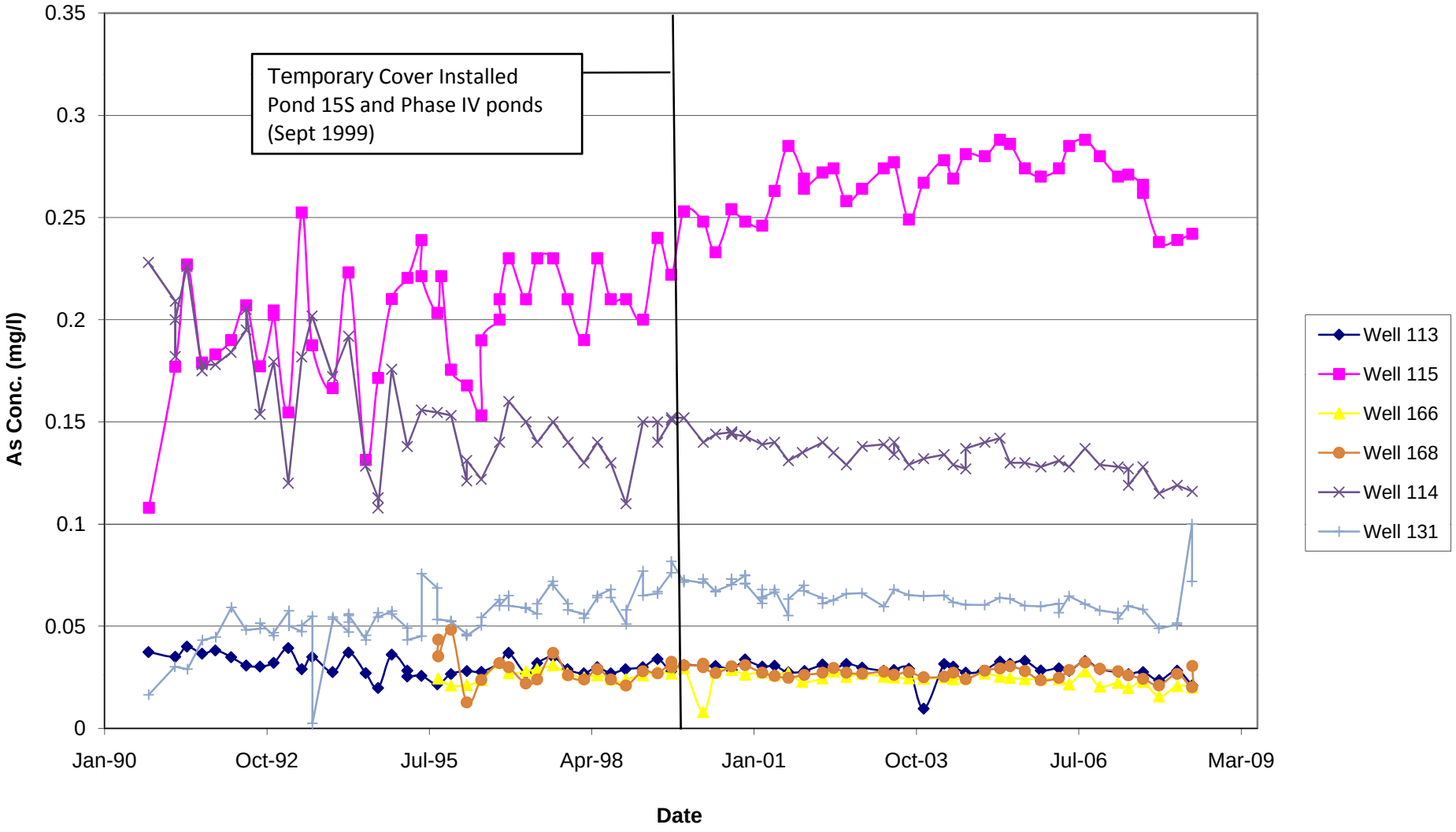


Figure 5.2-2B Potassium Concentrations - Former Ponds 3E, 4E, 5E and 6E Downgradient Wells

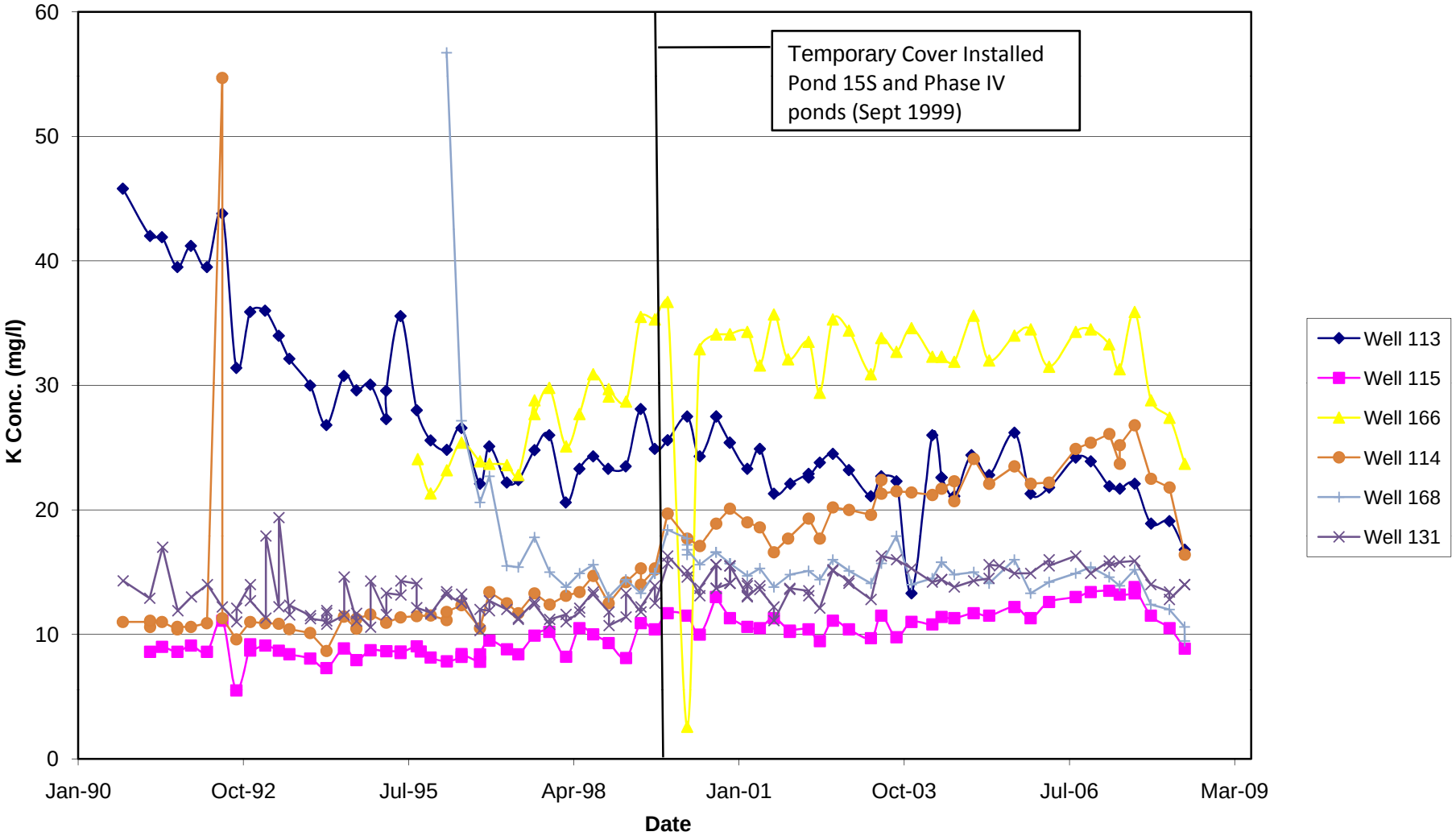


Figure 5.2-2C Ammonia Concentrations - Former Ponds Ponds 3E, 4E, 5E and 6E Downgradient Wells

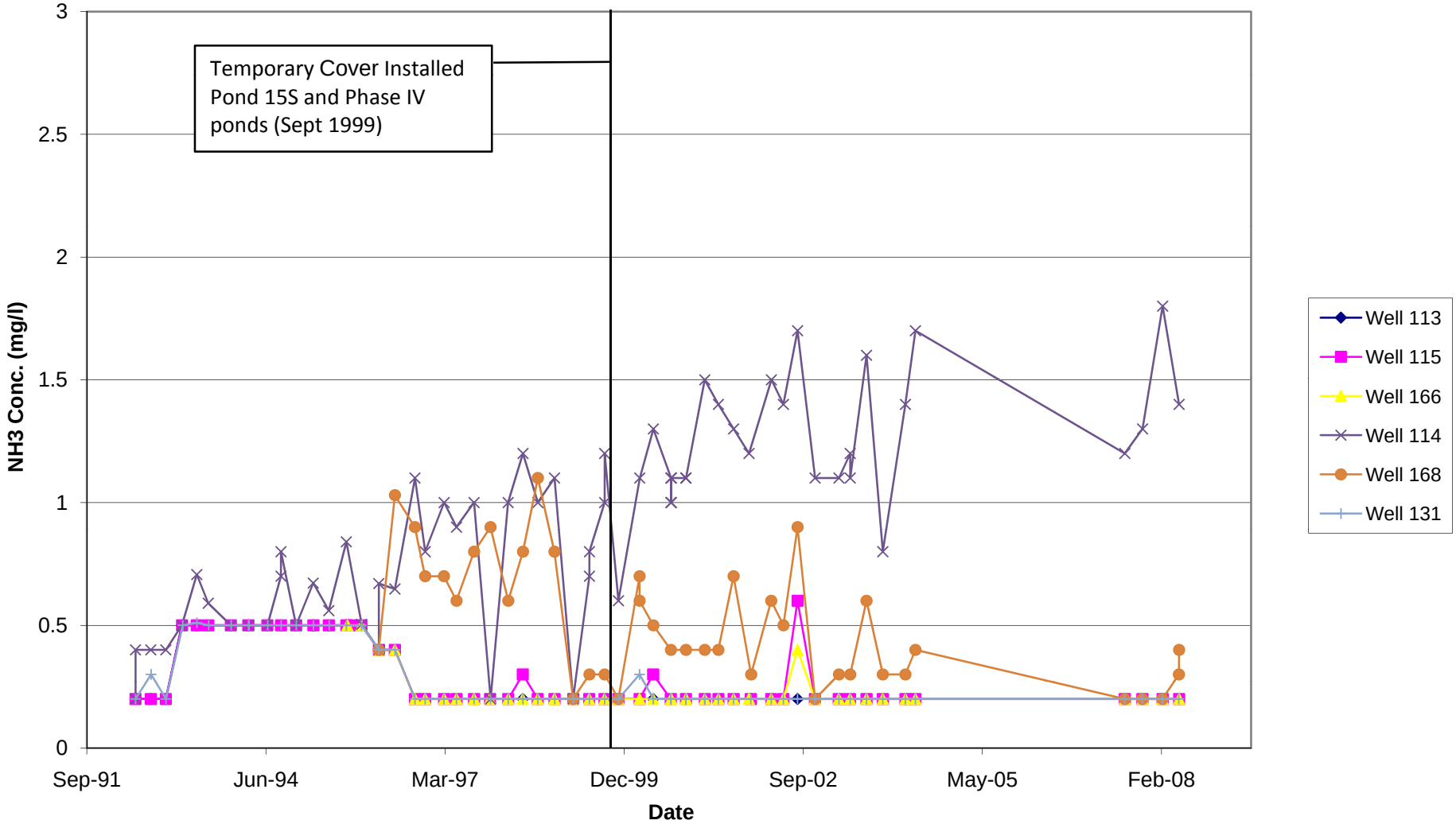


Figure 5.2-2D Nitrate Concentrations - Former Ponds 3E, 4E, 5E and 6E Downgradient Wells

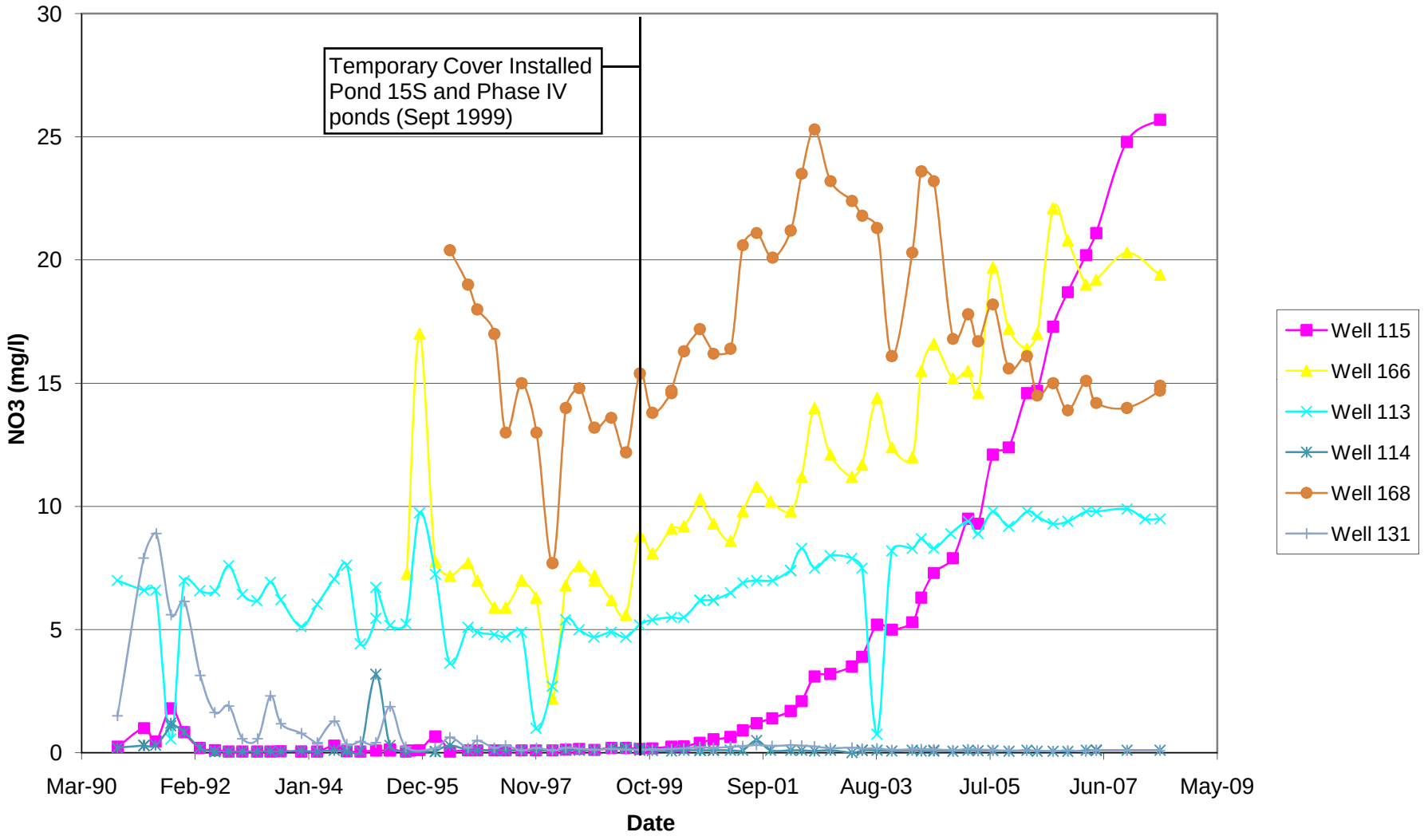
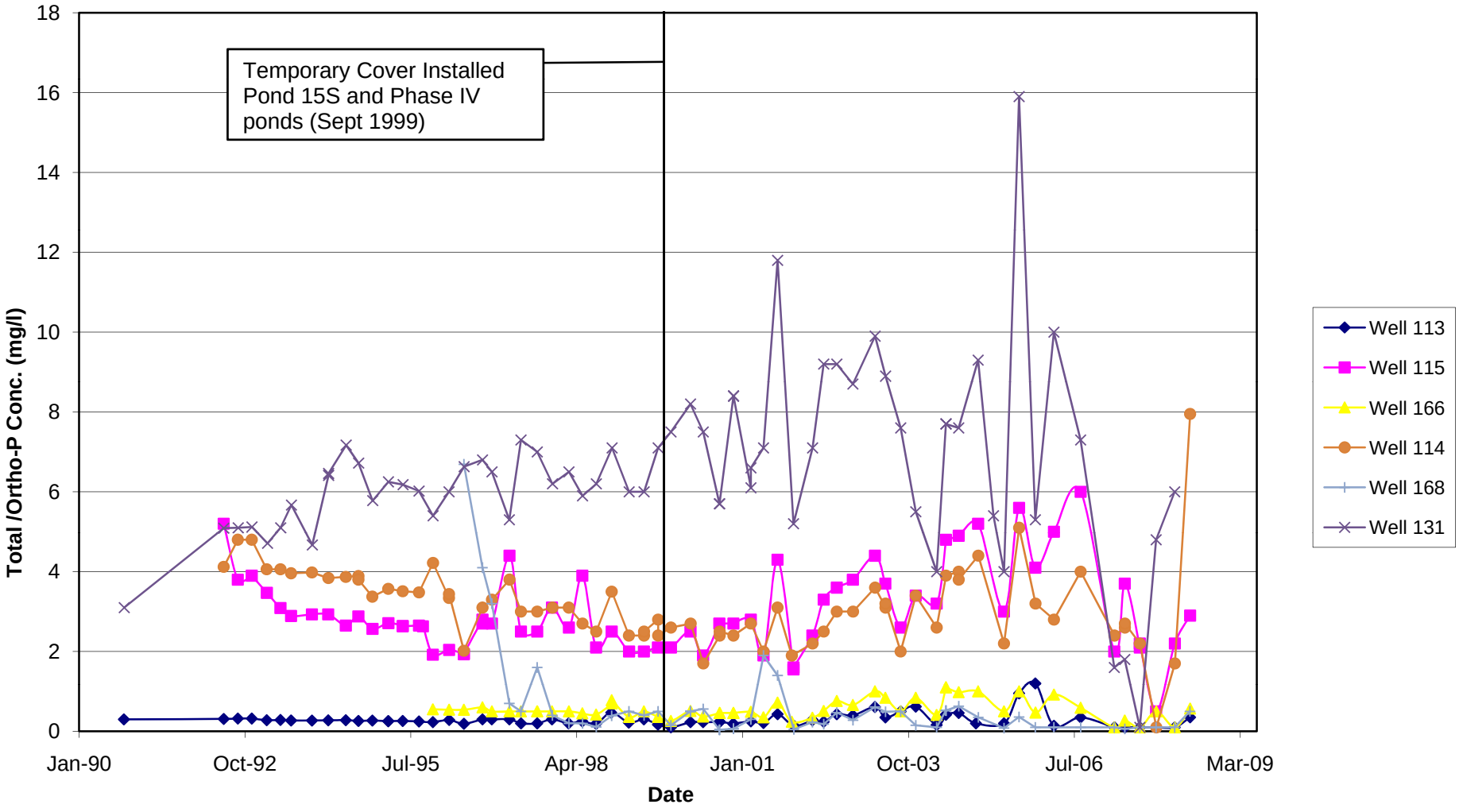


Figure 5.2-2E Total Phosphorus / Orthophosphate Concentrations - Former Ponds 3E, 4E, 5E and 6E Downgradient Wells



LEGEND

161 ○ SHALLOW MONITORING WELL

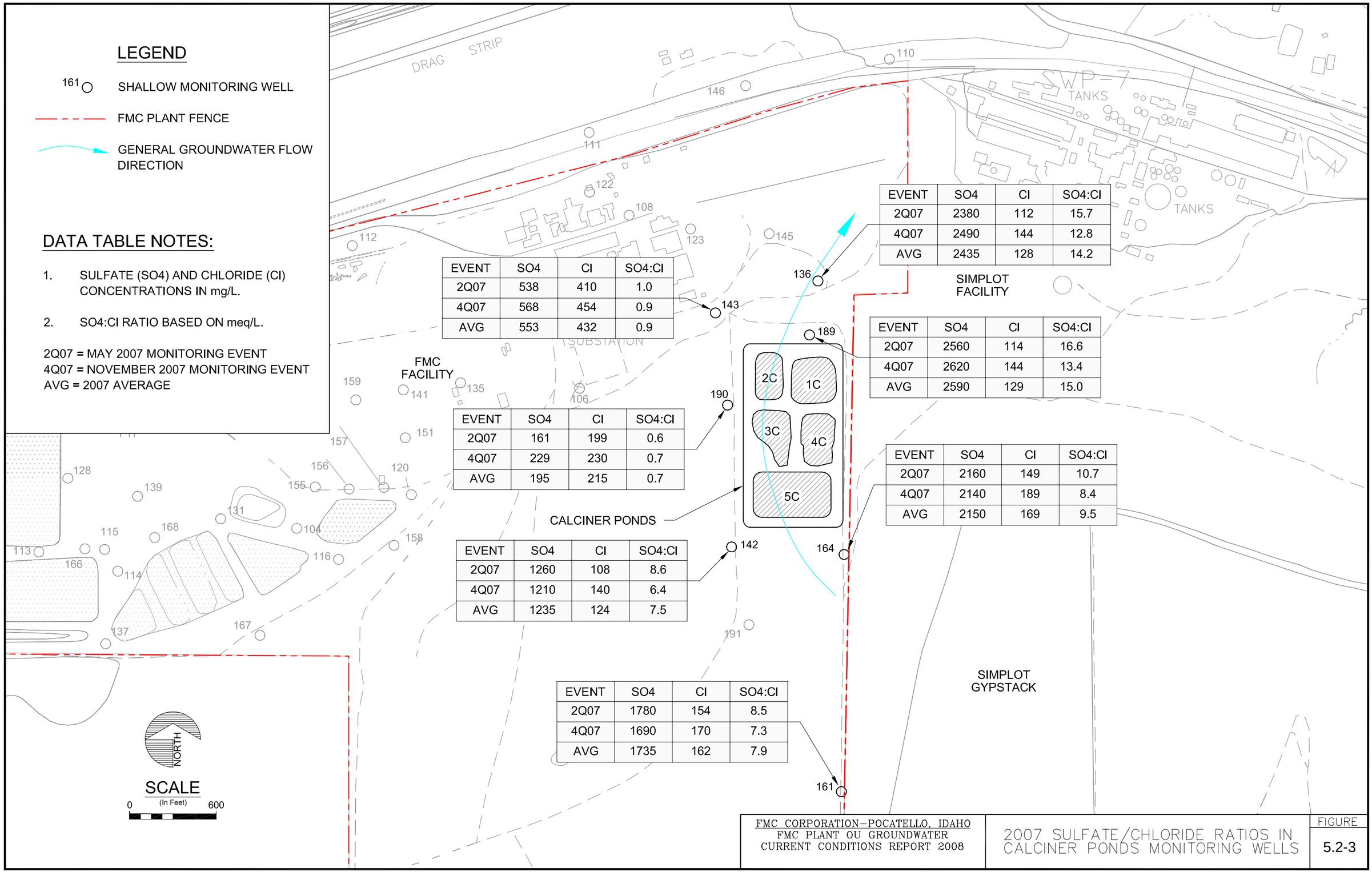
FMC PLANT FENCE

GENERAL GROUNDWATER FLOW DIRECTION

DATA TABLE NOTES:

1. SULFATE (SO4) AND CHLORIDE (Cl) CONCENTRATIONS IN mg/L.
2. SO4:Cl RATIO BASED ON meq/L.

2Q07 = MAY 2007 MONITORING EVENT
4Q07 = NOVEMBER 2007 MONITORING EVENT
AVG = 2007 AVERAGE



EVENT	SO4	Cl	SO4:Cl
2Q07	2380	112	15.7
4Q07	2490	144	12.8
AVG	2435	128	14.2

EVENT	SO4	Cl	SO4:Cl
2Q07	538	410	1.0
4Q07	568	454	0.9
AVG	553	432	0.9

EVENT	SO4	Cl	SO4:Cl
2Q07	2560	114	16.6
4Q07	2620	144	13.4
AVG	2590	129	15.0

EVENT	SO4	Cl	SO4:Cl
2Q07	161	199	0.6
4Q07	229	230	0.7
AVG	195	215	0.7

EVENT	SO4	Cl	SO4:Cl
2Q07	2160	149	10.7
4Q07	2140	189	8.4
AVG	2150	169	9.5

EVENT	SO4	Cl	SO4:Cl
2Q07	1260	108	8.6
4Q07	1210	140	6.4
AVG	1235	124	7.5

EVENT	SO4	Cl	SO4:Cl
2Q07	1780	154	8.5
4Q07	1690	170	7.3
AVG	1735	162	7.9

FMC CORPORATION–POCATELLO, IDAHO
FMC PLANT OU GROUNDWATER
CURRENT CONDITIONS REPORT 2008

2007 SULFATE/CHLORIDE RATIOS IN CALCINER PONDS MONITORING WELLS

FIGURE 5.2-3

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LEGEND

161 ○ SHALLOW MONITORING WELL

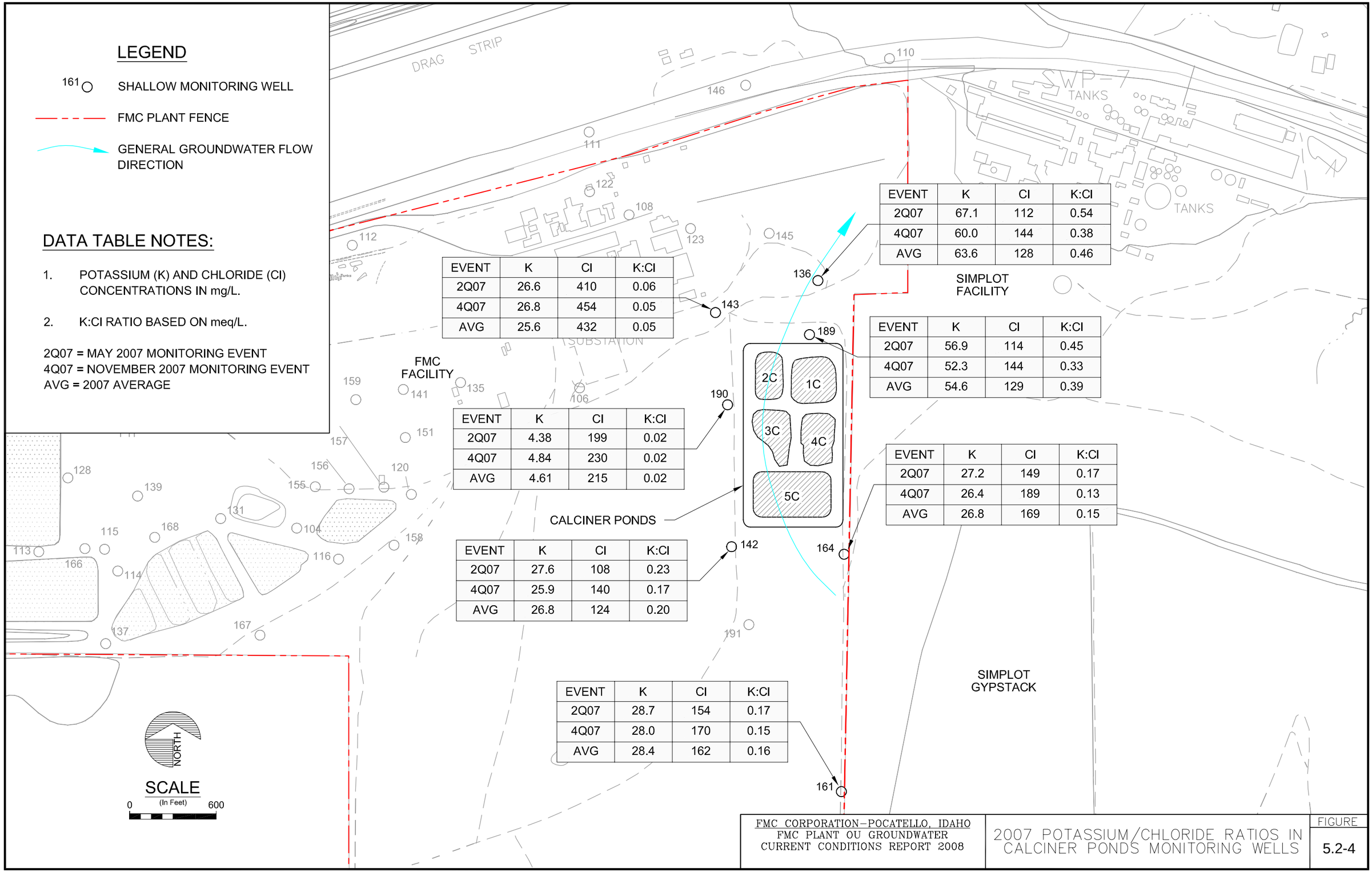
FMC PLANT FENCE

GENERAL GROUNDWATER FLOW DIRECTION

DATA TABLE NOTES:

1. POTASSIUM (K) AND CHLORIDE (Cl) CONCENTRATIONS IN mg/L.
2. K:Cl RATIO BASED ON meq/L.

2Q07 = MAY 2007 MONITORING EVENT
4Q07 = NOVEMBER 2007 MONITORING EVENT
AVG = 2007 AVERAGE



EVENT	K	Cl	K:Cl
2Q07	26.6	410	0.06
4Q07	26.8	454	0.05
AVG	25.6	432	0.05

EVENT	K	Cl	K:Cl
2Q07	67.1	112	0.54
4Q07	60.0	144	0.38
AVG	63.6	128	0.46

EVENT	K	Cl	K:Cl
2Q07	56.9	114	0.45
4Q07	52.3	144	0.33
AVG	54.6	129	0.39

EVENT	K	Cl	K:Cl
2Q07	4.38	199	0.02
4Q07	4.84	230	0.02
AVG	4.61	215	0.02

EVENT	K	Cl	K:Cl
2Q07	27.2	149	0.17
4Q07	26.4	189	0.13
AVG	26.8	169	0.15

EVENT	K	Cl	K:Cl
2Q07	27.6	108	0.23
4Q07	25.9	140	0.17
AVG	26.8	124	0.20

EVENT	K	Cl	K:Cl
2Q07	28.7	154	0.17
4Q07	28.0	170	0.15
AVG	28.4	162	0.16

FMC CORPORATION–POCATELLO, IDAHO
FMC PLANT OU GROUNDWATER
CURRENT CONDITIONS REPORT 2008

2007 POTASSIUM/CHLORIDE RATIOS IN CALCINER PONDS MONITORING WELLS

FIGURE 5.2-4

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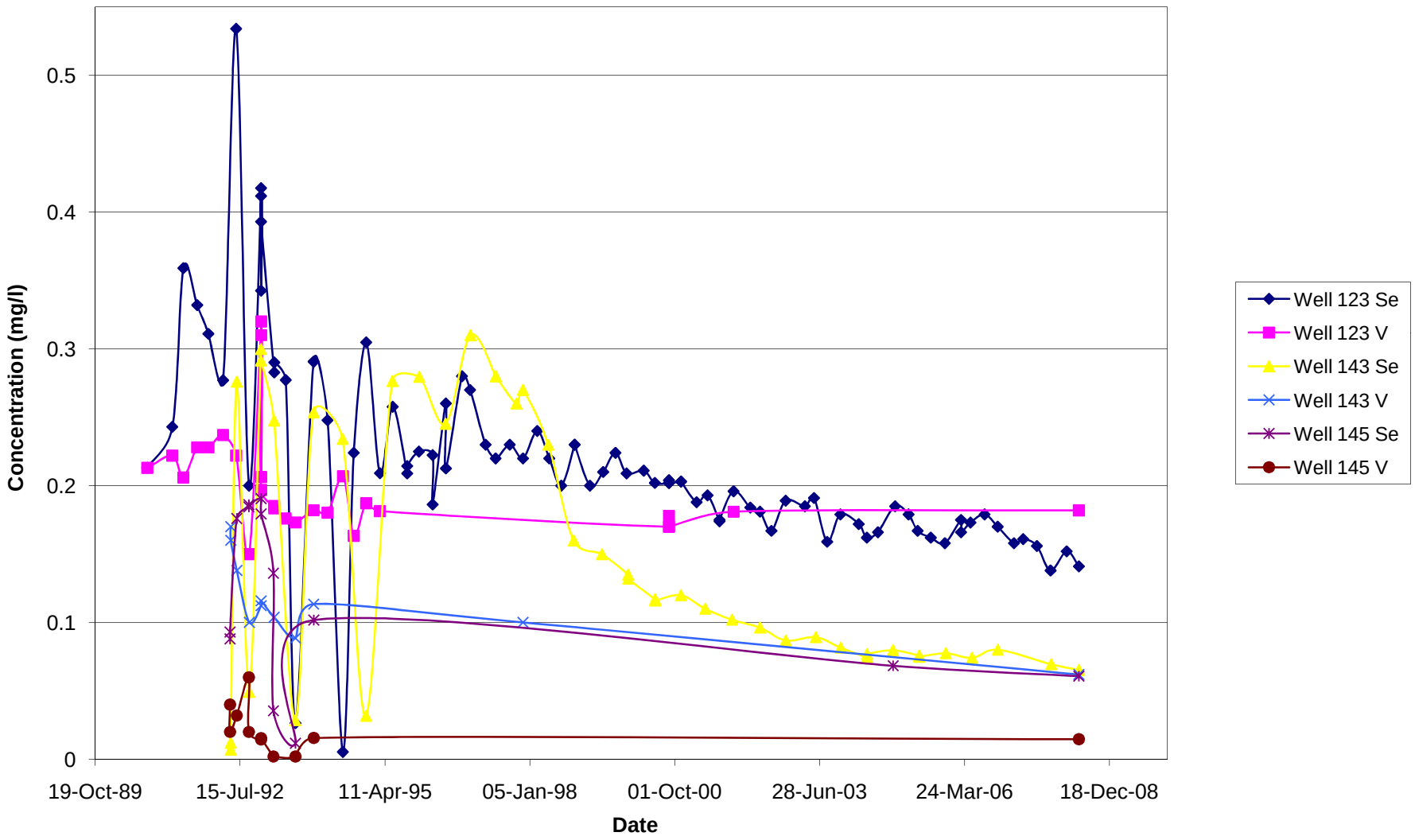
Figure 5.2-5 Wells 123, 143 and 145 Selenium and Vanadium Concentrations



Section 6
FATE AND TRANSPORT

This section describes the factors affecting the migration of inorganic constituents from EMF facility sources through the vadose zone and along flowpaths in groundwater. The fate and transport of chemicals in the subsurface is potentially affected by a variety of chemical, biological and physical reactions, transformations and processes which may take place in the unsaturated and saturated subsurface environment. These include the following factors:

- seepage rates
- pH change and soil mineralogy
- aquifer geochemistry
- advective mixing

Many of the chemicals originating from the EMF facilities decline in concentration to representative levels along one or more of the principal migration pathways. The decreases in chemical concentrations can be explained by one or more attenuation factors including ionic exchange, precipitation and oxidation, as well as by advective mixing. The chemicals can be loosely grouped into those that are highly attenuated in the vadose zone (e.g., cadmium), those that are attenuated along the groundwater flowpath (e.g., fluoride), and those that are relatively unattenuated in groundwater (e.g., sulfate).

As described in Section 5, the FMC-related constituents in groundwater principally originated at source areas to which a sustained, artificial head, containing high solute concentrations was applied. The principal factors affecting constituent migration in the vadose zone beneath these source areas are seepage rates and seepage fluid and soil chemistry. The principal factors affecting migration in the saturated zone are attenuation and advective mixing.

This section is devoted to discussion of the subsurface migration factors identified above. Factors affecting vadose zone migration, namely seepage rates and fluid and soil chemistry, are discussed in Section 6.1. Factors affecting constituent migration in groundwater, namely attenuation and advective mixing, are discussed in Section 6.2. The discussion relies on empirical observations based on the EMF RI and SRI subsurface data and the EMF RI and post-RI groundwater data, with support from the literature and various studies performed in conjunction with the EMF RI (e.g., climate and infiltration rates).

6.1 Principal Factors Affecting Migration in the Vadose Zone

This section begins with a discussion of seepage rates from the former unlined ponds described in Section 5.2 and the factors that affect seepage rates from these sources. This section also

provides a discussion of the effects of increasing soil pH on the mobility of constituents as they enter and move through the vadose zone and effects of source and vadose zone temperature on migration of elemental phosphorus in the subsurface.

Seepage Rates

As indicated in Section 5.2, FMC's former unlined "phossy" ponds (RU 22b), Pond 8S (RU 22a), kiln scrubber and overflow ponds (RUs 8 and 9) and former unlined calciner ponds (RU 14) are areas to which a sustained hydraulic head was applied at unlined impoundments. In addition to these former unlined pond areas, the calciner solids storage area (RU 16) was not subject to a sustained hydraulic head but did receive material with a high water content that caused infiltration to the subsurface.

The IWW pond and ditch (RU 10) was also an unlined feature operated with a sustained hydraulic head and the Railroad Swale (RU 22c) was an unlined area that was periodically subject to an artificial hydraulic head. Liquid from these areas likely migrated to groundwater and these areas may have been historic sources of constituents to groundwater.

There are currently no areas at the FMC Plant Site that are subject to a sustained hydraulic head. The timeline for the removal of sustained hydraulic head from those areas identified in Section 5.2 is summarized below:

- FMC ceased use of the kiln scrubber ponds and overflow pond in the late 1960s when the calciners were built in 1968. The concrete slab constructed for the calciners covered some of the area of the kiln scrubber ponds.

- FMC ceased operation and began filling the last of the old unlined "phossy" ponds (old ponds 3E through 7E in RU 22b) during the period from 1975 to 1979 (refer to the EMF RI Report, Appendix M, Table M-3 for the estimated operational life of the old phossy ponds in RU 22b).

- In 1986, new double-lined calciner ponds 1C and 2C were constructed and placed in service and the old unlined calciner ponds were removed from service.

- In 1988, the old unlined calciner ponds were excavated and the calciner sediments moved south to the Calciner Sediment Storage Area A, and the new double-lined calciner ponds 3C and 4C were constructed over the area of the old unlined ponds.

- In 1993, the remaining area of the old unlined ponds and calciner sediments in Storage Area A were excavated and moved to Calciner Sediment Storage Area B (the northern "half" of RU 16), and the new double-lined calciner (solar drying) pond 5C was constructed and placed in service.

- In 1993 and 1994, FMC lined a portion of the railroad swale; filled, dewatered and placed a temporary cover on Pond 8S; and terminated discharge of wastewater to the slag pit sump.

- In 1999, the final cover system was constructed over Pond 8S.

- The FMC plant permanently ceased operation in December 2001, after which no additional calciner solids were generated or placed in the calciner solids storage area (RU 16).

- FMC terminated the IWW discharge in August 2002; this eliminated the last unlined area at the FMC Plant Site that had a sustained hydraulic head.

- The final closure of all RCRA ponds (RU 22a) was completed by 2005; because the ponds were dewatered prior to closure, this eliminated the last of the lined areas at the FMC Plant Site that had a sustained hydraulic head.

The Simplot gypsum stack(s) remains an ongoing source within the joint fenceline area of the EMF Site that has a sustained applied head.

The surface area of an impoundment is one of the most significant factors relating to the flux of water through the vadose zone; depth of the fluids is of secondary importance (Johnson and Finlayson, 1989). The results of a water balance study at Pond 8S performed in 1992 indicated there was an average seepage rate of 106 inches per year from this then-active pond (Bechtel, 1993g). This represented a deep recharge rate of 15 gallons per minute over the entire area of the pond (117,474 square feet). Assuming other old phossy ponds (old ponds 3E through 7E) had seepage rates similar to Pond 8S, the total reduction in pond seepage was estimated at approximately 320 gpm from taking those ponds out of service and either filling them to grade or excavating and replacing them with new lined ponds.

The other old unlined phossy ponds are assumed to be similar to Pond 8S because of the similarity of the sludges at the base of these ponds. The pond sludges, which are an important seepage-controlling factor, are very fine-grained materials slurried to the ponds for storage. Sludges settle to the bottom of the ponds, forming a low-permeability layer that reduces seepage. Permeability reduction by settling out of suspended fine-grained sediments is a well-documented process at artificial recharge ponds (Johnson and Finlayson, 1989).

In the absence of an artificially applied head, seepage is limited to that from natural precipitation. The average infiltration throughout the Eastern Snake River Plain is about 10% of mean annual precipitation (Wood and Low, 1986), resulting in approximately 1 inch of infiltration per year.

pH Change and Soil Mineralogy

As described in the EMF RI Report, Section 4.2 and the SRI Report, most of the metals migrating in native soils appeared to be associated with low pH fluids of relatively high ionic strength. When the low-pH fluids entered the vadose zone, there was a distinct increase in pH as the fluids reacted with the alkaline carbonate-rich loess. Increasing fluid pH can result in precipitation of some metals. This pH-induced precipitation is the most efficient mechanism to reduce concentrations of some metals in water (Schwartz and Domenico, 1992). The increase in pH within the vadose zone beneath the FMC source areas was sufficient to precipitate several metals. Such evidence of precipitation of a mineral phase may be seen in the EMF RI and SRI data as very steep concentration gradients of particular metals in the soils beneath sources. For example, soil concentrations of chromium, cadmium and vanadium decrease rapidly with depth and increasing pH as shown in EMF RI Figures 5.3-1a and 1b. Concentrations of these metals generally drop to representative levels within 10 feet of the native soil/fill or waste interface.

Adsorption onto soil grains also appears to play a role in controlling the mobility of various metal constituents in the vadose zone. The occurrence of elevated concentrations of zinc in deeper soil samples, and of cobalt in some monitoring wells, indicates these two metals are more mobile through the vadose zone than cadmium, chromium and vanadium. Zinc and cobalt, along with a number of other elements including cadmium, adsorb to calcite grains, one of the carbonate minerals in the loess.

Source Area Temperature (P4 Migration)

As described in Section 5.2.2.1, the elemental phosphorus (P4) production, storage and railcar loading operations were located at the Furnace Building, Phos Dock, and Secondary Condenser area (RU 1). Elemental phosphorus (P4) is a liquid at temperatures above 44 C and freezes (i.e., becomes solid) below that temperature (although P4 can supercool and remain a liquid under quiescent conditions). The P4 was maintained in a liquid state during the majority of the manufacturing and handling processes in these process areas. P4 was handled at temperatures typically in the range of 60 to 66 C while being transferred (i.e., displaced with water or pumped) between product vessels/tanks and for railcar loading. In the event of a P4 release to the subsurface, it would be released as a liquid, and migrate in the subsurface until it encountered soils with ambient temperatures less than 44 C at which point the P4 would eventually freeze.

In contrast to the P4 processes in RU1, the old underground pipelines that transported P4 wastewater (precipitator slurry and phossy water) to the phossy ponds were not heated. The old pipelines were placed underground to prevent the wastewater in the pipelines from freezing during winter conditions. The newer aboveground pipelines at the plant (circa 1998) were insulated and heated with tracing to prevent wastewater freezing in the pipelines. The P4 wastewater streams were at typical operating temperatures (60 to 66 C) in RU 1 when pumped into the pipelines. The temperature of the wastewater in the old underground pipelines would not have added a significant heat load (increased temperature) to the surrounding soil beyond a few feet from these lines.

Upon discharge into the ponds, the wastewater streams were also typically above 44 C, otherwise the P4 would freeze and plug the pipelines. However, the ponds (pond water and sediments) were not heated and were at ambient temperatures (15 to 25 C). P4 in the precipitator slurry and phossy water waste streams froze to a solid state rapidly upon entry into the ponds and remained in a solid phase within the pond sediments. Therefore, potential releases of P4 to the subsurface from the unlined ponds would have been in the form of dissolved P4 in the pond solute, at a concentration below the solubility limit of P4 of 3 mg/l at 15 C.

Soil Temperature (P4 Migration)

As described in Section 5.2.2.1, soils beneath the slag pit and furnace building were heated to temperatures above 44 C from the intense heat source of continuous tapping of molten slag into the slag pit, until slag ladling was fully installed in 2000. As described above, when ambient temperatures exceed 44 C, elemental phosphorus is in a mobile, liquid state. In this state, it migrates through soil until it reaches areas with lower temperatures, at which time it solidifies and is no longer mobile as a liquid phase. P4 releases from process equipment (all above the melting point) migrated in a vertical, but tortuous path through the soil column. As long as ambient temperatures remained above the melting point of P4, the P4 continued to migrate vertically (following the path of least resistance) to the water table. The 2007 SRI field investigation provided evidence that 1) the soil column was greater than 44 C, 2) P4 did migrate vertically through the soil column to groundwater, and 3) ambient groundwater temperatures of greater than 44 C probably did underlie the furnace building and slag pit, allowing horizontal migration of P4 at the groundwater interface (capillary fringe).

Once the ambient temperature of soils and groundwater fell below the P4 melting point, soluble concentrations of P4 would be transported by the groundwater. The solubility of P4 in water is 3 mg/l at 15 C. As previously stated, the maximum concentration of P4 observed in well 108 was 0.258 mg/l (November 2003), substantially below the solubility limit of P4 in water. This indicates that P4 in groundwater at well 108 is in the dissolved state rather than colloidal, particle, or particle-sorbed states.

Soil temperatures are not elevated above a natural range of subsoil temperatures (approximately 12 – 17 C) in the subsurface beneath the precipitator slurry and phossy water pipelines, excluding those segments of pipelines in RUs 1 and 2 that were within the 44 C isotherm associated with the slag pit. In the areas outside of the 44 C isotherm in RUs 1 and 2, a release of P4 to the subsurface (e.g., pipeline leak) would freeze fairly rapidly and be immobilized in an area near the point of release. Migration of P4 beyond a few feet from the lines would have been limited to dissolved P4 at a concentration below the solubility limit of P4 of 3 mg/l at 15 C.

Similarly, soil temperatures are not elevated in the subsurface beneath the old phossy ponds area (RU 22b) or the railroad swale (RU 22c). P4 vertical migration from these sources thus would be limited to potential migration of dissolved P4 in solute through the soil column to groundwater. The fate of P4 in aqueous solutions is discussed in Section 6.2.

6.2 Principal Factors Affecting Migration in the Saturated Zone

Constituent migration in the saturated zone can be thought of as an extension of the flowpath from the source through the vadose zone and into the aquifer. Once the percolating fluids reach the saturated zone, aquifer geochemistry and advective mixing are the primary factors affecting chemical concentrations.

Aquifer Geochemistry

When low pH seepage and neutral-to-basic pH groundwater mix in the saturated zone, there is an overall increase in pH and constituents still in solution may precipitate. As illustrated on EMF RI Figure 5.3-2, there is an inverse relationship between pH and solute concentrations in groundwater downgradient from former Pond 8S and from the former unlined calciner ponds, Simplot gypsum stack and other sources in the joint fenceline / calciner ponds area.

Fluoride precipitation is another chemical reaction that occurs when infiltrating fluids and groundwater mix. The fluids from various FMC sources contain elevated fluoride concentrations compared to representative groundwater. For example, fluoride concentrations were over 1,500 mg/l in former Pond 8S effluent compared to the representative groundwater concentration of 0.8 mg/l. Equilibrium modeling indicates that the groundwater is nearly saturated with respect to fluoride at concentrations of about 0.75 mg/l. Conditions in the aquifer thus favor precipitation of the mineral fluorite (SII, 1994). Therefore, additional fluoride introduced into the aquifer cannot be held in solution by the groundwater, and it precipitates. The rapid decrease in fluoride concentrations can be seen at former Pond 8S, where fluoride concentrations decrease rapidly within a very short distance from the source.

Attenuation of fluoride can be confirmed by comparing the rate of its concentration decrease along the groundwater flowpath from the former ponds with total dissolved solids (TDS). TDS includes conservative solutes such as chloride and potassium for which any decrease in concentration with distance from a source is associated with advective mixing. The pronounced decrease in fluoride concentrations relative to TDS concentrations is an indication that fluoride precipitation occurred (EMF RI Figure 5.3-3).

Eh also plays a role in the mobility of certain constituents in groundwater. For example, reducing conditions are observed (Eh -55 to -150 mV) at the monitoring wells located immediately downgradient from former Pond 8S. Oxidizing conditions prevail in the aquifer downgradient from the pond (+100 mV at well 134). When infiltrating fluid from this pond mixes with aquifer water, and Eh increases, there may be shifts in the valence state of certain chemicals that affect their solubility. These changes may reduce or increase mobility, depending on the chemical in question. Two reactions that were apparent downgradient from former Pond 8S are the transformation of ammonia to nitrate and total phosphorus to orthophosphate. Both these reactions reflect a shift from reducing to oxidizing conditions as the infiltrating fluid mixes and equilibrates with the groundwater.

Advective Mixing

The most significant factor affecting the fate and transport of EMF-related constituents in groundwater is advective mixing. Advective mixing occurs when water with high solute concentrations mixes with water having low concentrations. The mixing results in a decrease of the high solute concentrations. This can be illustrated by tracking the concentration of a conservative solute along a groundwater flowpath. Decreasing concentration with distance from a source is a good indication that advective mixing occurs. The rate of this decrease, or slope of the line defined by distance (x) versus concentration (y), provides a qualitative assessment of the advective mixing factor.

Sulfate is a conservative solute introduced into the aquifer from most of the EMF source areas. Its introduction into groundwater increased sulfate concentrations in wells immediately downgradient of source areas by 4 to 30 times the representative concentrations. However, these elevated concentrations often decreased to levels of between one and two times the representative concentrations within several hundred feet downgradient from these sources. As an example, peak potassium concentrations in groundwater at former Pond 8S are in the range of 300 to over 1,300 mg/l. Potassium concentrations decrease to the range of 30 to 60 mg/l, or by a factor of 5 to as much as 40, within 800 feet downgradient from the pond at wells 151, 141 and 159.

In summary, mixing of small volumes of affected groundwater with large volumes of unaffected groundwater within the EMF aquifer system substantially reduces the concentrations of all constituents, including conservative, non-attenuated solutes such as arsenic, potassium, sulfate and selenium along the groundwater flowpaths.

Oxidation / Hydrolysis (P4 Fate in Groundwater)

As described in Sections 4 and 5, elemental phosphorus is detected in groundwater at wells 108 and 122 downgradient from RUs 1 and 2, but not at wells 111, 146 and 110 further downgradient from wells 108 and 122. Although the reduction in P4 concentrations could be due in part to advective mixing, oxidation and hydrolysis of P4 in groundwater are likely the primary mechanisms whereby the P4 is converted to phosphorus compounds (e.g., orthophosphate) as groundwater migrates downgradient from these wells. The following discussion regarding the fate of elemental phosphorus in water is largely taken from the ATSDR Toxicological Profile for white (elemental) phosphorus (ATSDR, 19XX).

Elemental (white) phosphorus can exist in water as 1) dissolved phosphorus in amounts ≤ 3 mg/L, 2) in the colloidal state, 3) as large particles of elemental phosphorus at concentrations >3 mg/L, or 4) in the particle-sorbed state (Bullock and Newlands 1969; EPA 1991). P4 can undergo oxidation and hydrolysis in water. The rate of these reactions depends on the dissolved oxygen concentration, temperature, state of the phosphorus in water (dissolved, sorbed, colloidal, or particle form), and possibly the pH of the solution. The rate of reaction grows faster as the temperature of the water increases (Lai and Rosenblatt 1977a). At concentrations well below the

solubility limit (3 mg/L), elemental phosphorus disappeared from water by a first-order process with a half-life of 2 hours at ≈10°C and 0.85 hours at 30°C (EPA 1991; Zitko et al. 1970). The rate of phosphorus disappearance in water increased with the oxygen (or air) concentration and the pH of water (Lai and Rosenblatt 1977a). However, the faster initial disappearance half-life of 3.5 hours (compared to distilled water at pH 4.2) observed in the tested river water at 22°C and a pH of 7.6 may have been due to the catalytic effects of ions present in the tested river water, rather than the pH effect (Lai and Rosenblatt 1977a).

The P4 concentrations measured in groundwater at wells 108 and 122 are far below the solubility limit of P4 and indicate that the dissolved (rather than sorbed, colloidal or particle) form is present in groundwater at these wells. As described in Section 5, at wells 108 and 122 temperature is in the range of 17 to 19 C, pH ranges from 6.9 to 7.1, and the dissolved oxygen ranges from 0.3 to 4.2 mg/l (May 2008). The time and travel distance downgradient from these wells by which P4 has oxidized / hydrolyzed to concentrations below the detectable level in groundwater can be estimated by applying a half-life of 12 hours (estimated from the literature cited above) and the calculated flow velocity of 11 feet per day for groundwater in the area of the slag pit sump (Section 4.2.2.2). The calculated travel time and distances from wells 108 and 122 are summarized below:

Well	Maximum P4 Conc. (ug/l)	Detection Limit (DL) Conc. (ug/l)	Half-Lives (HL) to Decrease Below DL	Days to Decrease to Below DL (12 hr HL)	Distance from Well to Below DL Concentration (Feet)
108	258	0.02	14	7	77
122	7.19	0.02	9	4.5	50

As further described in the ATSDR Toxicological Profile, the referenced experiments discussed above determine the rate of disappearance and the half-life of elemental phosphorus in water in open systems. The phosphorus in these experiments disappeared due to hydrolysis / oxidation and evaporation. Spanggord et al. (1985) studied the loss of elemental phosphorus in sealed reaction flasks. In a closed reaction flask with argon-saturated water, the loss of white phosphorus can only be due to hydrolysis. The estimated half-life for hydrolysis at ambient temperatures was 84 hours (Spanggord et al. 1985). The estimated half-lives of white phosphorus at ambient temperatures due to a combination of hydrolysis and oxidation reaction were 42 hours in air-saturated water and 56 hours in non-air-saturated water (Spanggord et al. 1985). Phosphine forms both in the presence and absence of air. However, since phosphine is a gas with a low water solubility, it either oxidizes or volatizes rapidly from water (Lai and Rosenblatt 1977a).

The travel time and distances from wells 108 and 122 by which P4 has oxidized / hydrolyzed to concentrations below the detectable level in groundwater were also calculated using the

estimated half-life of P4 in non-air-saturated water of 56 hours. The results are summarized below:

Well	Maximum P4 Conc. (ug/l)	Detection Limit (DL) Conc. (ug/l)	Half-Lives (HL) to Decrease Below DL	Days to Decrease to Below DL (56 hr HL)	Distance from Well to Below DL Concentration (Feet)
108	258	0.02	14	33	360
122	7.19	0.02	9	21	230

These travel time / distance estimates are reasonable and support the observation that dissolved P4 is present at wells 108 and 122, but that as groundwater migrates downgradient, P4 concentrations fall below a detectable level within approximately 1,000 feet (the flowpath from well 122 to well 146) to 2,000 feet (the flowpath from well 108 to well 110).

As described in Section 5, phosphorus compounds (e.g., hypophosphorus acid, phosphorus acid, and phosphoric acids) are collectively quantitated as total phosphorus. The P4 concentrations at wells 108 and 122 are so low compared to the total phosphorus concentrations in the western ponds area-impacted groundwater flowing through wells that the contribution from elemental phosphorus hydrolysis / oxidation to the total phosphorus in groundwater downgradient from RUs 1 and 2 is indistinguishable.

6.3 Groundwater Migration and Discharge to the Portneuf River

This section provides a summary discussion of the weight-of-evidence supporting the EMF RI conclusion that EMF facility-impacted (and un-impacted) groundwater migrates from the EMF facilities and discharges to the Portneuf River as bank seeps / springs and baseflow to the river in the area between and including Swanson Road Spring (aka the Spring at Batiste Road) and Batiste Spring. A summary of the EMF RI, the IDEQ evaluation of EMF-related water quality impacts and the recent (2008) EMF geophysical study are provided below.

6.3.1 Summary of EMF RI Findings

Section 5.4 of the EMF RI Report described the fate and transport of EMF-related constituents present in groundwater from the facilities to Batiste and Swanson Road Springs and the Portneuf River. Transport was described in terms of two types of fluxes: constituent mass fluxes and groundwater fluxes. Groundwater flux is the volume of water crossing a given cross-section per unit time. Constituent flux is the mass of dissolved constituents transported by the water. EMF-related constituent fluxes and background constituent fluxes were calculated and compared

in Section 5.4 of the EMF RI. The EMF RI analysis addressed the transport of arsenic, nitrate, selenium, sulfate, and total phosphorus.

The present report does not summarize the results of the EMF RI flux calculations because those were based on the results of the groundwater and surface water investigations at the time of the EMF RI. As described in Section 5, groundwater concentrations of several of the evaluated parameters – arsenic, nitrate and selenium – have decreased measurably in groundwater at the FMC Plant Site wells since the time of the EMF RI. More importantly, the IDEQ study provides a more definitive evaluation of the water quality impacts related to the EMF-impacted groundwater discharged to the Portneuf River.

6.3.2 IDEQ Evaluation of Water Quality Impacts

This section was adapted from the summary and conclusions sections of the "Evaluation of Water Quality Impacts Associated with FMC and Simplot Phosphate Ore Processing Facilities, Pocatello, Idaho," January 2004 (IDEQ, 2004). The IDEQ performed a multi-step study to evaluate the potential phosphorus and nitrogen loading contributions from ground water migrating from beneath the EMF facilities, as well as other local potential contaminant sources, to the lower Portneuf River. The primary objective was to provide information for development of a TMDL for the lower Portneuf River.

Numerous data sources were utilized to evaluate orthophosphate trends over time and space, geochemical controls on contaminant transport, and loading of various sources in the study area to the lower Portneuf River. These data sources included ground water monitoring data from the FMC and Simplot (Don Plant) facilities, ground water monitoring data from the Simplot wastewater land application site, water quality and stream discharge data from the springs discharging to the river collected by IDEQ personnel, water quality data from the Batiste Spring channel collected by IDEQ personnel, and other data.

IDEQ identified and evaluated five potential sources of nitrate and phosphorus contribution to the river: discharges from 1) regional ground water, 2) Batiste Spring, 3) the City of Pocatello wastewater treatment plant, 4) the Simplot wastewater land application site and 5) ground water underflow from the FMC and Simplot facility areas.

IDEQ analyzed source fluids and groundwater at the Simplot and FMC facilities for stable isotopes of oxygen, hydrogen, and sulfur as tracers for delineation of facility impacts to ground water. Oxygen and deuterium ratios in water are affected by evaporative processes and were used to evaluate the extent of impacts from Simplot gypsum stack seepage.

IDEQ's evaluation of groundwater and surface water determined that the zone of ground water contribution from the FMC and Simplot area is controlled by hydrogeological conditions. The IDEQ evaluation indicates this zone extends about 200 to 300 feet along the west side of the river, between the river transect adjacent to Swanson Road Spring (IDEQ transect T-1A) and the river transect about 270 feet downstream from T-1A (IDEQ transect T-2).

Based on IDEQ's evaluation of water quality and stable isotope data, IDEQ concluded that the source of water to Batiste Spring has changed over time. Groundwater discharge at the spring during the IDEQ study period (2001-2002) appeared to be from regional ground water, whereas underflow from the FMC and Simplot facilities supplied much of the water to this spring in the past. IDEQ theorized that the significant decrease in area-wide precipitation (i.e., significant drought period) over the past several years may have caused the observed change in the ground water flow system. As described in Section 5, recent concentration trends for Batiste Spring indicate that EMF-related constituents have returned to levels that indicate the groundwater flow system has returned to pre-regional drought conditions, similar to those during the period of the EMF RI.

6.3.3 EMF Geophysical Study

As described in Section 3, Simplot and FMC implemented a geophysical study in the area between the FMC and Simplot plant sites and the zone of groundwater discharge to the Portneuf River between Swanson Road Spring (aka the Spring at Batiste Road) and Batiste Spring during June 2008. The companies submitted their draft report to the Agencies on September 16.

As described in the draft report, the resistivity survey commenced on June 18 and concluded on June 23, 2008. The survey was performed using a modified Schulumberger-Wenner array, employing 56 electrodes placed in a line with an average spacing of 6 meters or 19.8 feet between each electrode. Using this type of array, the depth of the survey was approximately 100 feet below ground surface. The survey was conducted along 7 lines that totaled 12,133 feet. Downhole electromagnetic induction (EM) logs at nine monitoring wells were taken from July 15 to July 16, 2008. The logging was done to provide a detailed measure of changes in conductivity with depth, thus helping to better interpret the results of the surface survey. An EM-39 probe was used to perform the logging. The probe is most sensitive to materials in an annulus 20 to 100 cm from the borehole, minimizing the effects from drilling and well installation, and provides a vertical resolution of less than 0.5 m. The geophysical data were reduced to profiles of subsurface resistivity. As part of the effort to interpret the profiles and correlate the resistivity profiles with groundwater chemistry, the available lithologic, groundwater chemistry, and utility location data were mapped onto the profiles.

FMC and Simplot recently received comments on the draft report from the Agencies. Although the Agencies did not agree with all of the conclusions in the draft report, the comments generally supported the overall conclusions:

1. Due to influences of saturation, lithology, and effects of utilities, the signature of influenced groundwater is not always readily apparent in the results; however, after careful consideration of all influences, the geophysical data may be useful in locating zones of higher conductance groundwater in some areas;

2. Resistivity profile lines 3 and 5 (located near Interstate 86) may be interpreted to indicate that the flow of high conductance groundwater is constricted to a narrow zone only a few hundred feet wide prior to discharge to the Portneuf River; and,

3. The results of the resistivity surveys generally correlate with the Conceptual Site Model (CSM) for groundwater flow and transport of groundwater affected by the EMF facilities.

6.4 Summary

EMF RI data indicate that the EMF-related constituents transported via the vadose zone and groundwater pathways primarily originate at source areas to which a sustained artificial head, containing high solute concentrations, is or was applied. These source areas include FMC's former unlined ponds and Simplot's gypsum stack.

The principal factors affecting migration in the vadose zone are seepage rates and seepage fluid and soil chemistry. Seepage from the FMC Plant Site source areas has been significantly reduced due to pond closures, the calciner ponds area remedial action, and the 2001 plant shutdown. In addition to reductions in seepage, the presence of alkaline, carbonate-rich loess beneath large portions of the EMF facilities has contributed to the attenuation of some metals in the vadose zone. The generally low-pH seepage reacts with the loess, resulting in an increase in the pH of the fluid, thereby inducing metals precipitation.

The principal factors affecting migration in the saturated zone are aquifer geochemistry and advective mixing. When seepage reaches the saturated zone, it reacts with the neutral-to-basic pH groundwater, resulting in precipitation of additional constituents that were present in the migrating fluids. In addition, the introduction of fluoride to groundwater is limited because the groundwater is naturally at the saturation point of fluoride.

The most significant factor in the reduction of groundwater constituent concentrations is advective mixing. Mixing of small volumes of EMF-affected groundwater with large volumes of unaffected groundwater within the EMF aquifer system substantially reduces the concentration of all constituents, including conservative, non-attenuating solutes such as sulfate, along the groundwater flowpath.

Elemental phosphorus concentrations in groundwater observed at wells 108 and 122 decrease downgradient along flowpaths to undetected levels at wells 146 and 110. Oxidation / hydrolysis converts the low levels of dissolved P4 observed at these wells to various phosphorus compounds that contribute a small increment of total phosphorus to groundwater beneath RUs 1 and 2. The increment of total phosphorus originating from dissolved P4 is not distinguishable from total phosphorus / orthophosphate concentrations in groundwater flowing from the upgradient western ponds area of the FMC Plant Site.

EMF facility-impacted groundwater migrates from the EMF facilities and discharges to the Portneuf River as bank seeps / springs and baseflow to the river in the area between and including Swanson Road Spring (aka the Spring at Batiste Road) and Batiste Spring.

Section 7
UPDATE TO THE BASELINE HUMAN HEALTH RISK ASSESSMENT

7.1 Introduction

This section provides an update to the findings of EPA's Baseline Human Health Risk Assessment (HHRA) with respect to potential health effects associated with exposure to groundwater at the FMC Plant OU. The Baseline HHRA determined that ingestion of groundwater posed an unacceptable risk to potential future receptors. This update serves to evaluate if there has been a significant change to that finding in the intervening 12 years, based on changes in groundwater contaminant concentrations, toxicity factors and/or the addition of elemental phosphorus and total cyanide as FMC-related constituents in groundwater as described in Sections 4 and 5 above.

In this update, risks associated with exposure to groundwater are evaluated separately for the same four areas of the FMC Plant OU previously defined in Section 5:

- Western Ponds Area;
- Central Plant Area;
- Joint Fenceline / Calciner Ponds Area; and,
- Area North of Highway 30 and Interstate 86.

Section 7.2 provides an overview of the Baseline HHRA groundwater Conceptual Site Model (CSM), along with the methods and assumptions that were subsequently used to quantitatively evaluate risks associated with potential exposure to groundwater. The Baseline HHRA findings are also summarized, with emphasis on the results for specific wells within the four distinct groundwater areas to be evaluated in this update.

Section 7.3 presents the updated Conceptual Site Model (CSM) for exposure to groundwater at the FMC Plant OU. The CSM identifies potential sources of groundwater contamination, as well as viable exposure scenarios under both current conditions and potential future uses of the FMC Plant OU. This section also identifies the specific receptors, exposure pathways and groundwater wells selected for inclusion within this risk assessment update.

Section 7.4 identifies both the groundwater chemicals and radionuclides of potential concern (COPCs/ROPCs) being evaluated in this update to the Baseline HHRA. This section also describes the data used in the update, and the process by which COPCs/ROPCs were screened to define chemicals and radionuclides of concern (COCs/ROCs). The approach used to develop COC/ROC exposure point concentrations (EPCs) to input into the quantitative exposure assessment update is also described in this section.

Section 7.5 summarizes the methods and assumptions used to quantify exposures in the risk assessment update. Specifically, this section describes the methods and assumptions that were used to characterize COC/ROC intakes (doses) for each potential receptor and exposure pathway of concern.

Section 7.6 summarizes the sources of data that were used to characterize the toxicity of the COCs/ROCs evaluated in the risk assessment update. Section 7.7 presents the methods and assumptions that were used to characterize receptor risks. The discussion of risk characterization methods and assumptions is followed by a presentation of the risk assessment update findings. Finally, conclusions based upon the risk assessment update findings are presented in Section 7.8.

It should be noted that multiple references to tables and figures from the EMF HHRA (E&E, 1996) are made throughout this section. All referenced tables and figures from this document are provided in Appendix K.

7.2 Baseline HHRA Evaluation of Exposure to Groundwater

The Baseline HHRA of the EMF Site was performed by E&E, an EPA contractor (E&E, 1996). In the Baseline HHRA, E&E developed a Conceptual Site Model (CSM) for the entire study area (Figure 1-4 in the Baseline HHRA), which identified both ingestion and dermal contact with contaminated groundwater as viable exposure pathways for potential future residents near the FMC and Simplot facilities; however, risks to residential receptors were only quantitatively evaluated for the ingestion pathway. While worker exposure to contaminated groundwater was not shown as a complete pathway in the CSM figure, the body of the Baseline HHRA did identify ingestion of groundwater by potential future workers as a viable exposure pathway, and worker risks were quantitatively evaluated for this pathway in the assessment.

In order to identify COPCs/ROPCs in groundwater, E&E initially screened the Remedial Investigation (RI) groundwater data collected from April 1992 through March 1994 against both representative (background) levels and health-based criteria for each analyte. The COPCs/ROPCs identified as a result of this screening process are shown in Table 2-1 of the Baseline HHRA. For each groundwater COPC/ROPC identified in the Baseline HHRA, risks to potential future residential and worker receptors were quantified for the groundwater ingestion pathway. Risks via other potential groundwater exposure pathways, even those identified in the CSM (i.e., dermal contact), were not quantified.

Risks were calculated for each individual, non-background shallow well for which RI data were available. Depending upon the amount of available data, the exposure point concentration (EPC) for each COPC/ROPC within each well was characterized by either the maximum concentration or the 95% upper confidence limit (UCL) on the arithmetic mean of the concentrations measured in that well. The well-specific EPCs for COPCs and ROPCs are shown in Tables G-10 and G-11 of the Baseline HHRA, respectively. In addition, the background concentration of each COPC/ROPC was characterized based upon the 95% UCL on the mean concentration in the RI groundwater background dataset (Table G-12 of the Baseline HHRA).

In the Baseline HHRA, exposure of potential future residents was assumed to be applicable to the FMC-owned properties located to the north of Highway 30 (i.e., E&E assumed that future residential development could occur upon the FMC owned northern properties). Potential future residential exposure to groundwater in wells within this area was evaluated under both a "high end", reasonable maximum exposure (RME) scenario and a central tendency (CT) scenario. The RME scenario was conceptually intended to represent exposures at the high end of the plausible range (above the 90th percentile but not higher than the highest exposure that could reasonably be expected for an individual in the group). By contrast, the CT scenario was intended to represent the average or typical exposure a member of the group might experience. The RME and CT exposure factors used to characterize potential future groundwater exposure to an age-integrated residential receptor are shown in Table 3-17 of the Baseline HHRA.

With respect to the FMC Plant Site, the Baseline HHRA evaluated exposure to potential future workers under a "high end", RME scenario only (i.e., E&E assumed that potential future use of the FMC Plant Site would remain commercial/industrial). The RME exposure factors used to characterize potential groundwater exposure to potential future workers are shown in Table 3-27 of the Baseline HHRA. The COPC/ROPC EPCs were subsequently combined with the exposure factors and COPC/ROPC-specific oral toxicity factors to estimate COPC/ROPC-specific incremental cancer and chronic non-cancer risks above background for each shallow well.

7.2.1 Baseline HHRA Findings for Potential Future Residents in the FMC Plant OU Area North of Highway 30 and Interstate 86

RME incremental non-cancer hazard quotients (HQs) for potential future residents ingesting groundwater from select shallow wells in the Area North of Highway 30 and Interstate 86 are shown in Table 7-1. The specific wells shown in Table 7-1 were selected because they are representative of worst-case impacts in the area; the well selection process is described in more detail in Section 7.3.

As shown in this Table 7-1, the Baseline HHRA estimated RME incremental HQs to residential receptors of up to 12.58 (well TW-9S) in this area. Manganese (63% of total HQ) and arsenic (27% of total HQ) both exceeded an HQ of 1, indicating that adverse non-cancer health effects could potentially occur from ingestion of these constituents in groundwater from this well. No other constituents exceeded a HQ of 1 within any well in the Area North of Highway 30 and Interstate 86.

RME incremental chemical and radiological cancer risks for potential future residents ingesting groundwater from select shallow wells in the Area North of Highway 30 and Interstate 86 are shown in Table 7-2. As shown in this table, the Baseline HHRA estimated RME incremental cancer risks above background to residential receptors in excess of 1E-04 in wells TW-9S and 517. Incremental cancer risks in other wells within this area were generally greater than 1E-05. Arsenic was identified as the primary contributor to the estimated incremental cancer risks, comprising over 80 to 100% of the total chemical and radiological cancer risk in each well.

7.2.2 Baseline HHRA Findings for Potential Future Workers at the FMC Plant OU

To maintain consistency with the previous discussion of groundwater quality and source areas, the Baseline HHRA findings for worker exposures are summarized for each of the four groundwater areas defined in Section 5 (i.e., Western Ponds Area; Central Plant Area; Joint Fenceline / Calciner Ponds Area; and, Area North of Highway 30 and Interstate 86).

Baseline HHRA worker incremental non-cancer HQs in select shallow wells within each groundwater area across the entire FMC Plant OU are presented in Table 7-3. As shown in this table, the Baseline HHRA estimated RME incremental HQs of greater than one for arsenic and manganese within at least one well in each of the four groundwater areas of the FMC Plant OU. In addition, boron and fluoride were identified above an incremental HQ of one in the Western Ponds Area. No other constituents were identified above a non-cancer HQ of one in either the Western Ponds Area, or any other area of the FMC Plant OU.

Incremental chemical cancer risks for potential future workers ingesting groundwater from shallow wells within each of the four groundwater areas at the FMC Plant OU are shown in Table 7-4. As shown in this table, the Baseline HHRA estimated RME incremental cancer risks above background to hypothetical worker receptors for site-impacted groundwater in excess of 1E-04 in wells within all four groundwater areas of the FMC Plant OU. Moreover, incremental cancer risks in excess of 1E-03 were identified for wells within the Western Ponds Area, Central Plant Area and Joint Fenceline/Calciner Ponds Area of the FMC Plant Site. Arsenic was identified as the primary contributor to the estimated incremental cancer risks, comprising over 80 to 100% of the total chemical and radiological cancer risk in each well.

7.2.3 Consequences of Baseline HHRA Findings

As a consequence of the Baseline HHRA findings, remedial action objectives (RAOs) for the groundwater ingestion pathway were established in the 1998 ROD for the FMC Subarea. Specifically, RAOs were established to prevent potential ingestion of groundwater containing COCs/ROCs having concentrations exceeding risk-based concentrations (RBCs) or MCLs (chemical specific ARARs). The chemical-specific RBCs established in the ROD were developed to correspond to an incremental cancer risk of 10^{-6} or an incremental non-cancer Hazard Index of 1.0.

Given that the Baseline HHRA findings for the groundwater ingestion pathway exceeded the ROD RAOs for this pathway, a component of the groundwater remedy specified in the 1998 ROD was implementation of restrictions on use of site-impacted groundwater to prevent potential future worker receptors from being exposed to groundwater containing COPC/ROPC concentrations in excess of MCLs or RBCs. In addition, based on the overall findings of the Baseline HHRA, the 1998 ROD remedy for the soil and groundwater included implementation of land use restrictions that prohibit residential use of the FMC properties. In anticipation of the ROD remedy, in 1995 FMC established and recorded legally enforceable land use controls, in the form of deed restrictions, that eliminate the possibility of future residential development at all

the FMC Plant OU properties (these restrictions were not placed on the Batiste Springs parcel at that time because FMC did not acquire that parcel until 1996). Even apart from these deed restrictions, there is no reasonable likelihood of future residential use of the FMC Plant OU properties based on current land use and foreseeable future land use trends.

7.3 Updated Groundwater Conceptual Site Model (CSM)

The current Conceptual Site Model (CSM) for the FMC Plant OU is documented in the Supplemental Remedial Investigation Report (SRI) (MWH, 2008). Identified and potential sources of groundwater impacts were previously discussed in Section 5.2 of this Groundwater Current Conditions report. A detailed discussion of these sources was presented in that section with respect to the four groundwater areas of the FMC Plant OU: the Western Ponds Area, the Central Plant Area, the Joint Fenceline / Calciner Ponds Area, and the Area North of Highway 30 and Interstate 86).

FMC expects that the ROD amendment for the FMC Plant OU will include, as a component of the groundwater remedy, implementation of restrictions on use of site-impacted groundwater consistent with the 1998 ROD that would prevent potential future worker receptors from being exposed to groundwater containing COPC/ROPC concentrations in excess of MCL or RBCs. Based on that component of the 1998 ROD groundwater remedy, the updated CSM for the FMC Plant OU does not consider exposure to site- impacted groundwater to be a viable pathway. However, in order to update the Baseline HHRA findings with respect to groundwater-related exposures, risks to potential future workers from groundwater ingestion were evaluated for wells within each of the four groundwater areas of the FMC Plant OU.

Specifically, based upon the findings of the assessment of groundwater quality and source areas (Section 5), the most heavily impacted wells within each of the four groundwater areas within the FMC Plant OU were identified for further evaluation. Consequently, wells 134, 139 and 168 (located downgradient of the old phossy ponds) and well 156 (located immediately downgradient of the Pond 8S), were selected to evaluate risks associated with the Western Ponds Area. Wells 108 (located downgradient of the furnace building) and 123 (located downgradient of the former kiln scrubber ponds), were selected to evaluate risks associated with the Central Plant Area. Well 143 (located within the area impacted by the former kiln scrubber ponds and downgradient from joint fenceline / calciner ponds area sources) and well 136 (located downgradient of the former unlined calciner ponds and calciner pond sediment storage area) were selected to evaluate the Joint Fenceline / Calciner Ponds Area. Finally, FMC selected wells TW-9S and 517 to evaluate risks in the Area North of Highway 30 and Interstate 86. Well TW-9S is located in an area that appears to be impacted primarily by downgradient migration of Western Ponds Area impacted groundwater and well 517 that appears to be influenced by converging groundwater from the FMC western ponds area, the joint fenceline area and potentially Simplot plant sources were selected to evaluate risks in the Area North of Highway 30 and Interstate 86. The locations of each of these ten most heavily impacted wells are shown on Figure 7-1.

Risks to current workers at the FMC Plant OU (maintenance workers on the plant site) were not evaluated because site-impacted groundwater is not currently being pumped from any well on the FMC Plant OU for the purpose of providing a drinking water source. As stated in Section 1.2, FMC production well #3, a deep well, is still in use and meets the SDWA standards for drinking water. Risks to potential future workers at the FMC Plant OU were evaluated, consistent with the Baseline HHRA.

As previously stated, FMC has implemented legally enforceable land use controls for all land parcels comprising the FMC Plant OU (except the Batiste Springs parcel) prohibiting future residential development at these properties, and based on current and foreseeable land use trends there is no reasonable likelihood of such development within the FMC Plant OU even if no deed restrictions were in place. However, in order to update the previous findings of the Baseline HHRA, risks to hypothetical future residents from the ingestion of groundwater from wells within the FMC-owned Area North of Highway 30 and Interstate 86 were calculated.

7.4 Evaluation of COPCs/ROPCs

Chemicals and radionuclides of potential concern (COPCs/ROPCs) in groundwater at the FMC Plant OU that were subject to further evaluation in this assessment are identified in Table 7-5. The constituents identified in this table are comprised of the analytes evaluated during the May (2Q) 2008 CERCLA Special Program, for which toxicity criteria are also available to evaluate risks. The May (2Q) 2008 analyte list is used as a starting point for the risk assessment update because this list was approved by EPA as being inclusive of all constituents with potential remaining concerns after up to 18 years of groundwater monitoring at the FMC Plant OU.

As shown in Table 7-5, the groundwater COPCs consist of metals (antimony, arsenic, boron, cadmium, manganese, mercury, selenium, uranium and vanadium), general minerals/nutrients nitrate and fluoride, and the inorganic constituents, identified based on post-RI groundwater monitoring, elemental phosphorus and total cyanide. ROPCs consist of radium-226 and radium-228.

This section presents the data and data treatment procedures followed to identify chemicals and radionuclides of concern (COCs/ROCs) in groundwater at the FMC Plant OU. Subsequent steps taken to develop COC/ROC-specific EPCs within each of the ten wells selected for evaluation in this update to the Baseline HHRA are also described.

An overview of the analytical data used to characterize groundwater concentrations of COPCs/ROPCs is initially presented in Section 7.4.1. Steps taken to combine and treat the analytical data (e.g., averaging of field duplicates, etc.) to develop a database for use in the risk assessment update are presented in Section 7.4.2. In Section 7.4.3, COPC/ROPC concentrations are compared to representative (background) concentrations and risk-based screening levels (maximum contaminant levels [MCLs] or preliminary remediation goals [PRGs]) to identify COCs/ROCs to be carried forward into the quantitative exposure assessment. Procedures

followed to develop EPCs for the identified COCs/ROCs in each of the ten wells selected for evaluation in the risk assessment update are discussed in Section 7.4.4.

7.4.1 Analytical Data

The analytical data used to characterize current groundwater COPC/ROPC concentrations in the selected wells within the four groundwater areas of the FMC Plant OU consists of the same data set used to evaluate current groundwater quality in Section 5.1 (i.e., November 2006 through May 2008). This 20 month time interval is also considered appropriate because it roughly corresponds to the time interval over which the RI data incorporated into the Baseline HHRA were collected (i.e., April 1992 through March 1994).

7.4.2 Data Treatment

The groundwater analytical data described in Section 7.4.1 contains, in addition to the specific sample results, laboratory QA/QC-related analyses (e.g., matrix spikes, field duplicates, laboratory replicates, etc.). These data required treatment in order to derive a single concentration value for each parameter within each sample procured, for further consideration in the exposure assessment. The sequential process described below was used to treat the groundwater data for purposes of the exposure characterization.

Initial Database Deletions

Data associated with matrix spike/matrix spike duplicate samples were initially removed from the data sets; any impact on the data sets would already be reflected in individual sample result amendments during data validation. Data that were flagged as "rejected" during data validation were also deleted. Finally, data from the November 2006 through May 2008 sampling events associated with constituents that were not identified as COPCs/ROPCs (e.g., temperature, pH, etc.), were also removed from the data sets.

Treatment of Non-Detects

If a COPC/ROPC was not detected in a groundwater sample, the detection limit (method detection limit if available, or otherwise the reporting limit) was used to characterize the concentration. Samples with detections were differentiated from non-detect samples by a flag within a separate field in the analytical database.

Hierarchy and Treatment of Laboratory Replicate, Field Duplicate and Field Split Data

Field duplicate, laboratory replicate and split samples were collected and analyzed within several of the data sets available for characterizing groundwater at the FMC Plant OU. Consequently, there are multiple results for some of the samples collected.

Data associated with field duplicate, laboratory replicate and split samples were treated sequentially, as described below.

Treatment of Laboratory Replicates

Laboratory replicates were initially treated as follows:

- If the primary sample and laboratory replicate results were both reported as detects, the average concentration was calculated and used in all further data treatment steps.

- If the sample and laboratory replicate results were both reported as non-detects, the lower detection limit of the two analyses was assigned to the sample and used in all further data treatment steps.

- If either the primary sample or laboratory replicated result was reported as a detect and the associated sample or laboratory replicated result was reported as a non-detect, the detected result was selected and used in all further data treatment steps.

Field duplicates and field splits were treated sequentially in the same manner as laboratory replicates. If an analyte was detected in both, the average was used. If the analyte was not detected in either, the lowest detection limit was assigned to the sample. If one was a detect and the other a nondetect, the detected value was used as the sample result.

Treatment of Nondetects

The data for each COPC/ROPC in each well were reviewed to determine the presence of any non-detect samples with detection limits in excess of the maximum concentration detected in other samples. The identified high detection limit non-detect samples were removed from the data sets. The lowest detection limit was used to characterize the concentration for wells in which a COPC was never detected during the November 2006 through May 2008 timeframe.

7.4.3 Comparison of Groundwater Concentrations to Representative (Background) Levels and Risk-Based Concentrations

The treated data were initially compared to the representative (background) levels established during the EMF RI (Bechtel, 1996) (except for arsenic), and risk-based concentrations (RBCs). For arsenic, the 95% UPL representative (background) levels derived in Section 4.3 were used in this initial screening process. Specifically, the lower of the representative levels for the Michaud and Bannock hydrogeochemical regimes was conservatively used to characterize the background level of each COPC/ROPC. The RBC for each COPC/ROPC was characterized by the maximum contaminant level (MCL) or, in the absence of an MCL, the EPA Region 6 preliminary remediation goal (PRG) for the residential groundwater ingestion pathway. The purpose of this comparison was to identify which COPCs/ROPCs exceed both background and

the RBC in one or more sample, thereby warranting inclusion as COCs/ROCs for evaluation in the quantitative exposure assessment.

Table 7-5 summarizes the findings of the background and risk-based concentration (RBC) comparison. The background level and RBC for each COPC/ROPC are identified in the first columns of the table. The detection frequency and maximum detected concentration of each COPC/ROPC is provided in the subsequent table columns. COPCs/ROPCs that were detected in groundwater in at least one sample at a level in excess of background and the RBC are highlighted in red. Each COPC identified as exceeding both background and the RBC (no ROPCs were found to exceed the background and RBC) was carried forward as a COC for evaluation in the quantitative risk assessment.

7.4.4 COC Exposure Point Concentrations

The maximum detected concentration of each COC was used to characterize the EPC within each of the ten wells selected for evaluation in this risk assessment update. In the event that a COC was never detected in a well during the timeframe of interest, the minimum detection limit achieved for analyses performed on samples from that well was used to characterize the COC concentration. The EPCs developed for each combination of COC and well are shown in Table 7-6. These EPCs were subsequently incorporated into the exposure characterization. In addition, the 95% UCL on the mean background concentrations shown in Table G-12 of the Baseline HHRA were again used to characterize background exposure point concentrations in this update for the purpose of quantifying incremental risks.

7.5 Exposure Assessment

This section outlines how the groundwater COC EPC estimates for each of the wells evaluated were used to quantify potential chronic exposures via the groundwater ingestion pathway. As developed below, the assessment quantifies Intake (I) to characterize chronic COC exposures via the groundwater ingestion exposure pathway.

7.5.1 COC Intake (Dose) Rates

To evaluate risks associated with exposure via groundwater ingestion an estimate of COC intake is initially required. The methods and assumptions used to derive RME COC intake estimates for both residential and worker receptors via this exposure pathway are identical to those adopted in the Baseline HHRA, and are summarized below.

Workers

Worker exposure to COCs via groundwater ingestion was evaluated as follows:

Equation 7-1

$$I_{ING(C)} = \frac{C_{GW} \times EF \times ED \times IR}{BW \times AT \times 365 days/year}$$

Where:

$I_{ING(C)}$ = COC intake via groundwater ingestion (mg/kg-day); for evaluating exposure used to assess noncarcinogenic effects, the intake is referred to as average daily dose (ADD); for evaluating exposure used to assess carcinogenic risk, the intake is referred to as lifetime average daily dose (LADD),

C_{GW} = COC EPC in groundwater (mg/L),

EF = Exposure frequency (250 days/year),

ED = Exposure duration (25 years),

IR = Groundwater ingestion rate (1 L/day),

BW = Body weight (70 kg), and

AT = Averaging time (70 years for carcinogenic effects; 25 years for non-carcinogenic effects).

Age-Integrated Residents

Residential exposure to COCs via groundwater ingestion was evaluated as follows:

Equation 7-2

$$I_{ING(C)} = \frac{C_{GW}}{AT} \times \left(\frac{EF_C \times ED_C \times IR_C}{BW_C} + \frac{EF_A \times ED_A \times IR_A}{BW_A} \right)$$

Where:

IING(C) = COC intake via groundwater ingestion (mg/kg-day); for evaluating exposure used to assess noncarcinogenic effects, the intake is referred to as average daily dose (ADD); for evaluating exposure used to assess carcinogenic risk, the intake is referred to as lifetime average daily dose (LADD),

C_{GW} = COC EPC in groundwater (mg/L),

EF_C = Exposure frequency (350 days/year),

ED_C = Exposure duration (6 years),

IR_C = Groundwater ingestion rate (1 L/day),

BW_C = Body weight (15 kg),

EF_A = Exposure frequency (350 days/year),

ED_A = Exposure duration (24 years),

IR_A = Groundwater ingestion rate (2 L/day),

BW_A = Body weight (70 kg), and

AT = Averaging time (70 years for carcinogenic effects; 30 years for non-carcinogenic effects).

The resulting well- and COC-specific average daily dose (ADD) rates and lifetime average daily dose (LADD) rates, used to evaluate non-carcinogenic and carcinogenic effects, respectively, are presented in Table 7-6.

7.6 Toxicity Assessment

The purpose of the toxicity assessment is to identify toxicity values and criteria to be used in the risk characterization to evaluate the potential for adverse human health effects. Toxicity values and criteria are developed by government agencies through the process of a dose-response assessment. Dose-response assessments characterize the quantitative relationship between the dose of an agent (chemical or radionuclide) and the potential for adverse health effects occurring in exposed populations. When evaluating the potential for carcinogenesis, the dose-response assessment results in a quantitative estimate of the probability of the incidence of cancer upon exposure to a given dose of a chemical. When evaluating the potential for adverse noncarcinogenic toxicity, the dose-response assessment results in a standard or acceptable exposure level to which a receptor's potential exposure may be quantitatively compared.

For many chemicals, standard procedures for toxicity assessment have been used to identify dose-response relationships from which resulting toxicity values and criteria are available. Toxicity values/criteria are developed based on toxic effect (carcinogenic or noncarcinogenic), route of exposure (inhalation, oral, or external), and length of exposure (sub-chronic or chronic).

The toxicity values used to evaluate risks to potential future receptors from exposure to COCs in groundwater across the FMC Plant OU are discussed in the following subsections.

7.6.1 Toxicity Values for COCs

Standard EPA procedures for identifying appropriate toxicity values for COCs were used in this risk assessment update. These procedures include identifying route-specific toxicity values for noncarcinogenic and carcinogenic health effects, and summarizing other relevant toxicity information. The oral (i.e., ingestion) exposure route was evaluated to identify appropriate COC toxicity values.

All chemicals can potentially cause noncarcinogenic health effects, while the potential for causing cancer is limited to certain chemicals. Therefore, oral noncarcinogenic-toxicity values were sought for all of the COCs, while carcinogenic-toxicity values were sought for those COCs with sufficient evidence of carcinogenicity as identified by EPA, or otherwise, based on the categorization scheme discussed below.

Chronic Noncarcinogenic Toxicity Values

The toxicity values that are currently developed by EPA to evaluate the potential for noncarcinogenic health effects during a chronic oral exposure (equal to or greater than seven years) are oral reference doses (RfD_os). The lower the RfD_o for a chemical, the greater its toxicity and, consequently, the acceptable exposure limit will be lower.

Chronic RfD_os are expressed in units of mg/kg-day, and represent a daily intake of a chemical at which no appreciable adverse noncarcinogenic effects are expected to occur over the duration of exposure to the human population, including sensitive subgroups such as children. RfD_os were used to assess the non-carcinogenic toxicity via groundwater ingestion pathway.

Carcinogenic Toxicity Values

Carcinogenic-toxicity values for the oral route of exposure are currently developed by EPA as a cancer slope factor (CSF_o), expressed as $(mg/kg\text{-}day)^{-1}$. The greater the CSF for a chemical, the greater is its carcinogenic potency and the lower is the acceptable exposure for receptors in the study area.

7.6.2 Selection of Chronic Noncarcinogenic and Carcinogenic Toxicity Values

Because no single source provides toxicity values for all COCs, a hierarchical list was used to obtain the set of the most current and reliable values. EPA's current hierarchy of data sources to be used to characterize COC cancer and noncancer toxicity factors at Superfund sites (EPA, 2003) is as follows:

- IRIS (EPA's Integrated Risk Information System)
- EPA Provisional Peer-Reviewed Toxicity Values (PPRTVs)
- Other (Peer-Reviewed) Values, including:
- ATSDR (Agency for Toxic Substances and Disease Registry) Minimal Risk Levels
- HEAST (Health Effects Assessment Summary Tables)
- The California Environmental Protection Agency (Cal EPA) toxicity values

With regard to the third level, priority was given to values derived using similar methods and procedures as those used to derive Tier 1 and Tier 2 values, as well as to the date of the assessment. In addition to the sources listed above, values available from EPA's National Center for Environmental Assessment (NCEA), as quoted in EPA Regional screening tables, were also considered.

For some chemicals, a toxicity value for a given toxicity endpoint (i.e., noncarcinogenic or carcinogenic effect) may only be available for a different route of exposure (e.g., inhalation). Although EPA generally considers it inappropriate to develop oral toxicity values form inhalation toxicity values using route-to-route extrapolation without considering both dosimetry and mechanism of action, the use of route-to-route extrapolation to derive toxicity values was performed in this assessment.

Route-to-route extrapolations may be conservative or non-conservative relative to their actual values, but discarding a chemical completely from an exposure route is not conservative. In the absence of an oral toxicity value, route-to-route extrapolation was used, where possible, to develop an oral toxicity value from an inhalation toxicity value, unless evidence indicates such an extrapolation would be inappropriate. The primary criterion used to determine whether an extrapolation is appropriate was whether the critical toxic effect on which the available toxicity value is based occurs at the site of exposure, referred to as a portal of entry effect. Portal of entry effects cannot be assumed to affect other routes equally, nor can the absorption efficiencies among the exposure routes be assumed to be the same. Thus, route-to-route extrapolation was not performed for COCs where the critical toxic effect, on which the available inhalation toxicity value is based, is associated with a portal of entry effect.

To extrapolate a toxicity value from an inhalation to an oral route of exposure, standard adult exposure factors were used. An inhalation rate of 20 m^3/day and a body weight of 70 kg was assumed in the extrapolation, as follows:

Equation 7-3

$$RfD_O = \frac{RfC \times IR}{BW}$$

and

$$CSF_O = \frac{URF_i \times BW \times 1000}{IR}$$

Where:

RfC = Inhalation reference concentration (mg/m^3),

URF_i = Inhalation unit risk factor (ug/m^3)$^{-1}$,

RfD_o = Oral reference dose (mg/kg-day),

CSF_o = Oral cancer slope factor (mg/kg-day)$^{-1}$,

BW = Body weight (kg),

1000 = Conversion factor (ug/mg), and

IR = Inhalation rate (m^3/day).

RfCs, as developed by EPA under the RfC methodology (EPA, 1994a), are based on an assumption of continuous exposure in a residential setting, and thus are only directly applicable to continuous exposure to residential receptors. Consequently, for non-residential exposures (e.g., workers), the RfC must be scaled to the inhalation rate of the receptor of concern and the length of the exposure. The assumption of equal ventilation rates between workers and residents, which was incorporated into this assessment, introduces additional conservatism (i.e., protectiveness) to the risk assessment for workers.

The toxicity factors for carcinogenic COCs via the oral route of exposure are provided in Table 7-7. This table also includes the EPA weight-of-evidence for those COCs with a weight of evidence of “A”, “B”, or “C” (i.e., known, probable or possible human carcinogens, respectively). Information on the type of cancer and the study on which each slope factor or unit risk factor was based is also provided.

The chronic noncarcinogenic toxicity factors for the oral route of exposure are provided in Table 7-8. For each chronic toxicity factor identified, information regarding the study/data on which the toxicity value is based has been provided. Also included in the table are, for each noncarcinogenic toxicity value, the type of study on which the RfD_o was based, the critical effect (i.e., toxic endpoint) on which the value was based, uncertainty/modifying factors used to derive the value, and the EPA assessment of the overall confidence in the toxicity value.

7.7 Risk Characterization

The purpose of the risk characterization section is to present both the approaches that were used to quantify the potential for carcinogenic and noncarcinogenic health effects to occur for each of the receptors evaluated (Section 7.7.1) and the findings of the risk assessment update (Section 7.7.2). The risk characterization process generally results in quantitative estimates of carcinogenic risk and relative noncarcinogenic hazards. Integration of the data and analyses from the various components of the risk assessment process (hazard identification, toxicity assessment, and exposure assessment) determine whether there is a reasonable probability that any potential receptors could possibly experience any of the various toxic effects attributable to COCs in groundwater at the FMC Plant OU. The risk characterization assessed potential incremental carcinogenic risks and chronic noncarcinogenic hazards from exposure to COCs for each of the receptors identified in Section 7.3.

7.7.1 Risk Characterization: Methods and Assumptions

Because receptors may be exposed to multiple COCs concurrently, estimating risk by considering one chemical at a time can potentially underestimate total risk. For this reason, carcinogenic and non-carcinogenic risks to each receptor were evaluated based on the sum of the potential effects of all COCs combined, independent of whether the toxicological effects are, indeed, additive.

The equations and approaches used to characterize the potential for carcinogenic and noncarcinogenic effects are described in this section. It should be noted that the approaches used to characterize each of the exposure and toxicity parameters presented in the equations within this section were previously described in Sections 7.5 and 7.6, respectively.

Characterization of Potential Carcinogenic Risk

The lifetime incremental cancer risk potentially posed by a carcinogenic COC through the groundwater ingestion exposure pathway was calculated as the product of the lifetime average daily dose (intake) of the chemical through that exposure route and the oral cancer slope factor (CSF) for the chemical:

Equation 7-4

$$RISK_{ING}(m) = CSF_O(m) \times I_{ING(C)}(m)$$

Where:

$RISK_{ING}(m)$ = Lifetime incremental cancer risk due to chemical, m, from groundwater ingestion,

$CSF_o(m)$ = Oral cancer slope factor for chemical, m (mg/kg-day) $^{-1}$, and

$I_{ING(C)}(m)$ = Lifetime average daily dose (intake) for chemical, m through groundwater ingestion (mg/kg-day).

Cancer risks were subsequently summed for all COCs, regardless of the mechanism of action or target site of each carcinogen, to calculate a total incremental cancer risk to a receptor ($RISK_{total}$).

Characterization of Potential Chronic Noncarcinogenic Risk

Noncarcinogenic risk is evaluated via the hazard quotient (HQ) approach. The hazard quotient approach assumes that there is a threshold dose or exposure concentration (i.e., the RfD or RfC) for each chemical below which adverse health effects are unlikely. If the exposure level for the chemical is below this dose or exposure concentration (i.e., if the hazard quotient is less than 1), it is unlikely that noncarcinogenic effects would occur due to exposure to this chemical alone (EPA, 1989a).

As presented below, HQs were developed for each COC and then summed to evaluate total noncarcinogenic risk. The chronic noncarcinogenic risk for each COC was evaluated by comparing the dose, averaged over the time of exposure, to the chronic oral reference dose (RfD). The chronic risk, or hazard quotient (HQ), is expressed as the ratio of the exposure dose to the RfD (EPA, 1989a). The following equation was used to calculate the hazard quotient for each COC via the groundwater ingestion exposure route:

Equation 7-5

$$HQ_{ING}(m) = \frac{I_{ING(C)}(m)}{RfD_o(m)}$$

Where:

$HQ_{ING}(m)$ = Hazard quotient (unitless) for chemical, m, through groundwater ingestion,

$I_{ING(C)}(m)$ = Average daily dose for chemical, m, through groundwater ingestion (mg/kg-day), and

$RfD_o(m)$ = Oral reference dose for chemical, m (mg/kg-day).

Non-cancer HQs were subsequently summed for all COCs, regardless of the mechanism of action or target site of each non-carcinogen, to calculate a total incremental HQ to a receptor (HQ_{total}).

7.7.2 Risk Estimates by Groundwater Area

In this subsection, the risk characterization for each well selected for evaluation within the four groundwater areas within the FMC Plant OU is compared, when applicable, to the previous risk characterization in the Baseline HHRA.

7.7.2.1 Western Ponds Area

Well 134

Well 134 is located in the downgradient area of groundwater impacted by the old phossy ponds (RU 22b) and former pond 8S (RU 22a) in the western ponds area. As described in Section 5, the western ponds area has historically exhibited the highest manganese groundwater concentrations (and related risks) at the FMC Plant OU. As shown in Table 7-9, the Baseline HHRA estimated a manganese incremental non-cancer HQ for potential future workers of 7.1. While the current manganese EPC (2.34 mg/L) in well 134 exceeds the residential PRG (1.7 mg/L) used in the screening analysis described in Section 7.4, this EPC corresponds to an incremental non-cancer HQ for future workers (0.5) below the 1998 ROD RAO of 1. In fact, only the HQ for arsenic (2.8) currently exceeds the 1998 ROD RAO; however, this HQ estimate is significantly lower than the Baseline HHRA incremental arsenic HQ (4.2).

Incremental cancer risks to potential future workers from exposure to arsenic within well 134 (4.52E-04) are over two orders of magnitude greater than the 1998 ROD RAO. However, the current risk estimate is nearly two times lower than the corresponding Baseline HHRA incremental cancer risk estimate (7.89E-04).

No other COCs carried forward into the risk characterization were found to be associated with incremental cancer risks or hazard indices in excess of the 1998 ROD RAOs.

In summary, these findings support the conclusion that, while still impacted above a level of health concern, groundwater quality has improved in the area of well 134 since completion of the RI. Arsenic continues to be the primary risk driver in groundwater in the area of well 134.

Well 139

Well 139 is located downgradient from the old phossy ponds 3E, 4E, 5E and 6E in the western ponds area as described in Section 5.2. As shown in Table 7-9, the Baseline HHRA estimated a total incremental non-cancer HQ for potential future workers of 0.8 at well 139; this is below the 1998 ROD RAO. The current total incremental non-cancer HQ for well 139 is two-fold lower (0.4) than the Baseline HHRA finding.

The Baseline HHRA estimated incremental cancer risks to potential future workers from exposure to arsenic within well 139 (2.91E-05) nearly 30 time greater than the 1998 ROD RAO. However, the current arsenic EPC is lower than the level used to characterize background in the Baseline HHRA. Consequently current incremental cancer risks do not exceed the 1998 ROD RAO.

In summary, these findings support the conclusion that groundwater in the area of well 139 has improved since the RI to the point that it no longer contains contaminant concentrations above a level of health concern.

Well 156

Well 156 is located immediately downgradient of former pond 8S and contains elevated levels of phossy pond-related constituents. As shown in Table 7-9, incremental non-cancer HQs for potential future workers exceed the existing RAO of 1 for arsenic (5.4). However, the current HQ estimate is significantly lower than the corresponding Baseline HHRA incremental arsenic HQ for RI well 150 (25.6), the most impacted RI well located downgradient of Pond 8S. Moreover, the Baseline HHRA also projected incremental HQs in excess of one for manganese (3.9) and fluoride (2.3). The current HQ for manganese (0.1) is well below the existing RAO, and fluoride has not been detected in well 156 throughout the November 2006 - May 2008 timeframe. While current arsenic-related non-cancer hazards still significantly exceed the 1998 ROD RAO, these findings support the conclusion that groundwater quality has improved in this area since completion of the RI.

As also shown in Table 7-9, incremental cancer risks to potential future workers from exposure to arsenic within well 156 (8.71E-04) are nearly three orders of magnitude greater than the 1998 ROD RAO. However, the current risk estimate is approximately five times lower than the Baseline HHRA incremental cancer risk estimate for arsenic (4.79E-03) in well 150.

No other COCs carried forward into the risk characterization were found to be associated with incremental cancer risks or hazard indices in excess of the 1998 ROD RAOs.

In summary, these findings support the conclusion that, while still impacted above a level of health concern, groundwater quality has improved in the area of well 156 as described in Section 5. Arsenic continues to be the primary risk driver in groundwater in the area of well 156.

Well 168

Well 168 is located downgradient from the old phossy ponds 3E, 4E, 5E and 6E in the western ponds area, but closer to the source area than well 139. This well was included in the risk assessment update because the EPC for fluoride (5 mg/L) exceeds the MCL for this COC (4 mg/L). However, as shown in Table 7-9, the incremental non-cancer HQs to potential future workers for fluoride is estimated to be below 1. Incremental HQs are also below 1 for each of the other COCs evaluated. The total incremental HQ for well 168 is 1.4.

As also shown in Table 7-9, incremental cancer risks to potential future workers from exposure to arsenic within well 168 (9.07E-05) are nearly an order of magnitude greater than the 1998 ROD RAO.

In summary, despite the fact that fluoride concentrations exceed the MCL, exposure to arsenic is the primary issue of health concern related to groundwater in the area of well 168.

7.7.2.2 Central Plant Area

Well 108

Well 108 is located downgradient from the western ponds area groundwater impacts and has the highest concentrations of elemental phosphorus in groundwater. These concentrations are associated with the furnace building (RU 1) and slag pit (RU 2) source areas. As shown in Table 7-10, the Baseline HHRA did not calculate risks associated with exposure to elemental phosphorus in groundwater because RI data were not obtained for this constituent. Instead, incremental non-cancer HQs to potential future workers marginally above the 1998 ROD RAO of one were derived for manganese (1.2) and arsenic (1.0). The current incremental HQs for all COCs, except elemental phosphorus, are substantially below 1 (maximum of 0.3 for arsenic), supporting the conclusion that groundwater quality has improved in the area of well 108 since completion of the RI. However, the elemental phosphorus sampling and analysis at well108 began after the EMF RI and there has been no measurable improvement (e.g., decreasing trend) with respect to elemental phosphorus in groundwater at well 108 to date. The current incremental HQ estimate for elemental phosphorus (60.7) greatly exceeds the 1998 ROD RAO.

Incremental cancer risks to potential future workers from exposure to arsenic within well 108 (4.25E-05) are approximately four times greater than the 1998 ROD RAO. However, the current risk estimate is approximately four times lower than the corresponding Baseline HHRA incremental cancer risk estimate (1.79E-04).

No other COCs carried forward into the risk characterization were found to be associated with incremental cancer risks or hazard indices in excess of the 1998 ROD RAOs.

In summary, these findings support the conclusion that, while still impacted above a level of health concern, groundwater quality has improved in the area of well 108 since the time of the EMF RI. However, the elemental phosphorus sampling and analysis at well108 began after the EMF RI and there has been no measurable improvement (e.g., decreasing trend) with respect to elemental phosphorus in groundwater at well 108 to date. Elemental phosphorus and arsenic are the primary risk drivers in the area of well 108.

Well 123

Well 123 is located within the area of groundwater impacts primarily associated with the former kiln scrubber ponds and former kiln scrubber overflow pond. As shown in Table 7-10, the Baseline HHRA estimated an incremental non-cancer HQ for potential future workers of 19.2 for arsenic. Incremental HQs for all other constituents evaluated were below the ROD RAO of one. The current incremental HQ for arsenic (8.1) is significantly lower than the Baseline HHRA estimate. Incremental HQs for all other COCs remain below the ROD RAO.

Incremental cancer risks to potential future workers from exposure to arsenic within well 123 (1.30E-03) are over three orders of magnitude greater than the 1998 ROD RAO. However, the current risk estimate is nearly three times lower than the corresponding Baseline HHRA incremental cancer risk estimate (3.60E-03).

No other COCs carried forward into the risk characterization were found to be associated with incremental cancer risks or hazard indices in excess of the 1998 ROD RAOs.

In summary, these findings support the conclusion that groundwater in the area of well 123 is impacted above a level of health concern. However, risks associated with groundwater COCs have either improved or remained comparable to those observed during the RI. Arsenic remains the primary risk driver within groundwater in the area of well 123.

7.7.2.3 Joint Fenceline / Calciner Ponds Area

Well 136

Well 136 is located downgradient of the groundwater impacts from the joint fenceline / calciner ponds area as described in Section 5. As shown in Table 7-11, the Baseline HHRA estimated incremental non-cancer HQs to potential future workers above the 1998 ROD RAO of one for arsenic (17.8) and manganese (4.3). The current incremental HQ for arsenic (10.9) remains above the RAO. However, the incremental HQs for all other COCs, including manganese, are below this threshold.

Incremental cancer risks to potential future workers from exposure to arsenic within well 136 (1.76E-03) are more than three orders of magnitude greater than the 1998 ROD RAO. However, the current risk estimate is approximately two times lower than the corresponding Baseline HHRA incremental cancer risk estimate (3.34E-03).

No other COCs carried forward into the current risk characterization were found to be associated with incremental cancer risks or hazard indices in excess of the 1998 ROD RAOs.

In summary, these findings support the conclusion that, while still impacted above a level of health concern, groundwater quality has improved in the area of well 136 since the time of the EMF RI. Arsenic is the primary risk driver of concern in the area of well 136.

Well 143

Similar to well 136, well 143 is located within the former kiln scrubber ponds groundwater impact and is downgradient from impacted groundwater in the joint fenceline / calciner ponds area. As shown in Table 7-11, the Baseline HHRA estimated incremental non-cancer HQs to potential future workers above the 1998 ROD RAO of one for arsenic (15.0) and manganese (1.3). The current incremental HQ for arsenic (3.1) remains above the RAO. However, the incremental HQs for all other COCs, including manganese, are below this threshold. Concentrations and HQs for all other constituents decreased or are comparable to those previously estimated in the Baseline HHRA.

Incremental cancer risks to potential future workers from exposure to arsenic within well 143 (4.93E-04) are nearly fifty times greater than the 1998 ROD RAO. However, the current risk estimate is approximately five times lower than the corresponding Baseline HHRA incremental cancer risk estimate (2.82E-03).

No other COCs carried forward into the current risk characterization were found to be associated with incremental cancer risks or hazard indices in excess of the 1998 ROD RAOs.

In summary, these findings support the conclusion that, while still impacted above a level of health concern, groundwater quality has improved in the area of well 143 since the time of the EMF RI. Arsenic continues to be the primary risk driver in the area of well 143.

7.7.2.4 Area North of Highway 30 and Interstate 86

Well TW-9S

Well TW-9S is located in an area that appears to be impacted primarily by downgradient migration of western ponds area impacted groundwater. As shown in Table 7-12, the Baseline HHRA estimated incremental non-cancer HQs to potential future workers above the 1998 ROD RAO of one for arsenic (1.0) and manganese (2.2). The current worker incremental HQs for all COCs, including arsenic and manganese, are below this threshold. As shown in Table 7-13, the

Baseline HHRA estimated incremental non-cancer HQs to potential future residents above the 1998 ROD RAO of one for arsenic (3.4) and manganese (8.0). The current residential incremental HQ for arsenic (1.8) remains above the RAO. However, the incremental HQs for all other COCs, including manganese, are below this threshold.

As shown in Table 7-12, incremental cancer risks to potential future workers from exposure to arsenic within well TW-9S (8.12E-05) are approximately 8 times greater than the 1998 ROD RAO. However, the current worker cancer risk estimate is approximately two times lower than the corresponding Baseline HHRA incremental cancer risk estimate (1.82E-04). As shown in Table 7-13, incremental cancer risks to potential future residents from exposure to arsenic within well TW-9S (3.46E-04) are approximately 35 times greater than the 1998 ROD RAO. However, the current residential cancer risk estimate is approximately two times lower than the corresponding Baseline HHRA incremental cancer risk estimate (7.73E-04).

No other COCs carried forward into the current risk characterization were found to be associated with incremental cancer risks or hazard indices in excess of the 1998 ROD RAOs.

In summary, these findings support the conclusion that, while still impacted above a level of health concern, groundwater quality has improved in the area of well TW-9S since completion of the RI. Arsenic continues to be the primary risk driver in groundwater in the area of well TW-9S.

Well 517

Well 517 is located further to the east of the FMC site than well TW-9S and, as described in Section 5, appears to be influenced by converging groundwater from the FMC western ponds area and central plant area, the joint fenceline area and potentially Simplot plant sources.

As shown in Table 7-12, the Baseline HHRA estimated that incremental non-cancer HQs to potential future workers from exposure to well 517 are below the 1998 ROD RAO of one for all evaluated constituents. However, the current worker incremental HQ for arsenic (1.1) exceeds this threshold. As shown in Table 7-13, the Baseline HHRA estimated that incremental non-cancer HQs to potential future residents are above the 1998 ROD RAO of one for arsenic (2.4). The current residential incremental HQ for arsenic (4.0) exceeds the RAO by a slightly greater margin.

As shown in Table 7-12, incremental cancer risks to potential future workers from exposure to arsenic within well 517 (1.83E-04) are over two orders of magnitude greater than the 1998 ROD RAO. As shown in Table 7-13, incremental cancer risks to potential future residents from exposure to arsenic within well 517 (7.79E-04) are nearly three orders of magnitude greater than the 1998 ROD RAO.

No other COCs carried forward into the current risk characterization were found to be associated with incremental cancer risks or hazard indices in excess of the 1998 ROD RAOs.

In summary, groundwater quality in the vicinity of well 517 remains above a level of health concern and arsenic continues to be the primary risk driver. While arsenic-related risk estimates are slightly higher than those developed in the Baseline HHRA (by a factor of approximately 1.4), these findings support the conclusion that groundwater quality in the area of well 517 is essentially unchanged from the time of the Baseline HHRA.

Table 7-1

Baseline HHRA RME Incremental Non-Cancer Hazard Quotients (HQs) for Potential Future Residents Ingesting Groundwater from Wells in the Area North of Highway 30 and Interstate 86

Station	Chemical	Exposure Point Concentration (mg/l)	Background Concentration (mg/l)	Summary Intake Factor	Oral RfD	Exposure Point Hazard Quotient	Background Hazard Quotient	Incremental Hazard Quotient	EP/Bkgd Ratio
Wells in Area North of Highway 30 and Interstate 86									
517	Arsenic	3.3E-02	1.2E-02	3.5E-02	3.0E-04	3.8E+00	1.4E+00	2.4E+00	2.8E+00
517	Boron	6.2E-01	1.4E-01	3.5E-02	9.0E-02	2.4E-01	5.4E-02	1.9E-01	4.5E+00
517	Fluoride	2.7E-01	4.3E-01	3.5E-02	6.0E-02	1.6E-01	2.5E-01	0.0E+00	6.3E-01
517	Manganese	3.8E-02	3.9E-03	3.5E-02	5.0E-03	2.6E-01	2.7E-02	2.3E-01	9.7E+00
517	Nitrate	9.8E+00	2.5E+00	3.5E-02	1.6E+00	2.1E-01	5.5E-02	1.6E-01	3.9E+00
517	Selenium	2.1E-02	2.6E-03	3.5E-02	5.0E-03	1.4E-01	1.8E-02	1.3E-01	7.9E+00
517	Vanadium	9.9E-03	3.5E-03	3.5E-02	7.0E-03	4.9E-02	1.7E-02	3.2E-02	2.9E+00
	517 Total							**3.2E+00**	
TW-9S	Arsenic	4.2E-02	1.2E-02	3.5E-02	3.0E-04	4.8E+00	1.4E+00	3.4E+00	3.5E+00
TW-9S	Beryllium	2.0E-03	6.3E-04	3.5E-02	5.0E-03	1.4E-02	4.4E-03	9.5E-03	3.2E+00
TW-9S	Boron	7.1E-01	1.4E-01	3.5E-02	9.0E-02	2.7E-01	5.4E-02	2.2E-01	5.1E+00
TW-9S	Fluoride	2.6E-01	4.3E-01	3.5E-02	6.0E-02	1.5E-01	2.5E-01	0.0E+00	6.1E-01
TW-9S	Manganese	1.2E+00	3.9E-03	3.5E-02	5.0E-03	8.0E+00	2.7E-02	8.0E+00	3.0E+02
TW-9S	Mercury	1.4E-04	2.1E-04	3.5E-02	3.0E-04	1.6E-02	2.4E-02	0.0E+00	6.7E-01
TW-9S	Nitrate	1.4E+01	2.5E+00	3.5E-02	1.6E+00	3.1E-01	5.5E-02	2.5E-01	5.7E+00
TW-9S	Selenium	3.6E-03	2.6E-03	3.5E-02	5.0E-03	2.5E-02	1.8E-02	6.9E-03	1.4E+00
TW-9S	Trichloroethene	1.0E-03	2.8E-03	3.5E-02					3.6E-01
TW-9S	Vanadium	1.4E-01	3.5E-03	3.5E-02	7.0E-03	6.9E-01	1.7E-02	6.8E-01	4.1E+01
TW-9S	Zinc	2.3E-02	2.8E-02	3.5E-02	3.0E-01	2.7E-03	3.3E-03	0.0E+00	8.1E-01
	TW-9S Total							**1.3E+01**	

Signifies an incremental HQ greater than 1.

Table 7-2
Baseline HHRA RME Incremental Cancer Risks for Potential Future Residents Ingesting Groundwater from Wells in the Area North of Highway 30 and Interstate 86

Station	Compound	Exposure Point Concentration (mg/l)	Background Concentration (mg/l)	Summary Intake Factor	Oral SF	Exposure Point Cancer Risk	Background Cancer Risk	Incremental Cancer Risk	EP/Bkgd Ratio
Wells in Area North of Highway 30 and Interstate 86									
517	Arsenic	3.3E-02	1.2E-02	1.5E-02	1.8E+00	8.6E-04	3.1E-04	5.5E-04	2.8E+00
517	Radium-226	6.6E-01	5.6E-01	1.9E+04	3.0E-10	3.7E-06	3.1E-06	5.5E-07	1.2E+00
517 Total						8.6E-04	3.1E-04	**5.5E-04**	
TW-9S	Arsenic	4.2E-02	1.2E-02	1.5E-02	1.8E+00	1.1E-03	3.1E-04	7.7E-04	3.5E+00
TW-9S	Beryllium	2.0E-03	6.3E-04	1.5E-02	4.3E+00	1.3E-04	4.1E-05	8.7E-05	3.2E+00
TW-9S	Trichloroethene	1.0E-03	2.8E-03	1.5E-02	1.1E-02	1.6E-07	4.5E-07	0.0E+00	3.6E-01
TW-9S	Lead-210	4.5E+00	9.5E-01	1.9E+04	1.0E-09	8.5E-05	1.8E-05	6.7E-05	4.7E+00
TW-9S	Radium-226	7.9E-01	5.6E-01	1.9E+04	3.0E-10	4.4E-06	3.1E-06	1.3E-06	1.4E+00
TW-9S	Thorium-230	4.5E+00	9.5E-01	1.9E+04	3.8E-11	3.2E-06	6.7E-07	2.5E-06	4.7E+00
TW-9S	Uranium-234	4.5E+00	9.5E-01	1.9E+04	4.4E-11	3.7E-06	7.9E-07	2.9E-06	4.7E+00
TW-9S	Uranium-238	4.5E+00	9.5E-01	1.9E+04	6.2E-11	5.2E-06	1.1E-06	4.1E-06	4.7E+00
TW-9S Total						1.3E-03	3.7E-04	**9.4E-04**	

Signifies an incremental cancer risk greater than 1E-04.

Table 7-3

Baseline HHRA RME Incremental Non-Cancer Hazard Quotients (HQs) for Potential Future Workers Ingesting Groundwater from Wells Across the FMC Plant OU

Station	Chemical	Exposure Point Concentration (mg/l)	Background Concentration (mg/l)	Summary Intake Factor	Oral RfD	Exposure Point Hazard Quotient	Background Hazard Quotient	Incremental Hazard Quotient	EP/Bkgd Ratio
Wells in Western Ponds Area									
134	Arsenic	1.4E-01	1.2E-02	9.8E-03	3.0E-04	4.6E+00	3.9E-01	4.2E+00	1.2E+01
134	Boron	1.7E+00	1.4E-01	9.8E-03	9.0E-02	1.8E-01	1.5E-02	1.7E-01	1.2E+01
134	Fluoride	1.7E-01	4.3E-01	9.8E-03	6.0E-02	2.7E-02	7.0E-02	0.0E+00	3.9E-01
134	Manganese	3.6E+00	3.9E-03	9.8E-03	5.0E-03	7.1E+00	7.6E-03	7.1E+00	9.3E+02
134	Nickel	3.1E-02	7.1E-03	9.8E-03	2.0E-02	1.5E-02	3.5E-03	1.1E-02	4.3E+00
134	Nitrate	9.8E+00	2.5E+00	9.8E-03	1.6E+00	6.0E-02	1.5E-02	4.4E-02	3.9E+00
134	Selenium	5.6E-03	2.6E-03	9.8E-03	5.0E-03	1.1E-02	5.1E-03	5.8E-03	2.1E+00
134	Vanadium	2.0E-02	3.5E-03	9.8E-03	7.0E-03	2.8E-02	4.8E-03	2.3E-02	5.8E+00
	134 Total							**1.2E+01**	
139	Arsenic	1.7E-02	1.2E-02	9.8E-03	3.0E-04	5.4E-01	3.9E-01	1.6E-01	1.4E+00
139	Boron	9.3E-01	1.4E-01	9.8E-03	9.0E-02	1.0E-01	1.5E-02	8.6E-02	6.7E+00
139	Fluoride	1.6E+00	4.3E-01	9.8E-03	6.0E-02	2.5E-01	7.0E-02	1.8E-01	3.6E+00
139	Manganese	2.3E-02	3.9E-03	9.8E-03	5.0E-03	4.6E-02	7.6E-03	3.8E-02	6.0E+00
139	Mercury	5.2E-04	2.1E-04	9.8E-03	3.0E-04	1.7E-02	6.8E-03	1.0E-02	2.5E+00
139	Nitrate	4.1E+01	2.5E+00	9.8E-03	1.6E+00	2.5E-01	1.5E-02	2.4E-01	1.6E+01
139	Selenium	2.4E-02	2.6E-03	9.8E-03	5.0E-03	4.6E-02	5.1E-03	4.1E-02	9.0E+00
139	Vanadium	6.1E-03	3.5E-03	9.8E-03	7.0E-03	8.5E-03	4.8E-03	3.7E-03	1.8E+00
	139 Total							**7.5E-01**	
150	Arsenic	8.0E-01	1.2E-02	9.8E-03	3.0E-04	2.6E+01	3.9E-01	2.6E+01	6.7E+01
150	Boron	4.6E+01	1.4E-01	9.8E-03	9.0E-02	5.0E+00	1.5E-02	5.0E+00	3.3E+02
150	Fluoride	1.5E+01	4.3E-01	9.8E-03	6.0E-02	2.4E+00	7.0E-02	2.3E+00	3.4E+01
150	Manganese	2.0E+00	3.9E-03	9.8E-03	5.0E-03	3.9E+00	7.6E-03	3.9E+00	5.1E+02
150	Mercury	1.0E-04	2.1E-04	9.8E-03	3.0E-04	3.3E-03	6.8E-03	0.0E+00	4.8E-01
150	Nickel	2.7E-02	7.1E-03	9.8E-03	2.0E-02	1.3E-02	3.5E-03	9.8E-03	3.8E+00
150	Nitrate	2.2E-01	2.5E+00	9.8E-03	1.6E+00	1.3E-03	1.5E-02	0.0E+00	8.6E-02
150	Selenium	6.3E-03	2.6E-03	9.8E-03	5.0E-03	1.2E-02	5.1E-03	7.2E-03	2.4E+00
	150 Total							**3.7E+01**	
Wells in Central Plant Area									
108	Arsenic	4.1E-02	1.2E-02	9.8E-03	3.0E-04	1.3E+00	3.9E-01	9.6E-01	3.5E+00
108	Boron	7.4E-01	1.4E-01	9.8E-03	9.0E-02	8.0E-02	1.5E-02	6.5E-02	5.3E+00
108	Fluoride	2.7E+00	4.3E-01	9.8E-03	6.0E-02	4.5E-01	7.0E-02	3.8E-01	6.4E+00
108	Manganese	6.2E-01	3.9E-03	9.8E-03	5.0E-03	1.2E+00	7.6E-03	1.2E+00	1.6E+02
108	Mercury	2.0E-04	2.1E-04	9.8E-03	3.0E-04	6.5E-03	6.8E-03	0.0E+00	9.5E-01
108	Nitrate	1.6E+01	2.5E+00	9.8E-03	1.6E+00	9.5E-02	1.5E-02	8.0E-02	6.2E+00
108	Selenium	6.8E-03	2.6E-03	9.8E-03	5.0E-03	1.3E-02	5.1E-03	8.2E-03	2.6E+00
108	Trichloroethene	3.0E-03	2.8E-03	9.8E-03					1.1E+00
108	Vanadium	2.0E-02	3.5E-03	9.8E-03	7.0E-03	2.8E-02	4.8E-03	2.3E-02	5.7E+00
108	Zinc	4.1E-02	2.8E-02	9.8E-03	3.0E-01	1.3E-03	9.3E-04	4.0E-04	1.4E+00
	108 Total							**2.7E+00**	
123	Arsenic	6.0E-01	1.2E-02	9.8E-03	3.0E-04	2.0E+01	3.9E-01	1.9E+01	5.1E+01
123	Boron	1.0E+00	1.4E-01	9.8E-03	9.0E-02	1.1E-01	1.5E-02	9.9E-02	7.5E+00
123	Fluoride	8.4E-01	4.3E-01	9.8E-03	6.0E-02	1.4E-01	7.0E-02	6.7E-02	2.0E+00
123	Manganese	4.6E-01	3.9E-03	9.8E-03	5.0E-03	8.9E-01	7.6E-03	8.8E-01	1.2E+02
123	Mercury	1.1E-04	2.1E-04	9.8E-03	3.0E-04	3.5E-03	6.8E-03	0.0E+00	5.2E-01
123	Nickel	9.5E-03	7.1E-03	9.8E-03	2.0E-02	4.7E-03	3.5E-03	1.2E-03	1.3E+00
123	Nitrate	1.3E+01	2.5E+00	9.8E-03	1.6E+00	8.1E-02	1.5E-02	6.6E-02	5.3E+00
123	Selenium	3.8E-01	2.6E-03	9.8E-03	5.0E-03	7.4E-01	5.1E-03	7.4E-01	1.4E+02
123	Vanadium	2.1E-01	3.5E-03	9.8E-03	7.0E-03	2.9E-01	4.8E-03	2.9E-01	6.1E+01
	123 Total							**2.1E+01**	

Table 7-3

Baseline HHRA RME Incremental Non-Cancer Hazard Quotients (HQs) for Potential Future Workers Ingesting Groundwater from Wells Across the FMC Plant OU

Station	Chemical	Exposure Point Concentration (mg/l)	Background Concentration (mg/l)	Summary Intake Factor	Oral RfD	Exposure Point Hazard Quotient	Background Hazard Quotient	Incremental Hazard Quotient	EP/Bkgd Ratio
Wells in Joint Fenceline/Calciner Ponds Area									
136	Arsenic	5.6E-01	1.2E-02	9.8E-03	3.0E-04	1.8E+01	3.9E-01	1.8E+01	4.7E+01
136	Beryllium	2.0E-03	6.3E-04	9.8E-03	5.0E-03	3.9E-03	1.2E-03	2.7E-03	3.2E+00
136	Boron	8.2E-01	1.4E-01	9.8E-03	9.0E-02	9.0E-02	1.5E-02	7.4E-02	5.9E+00
136	Fluoride	1.6E+00	4.3E-01	9.8E-03	6.0E-02	2.5E-01	7.0E-02	1.8E-01	3.7E+00
136	Manganese	2.2E+00	3.9E-03	9.8E-03	5.0E-03	4.3E+00	7.6E-03	4.3E+00	5.6E+02
136	Mercury	1.7E-04	2.1E-04	9.8E-03	3.0E-04	5.5E-03	6.8E-03	0.0E+00	8.1E-01
136	Nickel	3.8E-02	7.1E-03	9.8E-03	2.0E-02	1.8E-02	3.5E-03	1.5E-02	5.3E+00
136	Nitrate	3.0E+00	2.5E+00	9.8E-03	1.6E+00	1.8E-02	1.5E-02	3.1E-03	1.2E+00
136	Selenium	7.7E-02	2.6E-03	9.8E-03	5.0E-03	1.5E-01	5.1E-03	1.4E-01	2.9E+01
136	Vanadium	2.8E-02	3.5E-03	9.8E-03	7.0E-03	3.9E-02	4.8E-03	3.5E-02	8.2E+00
136	Zinc	4.4E-02	2.8E-02	9.8E-03	3.0E-01	1.4E-03	9.3E-04	5.1E-04	1.5E+00
	136 Total							**2.3E+01**	
143	Arsenic	4.7E-01	1.2E-02	9.8E-03	3.0E-04	1.5E+01	3.9E-01	1.5E+01	4.0E+01
143	Beryllium	2.0E-03	6.3E-04	9.8E-03	5.0E-03	3.9E-03	1.2E-03	2.7E-03	3.2E+00
143	Boron	1.0E+00	1.4E-01	9.8E-03	9.0E-02	1.1E-01	1.5E-02	9.7E-02	7.4E+00
143	Fluoride	4.4E-01	4.3E-01	9.8E-03	6.0E-02	7.1E-02	7.0E-02	1.5E-03	1.0E+00
143	Manganese	6.9E-01	3.9E-03	9.8E-03	5.0E-03	1.3E+00	7.6E-03	1.3E+00	1.8E+02
143	Mercury	1.7E-04	2.1E-04	9.8E-03	3.0E-04	5.5E-03	6.8E-03	0.0E+00	8.1E-01
143	Nickel	6.9E-02	7.1E-03	9.8E-03	2.0E-02	3.4E-02	3.5E-03	3.0E-02	9.8E+00
143	Nitrate	8.4E+00	2.5E+00	9.8E-03	1.6E+00	5.1E-02	1.5E-02	3.6E-02	3.3E+00
143	Selenium	2.8E-01	2.6E-03	9.8E-03	5.0E-03	5.5E-01	5.1E-03	5.4E-01	1.1E+02
143	Vanadium	1.3E-01	3.5E-03	9.8E-03	7.0E-03	1.9E-01	4.8E-03	1.8E-01	3.9E+01
143	Zinc	1.3E-02	2.8E-02	9.8E-03	3.0E-01	4.2E-04	9.3E-04	0.0E+00	4.6E-01
	143 Total							**1.7E+01**	
Wells in Area North of Highway 30 and Interstate 86									
517	Arsenic	3.3E-02	1.2E-02	9.8E-03	3.0E-04	1.1E+00	3.9E-01	6.8E-01	2.8E+00
517	Boron	6.2E-01	1.4E-01	9.8E-03	9.0E-02	6.8E-02	1.5E-02	5.3E-02	4.5E+00
517	Fluoride	2.7E-01	4.3E-01	9.8E-03	6.0E-02	4.4E-02	7.0E-02	0.0E+00	6.3E-01
517	Manganese	3.8E-02	3.9E-03	9.8E-03	5.0E-03	7.4E-02	7.6E-03	6.6E-02	9.7E+00
517	Nitrate	9.8E+00	2.5E+00	9.8E-03	1.6E+00	6.0E-02	1.5E-02	4.4E-02	3.9E+00
517	Selenium	2.1E-02	2.6E-03	9.8E-03	5.0E-03	4.0E-02	5.1E-03	3.5E-02	7.9E+00
517	Vanadium	9.9E-03	3.5E-03	9.8E-03	7.0E-03	1.4E-02	4.8E-03	9.0E-03	2.9E+00
	517 Total							**8.9E-01**	
TW-9S	Arsenic	4.2E-02	1.2E-02	9.8E-03	3.0E-04	1.4E+00	3.9E-01	9.7E-01	3.5E+00
TW-9S	Beryllium	2.0E-03	6.3E-04	9.8E-03	5.0E-03	3.9E-03	1.2E-03	2.7E-03	3.2E+00
TW-9S	Boron	7.1E-01	1.4E-01	9.8E-03	9.0E-02	7.7E-02	1.5E-02	6.2E-02	5.1E+00
TW-9S	Fluoride	2.6E-01	4.3E-01	9.8E-03	6.0E-02	4.2E-02	7.0E-02	0.0E+00	6.1E-01
TW-9S	Manganese	1.2E+00	3.9E-03	9.8E-03	5.0E-03	2.3E+00	7.6E-03	2.2E+00	3.0E+02
TW-9S	Mercury	1.4E-04	2.1E-04	9.8E-03	3.0E-04	4.6E-03	6.8E-03	0.0E+00	6.7E-01
TW-9S	Nitrate	1.4E+01	2.5E+00	9.8E-03	1.6E+00	8.7E-02	1.5E-02	7.2E-02	5.7E+00
TW-9S	Selenium	3.6E-03	2.6E-03	9.8E-03	5.0E-03	7.1E-03	5.1E-03	1.9E-03	1.4E+00
TW-9S	Trichloroethene	1.0E-03	2.8E-03	9.8E-03					3.6E-01
TW-9S	Vanadium	1.4E-01	3.5E-03	9.8E-03	7.0E-03	2.0E-01	4.8E-03	1.9E-01	4.1E+01
TW-9S	Zinc	2.3E-02	2.8E-02	9.8E-03	3.0E-01	7.5E-04	9.3E-04	0.0E+00	8.1E-01
	TW-9S Total							**3.5E+00**	

Signifies an incremental HQ greater than 1.

Table 7-4
Baseline HHRA RME Incremental Cancer Risksfor Potential Future Workers Ingesting Groundwater from Wells Across the FMC Plant OU

Station	Compound	Exposure Point Concentration (mg/l)	Background Concentration (mg/l)	Summary Intake Factor	Oral SF	Exposure Point Cancer Risk	Background Cancer Risk	Incremental Cancer Risk	EP/Bkgd Ratio
Western Ponds Area									
134	Arsenic	1.4E-01	1.2E-02	3.5E-03	1.8E+00	8.6E-04	7.2E-05	7.9E-04	1.2E+01
134	Lead-210	2.5E+00	9.5E-01	6.3E+03	1.0E-09	1.6E-05	6.0E-06	9.9E-06	2.7E+00
134	Radium-226	9.8E-01	5.6E-01	6.3E+03	3.0E-10	1.8E-06	1.0E-06	7.7E-07	1.7E+00
134	Thorium-230	2.5E+00	9.5E-01	6.3E+03	3.8E-11	5.9E-07	2.2E-07	3.7E-07	2.7E+00
134	Uranium-234	2.5E+00	9.5E-01	6.3E+03	4.4E-11	6.9E-07	2.6E-07	4.3E-07	2.7E+00
134	Uranium-238	2.5E+00	9.5E-01	6.3E+03	6.2E-11	9.8E-07	3.7E-07	6.1E-07	2.7E+00
134 Total						8.8E-04	8.0E-05	8.0E-04	
139	Arsenic	1.7E-02	1.2E-02	3.5E-03	1.8E+00	1.0E-04	7.2E-05	2.9E-05	1.4E+00
139	Lead-210	8.4E-01	9.5E-01	6.3E+03	1.0E-09	5.3E-06	6.0E-06	0.0E+00	8.9E-01
139	Radium-226	9.3E-01	5.6E-01	6.3E+03	3.0E-10	1.7E-06	1.0E-06	6.8E-07	1.7E+00
139	Thorium-230	8.4E-01	9.5E-01	6.3E+03	3.8E-11	2.0E-07	2.2E-07	0.0E+00	8.9E-01
139	Uranium-234	8.4E-01	9.5E-01	6.3E+03	4.4E-11	2.3E-07	2.6E-07	0.0E+00	8.9E-01
139	Uranium-238	8.4E-01	9.5E-01	6.3E+03	6.2E-11	3.3E-07	3.7E-07	0.0E+00	8.9E-01
139 Total						1.1E-04	8.0E-05	3.0E-05	
150	Arsenic	8.0E-01	1.2E-02	3.5E-03	1.8E+00	4.9E-03	7.2E-05	4.8E-03	6.7E+01
151	Lead-210	4.7E-01	9.5E-01	6.3E+03	1.0E-09	3.0E-06	6.0E-06	0.0E+00	4.9E-01
151	Radium-226	1.1E+00	5.6E-01	6.3E+03	3.0E-10	2.0E-06	1.0E-06	9.8E-07	1.9E+00
151	Thorium-230	4.7E-01	9.5E-01	6.3E+03	3.8E-11	1.1E-07	2.2E-07	0.0E+00	4.9E-01
151	Uranium-234	4.7E-01	9.5E-01	6.3E+03	4.4E-11	1.3E-07	2.6E-07	0.0E+00	4.9E-01
151	Uranium-238	4.7E-01	9.5E-01	6.3E+03	6.2E-11	1.8E-07	3.7E-07	0.0E+00	4.9E-01
150 Total						4.9E-03	8.0E-05	4.8E-03	
Central Plant Area									
108	Arsenic	4.1E-02	1.2E-02	3.5E-03	1.8E+00	2.5E-04	7.2E-05	1.8E-04	3.5E+00
108	Trichloroethene	3.0E-03	2.8E-03	3.5E-03	1.1E-02	1.2E-07	1.1E-07	8.8E-09	1.1E+00
108	Lead-210	3.5E+00	9.5E-01	6.3E+03	1.0E-09	2.2E-05	6.0E-06	1.6E-05	3.7E+00
108	Radium-226	5.1E-01	5.6E-01	6.3E+03	3.0E-10	9.4E-07	1.0E-06	0.0E+00	9.1E-01
108	Thorium-230	3.5E+00	9.5E-01	6.3E+03	3.8E-11	8.2E-07	2.2E-07	6.0E-07	3.7E+00
108	Uranium-234	3.5E+00	9.5E-01	6.3E+03	4.4E-11	9.6E-07	2.6E-07	7.0E-07	3.7E+00
108	Uranium-238	3.5E+00	9.5E-01	6.3E+03	6.2E-11	1.4E-06	3.7E-07	9.9E-07	3.7E+00
108 Total						2.8E-04	8.0E-05	2.0E-04	
123	Arsenic	6.0E-01	1.2E-02	3.5E-03	1.8E+00	3.7E-03	7.2E-05	3.6E-03	5.1E+01
123	Lead-210	1.2E+00	9.5E-01	6.3E+03	1.0E-09	7.7E-06	6.0E-06	1.7E-06	1.3E+00
123	Radium-226	1.4E+00	5.6E-01	6.3E+03	3.0E-10	2.6E-06	1.0E-06	1.6E-06	2.5E+00
123	Thorium-230	1.2E+00	9.5E-01	6.3E+03	3.8E-11	2.8E-07	2.2E-07	6.1E-08	1.3E+00
123	Uranium-234	1.2E+00	9.5E-01	6.3E+03	4.4E-11	3.3E-07	2.6E-07	7.2E-08	1.3E+00
123	Uranium-238	1.2E+00	9.5E-01	6.3E+03	6.2E-11	4.7E-07	3.7E-07	1.0E-07	1.3E+00
123 Total						3.7E-03	8.0E-05	3.6E-03	

Table 7-4
Baseline HHRA RME Incremental Cancer Risksfor Potential Future Workers Ingesting Groundwater from Wells Across the FMC Plant OU

Station	Compound	Exposure Point Concentration (mg/l)	Background Concentration (mg/l)	Summary Intake Factor	Oral SF	Exposure Point Cancer Risk	Background Cancer Risk	Incremental Cancer Risk	EP/Bkgd Ratio
Joint Fenceline/Calciner Ponds Area									
136	Arsenic	5.6E-01	1.2E-02	3.5E-03	1.8E+00	3.4E-03	7.2E-05	3.3E-03	4.7E+01
136	Beryllium	2.0E-03	6.3E-04	3.5E-03	4.3E+00	3.0E-05	9.5E-06	2.1E-05	3.2E+00
136	Lead-210	9.6E-01	9.5E-01	6.3E+03	1.0E-09	6.0E-06	6.0E-06	4.0E-08	1.0E+00
136	Radium-226	1.7E+00	5.6E-01	6.3E+03	3.0E-10	3.2E-06	1.0E-06	2.2E-06	3.1E+00
136	Thorium-230	9.6E-01	9.5E-01	6.3E+03	3.8E-11	2.2E-07	2.2E-07	1.5E-09	1.0E+00
136	Uranium-234	9.6E-01	9.5E-01	6.3E+03	4.4E-11	2.6E-07	2.6E-07	1.8E-09	1.0E+00
136	Uranium-238	9.6E-01	9.5E-01	6.3E+03	6.2E-11	3.7E-07	3.7E-07	2.5E-09	1.0E+00
136 Total						3.5E-03	9.0E-05	3.4E-03	
143	Arsenic	4.7E-01	1.2E-02	3.5E-03	1.8E+00	2.9E-03	7.2E-05	2.8E-03	4.0E+01
143	Beryllium	2.0E-03	6.3E-04	3.5E-03	4.3E+00	3.0E-05	9.5E-06	2.1E-05	3.2E+00
143	Lead-210	1.7E+00	9.5E-01	6.3E+03	1.0E-09	1.1E-05	6.0E-06	4.6E-06	1.8E+00
143	Radium-226	2.5E+00	5.6E-01	6.3E+03	3.0E-10	4.6E-06	1.0E-06	3.6E-06	4.4E+00
143	Thorium-230	1.7E+00	9.5E-01	6.3E+03	3.8E-11	3.9E-07	2.2E-07	1.7E-07	1.8E+00
143	Uranium-234	1.7E+00	9.5E-01	6.3E+03	4.4E-11	4.6E-07	2.6E-07	2.0E-07	1.8E+00
143	Uranium-238	1.7E+00	9.5E-01	6.3E+03	6.2E-11	6.5E-07	3.7E-07	2.8E-07	1.8E+00
143 Total						2.9E-03	9.0E-05	2.8E-03	
Area North of Highway 30 and Interstate 86									
517	Arsenic	3.3E-02	1.2E-02	3.5E-03	1.8E+00	2.0E-04	7.2E-05	1.3E-04	2.8E+00
517	Radium-226	6.6E-01	5.6E-01	6.3E+03	3.0E-10	1.2E-06	1.0E-06	1.8E-07	1.2E+00
517 Total						2.0E-04	7.4E-05	1.3E-04	
TW-9S	Arsenic	4.2E-02	1.2E-02	3.5E-03	1.8E+00	2.5E-04	7.2E-05	1.8E-04	3.5E+00
TW-9S	Beryllium	2.0E-03	6.3E-04	3.5E-03	4.3E+00	3.0E-05	9.5E-06	2.1E-05	3.2E+00
TW-9S	Trichloroethene	1.0E-03	2.8E-03	3.5E-03	1.1E-02	3.8E-08	1.1E-07	0.0E+00	3.6E-01
TW-9S	Lead-210	4.5E+00	9.5E-01	6.3E+03	1.0E-09	2.8E-05	6.0E-06	2.2E-05	4.7E+00
TW-9S	Radium-226	7.9E-01	5.6E-01	6.3E+03	3.0E-10	1.5E-06	1.0E-06	4.1E-07	1.4E+00
TW-9S	Thorium-230	4.5E+00	9.5E-01	6.3E+03	3.8E-11	1.0E-06	2.2E-07	8.2E-07	4.7E+00
TW-9S	Uranium-234	4.5E+00	9.5E-01	6.3E+03	4.4E-11	1.2E-06	2.6E-07	9.7E-07	4.7E+00
TW-9S	Uranium-238	4.5E+00	9.5E-01	6.3E+03	6.2E-11	1.7E-06	3.7E-07	1.4E-06	4.7E+00
TW-9S Total						3.2E-04	9.0E-05	2.3E-04	

Signifies an incremental cancer risk greater than 1E-04.

Table 7-5
Comparison of COPC/ROPC Groundwater Data to Screening Levels

COPC/ROPC (a)	Representative (Background) Level (mg/L or pCi/L)		Groundwater MCL or Risk-Based Concentration (RBC) (mg/L or pCi/L)		Comparative Value (CV) for Screening (c)	Groundwater Data from November (4Q) 2006 through May (2Q) 2008		
	Michaud 95th Percentile (b)	Bannock 95th Percentile (b)				Frequency of Detection	Maximum Detected Concentration	Maximum Detected Concentration Exceed CV?
NUTRIENTS AND FLUORIDE (mg/l)								
Nitrate (NO3 as N)	5.52	1.60	10	MCL	10	246/263	38.2	Yes
Fluoride	0.80	0.60	4	MCL	4	238/263	5	Yes
METALS (mg/l)								
Antimony	0.1000	0.1340	0.006	MCL	0.1	5/39	0.0073	No
Arsenic	0.0141	0.0170	0.01	MCL	0.0141	280/314	0.36	Yes
Boron	0.2935	0.3078	7.3	RBC	7.3	23/39	6.24	No
Cadmium	0.0050	0.0050	0.005	MCL	0.005	14/250	0.00051	No
Manganese	0.0518	0.0201	1.7	RBC	1.7	20/39	2.34	Yes
Mercury	0.00074	0.00078	0.002	MCL	0.002	8/39	0.00028	No
Selenium	0.0057	0.0055	0.05	MCL	0.05	227/314	0.17	Yes
Vanadium	0.0745	0.1000	0.18	RBC	0.18	29/39	0.182	Yes
RADIOLOGICAL								
Radium-226	ND to 6.35 pCi/L		5 pCi/L combined	MCL	5 pCi/L combined	39/39	1.46 pCi/L combined	No
Radium-228	ND to 10.8 pCi/L							
Other Inorganics								
Elemental Phosphorus	(d)	(d)	0.00073	PRG	0.00073	3/18	0.03	Yes
Total Cyanide	(d)	(d)	0.2	MCL	0.2	9/39	0.13	No
Uranium	(d)	(d)	0.03	MCL	0.03	29/39	0.257	Yes

COPC/ROPC identified as a COC/ROC for evaluation in the quantitative risk assessment.

(a) COPC/ROPCs for the risk assessment update consists of analytes from the May (2Q) 2008 CERCLA Special Program with available toxicological data to characterize risks.
(b) The Bannock and Michaud representative concentrations are 95th percentile values for pre-1994 data as presented in Table 4.4-1 in the EMF RI Report with the exception of the representative arsenic concentration that is a 95% Upper Prediction Limit as described in Section 4.3 of the Groundwater Current Conditions Report for the FMC Plant OU.
(c) Comparative value (CV) is the greater of the risk-based concentration (RBC) and the lower of the two representative (background) levels.
(d) Parameter was not analyzed or detected during the EMF RI, so no representative concentration was calculated during the EMF RI.

Table 7-6
COC Exposure Point Concentrations and Intake Rates

COPC/ROPC (a)	Exposure Point Concentration (mg/L)	Background Exposure Point Concentration (mg/L)	Incremental RME Worker Average Daily Dose (ADD) (mg/kg-day)	Incremental RME Worker Lifetime Average Daily Dose (ADD) (mg/kg-day)	Incremental RME Resident Average Daily Dose (ADD) (mg/kg-day)	Incremental RME Resident Lifetime Average Daily Dose (ADD) (mg/kg-day)
Western Ponds Area						
Well 134						
Nitrate (NO3 as N)	2.12E+01	2.51E+00	1.83E-01	6.53E-02	NA	NA
Fluoride	2.00E-01	4.27E-01	0.00E+00	0.00E+00	NA	NA
Arsenic	9.82E-02	1.19E-02	8.44E-04	3.02E-04	NA	NA
Manganese	2.34E+00	3.90E-03	2.29E-02	8.16E-03	NA	NA
Selenium	5.00E-02	2.63E-03	-	-	NA	NA
Vanadium	1.38E-02	3.45E-03	1.01E-04	3.62E-05	NA	NA
Elemental Phosphorus	-	-	-	-	NA	NA
Uranium	1.00E-02	-	-	-	NA	NA
Well 139						
Nitrate (NO3 as N)	3.82E+01	2.51E+00	3.49E-01	1.25E-01	NA	NA
Fluoride	1.10E+00	4.27E-01	6.59E-03	2.35E-03	NA	NA
Arsenic	1.04E-02	1.19E-02	0.00E+00	0.00E+00	NA	NA
Manganese	2.00E-03	3.90E-03	-	-	NA	NA
Selenium	4.59E-02	2.63E-03	4.23E-04	1.51E-04	NA	NA
Vanadium	1.00E-02	3.45E-03	-	-	NA	NA
Elemental Phosphorus	-	-	-	-	NA	NA
Uranium	6.60E-03	-	6.46E-05	2.31E-05	NA	NA
Well 156						
Nitrate (NO3 as N)	1.00E-01	2.51E+00	-	-	NA	NA
Fluoride	1.00E-01	4.27E-01	-	-	NA	NA
Arsenic	1.78E-01	1.19E-02	1.63E-03	5.80E-04	NA	NA
Manganese	1.24E+00	3.90E-03	1.21E-02	4.32E-03	NA	NA
Selenium	3.90E-03	2.63E-03	1.24E-05	4.44E-06	NA	NA
Vanadium	1.00E-02	3.45E-03	-	-	NA	NA
Elemental Phosphorus	-	-	-	-	NA	NA
Uranium	1.00E-02	-	-	-	NA	NA
Well 168						
Nitrate (NO3 as N)	1.51E+01	2.51E+00	1.23E-01	4.40E-02	NA	NA
Fluoride	5.00E+00	4.27E-01	4.47E-02	1.60E-02	NA	NA
Arsenic	2.92E-02	1.19E-02	1.69E-04	6.05E-05	NA	NA
Manganese	-	3.90E-03	-	-	NA	NA
Selenium	3.46E-02	2.63E-03	3.13E-04	1.12E-04	NA	NA
Vanadium	-	3.45E-03	-	-	NA	NA
Elemental Phosphorus	-	-	-	-	NA	NA
Uranium	-	-	-	-	NA	NA
Central Plant Area						
Well 108						
Nitrate (NO3 as N)	1.96E+01	2.51E+00	1.67E-01	5.97E-02	NA	NA
Fluoride	1.00E+00	4.27E-01	5.61E-03	2.00E-03	NA	NA
Arsenic	2.00E-02	1.19E-02	7.93E-05	2.83E-05	NA	NA
Manganese	4.87E-01	3.90E-03	4.73E-03	1.69E-03	NA	NA
Selenium	1.39E-02	2.63E-03	1.10E-04	3.94E-05	NA	NA
Vanadium	4.90E-03	3.45E-03	1.42E-05	5.07E-06	NA	NA
Elemental Phosphorus	1.24E-01	-	1.21E-03	4.33E-04	NA	NA
Uranium	4.90E-04	-	4.79E-06	1.71E-06	NA	NA
Well 123						
Nitrate (NO3 as N)	7.90E+00	2.51E+00	5.27E-02	1.88E-02	NA	NA
Fluoride	1.20E+00	4.27E-01	7.56E-03	2.70E-03	NA	NA
Arsenic	2.60E-01	1.19E-02	2.43E-03	8.67E-04	NA	NA

Table 7-6
COC Exposure Point Concentrations and Intake Rates

COPC/ROPC (a)	Exposure Point Concentration (mg/L)	Background Exposure Point Concentration (mg/L)	Incremental RME Worker Average Daily Dose (ADD) (mg/kg-day)	Incremental RME Worker Lifetime Average Daily Dose (ADD) (mg/kg-day)	Incremental RME Resident Average Daily Dose (ADD) (mg/kg-day)	Incremental RME Resident Lifetime Average Daily Dose (ADD) (mg/kg-day)
Manganese	1.22E-01	3.90E-03	1.16E-03	4.13E-04	NA	NA
Selenium	1.70E-01	2.63E-03	1.64E-03	5.85E-04	NA	NA
Vanadium	1.82E-01	3.45E-03	1.75E-03	6.24E-04	NA	NA
Elemental Phosphorus	1.50E-04	-	1.47E-06	5.24E-07	NA	NA
Uranium	8.90E-04	-	-	-	NA	NA
Joint Fencline/Calciner Ponds Area						
Well 136						
Nitrate (NO3 as N)	3.60E+00	2.51E+00	1.07E-02	3.81E-03	NA	NA
Fluoride	5.00E-01	4.27E-01	7.14E-04	2.55E-04	NA	NA
Arsenic	3.47E-01	1.19E-02	3.28E-03	1.17E-03	NA	NA
Manganese	1.06E+00	3.90E-03	1.03E-02	3.69E-03	NA	NA
Selenium	4.51E-02	2.63E-03	4.16E-04	1.48E-04	NA	NA
Vanadium	1.85E-02	3.45E-03	1.47E-04	5.26E-05	NA	NA
Elemental Phosphorus	-	-	-	-	NA	NA
Uranium	1.00E-03	-	-	-	NA	NA
Well 143						
Nitrate (NO3 as N)	1.53E+01	2.51E+00	1.25E-01	4.47E-02	NA	NA
Fluoride	5.00E-01	4.27E-01	7.14E-04	2.55E-04	NA	NA
Arsenic	1.06E-01	1.19E-02	9.21E-04	3.29E-04	NA	NA
Manganese	3.49E-01	3.90E-03	3.38E-03	1.21E-03	NA	NA
Selenium	8.01E-02	2.63E-03	7.58E-04	2.71E-04	NA	NA
Vanadium	6.19E-02	3.45E-03	5.72E-04	2.04E-04	NA	NA
Elemental Phosphorus	-	-	-	-	NA	NA
Uranium	8.00E-03	-	7.83E-05	2.80E-05	NA	NA
Area North of Highway 30 and Interstate 86						
Well 517						
Nitrate (NO3 as N)	1.11E+01	2.51E+00	8.41E-02	3.00E-02	2.98E-01	1.28E-01
Fluoride	6.00E-01	4.27E-01	1.69E-03	6.05E-04	6.00E-03	2.57E-03
Arsenic	4.68E-02	1.19E-02	3.41E-04	1.22E-04	1.21E-03	5.19E-04
Manganese	2.00E-03	3.90E-03	-	-	-	-
Selenium	1.38E-02	2.63E-03	1.09E-04	3.90E-05	3.88E-04	1.66E-04
Vanadium	1.48E-02	3.45E-03	1.11E-04	3.97E-05	3.94E-04	1.69E-04
Elemental Phosphorus	5.00E-05	-	-	-	-	-
Uranium	5.00E-04	-	4.89E-06	1.75E-06	1.74E-05	7.44E-06
Well TW-9S						
Nitrate (NO3 as N)	1.04E+01	2.51E+00	7.72E-02	2.76E-02	2.74E-01	1.17E-01
Fluoride	1.00E-01	4.27E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Arsenic	2.74E-02	1.19E-02	1.52E-04	5.42E-05	5.38E-04	2.31E-04
Manganese	4.55E-01	3.90E-03	4.41E-03	1.58E-03	1.57E-02	6.71E-03
Selenium	3.10E-03	2.63E-03	4.60E-06	1.64E-06	1.63E-05	6.99E-06
Vanadium	3.80E-03	3.45E-03	3.42E-06	1.22E-06	1.21E-05	5.21E-06
Elemental Phosphorus	5.00E-05	-	-	-	-	-
Uranium	1.00E-02	-	-	-	-	-

NA = Not applicable

Red font signifies that the analyte was not detected in the well during the November 2006 through May 2008 timeframe. The number corresponds to the minimum detection limit achieved during this timeframe.

Table 7-7
COC Cancer Slope Factors (CSFs)

Chemical	Weight of Evidence[a]	Oral CSF $(mg/kg\text{-}day)^{-1}$	Portal of Entry Effect (N/Y)	Type(s) of Cancer	Study Basis (Species / Route of Administration)	Note(s) on Toxicity Value	Source(s)[b]
Inorganics							
Arsenic	A	1.5	N	Skin	Human, epidemiological drinking water study		IRIS (EPA, 1998)

Footnotes:

[a] Weight of Evidence (U.S. EPA)

A	Known human carcinogen
B1/B2	Probable human carcinogen
C	Possible human carcinogen
D	Not classifiable as to human carcinogenicity

[b] Complete references are listed at the end of the table.

References:

EPA. 1998. IRIS Toxicity Profile for Arsenic, Inorganic. II. Carcinogenicity Assessment for Lifetime Exposure. Revised: April 1998. Accessed: November 2, 2007. http://www.epa.gov/iris/subst/0278.htm.

Table 7-8
COC Chronic Oral Reference Doses (RfDs)

Chemical	Oral RfD (mg/kg-day)	Portal of Entry Effect (N/Y)	Confidence in RfD/RfC	Critical Effect(s)	Study Basis (Species / Route of Administration)	Uncertainty/ Modifying Factors	Note(s) on Toxicity Value	Source(s)[a]
Inorganics								
Arsenic	0.0003	N	Medium	Hyperpigmentation, keratosis, possible vascular complications	Human, oral	3/1		IRIS (EPA, 1993a)
Boron	0.2	N	High	Decreased fetal weight	Rat, diet, gestational study	66/1		IRIS (EPA, 2004)
Cyanides	0.02	N	M	Weight loss, thyroid effects and nyelin degeneration	Rat, oral	100/5		IRIS (EPA, 1993b)
Fluoride	0.06	Y	High	Objectionable dental fluorosis (cosmetic effect)	Human (child), epidemiologic study	1/1	Critical effect occurred at the portal of entry, but may also be the result of systemic absorption.	IRIS (EPA, 1989)
Manganese	0.046	N	Medium	Central nervous system effects	Human, dietary intake data	3/1		IRIS (EPA, 1996a)
Nitrate	1.6	N	High	Methemoglobinemia	Human infants, oral	1/1		IRIS (EPA, 1991a)
Phosphorus (elemental)	0.00002	N	Low	Parturition mortality; forelimb hair loss	Rat reproductive study, gavage	1000/1	Value is for white phosphorous	IRIS (EPA, 1993c)
Selenium	0.005	N	High	Clinical selenosis	Human, epidemiological dietary study	3/1		IRIS (EPA, 1991b)
Uranium	0.0006	N	NA	Kidney lesions	Rat, drinking water	NA	Value is for soluble salts	EPA Region 10 (EPA Region 10, 2008)
Vanadium	0.005	N	Low	Decreased hair cystine	Rat, diet	100/1	Converted from the chronic oral RfD for vanadium pentoxide to vanadium by using molecular weight.	IRIS (EPA, 1996b)

Table 7-8 References

IRIS

EPA. 1989. IRIS Toxicity Profile for Fluorine (Soluble Fluoride). I.A. Reference Dose for Chronic Oral Exposure. Revised: June 1989. Accessed: September 21, 2007. http://www.epa.gov/iris/subst/0053.htm.

EPA. 1991a. IRIS Toxicity Profile for Nitrate. I.A. Reference Dose for Chronic Oral Exposure. Revised: October 1991. Accessed: October 30, 2008. http://www.epa.gov/iris/subst/0076.htm.

EPA. 1991b. IRIS Toxicity Profile for Selenium and Compounds . I.A. Reference Dose for Chronic Oral Exposure. Revised: September 1991. Accessed: September 21, 2007. http://www.epa.gov/iris/subst/0472.htm.

EPA. 1993a. IRIS Toxicity Profile for Arsenic, Inorganic. I.A. Reference Dose for Chronic Oral Exposure. Revised: February 1993. Accessed: September 21, 2007. http://www.epa.gov/iris/subst/0278.htm.

EPA. 1993b. IRIS Toxicity Profile for Cyanide, Free. I.A. Reference Dose for Chronic Oral Exposure. Revised: February 1993. Accessed: October 30, 2008. http://www.epa.gov/iris/subst/0031.htm.

EPA. 1993c. IRIS Toxicity Profile for White Phosphorus. I.A. Reference Dose for Chronic Oral Exposure. Revised: February 1993. Accessed: September 21, 2007. http://www.epa.gov/iris/subst/0460.htm.

EPA. 1996a. IRIS Toxicity Profile for Manganese. I.A. Reference Dose for Chronic Oral Exposure. Revised: February 1996. Accessed: October 29, 2008. http://www.epa.gov/iris/subst/0373.htm.

EPA. 1996b. IRIS Toxicity Profile for Vanadium. I.A. Reference Dose for Chronic Oral Exposure. Revised: December 1996. Accessed: October 30, 2008. http://www.epa.gov/iris/subst/0125.htm.

EPA. 2004. IRIS Toxicity Profile for Boron and Compounds. I.A. Reference Dose for Chronic Oral Exposure. Revised: August 2004. Accessed: September 21, 2007. http://www.epa.gov/iris/subst/0410.htm.

EPA, Region 10

EPA Reg 10. 2008. Memorandum from Marc Stifelman, EPA Region 10 Office of Environmental Assessment to Kira Lynch, EPA Region 10 Office of Environmental Cleanup RE: Recommended toxicity value for uranium, noncancer endpoint for the Eastern Michaud Flats Site. July 10, 2008.

Table 7-9
Comparison of Current and Baseline HHRA Worker Risk Estimates for Wells in the Western Ponds Area of the FMC Plant OU

	Western Ponds Area																							
	Exposure Point Concentrations (mg/L)								Worker Incremental Cancer Risk								Worker Incremental Non-Cancer HQ							
	Well 134		Well 139		Well 156[a]		Well 168		Well 134		Well 139		Well 156[a]		Well 168		Well 134		Well 139		Well 156[a]		Well 168	
COCs	Current	Baseline HHRA	Current	Baseline HHRA	Current	Baseline HHRA	Current	Baseline HHRA	Current	Baseline HHRA[b]	Current	Baseline HHRA[b]	Current	Baseline HHRA[b]	Current	Baseline HHRA[b]	Current	Baseline HHRA[b]	Current	Baseline HHRA[b]	Current	Baseline HHRA[b]	Current	Baseline HHRA[b]
Metals																								
Arsenic	9.82E-02	1.41E-01	1.04E-02	1.66E-02	1.78E-01	7.96E-01	2.92E-02	-	4.52E-04	7.89E-04	0.00E+00	2.91E-05	8.71E-04	4.79E-03	9.07E-05	-	2.8	4.2	0.0	0.2	5.4	25.6	0.6	-
Manganese	2.34E+00	3.64E+00	2.00E-03	2.34E-02	1.24E+00	1.99E+00	-	-	-	-	-	-	-	-	-	-	0.5	7.1	-	0.0	0.3	3.9	-	-
Selenium	5.00E-02	5.60E-03	4.59E-02	2.37E-02	3.90E-03	6.30E-03	3.46E-02	-	-	-	-	-	-	-	-	-	-	0.0	0.1	0.0	0.0	0.0	0.1	-
Vanadium	1.38E-02	2.00E-02	1.00E-02	6.09E-03	1.00E-02	-	-	-	-	-	-	-	-	-		-	0.0	0.0	-	0.0	-	-	-	-
Nutrients and Fluoride																								
Elemental Phosphorus	-	-	-	-	1.20E-04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1	-	-	-
Fluoride	2.00E-01	1.66E-01	1.10E+00	1.56E+00	1.00E-01	1.46E+01	5.00E+00	-	-	-	-	-	-	-	-	-	0.0	0.0	0.1	0.2	-	2.3	0.7	-
Nitrate	2.12E+01	9.79E+00	3.82E+01	4.10E+01	1.00E-01	2.16E-01	1.51E+01	-	-	-	-	-	-	-	-	-	0.1	0.0	0.2	0.2	-	0.0	0.1	-
Other																								
Uranium	1.00E-02	-	6.60E-03	-	1.00E-02	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1	-	-	-	-	-
Total	**-**	**-**	**-**	**-**	**-**	-	**-**	**-**	**4.52E-04**	**8.02E-04**	**0.00E+00**	**2.98E-05**	**8.71E-04**	**4.83E-03**	**9.07E-05**	**-**	**3.4**	**11.6**	**0.5**	**0.8**	**5.7**	**36.8**	**1.4**	-

Red font signifies that the analyte was not detected in the well during the November 2006 through May 2008 timeframe. The number corresponds to the minimum detection limit achieved during this timeframe.

a = Baseline HHRA results for well 150 used in comparison to current results for post-RI well 156.
b = Baseline HHRA total cancer risk and non-cancer HQs include risk estimates for additional COPCs/ROPCs carried forward into Baseline HHRA quantitative assessment.

Table 7-10
Comparison of Current and Baseline HHRA Worker Risk Estimates for Wells in the Central Plant Area of the FMC Plant OU

	Central Plant Area											
	Exposure Point Concentrations (mg/L)				Worker Incremental Cancer Risk				Worker Incremental Non-Cancer HQ			
	Well 108		Well 123		Well 108		Well 123		Well 108		Well 123	
COCs	Current	Baseline HHRA	Current	Baseline HHRA	Current	Baseline HHRA[a]	Current	Baseline HHRA[a]	Current	Baseline HHRA[a]	Current	Baseline HHRA[a]
Metals												
Arsenic	2.00E-02	4.12E-02	2.60E-01	6.00E-01	4.25E-05	1.79E-04	1.30E-03	3.60E-03	0.3	1.0	8.1	19.2
Manganese	4.87E-01	6.15E-01	1.22E-01	4.56E-01	-	-	-	-	0.1	1.2	0.0	0.9
Selenium	1.39E-02	6.84E-03	1.70E-01	3.79E-01	-	-	-	-	0.0	0.0	0.3	0.7
Vanadium	4.90E-03	1.97E-02	1.82E-01	2.10E-01	-	-	-	-	0.0	0.0	0.3	0.3
Nutrients and Fluoride												
Elemental Phosphorus	1.24E-01	-	1.50E-04	-	-	-	-	-	60.7	-	0.1	-
Fluoride	1.00E+00	2.75E+00	1.20E+00	8.38E-01	-	-	-	-	0.1	0.4	0.1	0.1
Nitrate	1.96E+01	1.55E+01	7.90E+00	1.32E+01	-	-	-	-	0.1	0.1	0.0	0.1
Other												
Uranium	4.90E-04	-	8.90E-04	-	-	-	-	-	0.0	-	0.0	-
Total	**-**	**-**	**-**	**-**	**4.25E-05**	**1.98E-04**	**1.30E-03**	**3.60E-03**	**61.3**	**2.7**	**9.0**	**21.3**

Red font signifies that the analyte was not detected in the well during the November 2006 through May 2008 timeframe. The number corresponds to the minimum detection limit achieved during this timeframe.

a = Baseline HHRA total cancer risk and non-cancer HQs include risk estimates for additional COPCs/ROPCs carried forward into Baseline HHRA quantitative assessment.

Table 7-11
Comparison of Current and Baseline HHRA Worker Risk Estimates for Wells in the Joint Fenceline/Calciner Ponds Area of the FMC Plant OU

	Joint Fenceline/Calciner Ponds Area											
	Exposure Point Concentrations (mg/L)				Worker Incremental Cancer Risk				Worker Incremental Non-Cancer HQ			
	Well 136		Well 143		Well 136		Well 143		Well 136		Well 143	
COCs	**Current**	**Baseline HHRA**	**Current**	**Baseline HHRA**	**Current**	**Baseline HHRA[a]**	**Current**	**Baseline HHRA[a]**	**Current**	**Baseline HHRA[a]**	**Current**	**Baseline HHRA[a]**
Metals												
Arsenic	3.47E-01	5.58E-01	1.06E-01	4.73E-01	1.76E-03	3.34E-03	4.93E-04	2.82E-03	10.9	17.8	3.1	15.0
Manganese	1.06E+00	2.20E+00	3.49E-01	6.90E-01	-	-	-	-	0.2	4.3	0.1	1.3
Selenium	4.51E-02	7.65E-02	8.01E-02	2.79E-01	-	-	-	-	0.1	0.1	0.2	0.5
Vanadium	1.85E-02	2.82E-02	6.19E-02	1.33E-01	-	-		-	0.0	0.0	0.1	0.2
Nutrients and Fluoride												
Elemental Phosphorus	-	-	-	-	-	-	-	-	-	-	-	-
Fluoride	5.00E-01	1.56E+00	5.00E-01	4.36E-01	-	-	-	-	0.0	0.2	0.0	0.0
Nitrate	3.60E+00	3.02E+00	1.53E+01	8.38E+00	-	-	-	-	0.0	0.0	0.1	0.0
Other												
Uranium	1.00E-03	-	8.00E-03	-	-	-	-	-	-	-	0.1	-
Total	**-**	**-**	**-**	**-**	**1.76E-03**	**3.36E-03**	**4.93E-04**	**2.85E-03**	**11.3**	**22.6**	**3.6**	**17.3**

Red font signifies that the analyte was not detected in the well during the November 2006 through May 2008 timeframe. The number corresponds to the minimum detection limit achieved during this timeframe.

a = Baseline HHRA total cancer risk and non-cancer HQs include risk estimates for additional COPCs/ROPCs carried forward into Baseline HHRA quantitative assessment.

Table 7-12
Comparison of Current and Baseline HHRA Worker Risk Estimates for Wells in the FMC Plant OU Area North of Highway 30 and Interstate 86

	Area North of Highway 30 and Interstate 86											
	Exposure Point Concentrations (mg/L)				Worker Incremental Cancer Risk				Worker Incremental Non-Cancer HQ			
	Well 517		Well TW-9S		Well 517		Well TW-9S		Well 517		Well TW-9S	
COCs	Current	Baseline HHRA	Current	Baseline HHRA	Current	Baseline HHRA[a]	Current	Baseline HHRA[a]	Current	Baseline HHRA[a]	Current	Baseline HHRA[a]
Metals												
Arsenic	4.68E-02	3.29E-02	2.74E-02	4.16E-02	1.83E-04	1.28E-04	8.12E-05	1.82E-04	1.1	0.7	0.5	1.0
Manganese	2.00E-03	3.77E-02	4.55E-01	1.15E+00	-	-	-	-	-	0.1	0.1	2.2
Selenium	1.38E-02	2.07E-02	3.10E-03	3.62E-03	-	-	-	-	0.0	0.0	0.0	0.0
Vanadium	1.48E-02	9.92E-03	3.80E-03	1.40E-01	-	-		-	0.0	0.0	0.0	0.2
Nutrients and Fluoride												
Elemental Phosphorus	5.00E-05	-	5.00E-05	-	-	-	-	-	-	-	-	-
Fluoride	6.00E-01	2.71E-01	1.00E-01	2.59E-01	-	-	-	-	0.0	0.0	0.0	0.0
Nitrate	1.11E+01	9.78E+00	1.04E+01	1.42E+01	-	-	-	-	0.1	0.0	0.0	0.1
Other												
Uranium	5.00E-04	-	1.00E-02	-	-	-	-	-	0.0	-	-	-
Total	**-**	**-**	**-**	**-**	**1.83E-04**	**1.29E-04**	**8.12E-05**	**2.28E-04**	**1.3**	**0.9**	**0.6**	**3.5**

Red font signifies that the analyte was not detected in the well during the November 2006 through May 2008 timeframe. The number corresponds to the minimum detection limit achieved during this timeframe.

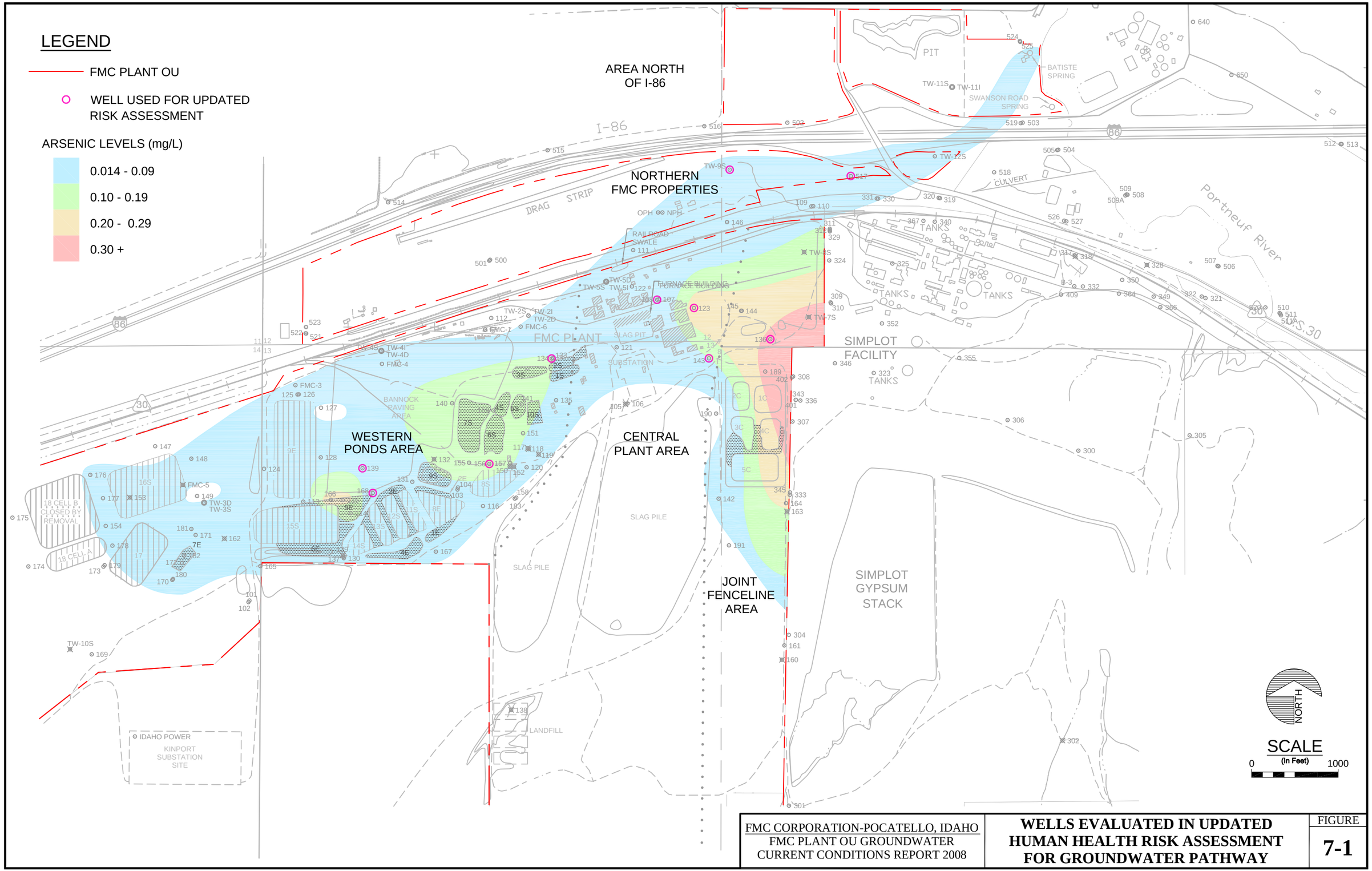
a = Baseline HHRA total cancer risk and non-cancer HQs include risk estimates for additional COPCs/ROPCs carried forward into Baseline HHRA quantitative assessment.

Table 7-13
Comparison of Current and Baseline HHRA Residential Risk Estimates for Wells in the FMC Plant OU Area North of Highway 30 and Interstate 86

	Area North of Highway 30 and Interstate 86											
	Exposure Point Concentrations (mg/L)				Worker Incremental Cancer Risk				Worker Incremental Non-Cancer HQ			
	Well 517		Well TW-9S		Well 517		Well TW-9S		Well 517		Well TW-9S	
COCs	**Current**	**Baseline HHRA**	**Current**	**Baseline HHRA**	**Current**	**Baseline HHRA[a]**	**Current**	**Baseline HHRA[a]**	**Current**	**Baseline HHRA[a]**	**Current**	**Baseline HHRA[a]**
Metals												
Arsenic	4.68E-02	3.29E-02	2.74E-02	4.16E-02	7.79E-04	5.47E-04	3.46E-04	7.73E-04	4.0	2.4	1.8	3.4
Manganese	2.00E-03	3.77E-02	4.55E-01	1.15E+00	-	-	-	-	-	0.2	0.3	8.0
Selenium	1.38E-02	2.07E-02	3.10E-03	3.62E-03	-	-	-	-	0.1	0.1	0.0	0.0
Vanadium	1.48E-02	9.92E-03	3.80E-03	1.40E-01	-	-		-	0.1	0.0	0.0	0.7
Nutrients and Fluoride												
Elemental Phosphorus	5.00E-05	-	5.00E-05	-	-	-	-	-	-	-	-	-
Fluoride	6.00E-01	2.71E-01	1.00E-01	2.59E-01	-	-	-	-	0.1	0.0	0.0	0.0
Nitrate	1.11E+01	9.78E+00	1.04E+01	1.42E+01	-	-	-	-	0.2	0.2	0.2	0.3
Other												
Uranium	5.00E-04	-	1.00E-02	-	-	-	-	-	0.0	-	-	-
Total	**-**	**-**	**-**	**-**	**7.79E-04**	**5.47E-04**	**3.46E-04**	**9.39E-04**	**4.5**	**3.2**	**2.3**	**12.6**

Red font signifies that the analyte was not detected in the well during the November 2006 through May 2008 timeframe. The number corresponds to the minimum detection limit achieved during this timeframe.

a = Baseline HHRA total cancer risk and non-cancer HQs include risk estimates for additional COPCs/ROPCs carried forward into Baseline HHRA quantitative assessment.



FMC CORPORATION-POCATELLO, IDAHO FMC PLANT OU GROUNDWATER CURRENT CONDITIONS REPORT 2008	**WELLS EVALUATED IN UPDATED HUMAN HEALTH RISK ASSESSMENT FOR GROUNDWATER PATHWAY**	FIGURE **7-1**

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Section 8
CONCLUSIONS AND RECOMMENDATIONS

FMC recognizes that identified and potential FMC Plant Site source area impacts to groundwater will be evaluated in the Supplemental Feasibility Study (SFS) for the FMC Plant OU. FMC prepared this groundwater current conditions report to provide a summary of the EMF RI groundwater investigations and to compile the substantial post-RI groundwater information developed under multiple regulatory programs and agencies into a single compendium to augment the Administrative Record for the FMC Plant OU. This report and the conclusions and recommendations presented in this section should be viewed as a companion to the SRI Report for the FMC Plant OU (MWH, 2008).

8.1 Conclusions

The conclusions presented below are organized to follow the same organization as the sections of this report.

Land and Groundwater Use

Current and anticipated future water and land use within the EMF groundwater study area have a low potential to alter the extent and transport of the FMC-impacted groundwater plume.

There is no migration of FMC site-related constituents in groundwater beyond FMC- (and Simplot-) owned properties. No domestic or public water supply wells are downgradient of site-impacted groundwater. FMC and Simplot-impacted groundwater discharges and mixes with the Portneuf River in the area between and including Swanson Road Spring (aka the Spring at Batiste Road) and Batiste Spring and, as such, migrates into the Off-Plant OU as surface water.

Groundwater used at FMC for drinking water purposes (Well #3 and New Pilot House well) continues to meet federal drinking water standards.

Geology and Hydrogeology

Groundwater gradients within the EMF study area are very stable and have not changed significantly, as demonstrated by 18 years of quarterly monitoring. Decreased (virtually ceased) extraction at the FMC production wells after the plant shutdown in 2001 has had no observable effect on groundwater gradients in the EMF study area.

Migration of site-related constituents from the shallow groundwater zone to the deeper zone is inhibited by upward vertical hydraulic gradients and the presence of confining strata throughout large portions of the EMF study area.

Northward flow of impacted groundwater from the western ponds area and central plant areas of the FMC Plant Site is limited to the area south of I-86, due to the effects of converging flow of groundwater from the Michaud aquifer to west and northwest.

Virtually all groundwater underflowing the EMF facilities discharges to the Portneuf River at Batiste Spring, the Spring at Batiste Road (aka Swanson Road Springs), and as bank seeps and baseflow to the river in the reach bounded by these springs.

Results of EMF RI and Post-RI Groundwater Studies and Monitoring

The spatial locations and depth of the screened intervals for the groundwater monitoring well network at the FMC Plant Site are adequate and effective for the identification of the nature and extend of groundwater impacts at the site. The additional water table wells installed at the direction of EPA demonstrated that wells screened in the saturated fine-grained horizon above the shallow aquifer zone do not yield sufficient water to reasonably conclude that significant horizontal groundwater flow occurs in the fine-grained (aquitard) horizon. In addition, the water quality results from the water table wells did not lead to new or different conclusions compared to the shallow aquifer wells.

Various constituents in groundwater exceed background levels beneath the FMC Plant OU in areas downgradient from former unlined phossy ponds in the western ponds area, in the eastern portion of the central plant area associated with the former kiln scrubber ponds and former kiln scrubber overflow pond, and the former unlined calciner ponds and Simplot gypsum stack in the joint-fenceline area. The supplemental sampling events provided additional results, consistent with the EMF RI, that the following constituents are FMC-related contaminants in groundwater:

- Common Ions: Potassium, chloride and sulfate
- Nutrients and Fluoride: Ammonia, nitrate, total phosphorus / orthophosphate and fluoride;
- Metals: Arsenic, boron, manganese and selenium, and vanadium (only in the eastern central plant and joint fenceline areas).

Supplemental post-RI sampling events identified the additional FMC-related groundwater contaminants as total cyanide and elemental phosphorus. These inorganic constituents were not evaluated as potential groundwater COPCs during the EMF RI.

Supplemental sampling events for expanded metals, organic compound and radionuclide analytical parameters have provided further evidence supporting the findings of the EMF RI that the following constituents are not FMC-related contaminants in groundwater:

- Metals: aluminum, antimony, beryllium, cadmium, copper, lead, molybdenum, mercury, silver, thallium and zinc;

- Organic Compounds; and

- Radionuclides.

Supplemental sampling did not indicate that total uranium is a FMC-related constituent in groundwater. Elevated uranium (and gross alpha activity associated with the uranium 238 and 234 isotopes) in joint-fenceline area wells are more likely associated with naturally-occurring uranium in volcanic bedrock units within which these wells are screened.

FMC performed a re-evaluation of the representative (or background) concentration of arsenic in groundwater flowing onto the FMC Plant OU following a transparent and reproducible process. The recalculated 95% UPL values are comparable to the RI-calculated values. As expected due to the much larger data set for the Michaud representative well group, the Michaud and Combined 95% UPL are essentially the same value (14.1 and 14.2 ug/l, respectively). Consistent with the findings in the RI, the Bannock representative arsenic concentration 95% UPL of 17.0 ug/l is slightly higher than the Michaud and Combined value.

Based on the National Primary Drinking Water Regulations and EPA‘s represented intent to evaluate FMC‘s future groundwater monitoring results based on average concentrations from multiple wells and sampling events, FMC also calculated a 95% UCL for the arsenic representative concentrations for the Bannock, Michaud and Combined data sets. As recommended by the Pro UCL Technical Guide, the 95% UCL was calculated using the Kaplan-Meier method. The calculated 95% KM UCL groundwater arsenic representative concentrations for the Bannock, Michaud and Combined representative well data sets are 7.4, 6.2 and 6.2 ug/l, respectively.

For future purposes, the 95% UPL groundwater representative arsenic concentrations should be used for comparison to any individual (point-by-point) result for any existing or new wells after determining the underlying geochemistry, and thus the hydrogeochemical regime present in groundwater, at the specific well. The 95% KM UCL for the groundwater arsenic representative concentrations should only be used for comparison where a statistically meaningful average and 95% UCL is or can be calculated for any existing, new, or grouping of wells. The 95% UCL comparison should take into consideration the underlying geochemistry and thus the hydrogeochemical regime present in groundwater at the specific well or well group.

Groundwater Quality and Trends

The spatial extent of the FMC-related groundwater impacts is comparable to that defined during the EMF RI. Concentrations of FMC-related groundwater impacts in the western ponds area, central plant area and downgradient portions of the joint fenceline / calciner ponds area have decreased (groundwater beneath the FMC Plant Site has improved) and are expected to continue

to improve due to the lack of sustained hydraulic head on any identified or potential source areas at the site.

Increasing trends of sulfate, orthophosphate, potassium and arsenic in wells upgradient of the calciner ponds area (RU 14) indicate that the Simplot gypstack is contributing increasing levels of these constituents to groundwater upgradient of RU 14 over time. There is consequently a potential for these constituents to increase in concentration over time and potentially reverse the currently stable or decreasing concentration trends in the downgradient portions of the joint fenceline / calciner ponds area.

Source Area Evaluation

The following are the primary FMC-related source areas and source-distinguishable constituents contributing to groundwater impacts at the FMC Plant Site:

- Pond 8S within RU 22a (RCRA Ponds) - Potassium, chloride, sulfate, ammonia, nitrate, total phosphorus / orthophosphate, fluoride, arsenic, manganese, boron, selenium and total cyanide.

- Old ―Phossy" Ponds (RU 22b) and portions of RU 13 with identified ―phossy" pond solids in fill materials - Potassium, chloride, sulfate, ammonia, nitrate, total phosphorus / orthophosphate, fluoride, arsenic, manganese, boron, selenium and total cyanide.

- Furnace Building, Phos Dock and Secondary Condenser (RU 1) and Slag Pit (RU 2) – Elemental phosphorus.

- Former Kiln Scrubber Ponds and Calciners (RU 8) and Former Kiln Scrubber Overflow Pond (RU 9) - Ammonia, nitrate, fluoride, selenium, vanadium and total cyanide.

- Former Unlined Calciner Ponds, Calciner Sediment Storage Area ‗A', Calciner Ponds (RU 14) - Potassium, chloride, fluoride, arsenic, manganese, boron and selenium.

- Calciner Solids Storage Area (RU 16) – Potassium, chloride, sulfate and selenium.

- Slag Pile (RU 19) – Potassium and sulfate.

Due to the migration of site-impacted groundwater from the western ponds area through the central plant area and multiple sources in the joint fenceline / calciner ponds area including the Simplot gypstack, the evaluation of groundwater constituents attributable to the source areas listed above focuses on the contaminants that can be distinguished from other sources—based on their higher concentrations compared to upgradient groundwater, or based on the fact that the constituents are unique in groundwater at that source area.

Because the IWW pond and ditch (RU 10) and the Railroad Swale (RU 22c) had a sustained hydraulic head, liquid from these areas likely migrated to groundwater to some extent. These areas thus may have been past sources of constituents to groundwater. However, there is currently no discernable contribution to site-impacted groundwater from these areas.

Based on the collective EMF RI and SRI investigations and post-RI groundwater monitoring, there is no evidence that the other RUs (or portions of those RUs not identified as source areas) are sources of groundwater impacts at the FMC Plant OU.

Fate and Transport

The principal factors affecting migration in the vadose zone are seepage rates and seepage fluid and soil chemistry. Seepage from the FMC Plant Site source areas has been significantly reduced due to pond closures, the remedial action at the calciner ponds, and the 2001 plant shutdown. In addition to reductions in seepage, the presence of alkaline, carbonate-rich loess beneath large portions of the EMF facilities has contributed to the attenuation of some metals in the vadose zone.

The most significant factor in the reduction of groundwater constituent concentrations is advective mixing. Mixing of small volumes of EMF-affected groundwater with large volumes of unaffected groundwater within the EMF aquifer system substantially reduces the concentration of all constituents, including conservative, non-attenuating solutes such as sulfate, along the groundwater flowpath.

Elemental phosphorus concentrations in RU1 and RU2 impacted groundwater decrease downgradient along flowpaths to undetected levels at the FMC Plant Site boundary as monitored at wells 146 and 110. Oxidation / hydrolysis converts the low levels of dissolved P4 to various phosphorus compounds that contribute a small increment of total phosphorus to groundwater beneath RUs 1 and 2. The increment of total phosphorus that originated as dissolved P4 is not distinguishable from total phosphorus / orthophosphate concentrations in groundwater flowing from the upgradient western ponds area of the FMC Plant Site.

EMF facility-impacted groundwater migrates from the EMF facilities and discharges to the Portneuf River as bank seeps / springs and baseflow to the river at Swanson Road Spring (aka the Spring at Batiste Road), Batiste Spring, and the reach bounded by these two springs.

Updated Groundwater Human Health Risk Assessment

The update to the Baseline HHRA found that current cancer risk and non-cancer HQs are generally lower than those estimated in the Baseline HHRA. This finding is consistent with the finding discussed in Section 5 of this report that groundwater quality has generally improved across the FMC Plant OU since the time of the EMF RI. However, the current cancer and non-

cancer risk estimates still exceed levels of health concern. Specifically, both current incremental cancer risks and non-cancer HQs exceed the 1998 ROD RAOs for the groundwater ingestion pathway.

Arsenic remains the primary risk driver in groundwater at the FMC Plant OU. Arsenic-related incremental cancer risks to future workers exceed 1E-03, over three orders of magnitude greater than the 1998 ROD RAO, in portions of the Central Plant Area and Joint Fenceline / Calciner Ponds Area of the site. Incremental arsenic cancer risks to workers exceed 1E-04 in portions of the Western Ponds Area and the Area to the North of Highway 30 and Interstate 86. Arsenic incremental cancer risks to hypothetical future residents in the Area North of Highway 30 and Interstate 86 also exceed 1E-04. No other groundwater COC exceeds the 1998 ROD RAO for the cancer endpoint (i.e., an incremental cancer risk greater than 1E-06)

Arsenic is also the non-cancer risk driver in groundwater across the FMC Plant OU. Arsenic-related incremental non-cancer HQs to future workers exceed 10, over an order of magnitude greater than the 1998 ROD RAO, in portions of the Joint Fenceline / Calciner Ponds Area of the site. Arsenic non-cancer HQs to hypothetical future residents in the Area North of Highway 30 and Interstate 86 also exceed 1.

With one exception, incremental non-cancer HQs do not exceed 1 for any other groundwater COC in any well. Elemental phosphorus, which was not evaluated in the EPA Baseline HHRA, is associated with a significantly elevated incremental HQ (> 60) in well 108, located downgradient of the furnace building (RU 1) and slag pit (RU 2) source area. However, arsenic cancer risks were also elevated above the 1998 ROD RAO at well 108.

In summary, the findings of the update to the Baseline HHRA indicate that the extent to which groundwater contains FMC-related constituents above a level of health concern can effectively be delineated by arsenic concentrations within all four groundwater areas of the FMC Plant OU.

Overall

The EPA Guidance states that the objective of the RI process is not the unattainable goal of removing all uncertainty, but rather to gather information sufficient to support an informed risk management decision regarding the appropriate site remedy. Additionally, RI data are to be used to further confirm and/or refine the CSM. The information presented in this report and summarized in the conclusions indicates that the nature and extent of FMC-related groundwater impacts at the FMC Plant OU are well-defined and the risks posed to human health and the environment are sufficiently understood to allow the CERCLA process to proceed to the SFS. Groundwater conditions at the FMC Plant OU have been characterized to a sufficient extent to determine the need for remedial action and support the identification and evaluation of remedial options with respect to their performance, cost, protectiveness and other regulatory criteria.

8.2 Recommendations

Based on the current level of definition of the nature and extent of the plume, no additional groundwater investigations are recommended or necessary at this time to support the SFS process. There is sufficient information to proceed with the review, update and evaluation of remedial technologies to address FMC-impacted groundwater and remedial technologies for the identified and potential sources of groundwater contamination at the FMC OU in the Supplemental Feasibility Study (SFS).

Groundwater monitoring will continue at the FMC Plant OU and long-term CERCLA groundwater monitoring is anticipated to be a component of any remedial action selected for groundwater and possibly source control actions. A long-term CERCLA groundwater monitoring program will be developed during the SFS (and remedial design/remedial action) processes and additional groundwater monitoring wells may be identified as appropriate to accomplish the goals of that program. However, no additional monitoring wells are necessary at this time to support the SFS process.

The following factors and recommendations are relevant to both the short and long-term groundwater monitoring at the FMC Plant OU:

- FMC‘s RCRA and Calciner Ponds Remedial Action groundwater monitoring programs will continue as required by the RCRA regulations and IDEQ, respectively. Long-term CERCLA monitoring for the FMC Plant OU as contemplated by the 1998 ROD should be integrated with those programs.

- Routine groundwater monitoring for the FMC Plant OU should continue to focus on arsenic as the risk-driving groundwater COC, and on potassium, nitrate, total phosphorus / orthophosphate, chloride, sulfate and selenium as the parameters with the broadest FMC-related groundwater impact.

- Consistent with the EPA-approved post-closure plans for Pond 8S and the Slag Pit Sump, semi-annual monitoring for elemental phosphorus should continue at the well networks for these WMUs. In addition, semi-annual monitoring at wells 146 and 110 (downgradient from Slag Pit Sump wells 108 and 122) should be added to FMC‘s currently voluntary CERCLA groundwater monitoring program.

- Periodic (e.g., annual or biennial) monitoring events should include other groundwater constituents that are localized within the broader FMC-related impact and that are not significant risk-drivers, such as manganese, boron, vanadium and total cyanide.

- Routine groundwater monitoring of wells along the northern margin of EMF-impacted groundwater should continue as contemplated by the 1998 EMF ROD.

- Simplot has recently proposed the installation of additional monitoring wells in the area north of Highway 30 and I-86 and between existing well 517 and the area of EMF groundwater discharge to the Portneuf River between the Spring at Batiste Road and Batiste Spring. These wells appear to be appropriate to provide better monitoring well coverage and would be useful in evaluating groundwater impacts in this portion of the EMF Site.

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